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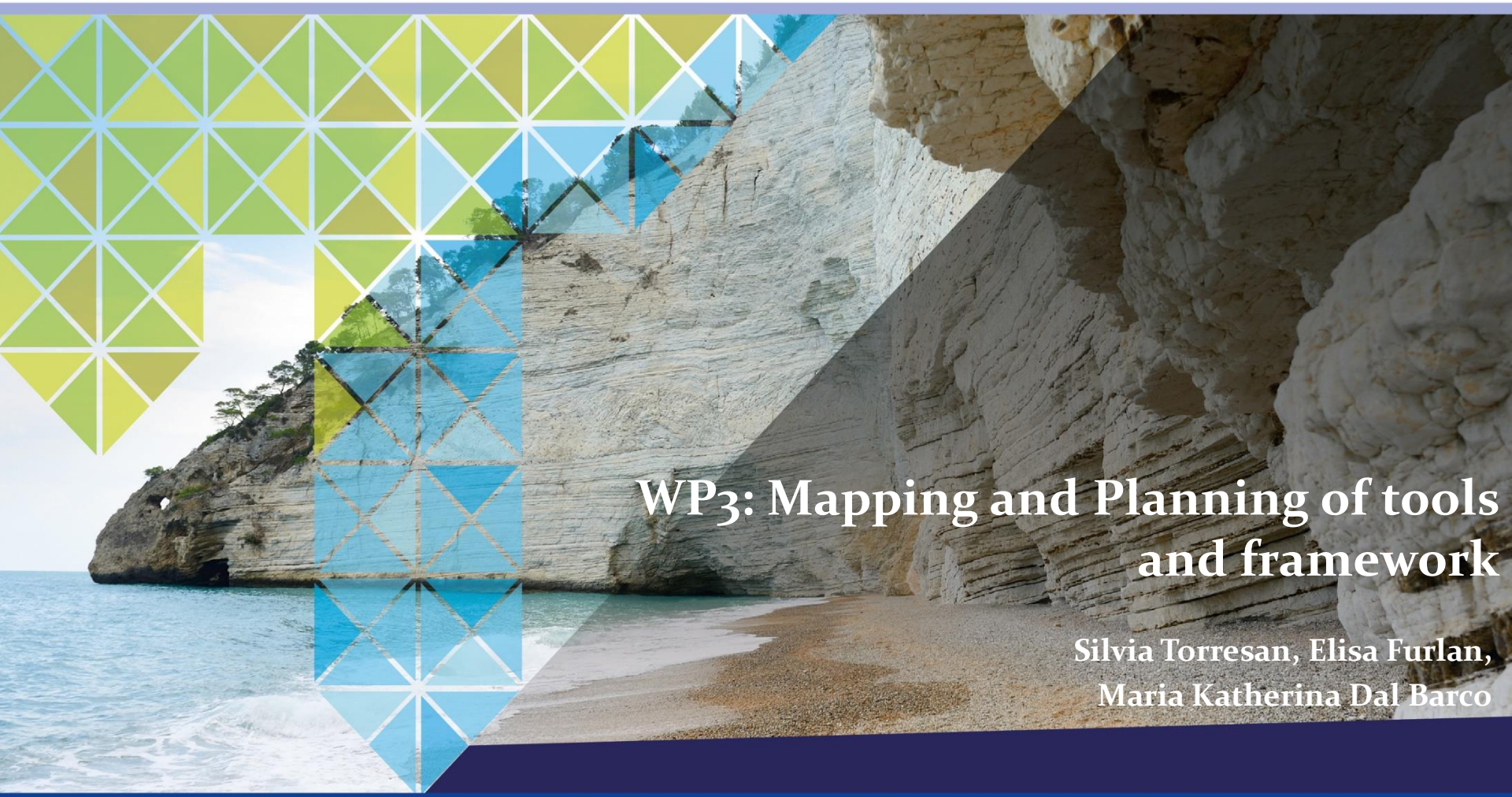


WP3: Mapping and Planning of tools and framework

Silvia Torresan, Elisa Furlan,
Maria Katherina Dal Barco

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Outline

- Objectives
- Main features of the deliverables
- Conclusions

WP3 - Main contents

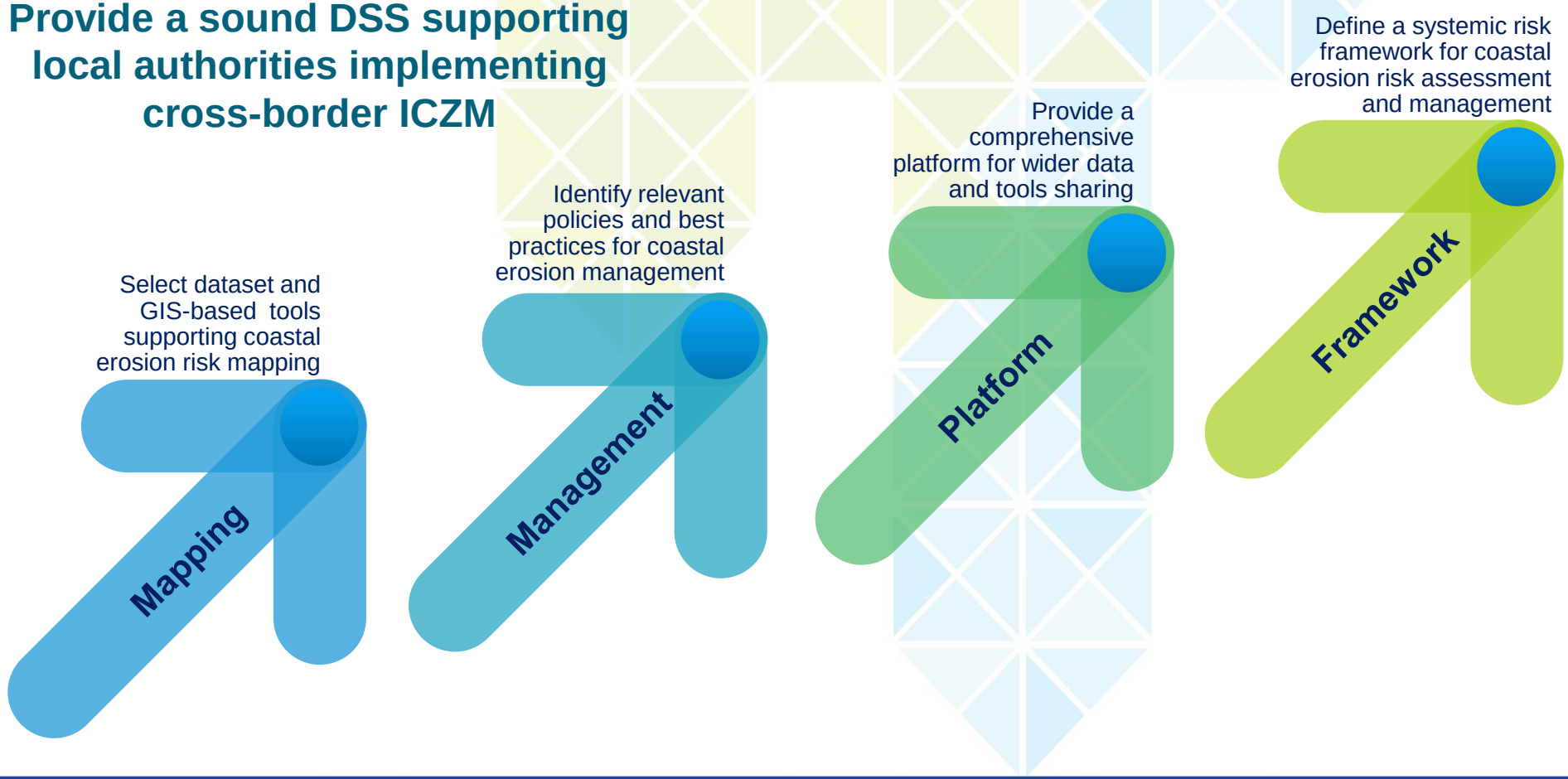
"**MAPPING** of existing tools and frameworks for coastal erosion risk assessment, environmental and administrative performance.

IDENTIFYING suitable indicators and decision support tools useful to characterize and quantify different elements at risk (i.e. beaches, wetlands, ports, agriculture, infrastructures, tourism, biodiversity) and risk management strategies in pilot areas"

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Objectives

Provide a sound DSS supporting local authorities implementing cross-border ICZM



Tasks and partners contributors

3.1 Census of needs/mapping of existing system for coastal management

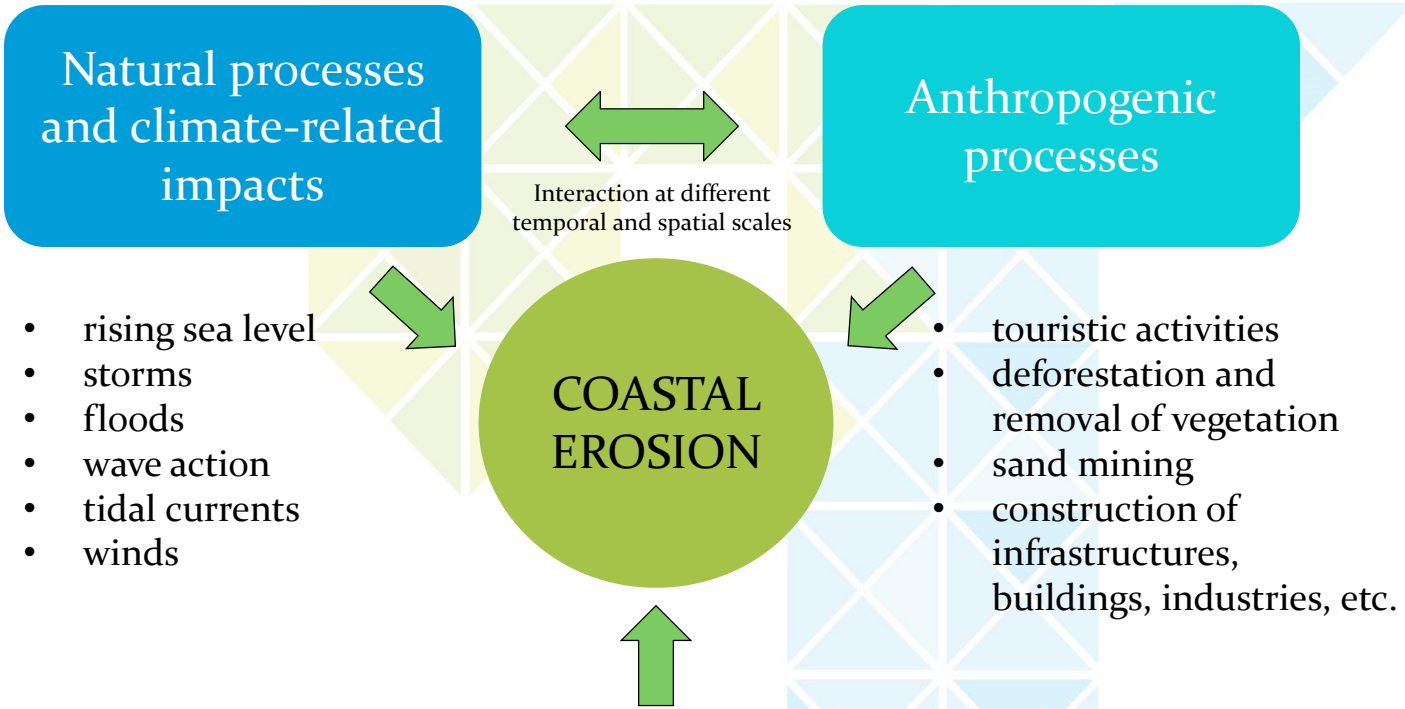
3.2 Census of needs/mapping of best practices to be integrated in Triton system

3.3 Context analysis (AS - IS) - Requirements Analysis for the creation of the platform

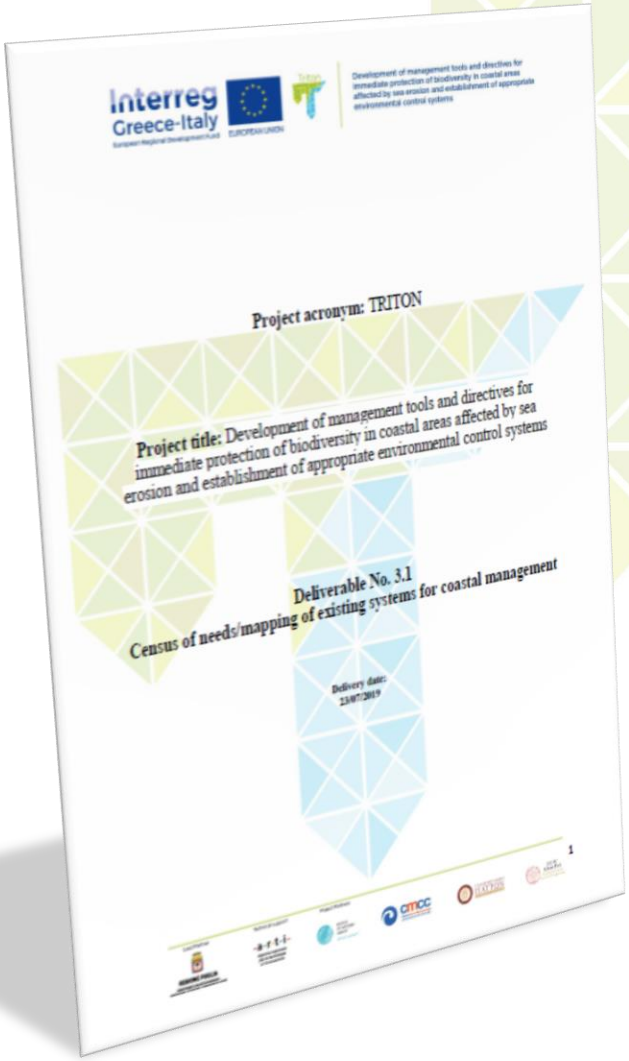
3.4 Design of the platform (TO - BE)

3.5 Development of the framework and tool for final users with training

Deliverable 3.1: OBJECTIVES



- Balance coastal development with risk management
- Reduce the consequences of coastal erosion
- Bridge the policy-implementation gap in the ICZM in the area of intervention (IT-GR)
- Improve the integration of coastal zone policies within broader spatial planning and socio-economic policies



MAIN FEATURES OF D3.1

- Coastal erosion processes: main terminologies and theories
- The Apulia region shoreline, Italy
  - Description of the case study
  - Available data
- The Messolongi shoreline, Greece
  - Description of the case study
  - Available data
- The Gulf of Patras, Greece
  - Description of the case study
  - Available data

Partners contributors

Coastal erosion processes: main terminologies and theories

Heterogeneity and **shape** depends on several factors (e.g. soil material, atmospheric agents, anthropic pressures)

Structure of the coast

Geomorphology of the coast

Coastline and beach classification

Coastal erosion and sedimentary balance

Remarkable differences between **rocky** and **sedimentary shores** (depending on lithology, cliff mineralogy, tectonic history, climate, waves, tides)

COASTLINE CLASSIFICATION
- **Dissipative**, slight slope
- **Intermediate**
- **Reflective**, pebble beaches (waves break near the shore)

BEACH CLASSIFICATION
- **Backshore**
- **Foreshore** (or beach face)
- **Shoreface** (or nearshore)

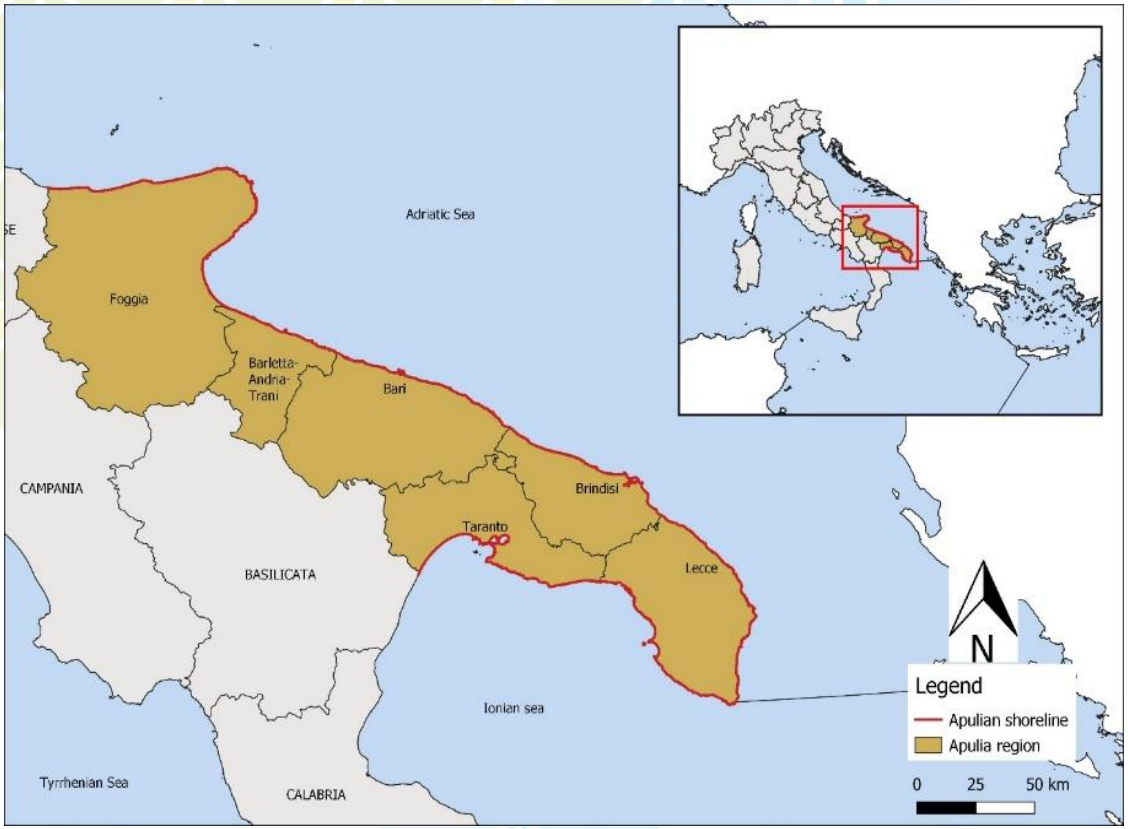
COASTAL EROSION may be **caused by** hydraulic action, abrasion, impact and corrosion by wind and water, and other forces, natural or unnatural.

NEGATIVE SEDIMENTARY BALANCE
Erosion is prelevant

POSITIVE SEDIMENTARY BALANCE
Depositional phenomena prevail

The Apulia region shoreline, Italy

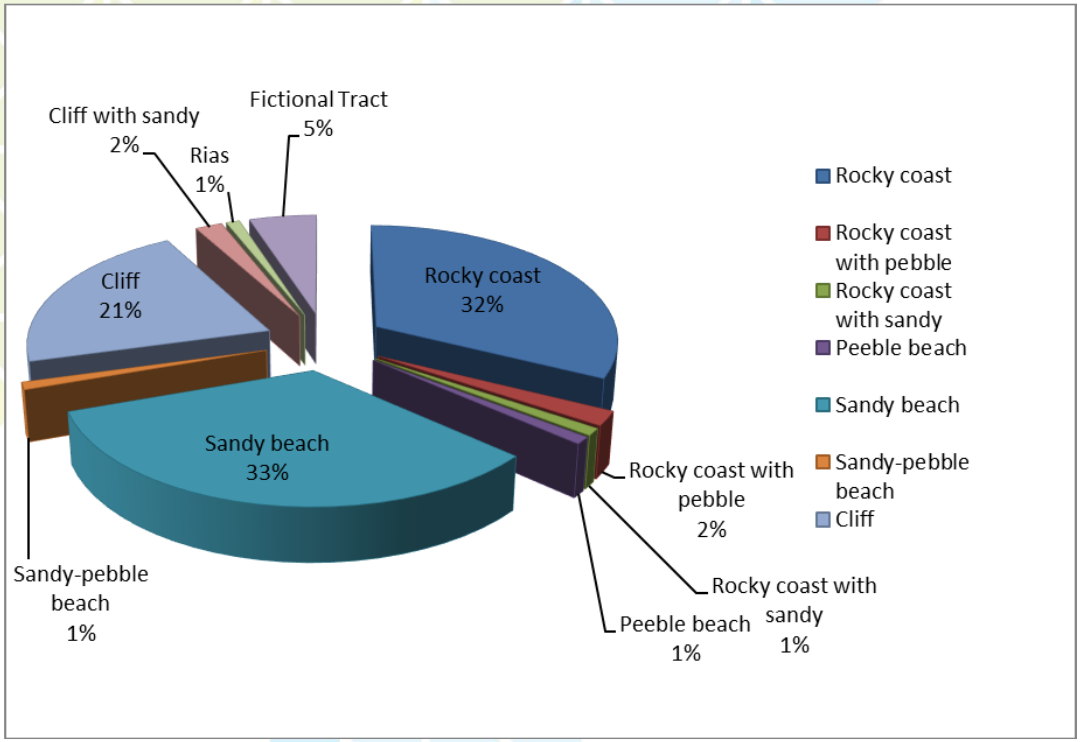
- 4 million inhabitants
- The city of Bari is the capital of the region
- The region is bathed by:
  - the Adriatic Sea (East);
  - the Ionian Sea (West);
  - the Strait of Otranto (South).
- 970 km of coastline
- 13.8% characterized by marine protected areas, national and regional parks



The Apulia region shoreline, Italy

Main coastline characteristics

The coastline is composed by:
- 33% of sandy beaches (310,2 km);
- 32% of rock (310,2 km);
- 21% by cliffs (197,4 km);
- 5% artificial structures (47 km);
- 8% other typologies (75 km)
  (i.e. rocky coast with pebble, rocky coast with sand, cliff with sand, pebble beach, rias)

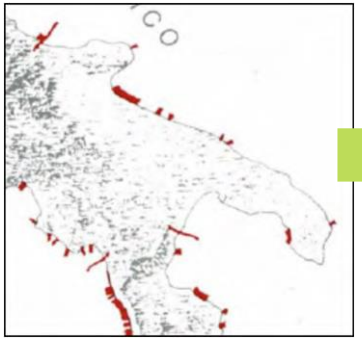


Sedimentary classification of the Apulia Region Coastline

(Source: Regional Coastal Plan, 2012)

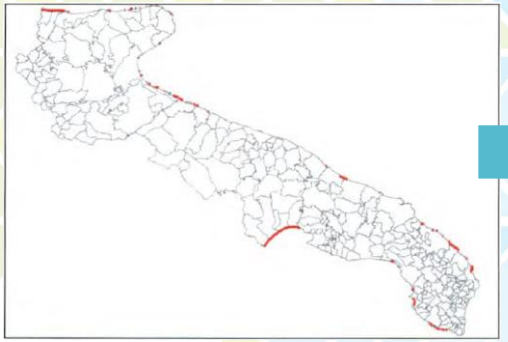
Evolution trend of the Apulia region coasts

Coastal erosion studies



- 1968 – Commissione De Marchi The study highlighted **the main erosion sections** along the Apulian coastline not providing specific information on length of each section.

- CNR-MURST 1997, Atlas of Italian Beaches – The study updated information on coastline evolution: **Significant reduction of Apulian shorelines** (mainly along river mouths and nearby anthropogenic activities and settlements).



- P.O.R. PUGLIA 2000-2006, Apulian coastline monitoring – The study updated information on coastline evolution (based on 2003 updated data) identifying a **further significant reduction of Apulian shoreline.**

- MATT 2006 (Italian Ministry of the Environment) Shoreline changes between 1950 and 2000, considering a shoreline deviation of 10 m **the study identifies hot spots areas consistent with previous studies.**

DGR 1694/2018; http://www.sit.puglia.it/portal/portale_pianificazione_regionale/Piano%20Regionale%20delle%20Coste/Documenti

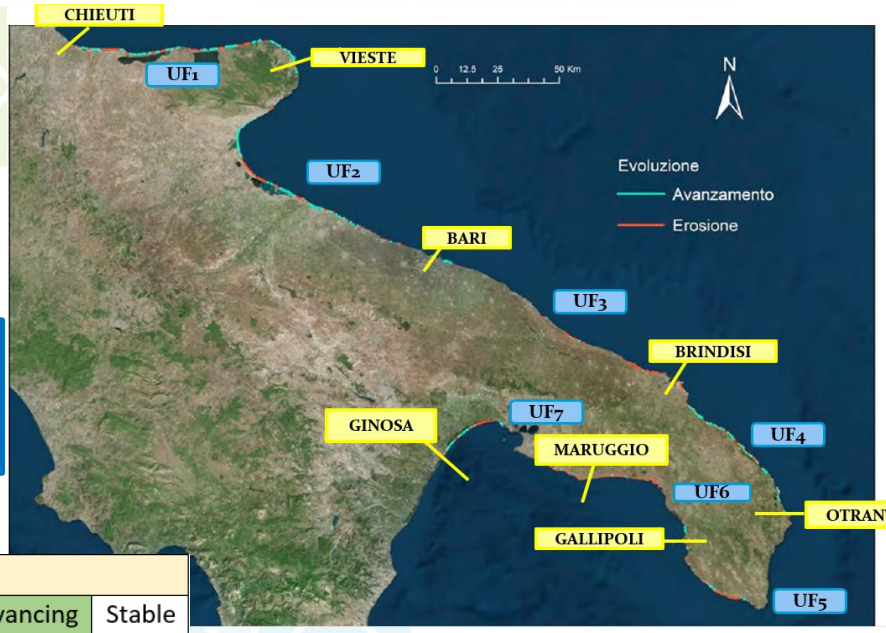
Evolution trend of the Apulia region sandy coasts

*Regional Action Plan (2012 and **updated in 2017**)*

- Shoreline analysis (2005-2017 timeframe)
- Identification of 7 Physiographic Units (UF)

A Physiographic Unit is defined as the stretch of the coast where solid transport is confined as the result of wave motion and coastal currents

- Analysis performed within a 10 m buffer zone



EVOLUTION 2005 – 2017 (10m range)							
Physiographic Unit	Sandy coast (km)	Retreating (km)	Advancing (km)	Stable (km)	Retreating (%)	Advancing (%)	Stable (%)
UF1	82.10	32.5	25.30	24.30	39.59	30.82	29.59
UF2	77.67	24.80	24.80	28.07	31.93	31.83	36.14
UF3	40.75	17.60	3.80	19.35	43.19	9.33	47.48
UF4	65.17	20.80	18.30	26.07	31.92	28.08	40.00
UF5	16.44	7.44	3.65	5.36	45.25	22.18	32.57
UF6	50.06	11.49	1.39	37.19	22.95	2.77	74.29
UF7	56.13	14.20	6.60	35.33	25.30	11.76	62.94
Total	388.31	128.83	83.83	175.65	33.18	21.59	45.23

Erosion: 129 km of sandy coast

Advancing: 84 km

Stable: 175 km

Adapted from PRC, Apulia region 2012

Evolution trend of the Apulia region sandy coasts

*Regional Action Plan (2012 and **updated in 2017**)*

- Shoreline analysis (2005-2017 timeframe)
- Identification of 7 Physiographic Units (UF)
- Analysis performed within a 30 m buffer zone

EVOLUTION 2005 – 2017 (30m range)							
Physiographic Unit	Sandy coast (km)	Retreating (km)	Advancing (km)	Stable (km)	Retreating (%)	Advancing (%)	Stable (%)
UF1	82.10	13.1	10.6	58.40	15.96	11.91	71.13
UF2	77.67	6.5	8.9	62.27	8.37	11.46	80.17
UF3	40.75	1.7	0	39.05	4.17	0	95.83
UF4	65.17	1.8	2.1	61.27	2.76	3.22	94.02
UF5	16.44	3.8	2.9	9.74	23.11	17.64	59.25
UF6	50.06	1.6	0	48.46	3.20	0	96.80
UF7	56.13	1.3	1.7	53.13	2.32	3.03	94.65
Total	388.31	29.8	26.2	332.31	7.67	6.75	85.58

focusing exclusively on retreating coasts identified within the 10-m range analysis

Adapted from PRC, Apulia region 2012

Retreating coasts per municipality within the 30-m range analysis

Province	Municipality Location	UF	Erosion Type	Length (M)	Area (M^2)	Type of Coastline
FOGGIA	Serracapriola Foce Fortore	1	Coastal Process	5287,9	168049,8	Sandy
	Lesina Sud di Acquarotta	1	Coastal Process	2909,4	58533,9	Sandy
	Cagnano Varano Sud di Capoiale	1	Coastal Process	2370,5	49867,9	Sandy
	Rodi Garganico Est del porto	1	Coastal Process	1987,2	28370,2	Sandy
	Vieste Torre di Porto Nuovo	1	Integrate Dynamics	572,4	14109,5	Sandy
	Manfredonia Ippocampo	2	Coastal Process	1546,4	31851,9	Sandy
	Zapponeta Foggiamare	2	Coastal Process	1378,5	19450,3	Sandy
BARLETTA-ANDRIA-TRANI	Margherita di Savoia Foce Ofanto	2	Coastal Process	3629,1	177960,0	Sandy
BRINDISI	Brindisi Apani	3	Coastal Process	1752,5	26381,9	Rocky with sandy beaches on foot
LECCE	Vernole Riserva Naturale Le Cesine Pantano Grande	4	Coastal Process	1059,6	18187,9	Sandy

Regional Action Plan
*(2012 and **updated in 2017**)*

Province	Municipality Location	UF	Erosion Type	Length (M)	Area (M^2)	Type of Coastline
LECCE	Lecce Nord Darsena di S. Cataldo	4	Coastal Process	775,4	8301,2	Sandy
	Salve Pescoluse	5	Coastal Process	2203,5	25456,7	Sandy
	Ugento Torre Mozza	5	Coastal Process	1585,6	44796,2	Sandy
	Porto Cesareo Sud di Bacino Grande	6	Coastal Process	1168,2	14641,7	Sandy
TARANTO	Manduria Palude del Conte	6	Coastal Process	436,1	12106,8	Sandy
	Torricella Torre Ovo	7	Coastal Process	638,7	4760,9	Rocky with sandy beaches
	Ginosa Foce Galaso	7	Mouth dynamic	699,6	6070,4	Sandy
TOTAL in km and km^2				29,8	0,71	

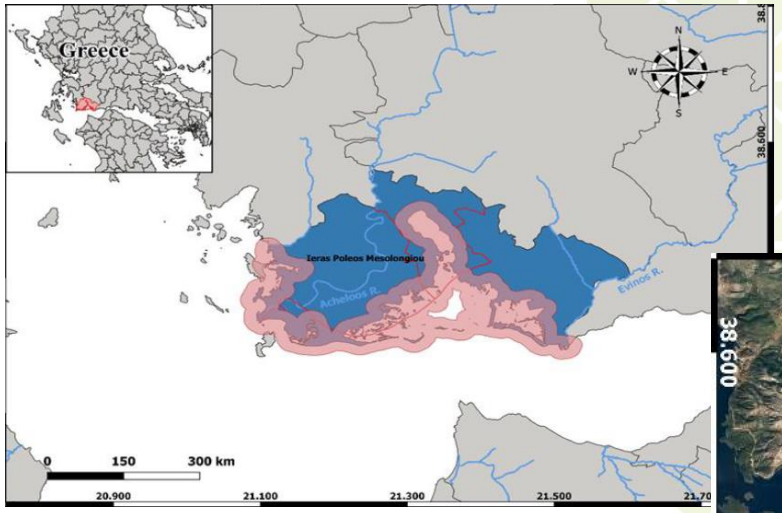
The Municipality of Ugento was selected as best practice in the field of coastal erosion management within the TRITON project, and the testing case of the proposed BN approach (WP4)

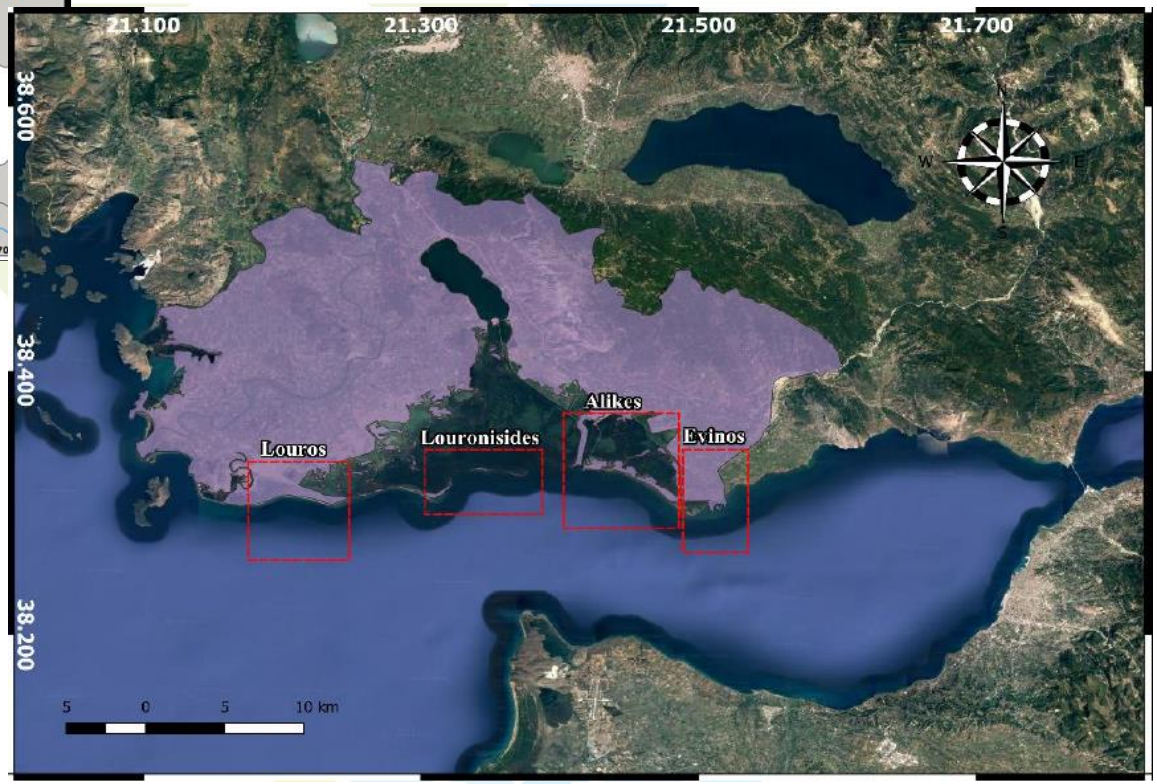
Available data for the Apulian case study

Data type	Spatial domain	Year	Spatial resolution	Time-frame Reference period	GIS Data Format	Reference/Link
Basemap data						
Administrative Boundaries	World	2015	/	/	Shape	
Coastline	Europe	2015	/	/	Shape	https://w
European Reference Grid	Europe	2011	1 km, 10 km, 100 km (plus 15 km buffer)	/	Shape	https://w
Bathymetry	Adriatic Sea	2018	200 m	/	Raster	http://w servic
Topographic data						
Digital Elevation Model (EU-DEM v1.1)	Europe	2016	25 m	/	GeoTIFF	http://l de
LIDAR	Italy	2016	15 cm	/	Shape	http://v the-ne
Climate forcing						
Sea level	Apulia region				Raster	ht
Sea temperature	Apulia region				Raster	ht
Sea salinity	Apulia region				Raster	htt
Sea surface currents	Apulia region				Raster	htt
Wave height and direction	Apulia region				Raster	ht
Marine circulation along main ports	Apulia region				Raster	ht
Extreme Sea Level and Extreme Storm Surge Level	Europe	2017	~ 11 km	Historical: 1969-2004 Future: 2009-2099 under RCP8.5, 4.5	NetCDF	http:/

Data type	Spatial domain	Year	Spatial resolution	Time-frame Reference period	GIS Data Format	Reference/Link
Geomorphological data						
Erosion of the coast	Apulia region			5/10/15 years		https://start.linksmt.it/web/guest/coste
Shoreline trend	Europe					https://www.eea.europa.eu/data-and-maps/data/geomorphology-geology-erosion-trends-and-coastal-defence-works
	Italy	2010	1:2000	/	Shape	http://www.pcn.minambiente.it/geoportal/catalog/search/resource/details.page?uuid=%7BC49FEE18-000C-4B37-B062-E76BCAD5104F%7D
Environmental data						
Protected areas	Europe	2017	/	/	GeoTIFF	https://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-13
Transportation of sediments	Apulia region					https://start.linksmt.it/web/guest/coste
Soil type	Europe	2006	1 km x 1 km	/	Raster	https://esdac.jrc.ec.europa.eu/content/european-soil-database-v2-raster-library-1kmx1km
Biodiversity/ Natura 2000	Europe	2018		/	Raster	https://www.eea.europa.eu/data-and-maps/data/natura-10
Nationally Designed Areas	Europe	2017	/	/	Shape	https://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-12#tab-gis-data
Socio-economic data						
Land cover	Europe	2018	500 m	CLC2018	GeoTIFF	https://land.copernicus.eu/local/urban-atlas
Urban Atlas	Europe	2012		/	Raster	https://land.copernicus.eu/local/urban-atlas/urban-atlas-2012/view
Settlement	Europe	2012 (released in 2017)	2.5 m pixel	2006-2012	Raster	https://land.copernicus.eu/pan-european/GHSL/european-settlement-map/esm-2012-release-2017-urban-green
Population and building census	Italy	2018	/	2018	Shape	https://www.istat.it/it/archivio/104317#accordions
Population projections	Italy	2018	/	2017-2065	Shape	http://dati.istat.it/Index.aspx?DataSetCode=DCIS_PREVDEM1

The Messolongi shoreline, Greece





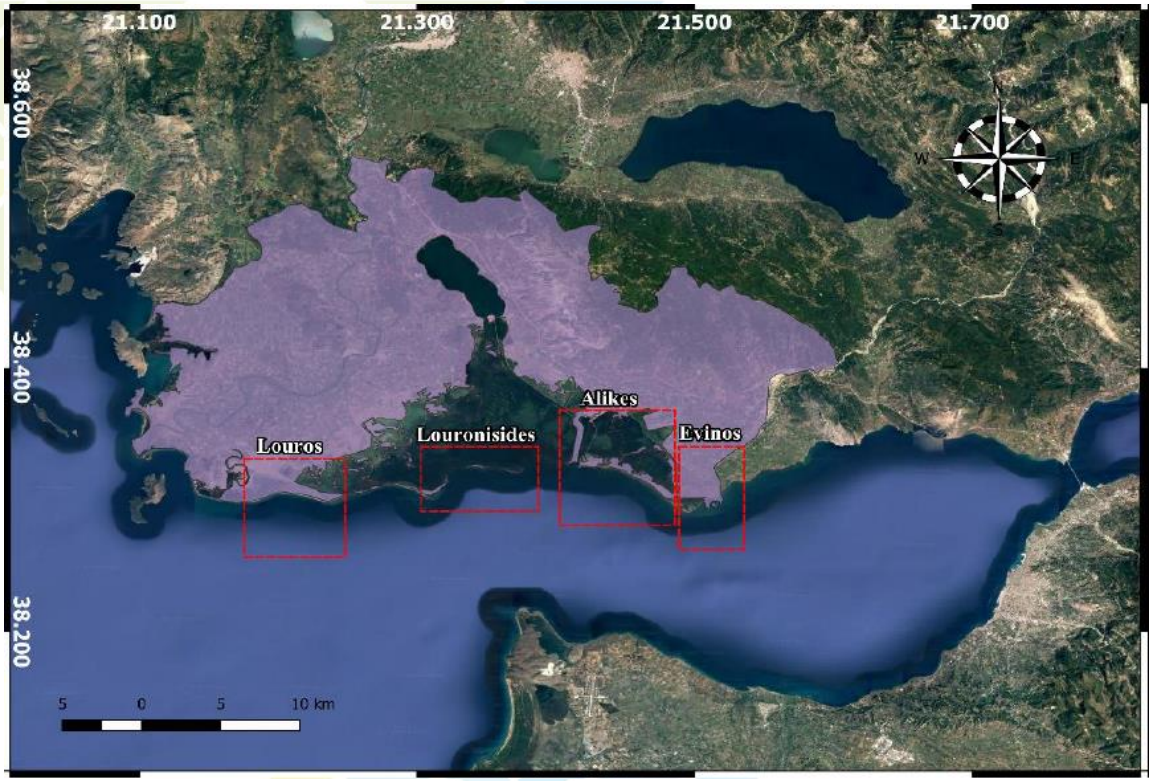
- 150 km² lagoon
  one of the largest in the Mediterranean Sea
- Formed through the siltation action of adjacent rivers, i.e. Acheloos and Evinos

The Messolongi shoreline, Greece

Based on the specific characteristics the case study area was divided into **four sub-areas:**

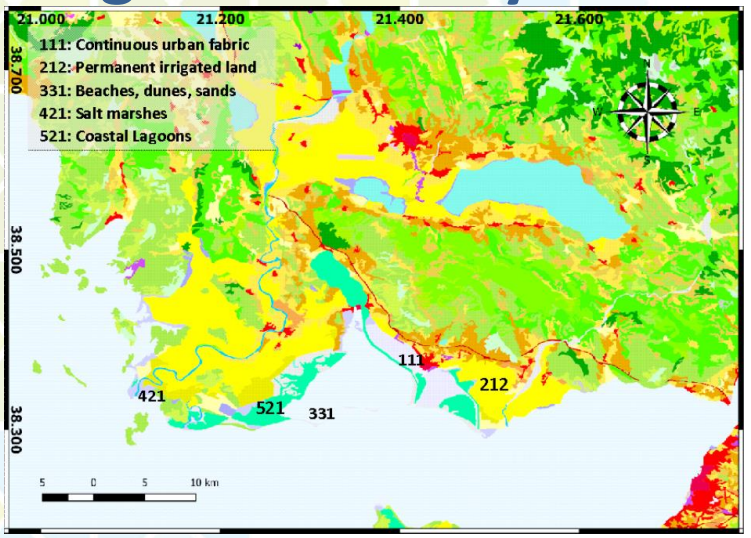
- *Louros*;
- *Louronisides*;
- *Alikes*;
- *Evinos*.

Site Name	Length (km)	Characteristics of the coast
Louros	4.90	Sandy beaches
Louronisides		
Prokopanistos	2.40	Fishing farms
Schinias	1.50	
Komma	1.73	
Alikes		
Tourlida	0.42	Sandy beaches
Alikes	7.20	
Evinos	3.51	Complex estuarine system



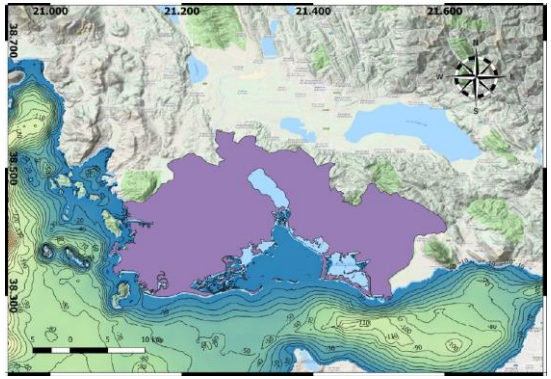
Available data for the Messolonghi case study

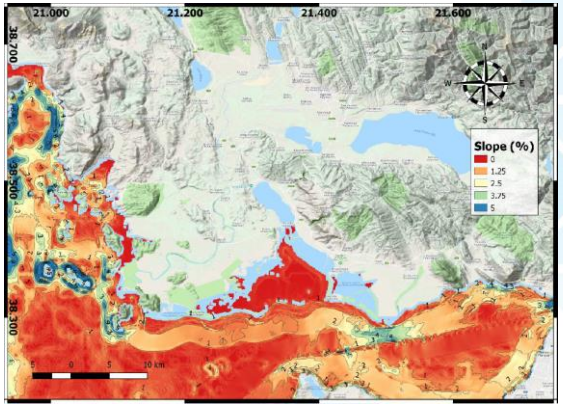
Variable	Temporal resolution	Source
Geomorphology		(Iagkadinou, 2005)
Bathymetric data	2018	EMODnet Hydrography portal
Land cover data	2018	CORINE Land Cover
River discharge data	1981-2010	HYPE model - SMHI
Oceanographic data	2006-2019	CMEMS, ESA, EUMETSAT, ECMWF
Currents data	2006-2019	CMEMS
Wave data	2006-2019	CMEMS
Meteorological data		CAMS, GPCC
Water quality parametrs		MODIS, Sentinel

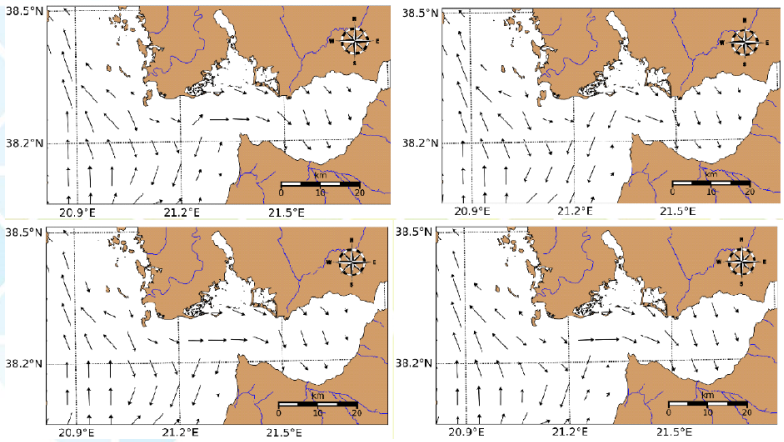


Land-cover (CORINE Land Cover)

Bathymetry (EMODnet)

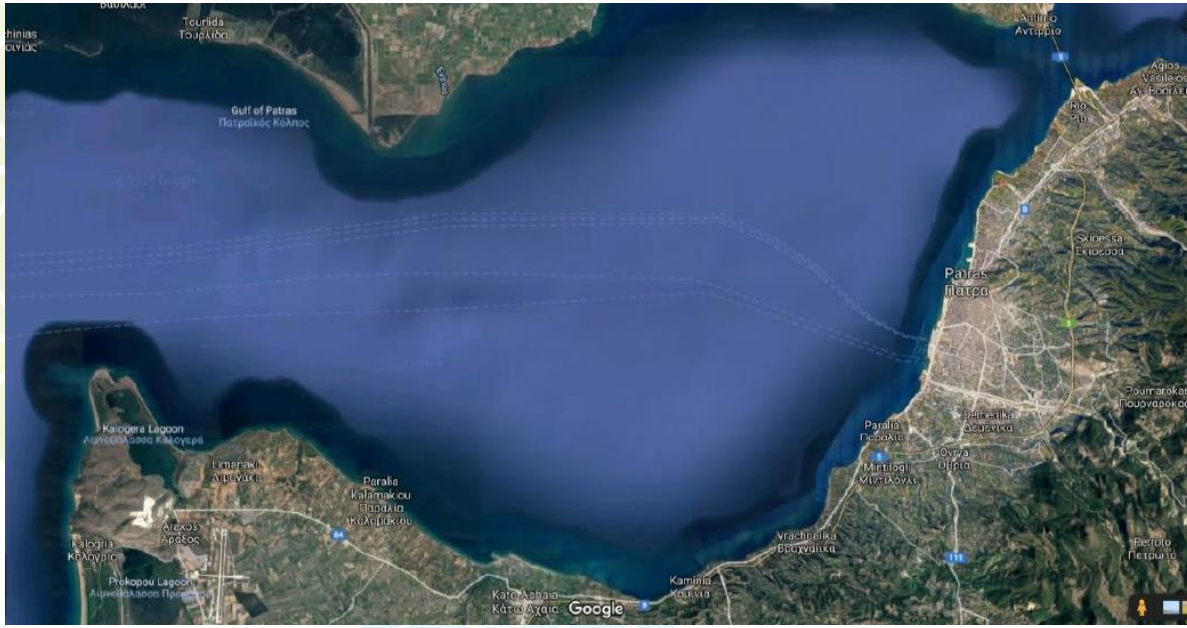






Currents (Copenicus CMEMS)

The Gulf of Patras, Greece



Main characteristics

- 50 km long
- 20 km wide
- 400 km² area

Borders

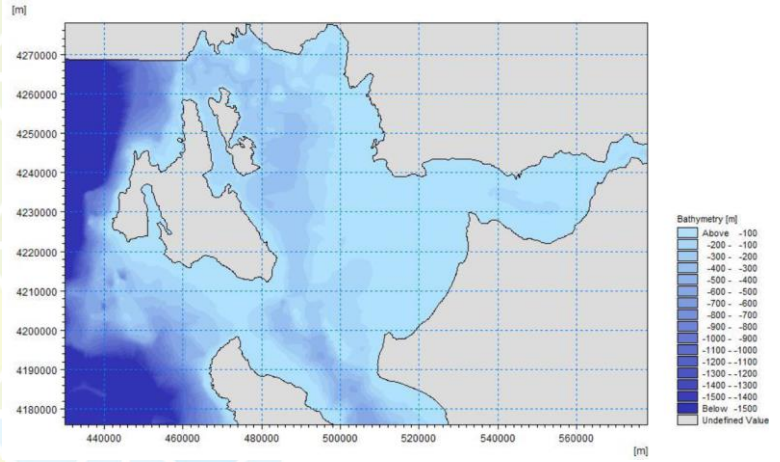
- The Gulf of Corinth (East);
- the Ionian Sea (West).

Anthropogenic pressures

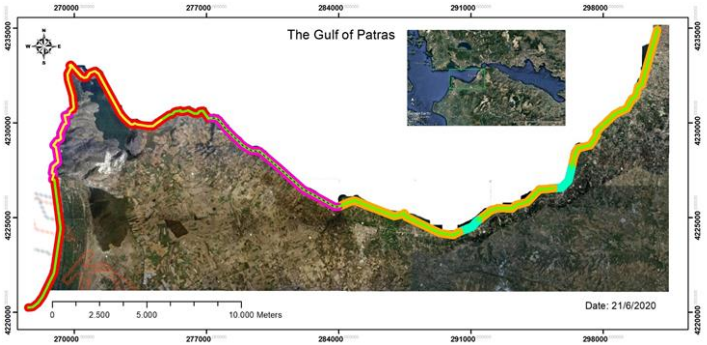
- Large oil deposits
- Industrial activities
- Shipping transport
- Coastal development
- Port of Patras, constructed in 2010

Available data for the Gulf of Patras case study

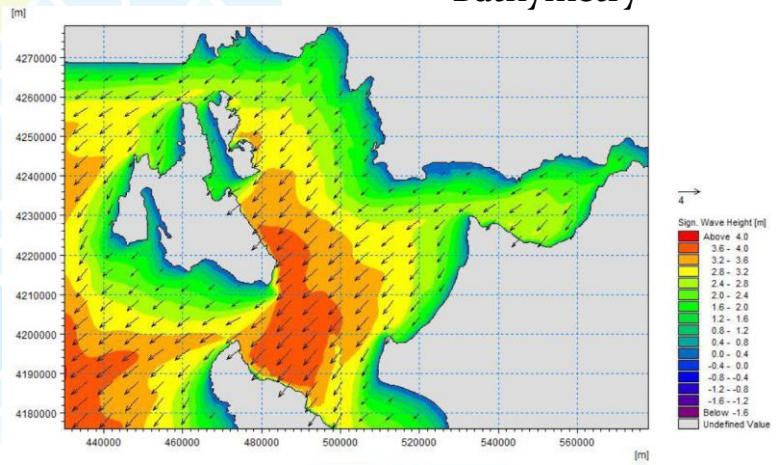
Variable	Source
Hydrological data	Hellenic geodatabase
Sea-water quality data	Hellenic geodatabase
Natura sites	Hellenic geodatabase
Meteorological data	HNMN
Bathymetry data	C-MAP database (DHI, 2014), TRITON D4.3 methodology
Wave, current and coastal erosion morpho-sedimentological data	TRITON D4.3 methodology
Coastal erosion data	EUROSION database



Bathymetry



Coastal erosion trends and data (EUROSION database)



Wave height, velocity and direction due to the action of NE winds

Deliverable 3.1: CONCLUSIONS

Vulnerabilities of the pilot cases

Data collection of pilot cases

TRITON D3.1

- Topographic
- Climate forcing
- Geomorphological
- Environmental
- Socio-economic

- Inform the application of risk-based methodologies and filed investigations (WP4)
- Identify the variables needed for the design of the DPSIR conceptual framework (D3.5)
- Support robust decision-making and provide the means for dynamic adaptive policy pathways in cross border ICZM implementation across Greece and Italy.

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Deliverable 3.2: OBJECTIVES

Current legislative framework

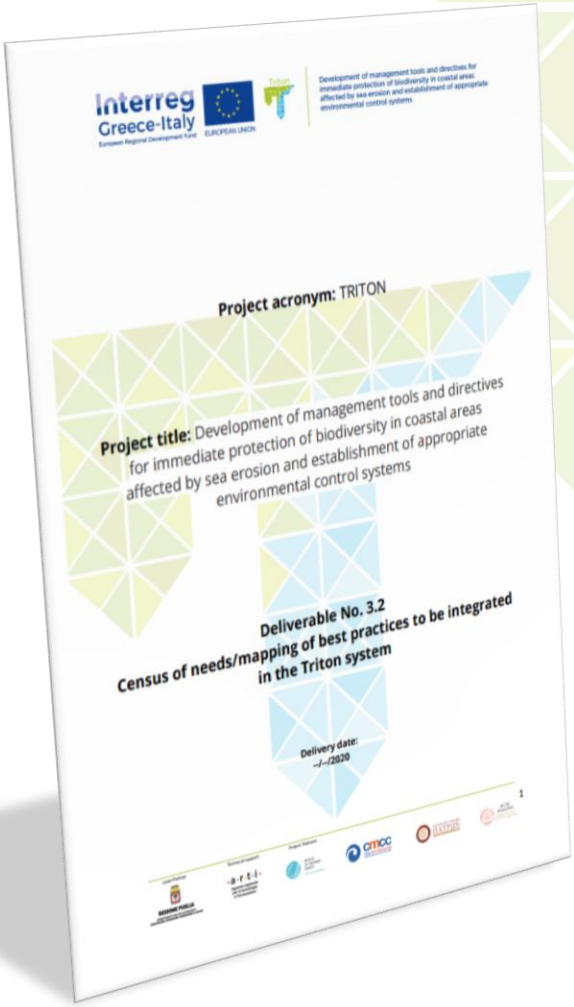
Interreg TRITON as Cooperation project between GR and IT

- Marine Directive 2017/845
- Marine Strategy Framework Directive 2008/56/EC
- Integrated Coastal Zone Management (ICZM)

Coastal erosion management

- Develop a specific tool for Integrated coastal management in the Adriatic-Ionian Sea

- Identification of measures and actions to be taken to achieve the Good Environmental Status (GES) by 2020
- Prevention and capitalization of assessments
- Setting a pattern of environmental targets
- Establishment and implementation of coordinated monitoring programmes for coastal management



MAIN FEATURES OF D3.2

- Best practices for coastal erosion assessment and management in the Apulian shoreline
- Legislative Framework in the Apulia region at 2020
- The Apulia region indicators for the best practices toward ICZM and risk erosion prevention
- Pilot cases and best practices:
  - Ugento, Apulia region
  - Bari Fesca San Girolamo

Partners contributors

Regione Puglia

The ICZM and MSP as an opportunity – LESSON LEARNED

1) It is possible to treat the coastal erosion management, risk prevention and maritime spatial planning **from different approaches.**

2) The census developed within TRITON project demonstrate the **complexity of the topic and stakeholders engagement**.

3) The census shows the best practices in coastal erosion management and prevention for the cooperation area Adriatic-Ionian, as a **contribution to the creation of a tool kit** for future users based on facts, data, indicators and pilot cases.

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

The ICZM and MSP as an opportunity for CDSS

Coastal management and coastal erosion risk prevention

Integrated Coastal Zone Management

Maritime Spatial Planning

Erosion Risk Prevention

- Introduction of **resilience principles** as indicator in coastal management, maritime spatial planning and erosion risks prevention;
- **Economic value for ecosystem services** could help policy makers in the decision for land conservation and coastal management;
- Prioritise the development of an **integrated framework** incorporating not just defenses, but also strategic risk management into decision tools and calls;
- Prevention measures at larger scale, since small-scale management isn't the best long-term strategy;
- Improve GIS for both managers and local authorities to capture and analyse geographical data;
- Training of operators and stakeholders to improve awareness of coastal management.

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Italian and Apulia region legislation and best practices within TRITON

- ITALIAN COMPETENCE
  a) Italian Civil Code and Italian Navigation Code, 1993
  b) Art. 117 of the Italian Constitution

- APULIA REGION
  1) Regulation for the protection and use of coasts
  2) Coastal planning
  3) Touristic ports
  4) Guidelines for coastal management
  5) Management of marine plant debris
  6) Shore maintenance activities

The Italian administrative framework in coastal erosion prevention

Maritime state property (Italian Civil Code and Italian Navigation Code, 1933):

- the shore;
- beaches, ports, bays;
- lagoons, river mouths on the sea, brackish basins in communication with the sea;
- channels for maritime public uses.

- The competence is extended to Territorial sea as well
- Maritime state property is individuated by the “Maritime divide”, a line splitting the territory by competence.
- The principal exploitation of maritime state property is for “public uses of the sea”, i.e. free bathing, fishing, transportation

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The Italian administrative framework in coastal erosion prevention

Italian Navigation Code and relevant Regulation rule the utilization of maritime state property by subjects different from Maritime Authorities, by means of:

- for-free consignment, in favour of territorial entities for other free public uses (e.g. urban centers, roads)
- for-payment concessions in all other cases (residential uses, enterprise inititatives, public entities for services on payment)

As of art. 117 of Italian Constitution and Decree Law 112/98, administrative competence of maritime state property are bestowed to Regions

- Except for areas of national interest, national-level ports, initiatives for energy supply, and territories of Port Authorities.
- Maritime law enforcement and protection of resources are entrusted to Corps of the Port Captaincies – Coast Guard
- State Property Agency cares for property management

Apulia Regional Frameworks

Regulation for the protection and use of coasts

Regulation for the protection and use of coasts

Administrative action is inspired by: Environment protection, safeguard and sustainable use; Coastal area planning; Accessibility of maritime state property; Simplification and transparency.

Regional functions:

- Programming, addressing and coordination;
- Regulation and guidelines on maritime state property for tourism;
- Monitoring of State Information System (SID);
- Concessions for coastal engineering construction projects;
- Authorization for procedures cared by Coast Guard for:
  - free-of-charge consignment to Municipalities for urbanization projects;
  - new works close to maritime divide.

All other functions (e.g. concessions for beach resorts) are entrusted to Municipalities.

Apulia Regional Frameworks

Regulation for the protection and use of coasts

Regional function of coordination is mainly realized through yearly Coastal Use Ordinance (Ordinanza Balneare).

It comes from a coordinated work with Coast Guard, environmental regional agency (ARPA Puglia), environmental protection entities (WWF, Site of Community Importance, Nature reserves) and beach resort representatives.

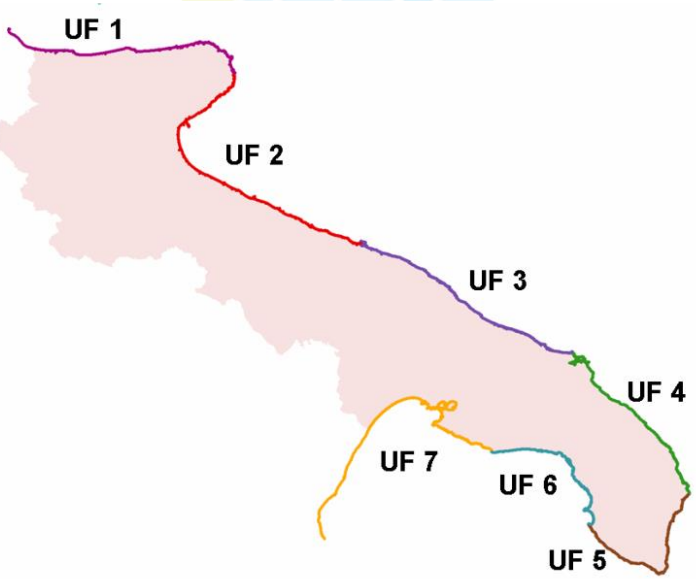
Apulia Regional Frameworks

Coastal planning

L.R. 17/2006 introduced coastal regional plan (PRC), in order to regulate activities and projects on maritime state property and to investigate the evolution of maritime system.

The Apulian PRC was approved through Regional Committee Resolution (D.G.R.) n. 2273 on 13 Oct. 2011.

- Individuation of 7 physiografic units (U.F.), as confined areas where sediments move, (limited by headlands or harbour jetties) extending outside of the Region

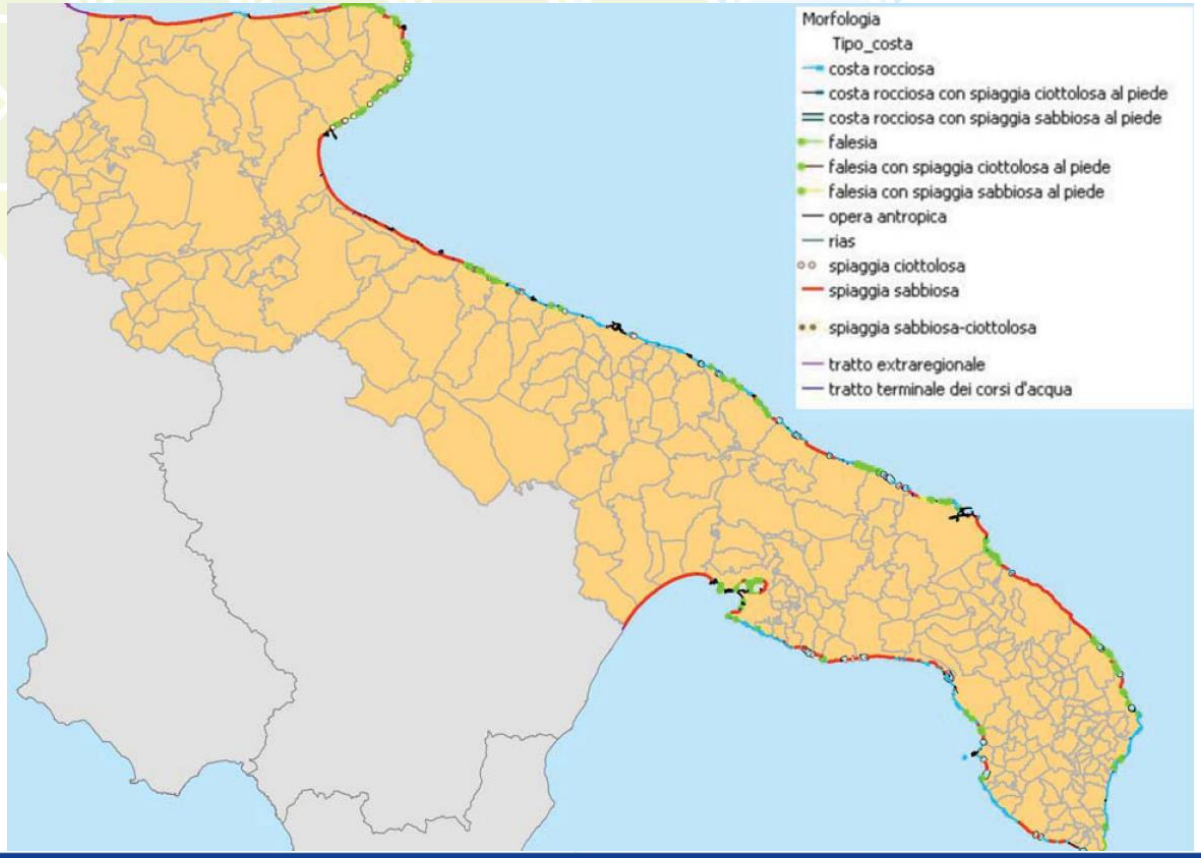


Apulia Regional Frameworks

Coastal planning

Taxonomy of coasts according to morphologic features

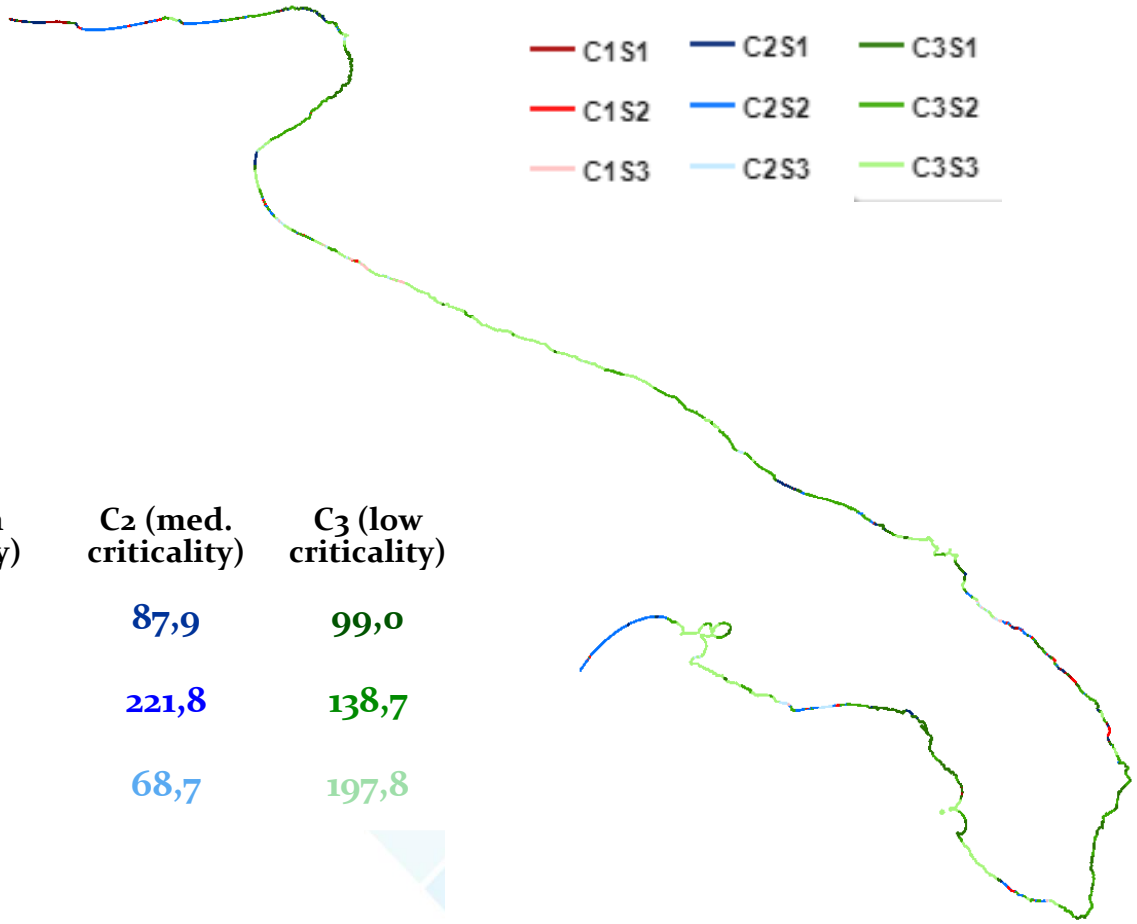
Type	km	%
Rocky	332.72	33.26
Rocky with gravel beach	6.16	0.63
Rocky with sandy beach	30.91	3.19
Gravel beach	9.73	1.00
Sandy beach	319.48	32.92
Gravel-sand beach	5.34	0.55
Cliff	205.64	21.19
Cliff with sandy beach	16.69	1.72
Rias	5.13	0.53
Man built environment	48.62	5.01
TOTAL	**970.42**	**100.00**



Apulia Regional Frameworks

Coastal planning

Taxonomy of coasts according to coast erosion criticality (C) and environmental sensibility (S)



TOTAL km	C1 (high criticality)	C2 (med. criticality)	C3 (low criticality)
S1 (high sensibility)	42,1	87,9	99,0
S2 (med. sensibility)	49,3	221,8	138,7
S3 (low sensibility)	35,0	68,7	197,8

Apulia Regional Frameworks

Coastal planning

For the application of the Regional Coastal Plan (PRC, Piano Regionale Coste) and the definition of Municipal Coast Plan (PCC, Piano Comunale Coste), technical standards for implementation (NTA) of PRC were adopted on 29 Febr. 2012.

NTA of PRC define the areas to be individuated in PCC

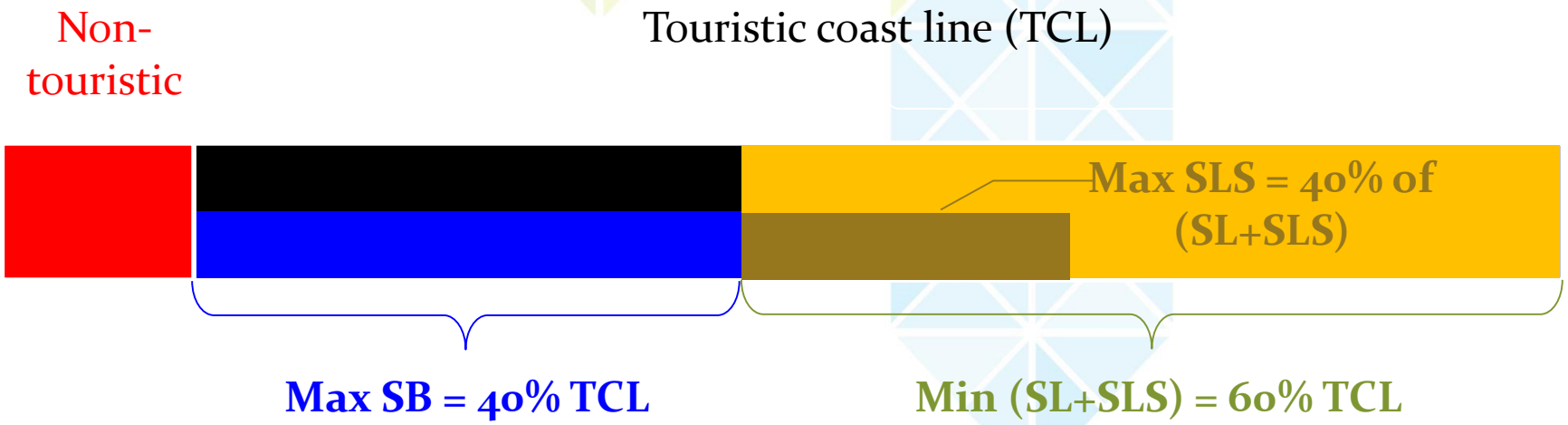
- Areas out of regional/municipal competence;
- Areas where concessions are forbidden (river/creek mouths, erosion risk cliffs, archaeological sites, beaches < 15 m width);
- Areas of interest for tourist activities;
- Areas for other aims (e.g. industries, fishery, navigation);
- Protected areas (e.g. natural reserves)

Apulia Regional Frameworks

Coastal planning

Within touristic interest areas, NTA of PRC define three kinds of areas, and relevant ratios within each municipal territory to be complied with in PCC:

- Beach resort (SB, Stabilimenti Balneari)
- Free beach with services (SLS, Spiagge Libere con Servizi)
- Free beach (SL, Spiagge Libere).



Apulia Regional Frameworks

Coastal planning

NTA of PRC define as well:

- the possible individuation of SL areas close to urban areas or residential settlement, and not far from SBs in order to reduce their impact, giving preference to removable structures (e.g. modular, not in concrete);
- limits on SB dimensions (between 20 and 150 m waterfront, with proper paths to reach the shore) and dimension of SB structures, to preserve waterfront view and do not hinder wave actions, casuing erosion;
- preference for new concessions in low-criticality and low-sensibility areas (C3.S3), whereas in areas with increasing criticality and sensibility (up to C1.S1) the structures should be very limited.

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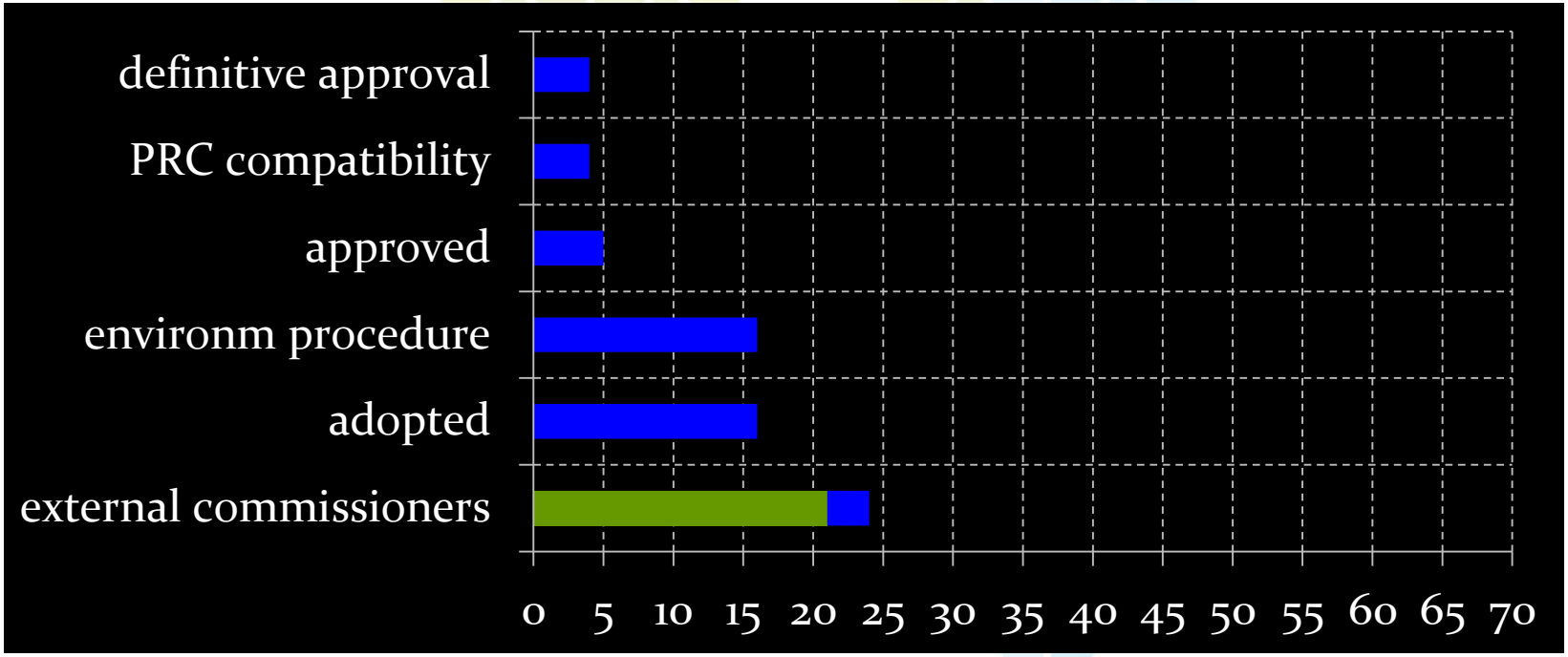
Apulia Regional Frameworks

Coastal planning

Advancement of PCCs in 69 Apulian coastal Municipalities

- Only 4 plans have been approved (one of them under variation)
- External commissioners are appointed to improve actions



Apulia Regional Frameworks

Coastal planning

On May 2018, a new investigation and analysis has been performed to update knowledge on coastal erosion on sandy and gravel beaches

Variations from 2005 to 2017 higher than 10 meters:

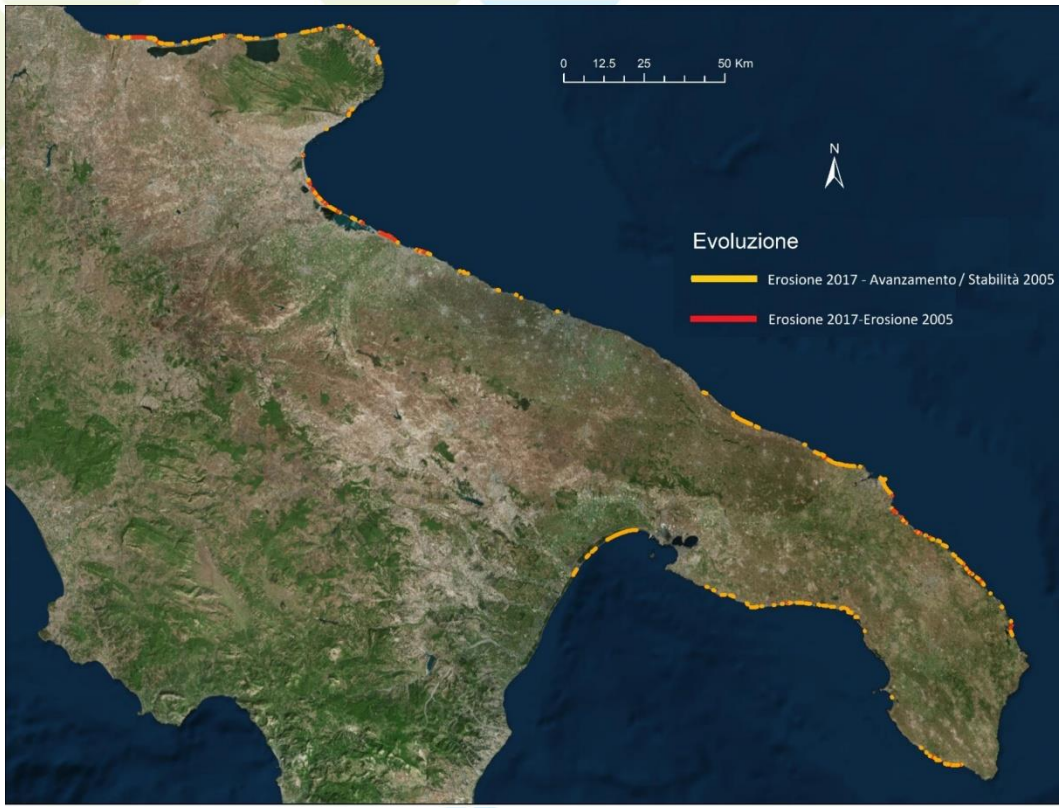
- Almost 1/3 of beaches is showing a receding trend, whereas roughly 1/5 is expanding.

	Beaches (km)	Receding (km)	Expanding (km)	Stable (km)
UF1	82.10	32.5	25.30	24.30
UF2	77.67	24.80	24.80	28.07
UF3	40.75	17.60	3.80	19.35
UF4	65.17	20.80	18.30	26.07
UF5	16.44	7.44	3.65	5.36
UF6	50.06	11.49	1.39	37.19
UF7	56.13	14.20	6.60	35.33
Total	388.31	128.83	83.83	175.65

Apulia Regional Frameworks

Coastal planning

- On May 2018, a new investigation and analysis has been performed to update knowledge on coastal erosion on sandy and gravel beaches
- Comparison between 2005 and 2017 levels of erosion
- More critical situations (more than 30 m variation) are seen on 30 km of beaches



Apulia Regional Frameworks

Coastal planning

- With D.G.R. 1694 of 26 Sept. 2018, an understanding with Politecnico di Bari has started the work for Regional Plan on Coastal Morphodynamism Evolution.
- The first aim is to analyze and update the data about:
  - coastal barriers
  - human activities in coastal regions
  - historical marine weather
  - hydraulic and sediments of main rivers,
  - coast morphology.
- Evolution scenarios according to climate trends will be analyzed, in order to individuate the most critical areas, subject to possible future erosion or marine floodings, and to define sites for advanced pilot projects to tackle coastal erosion.

Apulia Regional Frameworks

Coastal planning

- A regional risk map of coastal erosion will be elaborated, considering morphodynamic features, human activities and environmental aspects.
- The final yield of the planning action is the institution of Regional Coast Monitoring Desk, aimed to deal with detection of the state of coastal environment:
  - integrated with other public services (weather stations, wave buoys, orthophotos)
  - exploiting specific technologies, e.g. drones and the installation of image/video recording stations
  - performing continuous elaboration of data.

Apulia Regional Frameworks

Touristic ports

National Law on ports n. 84/1994 divides ports in:

- Cathegory I: for defense or national safety
- Cath. II Class I: international economic importance;
- Cath. II Class II: national economic importance;
- Cath. II Class III: regional economic importance.

L. 84/1994 highlights five main functions of ports:

a) Commercial and logistics;
b) Industrial and tankers;
c) Passenger transport and cruises;
d) Fishing;
e) Touristic and boating

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Apulia Regional Frameworks

Touristic ports

The D.P.R. 509/1997 points out three kinds of structures for boating:

- ***marinas*** (full touristic ports);
- ***touristic dockings*** (part of ports for tourism);
- ***moorings*** (remote points for boats, even floating buoys).

The Regional Division cares of projects and concessions for the first two kinds of structures (moorings are followed by Municipalities) out of Port Authorities

Apulia Regional Frameworks

Touristic ports

- The D.P.R. 509/1997 outlines the procedure for requiring the realization of touristic ports, from the application, to the publication for fair competition, to the analysis of projects.
- The content of projects for touristic ports is detailed by Ministerial Decree (D.M.) 14 april 1998.
- Through L.R. 17/2015, the Apulia Region has taken the responsibility for preliminary/definitive project evaluation regarding state property issues.
  - The environmental authorization for marinas is now managed at national level, by Ministry of Environment.
- The Division cares for Public Agency Meeting (Conferenza di Servizi) in order to collect the authorizations by involved subjects, taking care of territorial planning, structure compatibility, personal and navigation security, borders, fees.

Apulia Regional Frameworks

Touristic ports

The Division has set a **regulation of the procedure for realization of touristic ports**, preliminarly approved with D.G.R. 942 on 29 May 2019, inspired by D.P.R. 509/1997, with further details on public procurement, comparison criteria, techno-economic plan auditing.

The public concession, after collecting all authorizations, is given as a formal licence by the Regional Division

Fees based on Decrees of Ministry of Information and Transport deriving from L. 296/06 (land/sea areas, removable/fixed structures).

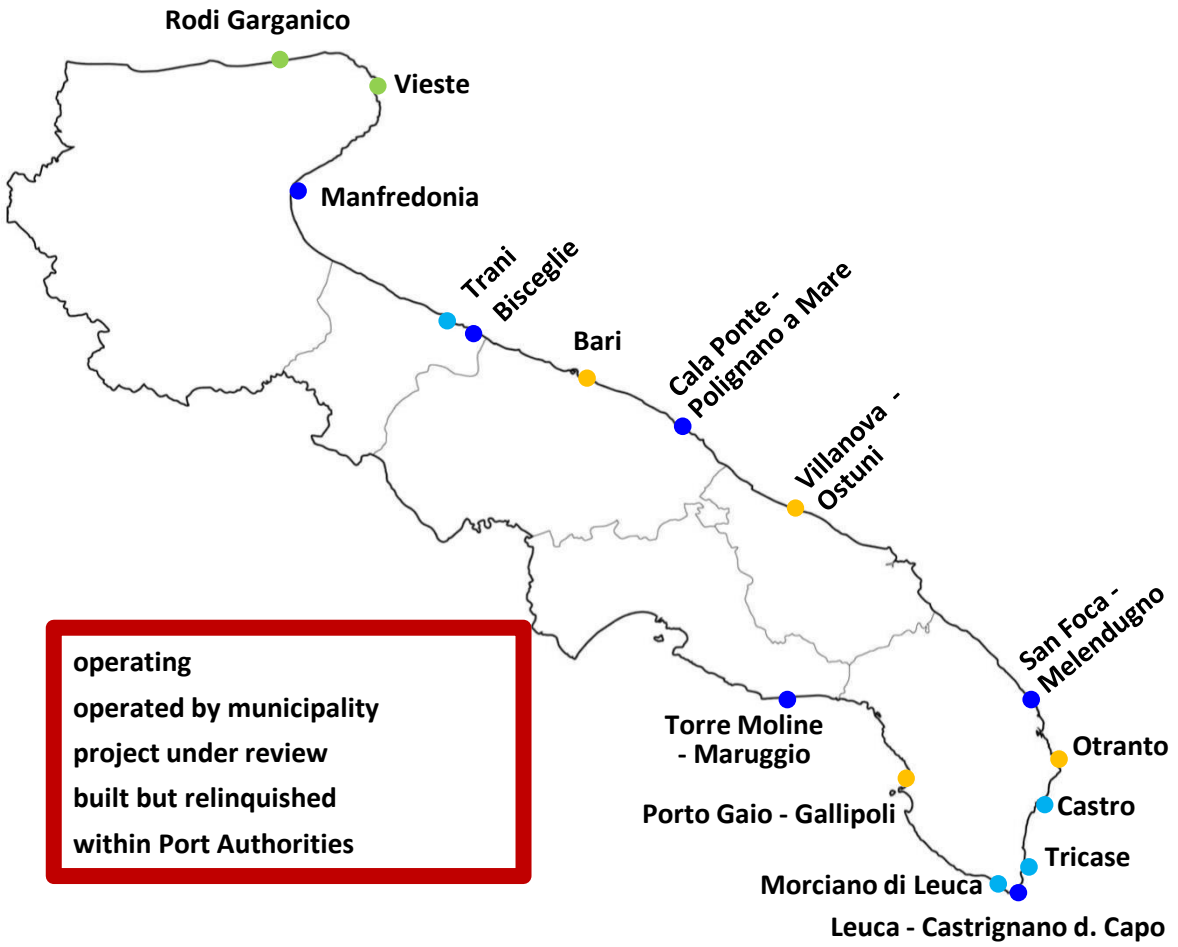
The Division cares for all aspects that can occur during licence running, according to Italian Navigation Code:

- Sub-licensing of secondary activities;
- Variations with respect to original project;
- Relinquishment of licence / escheat for non-compliance of obligations;
- Revocation of licence for new uses with higher public interest.

Apulia Regional Frameworks

Touristic ports

Current status of touristic ports in the Region



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Apulia Regional Frameworks

Guidelines for coastal management

Three main initiatives:

1) Guidelines for interventions to mitigate erosion of low shores (D.G.R. 10 Mar. 2011, n. 410)
2) Guidelines for management of marine plant debris on beaches (D.D. 22 Jun. 2015, n. 229, as modified on 2016 and 2017)
3) Guidelines for shore maintenance activities (DGR 3 Jul. 2019, n. 1197)

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Apulia Regional Frameworks

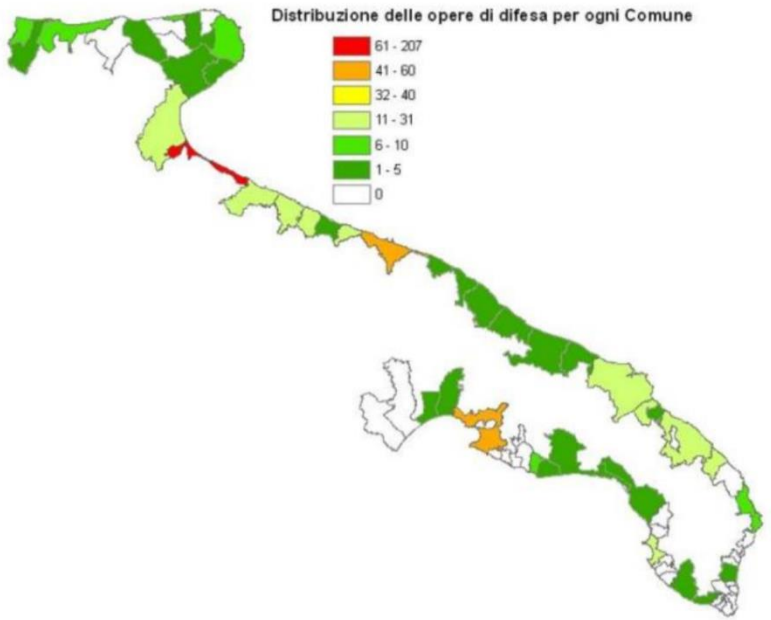
Guidelines for coastal management

Guidelines for interventions to mitigate erosion of low shores (D.G.R. 10 Mar. 2011, n. 410) analyzed, based on PRC activity and on territory plans by Regional Division and Agencies, the current conditions of:

- River hydraulics and sediment;
- Marine climate and currents;
- Diffusion of coastal protection structu

  (e.g. groynes, breakwaters, seawalls, ..

For each U.F. and specific local conditions, suggestions are drawn for new kind of structures (or no new ones), for the maintenance of exisiting ones, and possibility of beach nourishment.



Apulia Regional Frameworks

Management of marine plant debris

The accumulation of plant debris on beaches is associated with the action of the waves, especially in winter storms.
It has an important role in protecting beaches from erosion, but it can hinder tourism exploitation of beaches.
It is made up of *Posidonia oceanica* (*Neptune grass*) and *Cymodocea Nodosa (little Neptune grass)*.

- First national indications by Ministry of Environment on 17 Mar. 2006.
- A new communication by Ministry of Environment, on 20 May 2019, to improve good practices at national level, keeping results of some Regions.

Seamatter LIFE11+ Project (2014)

C. nodosa ***P. oceanica***

Apulia Regional Frameworks

Management of marine plant debris

Potential areas for the accumulation of marine plant debris on beaches

Apulia Regional Frameworks

Management of marine plant debris

Regional Guidelines D.D. 22 Jun. 2015, n. 229 point out six options for marine plant debris management:

- Option 0: no removal, for conservation of habitats
- Option 1: burying without transportation
- Option 2: local seasonal accumulation for coastal protecion (e.g. close to dunes or in a separate section of the beach, to be covered again on autumn)
- Option 3: removal and transfer in other places for seasonal accumulation and coastal protection
- Option 4: removal and transfer to composting facilities
- Option 5: removal and transfer to landfill sites

In any case, the debris should be selected in order to eliminate human waste (particularly butts and plastics).

Apulia Regional Frameworks

Management of marine plant debris

Coasts are classified in 20 macrotypes (MC) according to:

- Geomorphology of the shore (sandy, rocky, artificial structures)
- Quality for bathing
- Presence of erosion, dunes, protected areas
- Position in urban areas (for artificial structures)
- Specific areas (river mouths, channels, lagoons)

Matrix of options per macrotypes

- The lowest option should be always preferred, according to the specific situations
- Actions can be made by beach resort tenants in SB/SLS, or by Municipalities for SL.

Apulia Regional Frameworks

Shore maintenance activities

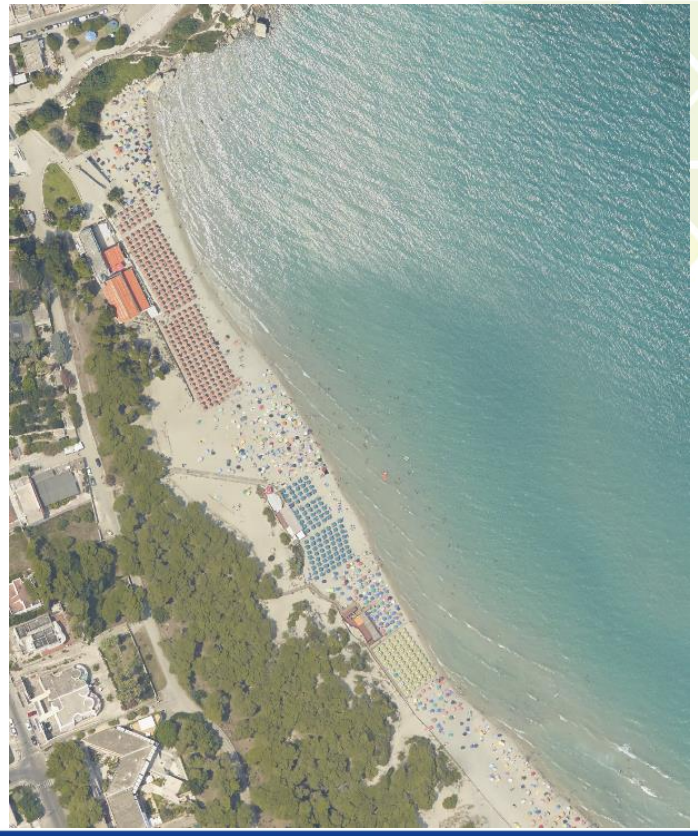
In the guidelines approved with D.G.R. 1197/2019, three kinds of intervention for shore maintenance are defined, individuating responsible subjects:

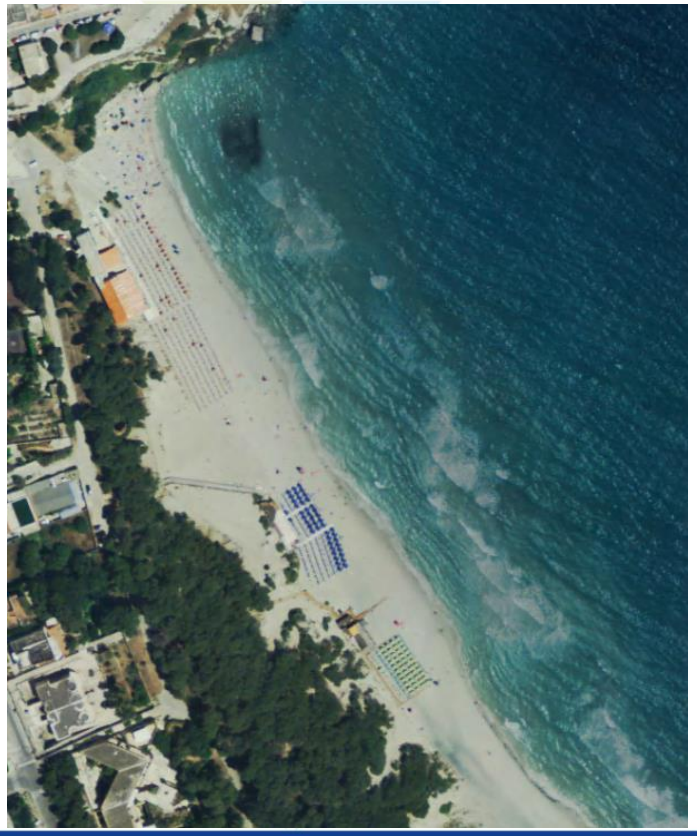
- ✓ **Shore restoration** (Municipalities, even funded by beach resort tenants);
- ✓ **Preparation of the shore for bathing season** (beach resort tenants, and Municipalities on SL);
- ✓ **Cleaning and maintenance during bathing season** (beach resort tenants, and Municipalities on SL).

Apulia Regional Frameworks

Shore maintenance activities

Maximum advancement of the coastline within 2 (or 5) years can be detected by means of certified orthophotos.





Apulia Regional Frameworks

Shore maintenance activities

- Coastal management units (SUGC) are defined with sediment balance in a short return time (2-5 years). For Apulian coasts, it can be individuated at -5 m bathymetrics, comparable with closure depth.

Within SUGC, independent cells or sites can be individuated, such as:

- beach between groynes;
- beach between two river mouths;
- cove beaches or pocket beaches, bounded by rocky headlands.

Apulia Regional Frameworks

Shore maintenance activities

In order to make shore restoration effective for the whole site, and to ensure fair treatment of beach resorts and free beaches, the responsibility is entrusted to Municipalities.

Two options:

Option 1: movement of dry sediments accumulated in the backshore to make coastline advance;

Option 2: movement of sediments from the shoreface (e.g. from breaker bars) to make coastline advance.

A monitoring plan is always required, in order to verify the effectiveness of actions.

Environmental authorization is required for Option 2 and in sites within or close to protected areas.

Apulia Regional Frameworks

Shore maintenance activities

Interventions should:

- leave a 5 m buffer from dunes
- be limited to move 20 m^3 of sediment per m of beach shoreline
- provide sediment cleaning and separation of waste
- preferably be perpendicular to shore line
- take submersed sediment around closure depth and create a smooth final profile

Particular care in the nesting period of loggerhead sea turtle (*Caretta caretta, 15 Jun. – 15 Oct.*) and Kentish plover (*Charadrius alexandrinus, 15 Feb. – 31 May*)

Apulia Regional Frameworks

Shore maintenance activities

Preparation of the shore for bathing season involves the regularization of backshore profile without coastline advancement.

- It should be performed by beach resort tenants in SB and SLS, and by municipalities in free beaches.
- It can be realized mechanically, e.g. with tractors, avoiding tracked vehicles, and eliminating waste.

Apulia Regional Frameworks

Shore maintenance activities

Cleaning and maintenance during bathing season involves waste elimination from the beach.

- It should be performed by beach resort tenants in SB and SLS and adjacent areas, and by municipalities in free beaches.
- It should be realized manually or by means of specific light machinery

Apulia Regional Frameworks

Other initiatives

Simplified regulation of licencing for temporary activities on maritime state property

Short term, up to 1 month (A.D. 233 of 24 Apr. 2017), for sport/music events, patronal festivals, fairs and trade shows, subject to licence and:

- payment of fee (even with minimum amount by law)
- publication of demand for competition in the case the activity generates profits

Very short term, up to 5 days (A.D. 344 of 8 Jun. 2017) only for free-of-charge sport events organized by sport associations within National Olympic Committee, subject to simple authorization by Municipality.

Areas should be individuated in PCC or compatible with PRC indications.

Pilot cases and best practices

The pilot cases carried out within TRITON in Ugento has been selected by European Topic Centre on Climate Change Adaptation (ETC-CCA) as god practice to be reused as NBS toward disaster risk reduction and climate change adaptation

Pilot cases and best practices

Information box - Ugento case study (Italy): Census of needs/mapping of best practices to be integrated in the TRITON system (Del. 3.2)

Site description and societal challenges addressed: The artificial channels in Ugento have been blocked by the leaves of Posidonia oceania that beach along the Ugento coast. 35,000 m3/a of leaf biomass is estimated to accumulate in the mouths of the channels. The basins and canals receive an increasing nutrient load associated with agriculture and tourism in the surrounding area and are subject to eutrophication due to the blockage by Posidonia remains. The coastal area where Posidonia remains accumulate is low sandy coast. The beaches are bordered by a dune cordon, which has partly degraded due to natural and anthropogenic causes.

Pilot cases and best practices

NBS evaluated / implemented: The beached leaves of Posidonia from the mouths of the channels (Torre San Giovanni and Torre Mozza) are used to reconstitute and protect dune cords that have degraded. Posidonia leaves function in erosion control, restoration of typical dune vegetation and provide habitat for a variety of organisms. The changes in the dunes will be monitored through phytosociological surveys.

Main results: The reuse of the Posidonia leaves accumulations for reconstituting the dune cordons allows to preserve the beaches in the wintertime and ensuring the maintenance of the main local economic activity in summertime. Furthermore, in this way, it is possible to avoid perpetrating the old practice of disposing of very large quantities of material in landfills, saving unnecessary costs and reducing the waste impact. These solutions, framed in a rigorous legislative framework of activities necessary for the movement of the biomass appears to be the strategy capable of enhancing the ecological role of Posidonia leaves toward the avoiding or minimizing of any form of impact on the surrounding environments.

Pilot cases and best practices

Effectiveness of NBS: Innovative methods for translocation of the Posidonia leaves have been completed from 2007 to 2013 along the shores of Ugento park. These integrated coastal management practices are able to maintain the physical and ecological processes regulating the morphology of the coast. This is important for maintaining tourism in the area.

Innovativeness: According to the current reference legislation for the management of Posidonia leaves, the biomass is considered Urban Solid Waste. Using the biomass in integrative management of the coastal environment has been recognized as an alternative to waste management. Managing the Posidonia accumulations in this way enables reconstituting sand dunes at the beach in the winter, promoting the main local economic activity in the summer and minimizing the quantity of waste disposed in landfills.

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Pilot cases and best practices

Transferability of results: The results and methodologies defined in Ugento as a "coastal design thinking" are transferable in similar situations for low sandy coast with dunes and Poseidonia oceanica. The integrated items at local level setup a specific framework allows to extend the reuse practices also by using plant biomass deriving from the leaves of the marine phanerogam. The paradigm is based on reuse-depollute-prevent the coastal erosion- remodel the dunes by circular integration of natural waste along the shoreline.

Lessons learned: The Ugento's model demonstrate the possibility to manage and prevent the coastal erosion along the low sandy coast characterized by the presence of dunas and Posidonia Oceanica. It consist of an interaction among different methodology from manual collecting of the waste on the dunes until to the monitoring by satellite of the impact of erosion and adoption of planning for long-term coastal management. The social awareness is a key factor for implement the prevention of erosion reuse the biomass together with a constant updating of biomaterial science to the dunes re-creation.

Deliverable 3.2: CONCLUSIONS

Common principles and opportunities for cross-border cooperation

Common challenges

Coastal erosion management

- These principles should be applied when implementing actions in ICZM and MSP contexts at Adriatic-Ionian Region level and beyond
- The study could be shared with other sub-regions of the Mediterranean, as a good practice of background document supporting cooperation on ICZM

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Deliverable 3.3: OBJECTIVES

AS-IS context analysis

- Overview of the indicators and datasets to be considered towards the implementation of the TRITON Decision Support System
- Evaluation of existing gaps and weaknesses in relation to cross border ICZM and MSP

Integrated coastal plans

based on the results of the TRITON Summer School

- Draw key priorities to fill in the identified management gaps
- Speed up the development and implementation of integrated coastal plans addressing cumulative risks arising from the complex interplay among multiple human-induced and natural pressures

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

MAIN FEATURES OF D3.3

- AS-IS context analysis toward the TRITON DSS
  - Indicators and datasets to support ICZM and MSP processes
  - Scientific and policy gaps for effective ICZM/MSP implementation
  - Common Actions in the AS-IS Context Analysis: the challenges ahead
- Fill the gaps: Key priorities for integrated coastal risk assessment and management

Partners contributors

Regione Puglia

Context analysis for the creation of the TRITON Platform toward the Coastal Decision Support System (CDSS)

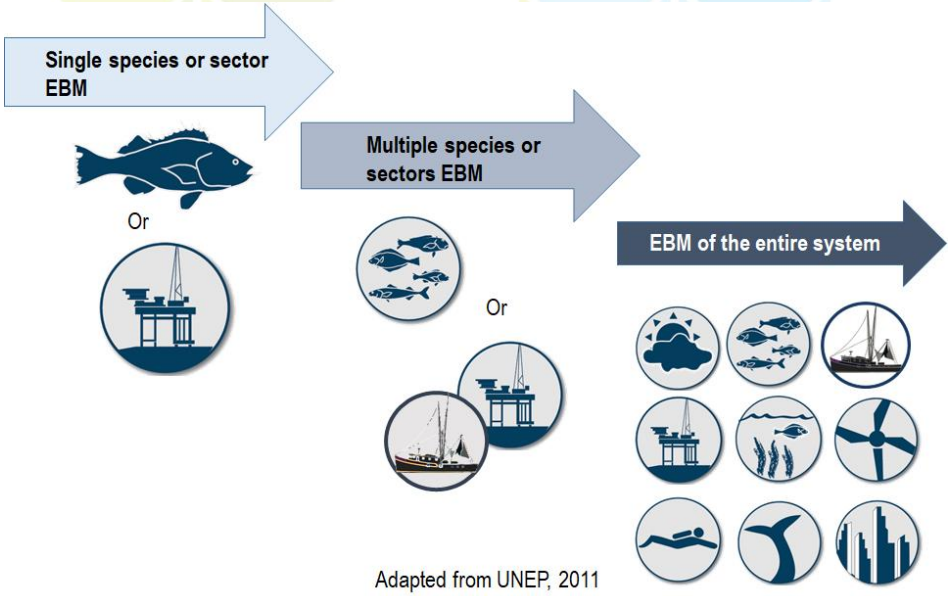
Starting from the premises of the whole project's results TRITON shaped as CDSS supporting a variety of actions as follows:

1) Draft of future policy documents between Greece and Italy;
2) Possible funding opportunities using PPP's and also EIB funds;
3) Common principles and elements through MSP-ICZM-ERP case studies for similar situation;
4) New projects (including new CAMPs under the Barcelona Convention system) to implement actions in the areas identified as key for cooperation;
5) Studies which can detail or even integrate some of the contents of the present document;
6) Position Paper of the ICZM and Erosion Risk prevention between Greece and Apulia Region toward EUSAIR Blue Growth Pillar Contribution

Context analysis for the creation of the TRITON Platform toward the Coastal Decision Supporting System

The main features of context analysis shows how to:

1) Use the ecosystem-based management to ensure sustainable development and integrity of the coastal zone, its ecosystems and related services and landscapes;
2) Address natural hazards and the effects of natural disasters, in particular coastal erosion and climate change; and
3) Achieve good governance among actors involved in and/or related to coastal zones.



Context analysis for the creation of the TRITON Platform toward the Coastal Decision Supporting System

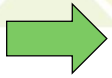
1. Identification and mapping of the interactions
   - Assessment of cumulative impacts, benefits and potential conflicts and synergies;
   - Interactions extend further beyond the coastal zones;
   - Assessment of environmental, social and economic implications.

2. Interactions of planning processes and plans for land and sea areas
   - Coordination of legal, administrative, consultation and technical processes;
   - Plan and manage inshore and offshore activities.

3. Integration of the different approaches, methodologies and tools applied respectively on land and at sea.

Deliverable 3.4: OBJECTIVES

TO-BE paradigm



WEB-GIS TRITON Platform

- combining the results and outcomes of the whole project toward their rationalization and easy visualization/exploitation under crosscutting research activities

- Support stakeholders and decision makers into the pursuit of possible solutions after the identification of the issues at stake
- support cross-border cooperation sharing training materials already presented in Greek and Italians project events and summarizing the project results in two comprehensive Power Point presentations


Project acronym: TRITON

Project title: Development of management tools and directives for immediate protection of biodiversity in coastal areas affected by sea erosion and establishment of appropriate environmental control systems

Deliverable No. 3.4
Design of the TRITON Platform

Delivery date:
....

MAIN FEATURES OF D3.4

- The TRITON PLATFORM
  - Objectives
  - Structure and main contents

Partners contributors

Regione Puglia

TRITON Platform - OBJECTIVES

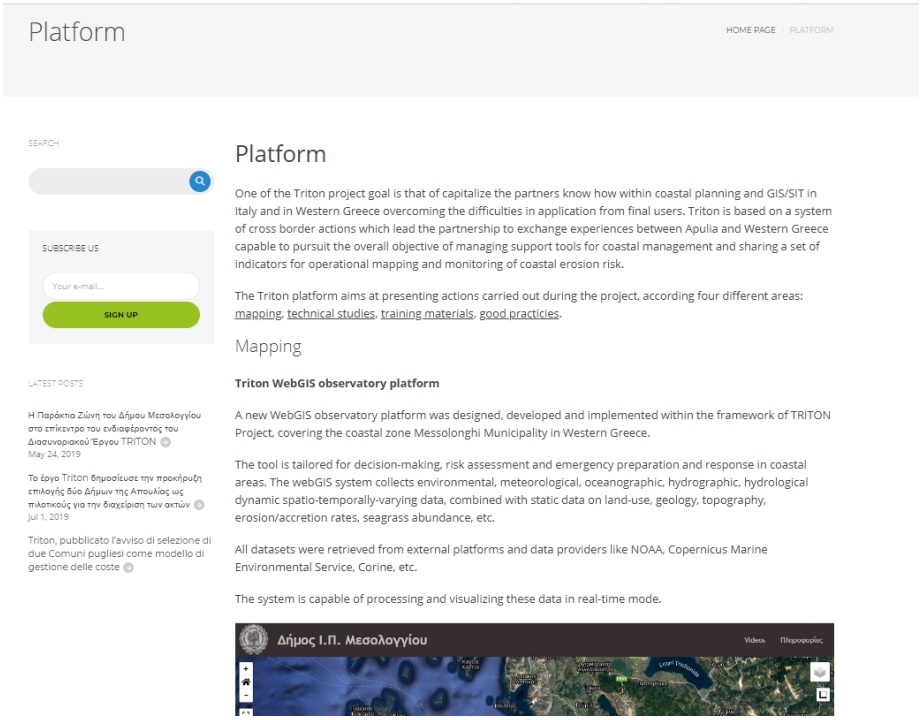
- a publicly **accessible** web-based source of spatial data, projects and training materials;
- it conveys **easy-to-access** and **easy-to-understand** information in both the Apulia Region and Greece Institutions, EUSAIR's and EU, environmental as well as other types of organizations involved in coastal and marine management (e.g. private companies, non-governmental organizations, academia), and the wider public.

Type of problem along the coastline	→	Possible solutions	Best practice	Legal framework	Link/repository

The Triton Platform aims at supporting policymaking on coastal management and maritime spatial planning toward coastal erosion prevention against three main aspects: environment, maritime issues and economic sectors, both within and outside the EUSAIR's perspective.

TRITON Platform – STRUCTURE AND MAIN CONTENTS

https://www.interregtriton.eu/platform/



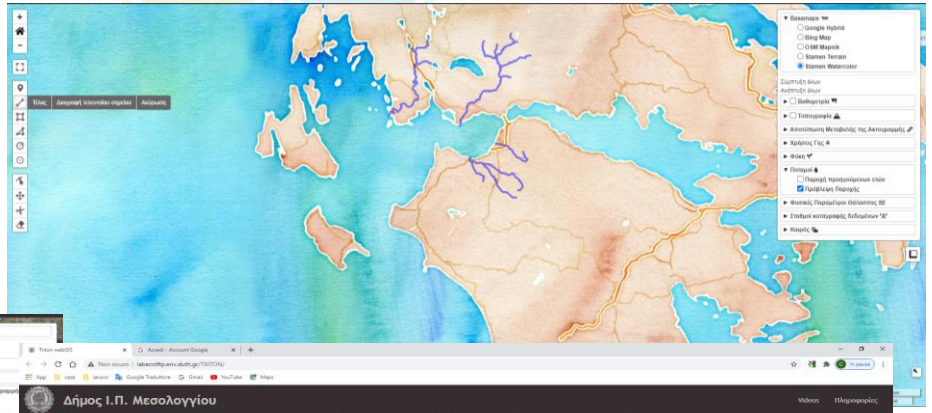
- It collects environmental, meteorological, oceanographic, hydrographic, hydrological dynamic spatio-temporally-varying data, combined with static data on land-use, geology, topography, erosion/accretion rates, seagrass abundance, etc.
- All datasets were retrieved from external platforms and data providers like NOAA, Copernicus Marine Environmental Service, Corine, etc.
- The system is capable of processing and visualizing these data **in real-time mode**.

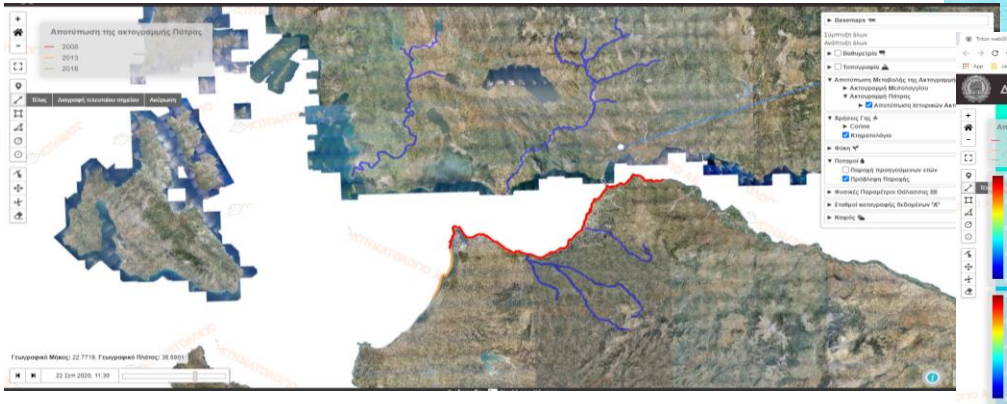
TRITON Platform – STRUCTURE AND MAIN CONTENTS

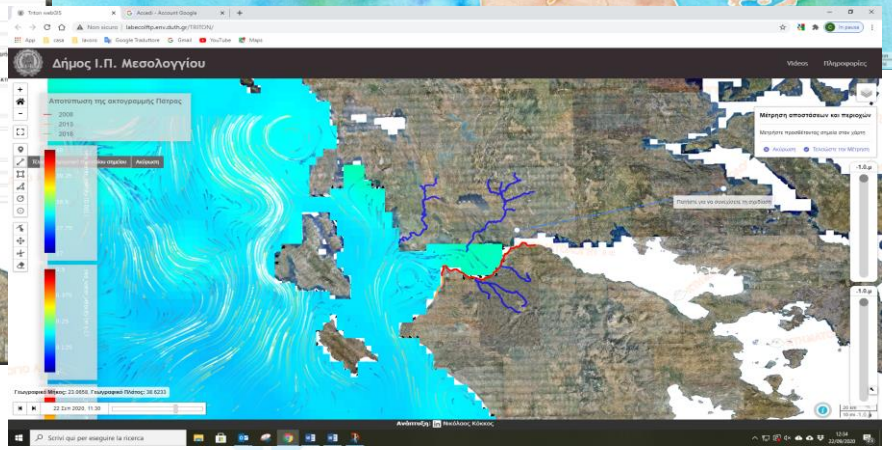
MAPPING → Triton WebGIS observatory platform

http://labecolftp.env.duth.gr/Triton/

Designed, developed and implemented within the framework of Triton Project, covering the coastal zone **Messolonghi Municipality** (Western Greece)



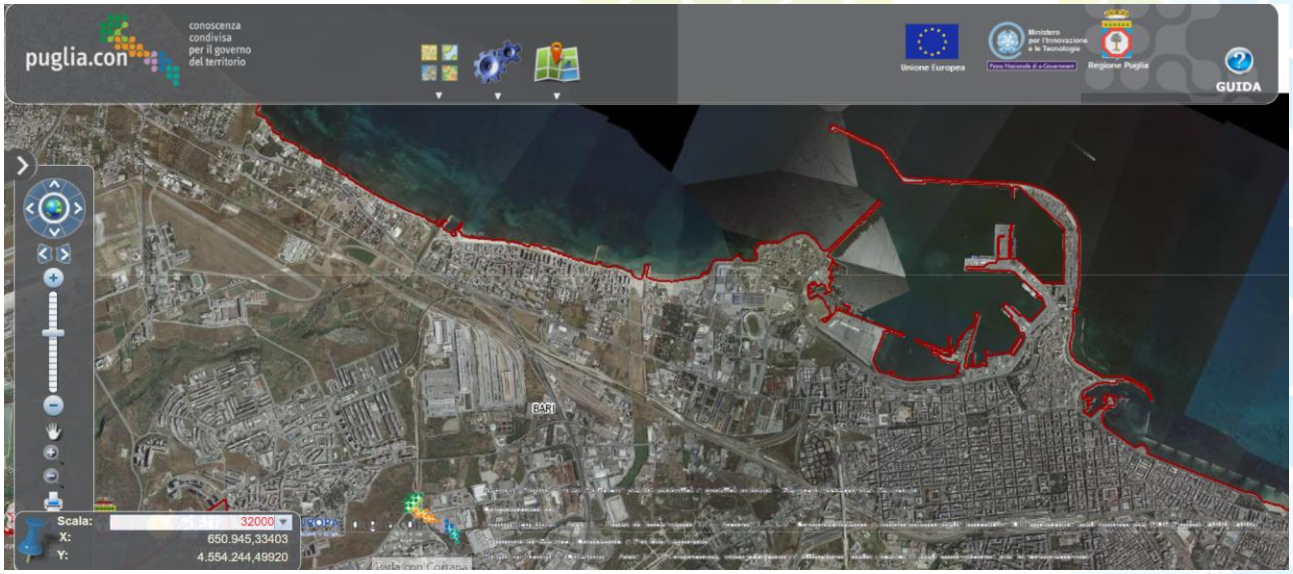




TRITON Platform – STRUCTURE AND MAIN CONTENTS

MAPPING → Apulia Region Territorial Information System

http://sit.puglia.it/portal/sit_portal



- Built in an integrated manner;
- Managed and made available through an Information System
  - it gives access to the territorial database;
  - continuously updated

TRITON Platform – STRUCTURE AND MAIN CONTENTS

TECHNICAL STUDIES

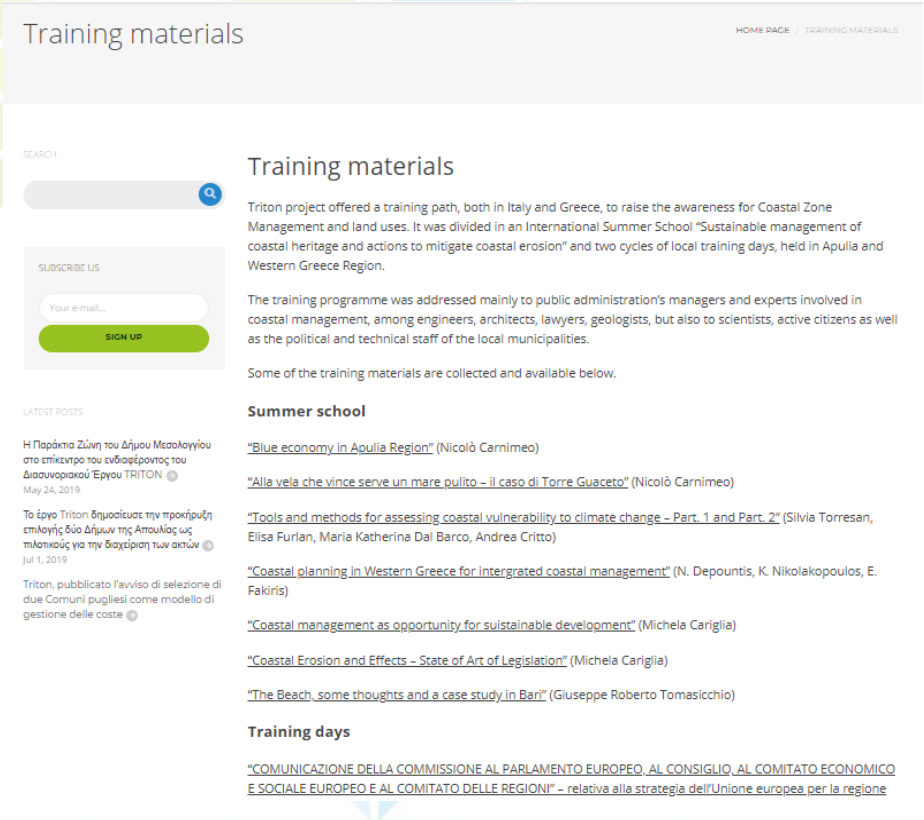
- mapping existing tools and frameworks for coastal erosion risk assessment, environmental and administrative performance
- planning suitable indicators and decision support tools useful to characterize and quantify different elements at risk (i.e. beaches, wetlands, ports, agriculture, infrastructures, tourism, biodiversity) thus to identify pilot areas
- analyzing pilot cases on WEB GIS/SIT and studying sea-water quality, climate change impacts, mapping and prioritization of coastal erosion risk in selected areas in Western Greece and Apulia Region.

TRITON Platform – STRUCTURE AND MAIN CONTENTS

TRAINING MATERIALS

https://www.interregtriton.eu/platform/training-materials/

- International Summer School "Sustainable management of coastal heritage and actions to mitigate coastal erosion"
- Local training days, held in Apulia and Western Greece Region



Training materials

HOME PAGE / TRAINING MATERIALS

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Η Παράκτια Ζώνη του Δήμου Μεσολογγίου στο επίκεντρο του ενδιαφέροντος του Διασυνοριακού Έργου TRITON
May 24, 2019

Το έργο Triton δημοσίευσε την προκήρυξη επιλογής δύο Δήμων της Απουλίας ως πιλοτικούς για την διαχείριση των ακτών
Jul 1, 2019

Triton, pubblicato l'avviso di selezione di due Comuni pugliesi come modello di gestione delle coste

Training materials

Triton project offered a training path, both in Italy and Greece, to raise the awareness for Coastal Zone Management and land uses. It was divided in an International Summer School "Sustainable management of coastal heritage and actions to mitigate coastal erosion" and two cycles of local training days, held in Apulia and Western Greece Region.

The training programme was addressed mainly to public administration's managers and experts involved in coastal management, among engineers, architects, lawyers, geologists, but also to scientists, active citizens as well as the political and technical staff of the local municipalities.

Some of the training materials are collected and available below.

Summer school

"Blue economy in Apulia Region" (Nicolò Carnimeo)

"Alla vela che vince serve un mare pulito – il caso di Torre Guaceto" (Nicolò Carnimeo)

"Tools and methods for assessing coastal vulnerability to climate change – Part. 1 and Part. 2" (Silvia Torresan, Elisa Furlan, Maria Katherina Dal Barco, Andrea Critto)

"Coastal planning in Western Greece for intergrated coastal management" (N. Depountis, K. Nikolakopoulos, E. Fakiris)

"Coastal management as opportunity for suistainable development" (Michela Cariglia)

"Coastal Erosion and Effects – State of Art of Legislation" (Michela Cariglia)

"The Beach, some thoughts and a case study in Bari" (Giuseppe Roberto Tomasicchio)

Training days

"COMUNICAZIONE DELLA COMMISSIONE AL PARLAMENTO EUROPEO, AL CONSIGLIO, AL COMITATO ECONOMICO E SOCIALE EUROPEO E AL COMITATO DELLE REGIONI" – relativa alla strategia dell'Unione europea per la regione

TRITON Platform – STRUCTURE AND MAIN CONTENTS

GOOD PRACTICES

https://www.interregtriton.eu/wp-content/uploads/2020/09/Good-practices_Projects.pdf

- A list of 176 real-world "good practices" and recommended key references for further information and details is provided.
- A selection of projects based on the scheme of problems/possible solutions in order to achieve an integrated approach to coastal planning.

Deliverable 3.5: OBJECTIVES

Design of a DPSIR conceptual framework

- **D**rivers
- **P**ressures (natural and anthropogenic)
- **S**tates
- **I**mpacts
- **R**esponses

Review of tools and methods

- Indicator and index-based
- Decision Support Systems
- Remote sensing techniques
- Bayesian Network (BN) approaches

Deliverable 3.5

- Implementation of tools and methods already developed
- Identification of risk-prone areas and receptors
- Simulation of future climate and management scenarios
- Support the development and implementation of risk-based policies

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy


Project acronym: TRITON

Project title: Development of management tools and directives for immediate protection of biodiversity in coastal areas affected by sea erosion and establishment of appropriate environmental control systems

Deliverable No. 3.5

Development of the framework and tool for final users with training

Delivery date: 23/12/2019

PROGRAMME: Interreg V-A Greece-Italy Programme 2014-2020

AXIS: Axis 2 (i.e. Integrated Environmental Management)

THEMATIC OBJECTIVES: 06 – Preserving and protecting the environment and promoting resource efficiency

PROJECT ACRONYM: TRITON

MAIN FEATURES OF D3.5

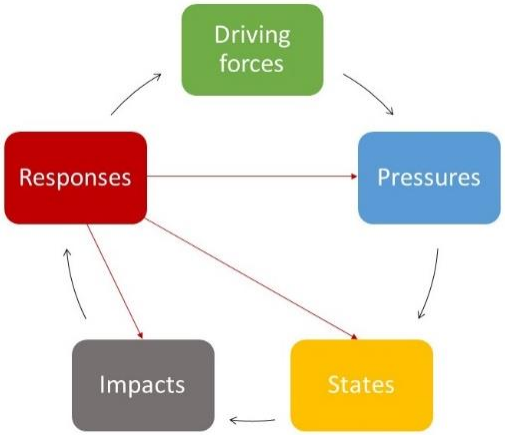
- Conceptual DPSIR-based framework for coastal erosion risk assessment and management.
- State of the art tools and methods for coastal erosion risk appraisal and management
  - Indicator and index-based methods;
  - Decision Support Systems (DSS);
  - Remote sensing techniques;
  - Bayesian Network (BN) approaches.

Partners contributors

Regione Puglia

cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

Conceptual framework for coastal erosion risk assessment and management



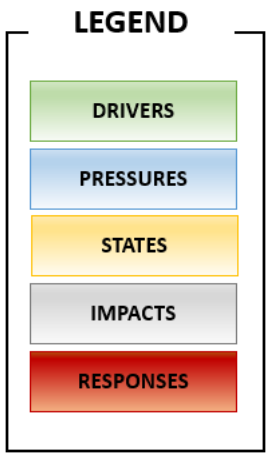
Developed by the European Environmental Agency (EEA, 1995), as an extension of the Pressure-State-Response model (OECD, 1970) to assess the environmental performance by using key indicators.

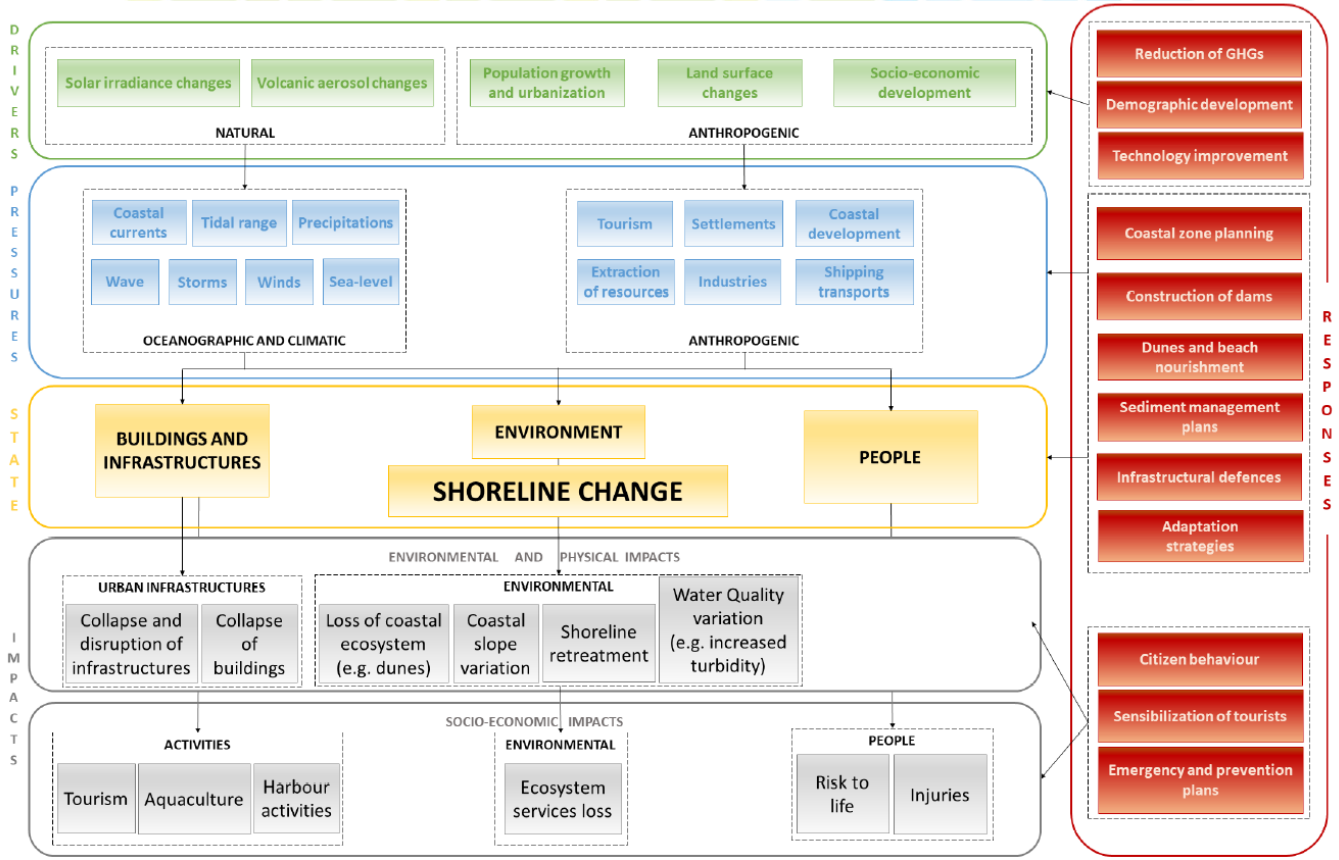
AIM:
describe the relationships between the origins and consequences of environmental issues.

D – driving forces: natural and anthropogenic forces which can drive variations in the state of the environment and human systems.
P – pressures: the means through which drivers are expressed.
S – states: the states of the exposed systems.
I – impacts: impacts on the environment, human health and activities.
R – responses: the re-evaluation of current management policies and the setting on of new measures.

The TRITON DPSIR conceptual framework for coastal erosion risk assessment and management

CONCEPTUAL FRAMEWORK





State of the art of tools and methods for coastal erosion risk assessment and management

53 tools & methods found

Indicator and index-based approaches

- Indicator: a **value** that represents a **phenomenon** that cannot be directly measured and may aggregate different types of data;
- Index: a **set** of aggregated or weighted **parameters** or **indicators.**

Decision Support Systems

A **software** aimed at assisting planners and policy makers across different phases of the decision-making process, supporting, rather than replacing, their judgment and, at length, improving effectiveness over efficiency.

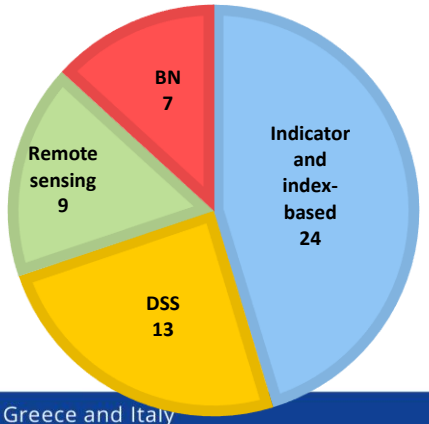
Remote sensing-based techniques

A **tool** able to detect the shoreline position and assess the relative shoreline change over a certain time period.

Bayesian Network approaches

Probabilistic graphical models widely used for knowledge representation and reasoning under uncertainty in natural resource management.

Increased complexity



Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

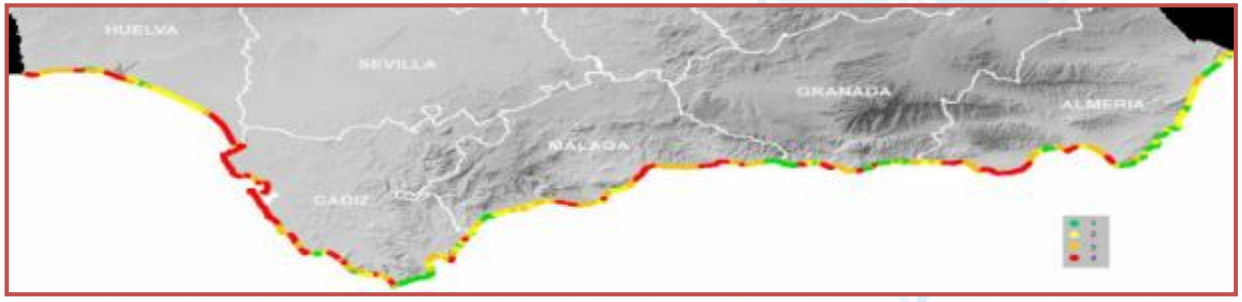
Indicator and index-based approaches

Coastal Vulnerability Index – CVI

The CVI is one of the **most commonly used** and **simple** methods to **assess coastal vulnerability** to **sea level rise**, in particular due to **erosion** and/or **inundation** (Gornitz et al., 1991).

The CVI provides a **simple numerical basis** for **ranking sections** of **coastline** in terms of their **potential for change** that can be used by **managers** to **identify** regions where **risks** may be **relatively high**.

The CVI **results** can be displayed on **maps** to highlight **regions** where the factors that contribute to shoreline changes may have the greatest potential to contribute to **changes** to **shoreline retreat** (Gutierrez et al., 2009).



Indicator and index-based approaches

Application of a Coastal Vulnerability Index. A case study along the Apulian Coastline, Italy

Pantusa et al., 2018

- Based on the methodology proposed by Gornitz et al., 1990,1991

$$CVI = \sqrt{(a \cdot b \cdot c \cdot d \cdot e \cdot f \cdot g \cdot h \cdot i \cdot l)/10}$$

- Considers 10 variables divided into 3 groups:
  - **Geological** (geomorphology, coastal slope, shoreline erosion/accresion, emerged beach width, dune width)
  - **Physical process** (relative sea level change, mean significant wave height, mean tide range)
  - **Vegetation** (width of vegetation behind the beach, Posidonia oceanica)

- Geography Information System (GIS) platform to better process the data
  - The coast has been divided into 24 transects
  - Each transect is classified with the respective CVI category

- A comparison with the Coastal Sensitivity Index (CSI) shows quite similar results

- FUTURE AIMS:

compare this CVI with more complex numerical models

Indicator and index-based approaches

Multi-scale coastal vulnerability index

McLaughlin and Cooper, 2010

The index integrates three sub-indices:

- a **coastal characteristic sub-index**, describing the resilience and coastal susceptibility to erosion;
- a **coastal forcing sub-index**, characterizing the forcing variables contributing to wave-induced erosion;
- a **socio-economic sub-index**, describing targets potentially at risk.

The computation of each sub-index is determined on the basis of various **variables**, whose specific **identification** (number and typology) **depends** on the considered **application scale** (i.e. national, regional or local).

Indicator and index-based approaches

Multi-scale coastal vulnerability index

McLaughlin and Cooper, 2010

- Sub-indices are calculated by the **sum** of the values of the relative **variables**;
- the results were then **normalized** by working the results out as a **percentage** of the **maximum** and **minimum scores;**
- the obtained number is then standardized to the **range 0-100**.

Coastal Characterization (CC) sub-index = {[(sum of CC var.) – 7]/28} x 100

Coastal Forcing (CF) sub-index = {[(sum of CF var.) – 4]/16}·x 100

Socio-Economic (SE) sub-index = {[(sum of SE var.) – 6]/24}·x 100

The final CVI index is computed through the **average** of the three sub-index values, as shown in the formula below:

CVI = (CC sub-index + CF sub-index + SE sub-index) / 3

Indicator and index-based approaches

Review: assessment of coastal risk of climate related hazards

Satta et al., 2016
Satta et al., 2017

Climatic threat/issue	Name of indicator	Purpose	Scale	Methods/tools aggregation	Highlights
Sea level rise, storms, erosion, droughts	Multi-Scale Coastal Risk Index for Local Scale (CRI-LS), 2016	Identify areas where the risk is relatively high at the local scale, identifying the most suitable adaptation measures.	Local scale	Variable ranked and weighted through an expert judgement elicitation. Resulting values are hosted in a geographic information system (GIS) platform: enables the individual variables and aggregated risk scores to be color-coded and mapped across the coastal hazard zone.	Interesting choice of indicators & methodology for multi-hazard scenario. However, it is not possible to apply it due to stakeholders involvement phase in identification of weights: the case study area is too wide to apply such methodology.
	Coastal Risk Index for risk assessment in the Mediterranean region (CRI-MED), 2017	Assess coastal risks and vulnerabilities associated with the physical and socioeconomic impacts of climate change in all Mediterranean coastal zones	Regional scale	Based on a GIS application; aggregation based on classification & ranking into sub-indices, consequently merged to calculate the overall index	

Satta et al., 2016: CRI-LS

- **Hotspot** of the Mediterranean Moroccan coast: **Coastal zone of Tetouan**
- Provides a set of maps that allow **identifying areas** within the coastal hazard zone with **relative higher risk** from climate-related hazards
- Can be used to **support coastal planning** and **management** process in selecting the most **suitable adaptation measures**

Satta et al., 2017: CRI-MED

- **Spatial risk index**, which combines variables representing **different aspects of risk**: coastal areas of relatively higher risk emerge from the **integration of the variables**
- Creates an **interface** between **theoretical concepts** of risk and the **decision-making process** relating to disaster risk reduction
- Allow researchers and policy-makers to identify coastal areas most at risk from coastal erosion and coastal flooding: resulting risk maps enable **identification** of **suitable** and **less suitable areas** for urban settlements, infrastructures and economic activities.

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Decision Support Systems

DSS Review

Tools	Name of tool	Objective	Type of data	Scale / study area	Timeframe scenarios	Reference
Decision Support System (DSS)	COSMO	Evaluate coastal management options considering anthropic forcing and climate change impacts	Socio-economic, climatic, environmental, hydrological	N / The Netherlands	100 years	Rijsberman & van Velzen, 1996
	SimLUCIA	assess the vulnerability of low-lying areas in the coastal zones and island to sea-level rise due to climate change	Climatic, environmental, socio-economic	L / Saint Lucia	40 years (1990-2030)	White *et al*, 1997
	RAMCO	Reduce the gap between the present state and the desired state of the coastal zone and support the coastal zone manager(s)	combines GIS with a dynamic system model for the (bio)physical and socio-economic coastal-zone interactions	L / Southwest Sulawesi, Indonesia	2020	Kok *et al.*, 2001
	WADBOS	Support the design and analysis of policy measures in order to achieve an integrated and sustainable management	Socio-economic, hydrological, environmental, ecological	L / Wadden Sea	10 years scenario	Engelen *et al.*, 2005
	CVAT	Assess hazards, vulnerability and risks related to climate change and support hazard mitigation options.	Environmental and socio-economic	L / New Hanover County, Maui County, Rhode Island (USA)	/	Flax *et al.*, 2002
	KRIM DSS	Determine how coastal systems reacts to climate change in order to develop modern coastal management strategies	Climatic, socio-economic, ecological, environmental, hydrological	L / Bremen (Germany)	2050	Kraft, 2003
	DITTY DSS	Preservation, protection and improvement of the quality of the environment through a prudent and rational utilization of the natural resources	biogeochemical, hydrodynamic, ecological, socio-economic models, GIS	L / Sacca di Goro lagoon (Italy)	2/3 years	Mocenni *et al.*, 2009
	IWRM DSS	Explore potential risks on coastal resources due to climate and water management policies	Climatic, environmental, socio-economic, geomorphological	N / Bangladesh	/	Zaman *et al.*, 2009
	DIVA DSS	Assessing coastal vulnerability and explore the effects of climate change impacts on coastal regions	Climatic, socio-economic, geography, morphological	L, N, R, G	2100	Hinkel & Klein, 2009
	SimCLIM	Assessing impacts and risks of climatic extremes in a changing climate	Hydrologic, climatic	R / Southeast Queensland, Australia	2050	Warrick, 2009
	Coastal Simulator	Long-term assessments of potential coastal impacts and responses	combines a geographical information system with a dynamic system model for the (bio)physical and socio-economic coastal-zone interactions	L / coast of Norfolk, UK	100 years	Mokrech *et al.*, 2011
	THESEUS DSS	Assess risk across a range of spatial and temporal scales to minimize coastal risk	Social, environmental, economic	L / Cesenatico, Italy	2020 (short-term) 2050 (medium-term) 2080 (long-term)	Zanuttigh *et al.*, 2014
	DSS DESYCO	Assessment of vulnerability to natural hazards and climate change	Climatic, biophysical, socio-economic, geomorphological, hydrological	L / Veneto, Friuli-Venezia Giulia, Marche, Apulia (IT)	2070-2100	Torresan *et al.*, 2016b

Decision Support Systems

DESYCO

DEcision support SYstem for COastal climate change impact assessment

MAIN OBJECTIVE:

Identify, prioritize and visualize areas and targets at risk from climate change impacts on coastal areas and related ecosystems.

DESYCO can be used to:

- Adopt a **Source-Pathway-Receptor-Consequence** risk assessment approach.
- Analyse long-term **climate change hazard scenarios**.
- **Rank** coastal **receptors** and **areas** vulnerable to or at risk from different climate change impacts.
- Produce **interactive GIS-based maps** (i.e. vulnerability, exposure, risk and damage maps).
- **Transfer information** about potential climate change impacts for **adaptation actions.**

Torresan et al., 2010

Remote sensing-based techniques

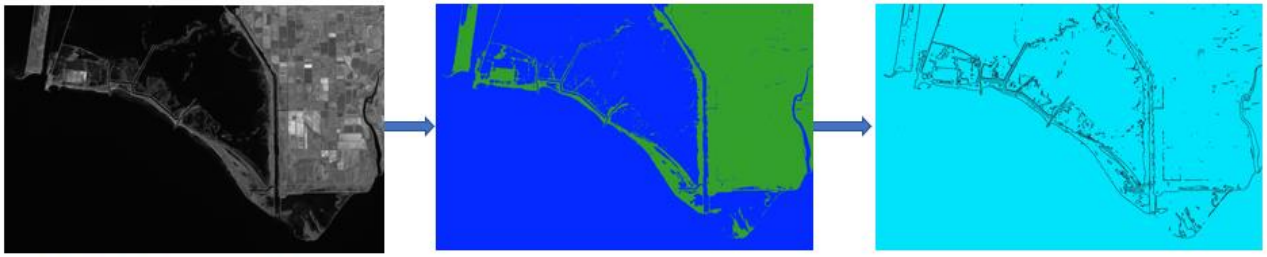
Remote sensing review

Tools	Name of tool	Objective	Type of data	Scale / study area	Timeframe scenarios	Reference
Remote sensing-based techniques	Shoreline Identification Techniques	Assessment and integration of conventional, RTK-GPS and image-derived beach survey methods for daily to decadal coastal monitoring	Real-time kinematic (RTK)-GPS surveys	L/Australia	2005-2008	Harley et al., 2010
		Assessment of beach and dune erosion and accretion using LiDAR: Impact of the stormy 2013–14 winter and longer-term trends on the Sefton Coast, UK	LiDAR	L/ Sefton Coast, UK	2013-2014	Pye and Blott, 2016
		Monitoring beach morphology changes using small-format aerial photography and digital softcopy photogrammetry	Aerial Photography	-	-	Hapke and Richmond,2000
		Science, technology and the future of small autonomous drones	RPAS, unmanned aerial vehicles, UAVs, or drones	-	-	Floreano and Wood, 2015
		Automatic Measurement of Shoreline Change on Djerba Island of Tunisia	Satellite Images	L/Tunisia	1984-2009	Bouchahma and Yan, 2012
	Shoreline Extraction Techniques	Automatic Measurement of Shoreline Change on Djerba Island of Tunisia	NDWI	L/Tunisia	1984-2009	Bouchahma and Yan, 2012
		Semi-automated construction of the Louisiana coastline digital land/water boundary using Landsat Thematic Mapper satellite imagery	Single Band	L/USA	-	Braud and Feng, 1998
		Automatic Coastline Extraction Using Edge Detection and Optimization Procedures	Edge Detection	L/Greece	1929-2000,	Paravolidakis et.al, 2018
	Evaluation of Shoreline Change Analysis	The Digital Shoreline Analysis System (DSAS) version 4.0- an ArcGIS extension for calculating shoreline change	DSAS	US Geological Survey	-	Thieler et.al, 2009

Remote sensing-based techniques

Methodological steps of the Digital Shoreline Analysis System (DSAS)

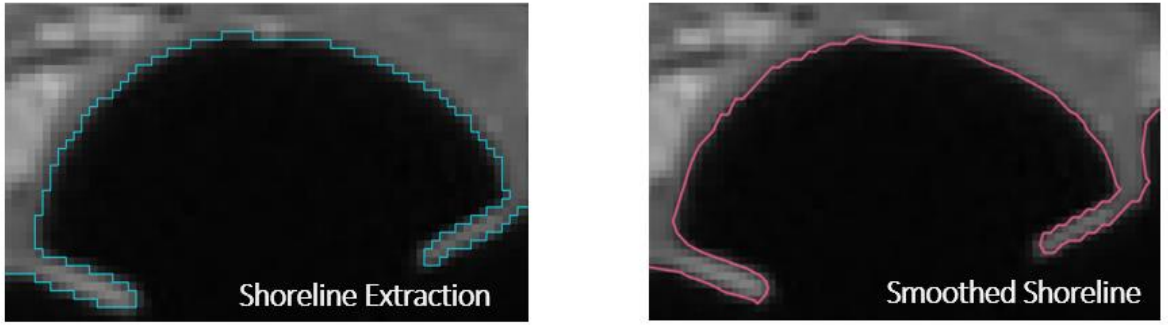
1. *selection of the most effective beach monitoring technique;*
2. *shoreline digitalization;*
3. *statistical analysis of shoreline change through the studied years.*



Satellite Image – Near Infrared Band

Classified Image (Land - Sea)

Raster to Vector

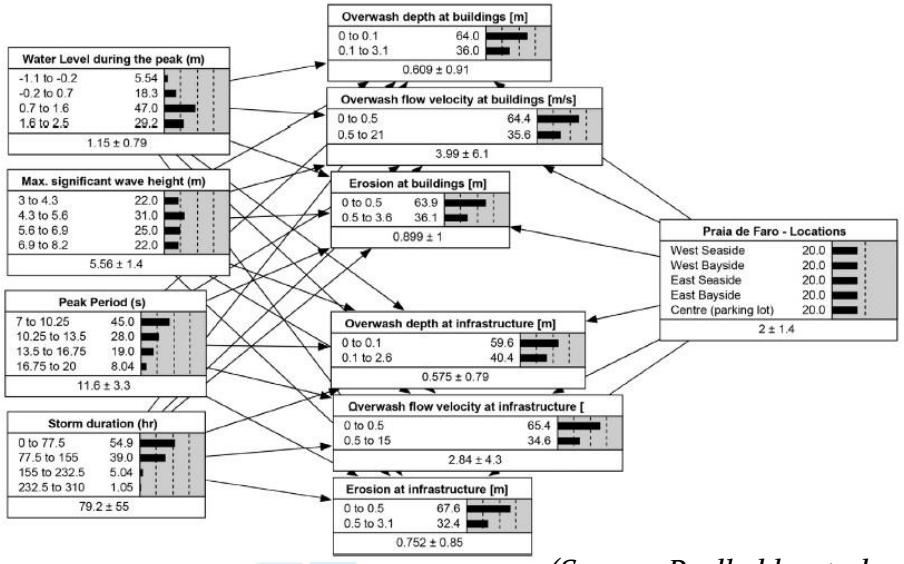


Thieler et al., 2009

Bayesian Network approaches

Theoretical background

- **BBNs are probabilistic graphical models** representing the system's components (variables) and their relationships (conditional interdependencies) by combining principles of Graph theory and Probability theory (Pearl, 2011).
- They are **graphically-based to facilitate the rapid conceptualization of the sys**tem to be managed (e.g. marine region) and the evaluation of the dependence/independence between data and their inherent uncertainty evaluated as belief probabilities.
- They allow to c**onsider multiple stressors and endpoints in the same framework**, supporting modelling and analysis of complex marine environments.
- **They integrate different knowledge domains, expertise and data sources** (e.g. GIS data, MCDA and environmental indicators) into a complex system acting as a **decision support tool** informing coastal risk assessment and management.



(Source: Poelhekke et al., 2016)

Methodological steps

Bayesian Network approaches

CONCEPTUAL MODEL:

Define the structure of the network and identify its main variables and relationships represented by using a conceptual/influence **'nodes and arrow'** diagram.

MODEL PARAMETRIZATION:

Define **states** for all variables (interval, boolean, labelled) and calculate the associated **prior probability** resulting from data distribution as well relationships between nodes described by the **conditional probability** distributions.

VALIDATION:

Evaluate the performance/prediction accuracy of the BN model through two different types of validation methods:

- the data-based validation;
- the qualitative evaluation.

SENSITIVITY ANALYSIS:

Evaluate **how sensitive are model outcomes** to changes in input nodes or other model parameters (e.g. changes in node's type of states.

SCENARIOS ANALYSIS:

By inferring behavior of the variables at stake against different conditions defined by setting specific state/s of a node/s (**evidence**) and then propagating information between nodes based on the Bayes theorem, thus resulting in **the posterior probability.**

(Source: Sperotto et al., 2019)

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Bayesian Network approaches

Bayesian Network review

Tools	Name of tool	Objective	Type of data	Scale / study area	Timeframe scenarios	Reference
Bayesian Networks (BN)	BN	Assessment of long-term shoreline change due to SLR	Geophysic and hydrologic	N / US Atlantic coast	50/100 years	Gutierrez *et al.*, 2011
	BN	Predicting decadal-scale Chinese coastal erosion due to SLR	Geophysic and hydrologic	N / Chinese coast	'What-if' scenario	Zhan *et al.*, 2014
	BN	Predicting coastal vulnerability to SLR and assessing the interactions between barrier and geomorphic variables	Hydrodynamic, geomorphological	R / Praia de Faro, Portugal	RP: 50 years	Poelhekke *et al.*, 2016
	BN	Assessing coastal vulnerability to storm surge events causing erosion	Geophysical, hydrological, socio-economic, environmental, anthropic influence	R / North Norfolk coast, UK	'What-if' scenario	Jäger *et al.*, 2017
	BN	Evaluate erosion risks and the effect induced by beach nourishment measures	Physical, morphological, ecological, environmental, socio-economic	R / Ria Formosa, Portugal	'What-if' scenario	Plomaritis *et al.*, 2017
	BN	Compare alternatives measures to reduce coastal risk in current and projected future scenarios	Hydro-morphodynamics	R / Tordera Delta, Spain and Lido degli Estensi-Spina, Italy	2100 for the Tordera Delta case study - 2050 for Lido degli Estensi case study	Sanuy *et al.*, 2018
	BERM-N	Quantify the issue of coastal erosion and assess the effectiveness of different nourishment measures in counteracting coastal erosion	Geomorphological	N / Holland coast	5/10 years	Giardino *et al.*, 2019

Bayesian Network approaches

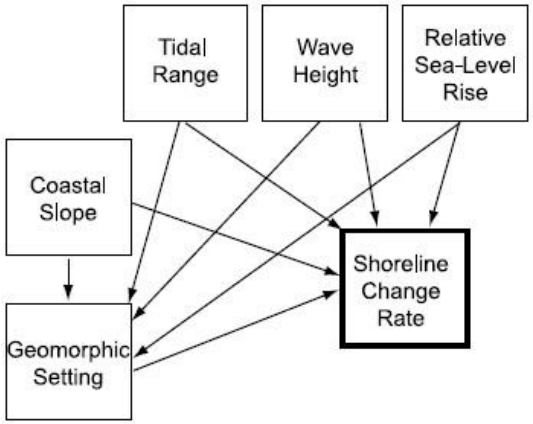
A Bayesian Network to predict coastal vulnerability to SLR

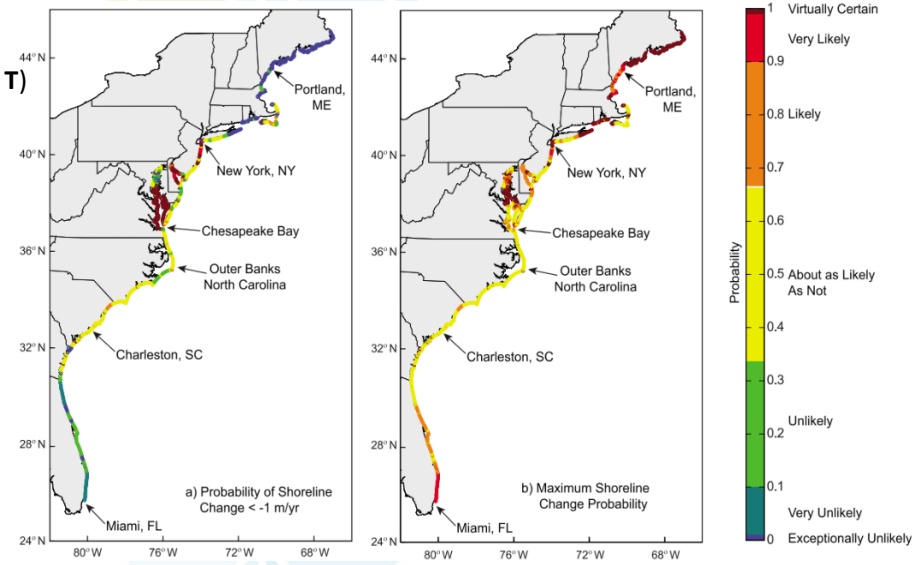
Gutierrez et al., 2011

Climatic threat/issue	Name of tool	Purpose	Scale
Long-term shoreline change/erosion	Bayesian Network	Assessment of long-term prediction uncertainty of shoreline change associated with sea level rise	National, Atlantic coast of the United States

The 6 nodes are divided into three categories:

- **Driving forces** (relative sea level rise rate **S**, mean wave height **W**, tidal range **T**)
- **Boundary conditions** (geomorphic settings **G**, coastal slope **β**)
- **Response** or **vulnerability indicator** (long-term shoreline change rate **R**)





Mapping outcomes

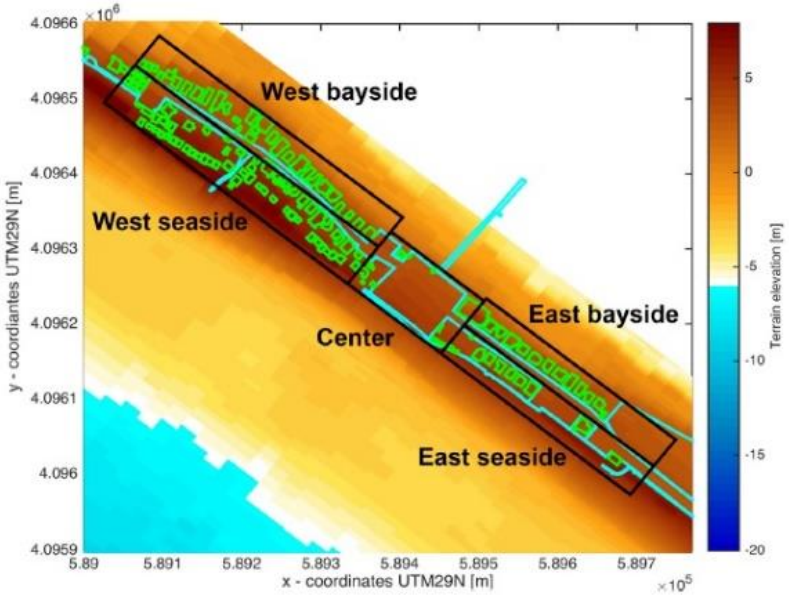
Bayesian Network approaches

Predicting coastal hazards for sandy coasts with a BN

Poelhekke et al., 2016

Climatic threat/issue	Name of tool	Purpose	Scale
Long-term shoreline change/erosion	Bayesian Network	Predicting coastal vulnerability SLR and assessing the interactions between barrier island geomorphic variables	Local, Praia de Faro, Portugal

The site has been divided into 5 areas



Configuration 1

- 4 boundary conditions
- Nodes discretised in 4 bins
- Erosion will take place? YES or NO

Configuration 2

- 4 boundary conditions
- Hazards discretised in 2 bins
- Erosion will take place above a certain threshold

Configuration 3

- 2 boundary conditions
- Hazards discretised in 2 bins
- Erosion will take place above a certain threshold

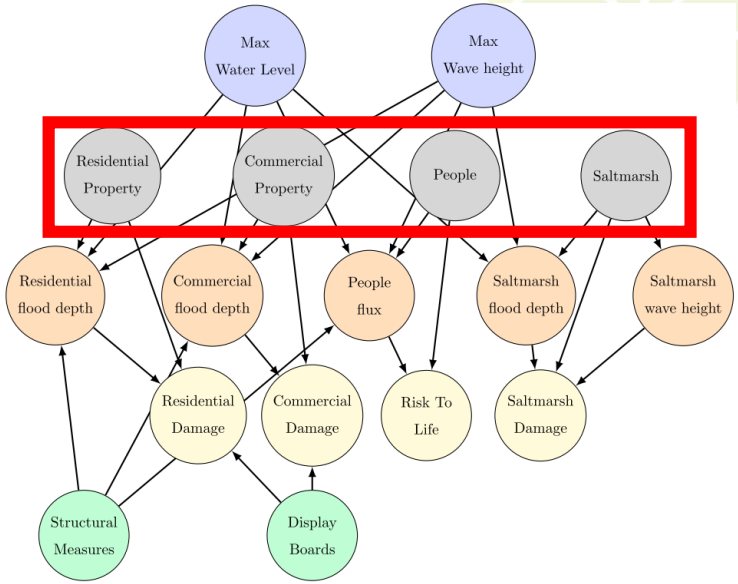
Baseline scenario analysis

Bayesian Network approaches

A Bayesian Network approach for coastal risk analysis and decision making

Jäger et al., 2017

Climatic threat/issue	Name of tool	Purpose	Scale
Erosion and flooding	Bayesian Network	Assessing the vulnerability to storm surges causing erosion	Local, North Norfolk – United Kingdom



- SOURCE: **Boundary conditions** (peak water level, max wave height, peak period, storm duration)
- PATHWAY: **Interaction** of water levels and waves with coastal landforms and ecosystems, coastal infrastructure and low-lying coastal hinterlands
- RECEPTOR: **Entities at risk** (people, built environments or ecosystems,…)

Integration of environmental and human receptors

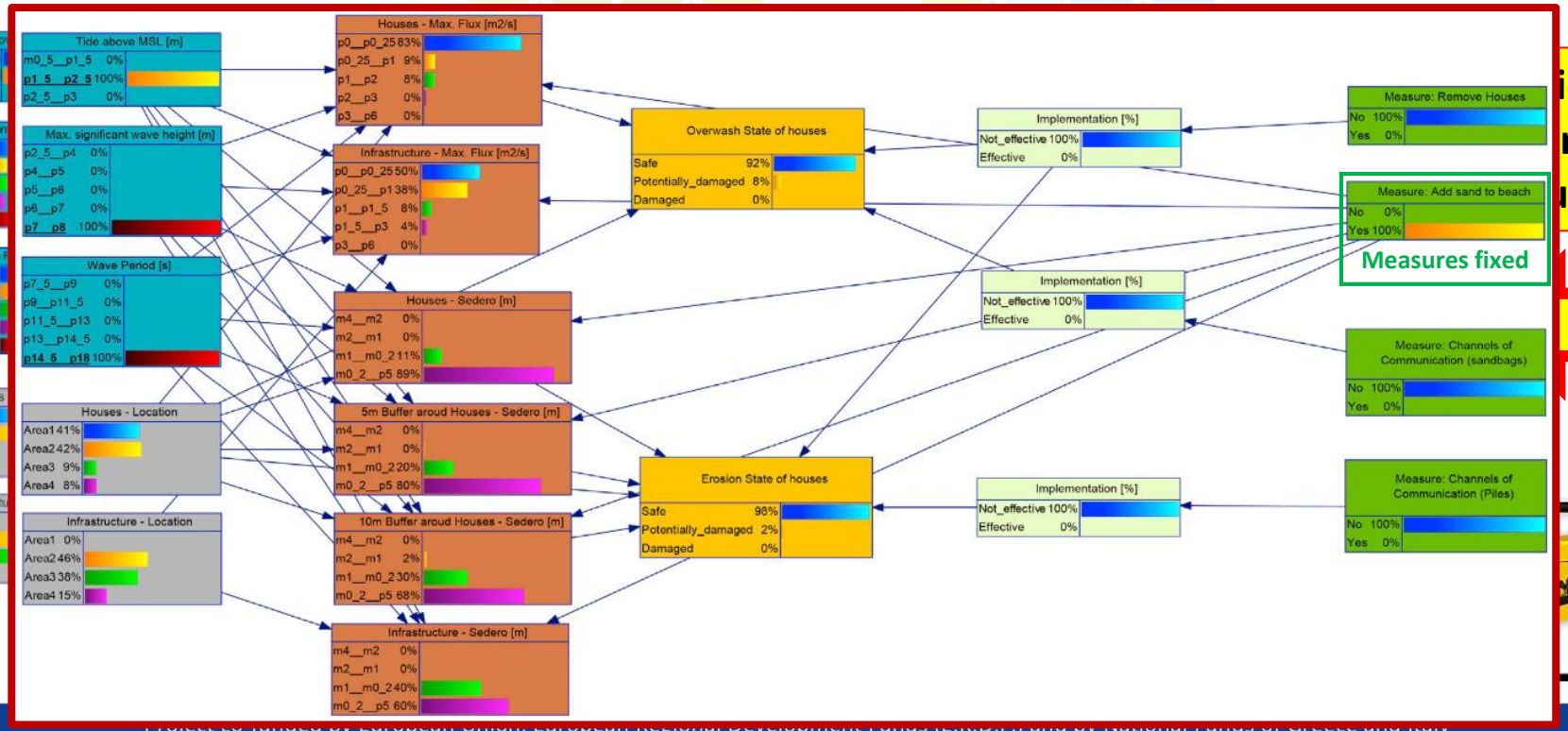
RISC-KIT

Bayesian Network approaches

Use of Bayesian Network for coastal hazards, impact and disaster risk reduction at a coastal barrier

Plomaritis et al., 2017

Climatic threat/issue	Name of tool	Purpose	Scale
Flooding and Coastal erosion	Bayesian Network	Reproduction of erosion, hazard potential impacts and the effect of the beach nourishment	Local, Ria Formosa coastal lagoon, Portugal

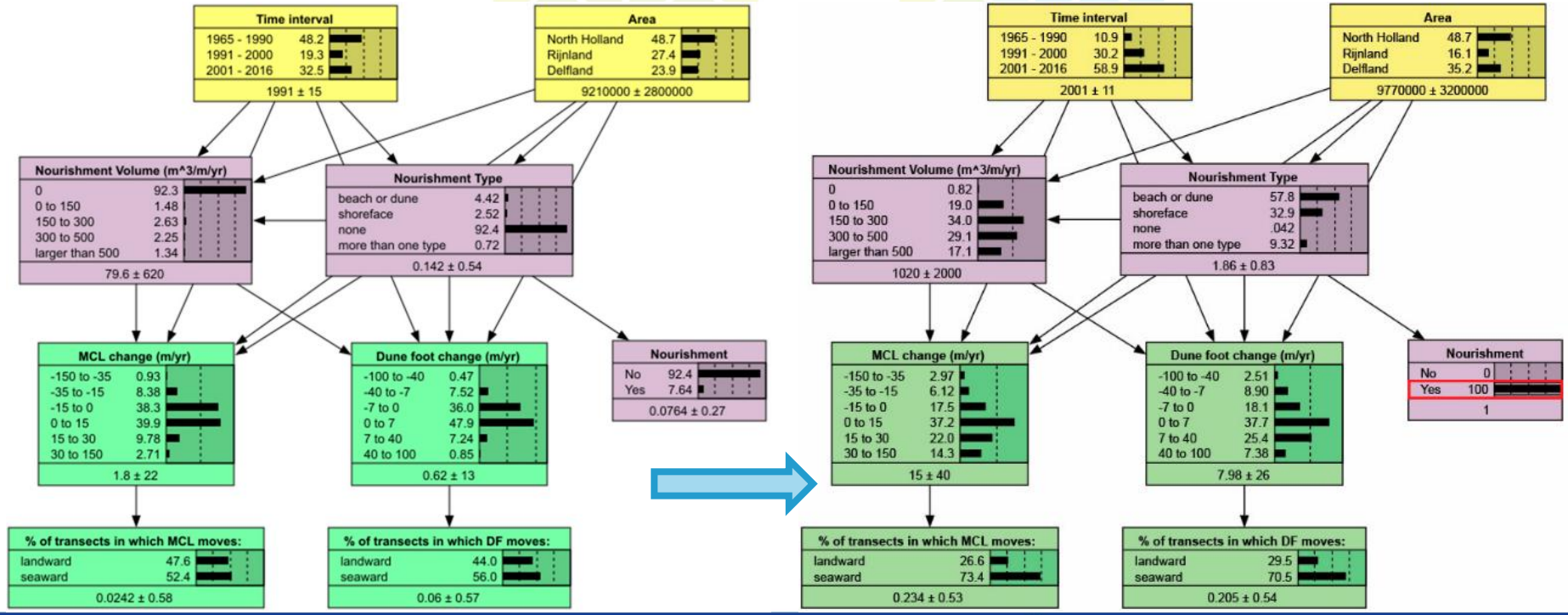


Bayesian Network approaches

A Regional Application of Bayesian Modelling for Coastal Erosion and Sand Nourishment Management

Giardino et al., 2019

Climatic threat/issue	Name of tool	Purpose	Scale
Coastal erosion	Bayesian Network	Quantify the issue of coastal erosion and assess the effectiveness of different nourishment designs in counteracting coastal erosion	National, Holland coast



Deliverable 3.5: CONCLUSIONS

Identification of tools

Identification of tools and methods (i.e. indicator and index-based, Decision Support Systems, remote sensing techniques, Bayesian Network approaches) already implemented for coastal erosion assessment and management in the cooperation area.

Identification of hotspots

Provide the tools and guidelines for the identification of hotspots and vulnerable areas, in order to support coastal erosion risk assessment and management implementing scenario analysis in the pilot cases.

APPLICATION

- Evaluation of coastal erosion processes (local scale)
- Development and implementation of coastal erosion risk-based management strategies

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Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy