Universidad de Cádiz
Facultad de Ciencias del Mar y Ciencias Ambientales

ScolaMAR
Erasmus+ Capacity building

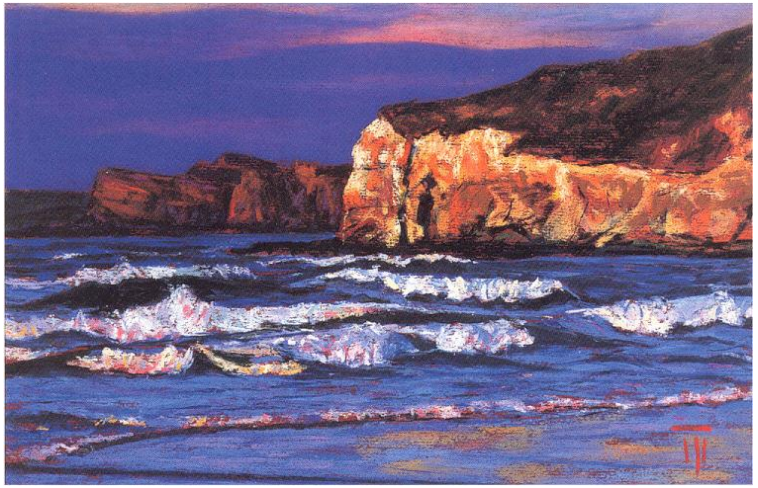
Co-funded by the Erasmus+ Programme of the European Union

ERASMUS+ Capacity Building – ScolaMAR Project

SCIENTIFIC CONFERENCE ON COASTAL RISKS:
RISKS FOR SOCIETIES' FACING ENVIRONMENTAL CHANGES VERSUS RISKS FOR NATURE UNDER HUMAN PRESSURE

(April 23-24, 2019)
Faculty of Sciences, University Mohammed V Rabat

Response to coastal erosion: examples from Spain and Italy



Prof. Giorgio Anfuso
Dpto Ciencias de la Tierra
Facultad de Ciencias del Mar y Ambientales
Polígono Río San Pedro s/n, 11510 Puerto Real (Cádiz), España.
E-mail: giorgio.anfuso@uca.es

Coastal Erosion

Effects of North Sea storm in 1953 in The Netherlands

Views of inundated areas in New Orleans following breaking of the levees surrounding the city as the result of storm surge from Hurricane Katrina - 2005

New Orleans – Katrina 2005

- **500 km defences damaged**
- **2000 km^2 flooded**

Coastal flooding

- **1835 human deaths**
- **72,000 evacuated**

Practical recommendations - we have to answer to following questions:

- **Where does erosion occur?**
- **Why does erosion occur there?**
- **Which values are at risk?**
- **What should be done to safeguard these values?**

- **Where does erosion occur?**

Observations, information from local inhabitants, aerial photographs, maps, etc.

- **Why does erosion occur there?**

Negative sedimentary budget. Reasons:

- **Longshore transport**
- **Offshore transport**
- **Accumulation of sediments up-drift of human structures**
- **Reduction of fluvial supplies**
- **Erosion due to specific currents**

- **Which values are at risk?**

Erosion is a natural process and problems rise when human structures are at risk:

- **Human life**
- **Land of economic value**
- **Areas of cultural and/or ecologic interest**

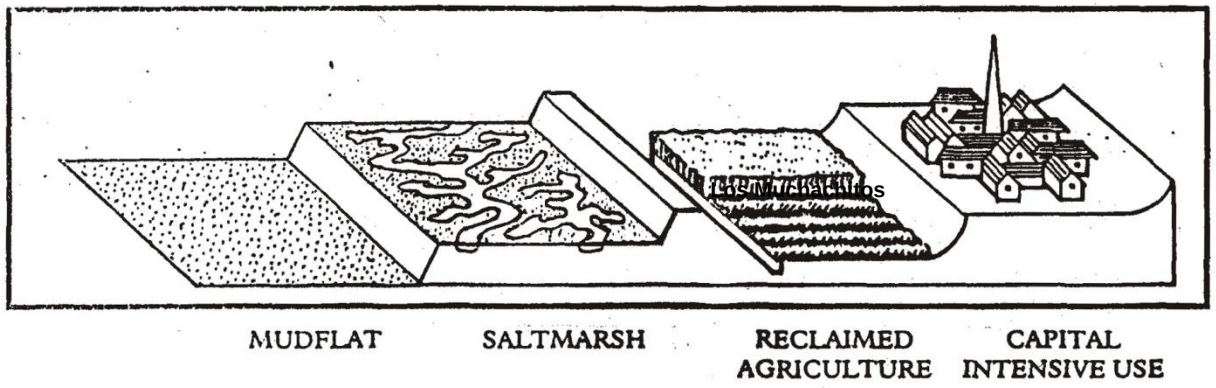
- **What should be done to safeguard these values?**
  - **Do nothing**
  - **Accommodation**
  - **Relocation**
  - **Protection**

Do nothing:

- **Expensive measures**
- **Low economic value**

Los Muchachitos

SCENARIO 1 **Managed retreat - abandonment of current line of sea defence protecting land in low-value use**



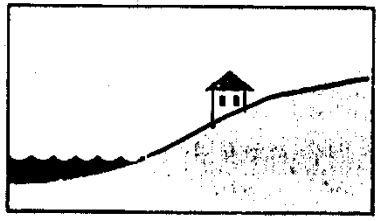
- **Salt marshes are not able to migrate landward because defenses - “coastal squeeze” (Doody 2004)**
- **The present defense is abandoned**

Theoretical framework for erosion management

Accommodation:

ACCOMMODATE

- **Structures are modified (e.g. on piles)**

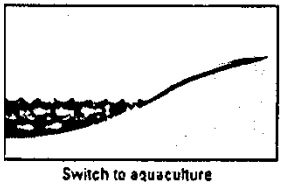


Buildings

- **Change land use**

Wetlands

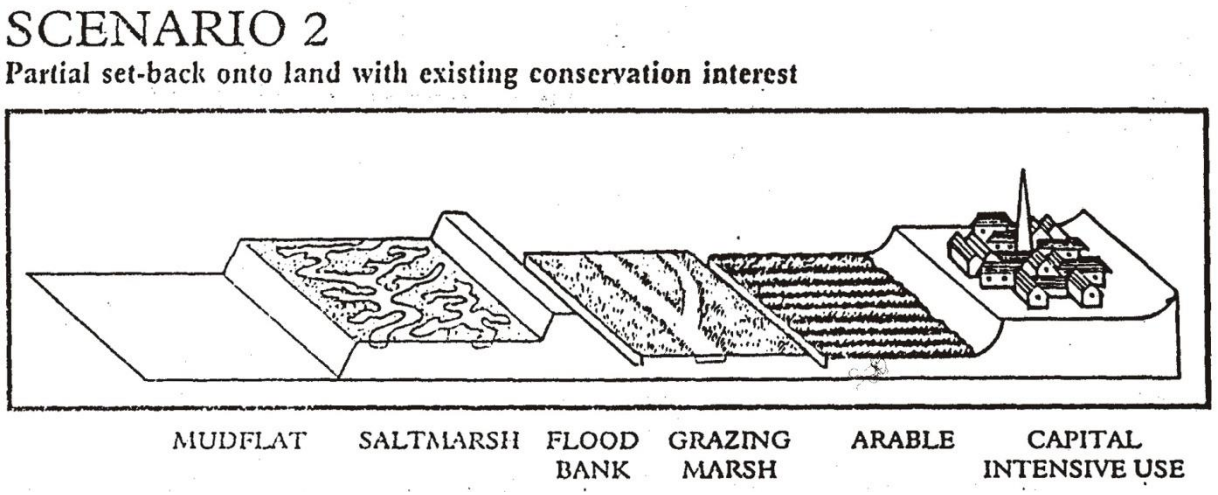
Crops

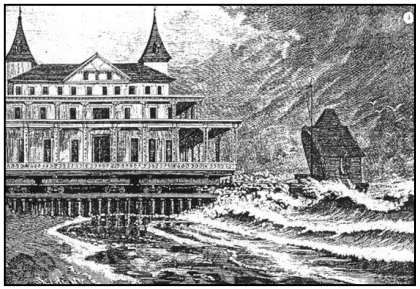


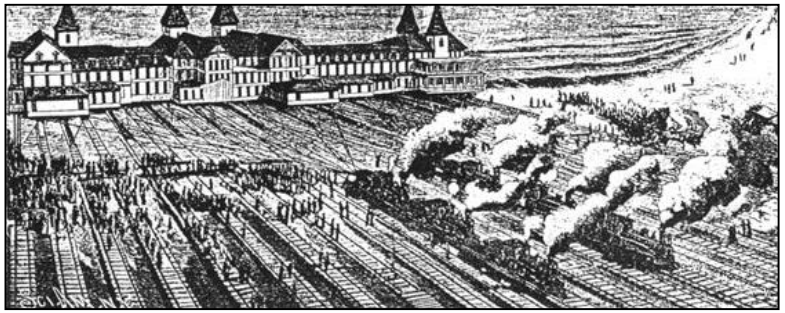
e.g. agricultural are transformed in salt harvesting areas or aquaculture areas

Relocation:

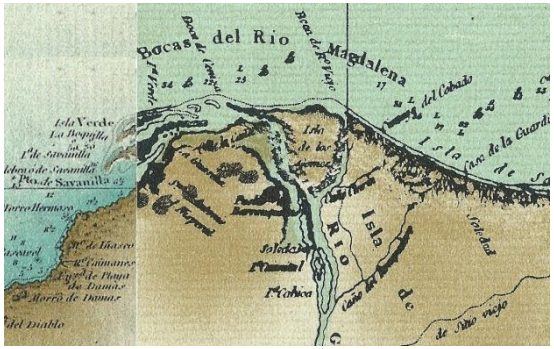
- **Is economically advantageous**
- **We move inland roads, houses, etc.**







Relocation:



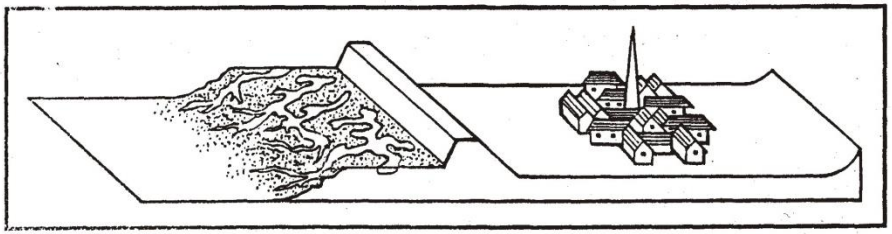
Delta Río Magdalena
Mapa Brigadier Fidalgo,
fecha: 1792 -1812

Protection:

- **Land use of great economic value**
- **Different types of intervention**

SCENARIO 3

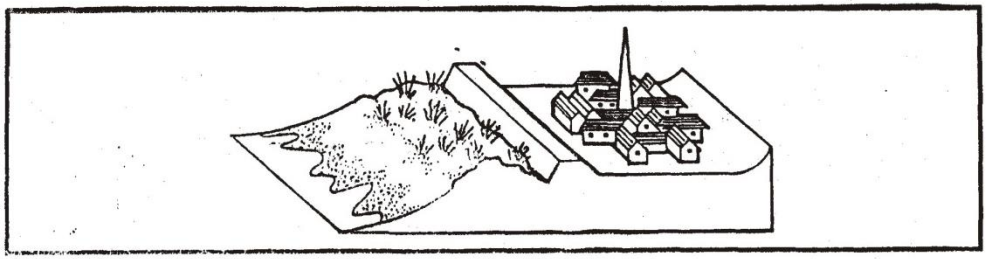
Maintenance of existing defences on muddy coasts protecting low-lying land in high-value use



MUDFLAT | DEGRADED SALTMARSH | FLOOD BANK | DEVELOPED EXPANSE OF LOW LYING LAND

SCENARIO 4

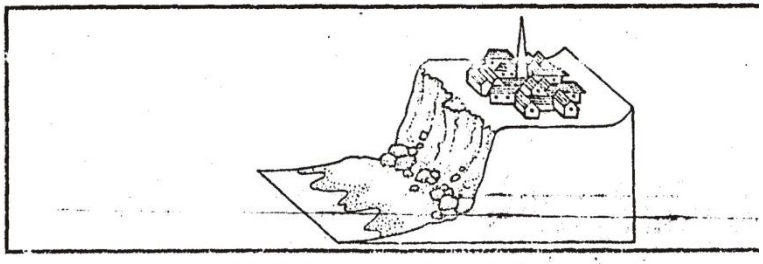
Maintenance of existing defences on sandy coasts protecting low-lying land in high-value use



BEACH | CAPITAL INTENSIVE USE

SCENARIO 5

Management of eroding soft cliffs fronting land in high-value use



BEACH AND FORESHORE | ERODING CLIFF | CAPITAL INTENSIVE USE

What about public opinion?

- **They generally prefer protection**

- **We have to convince public opinion that the solution depends on several things….if we are not able a "political" solution is preferred versus a "technical" one (in this case straw)**

Photo: Fige-finger, Ireland; action to protect dunes.
Copper & McKenna (2008). Working with natural processes: the challenge for coastal protection strategies. The Geographical Journal, 174 (4): 315-331.

Response to coastal erosion

Protection:

- ***Hard solution***
- ***Soft solution***

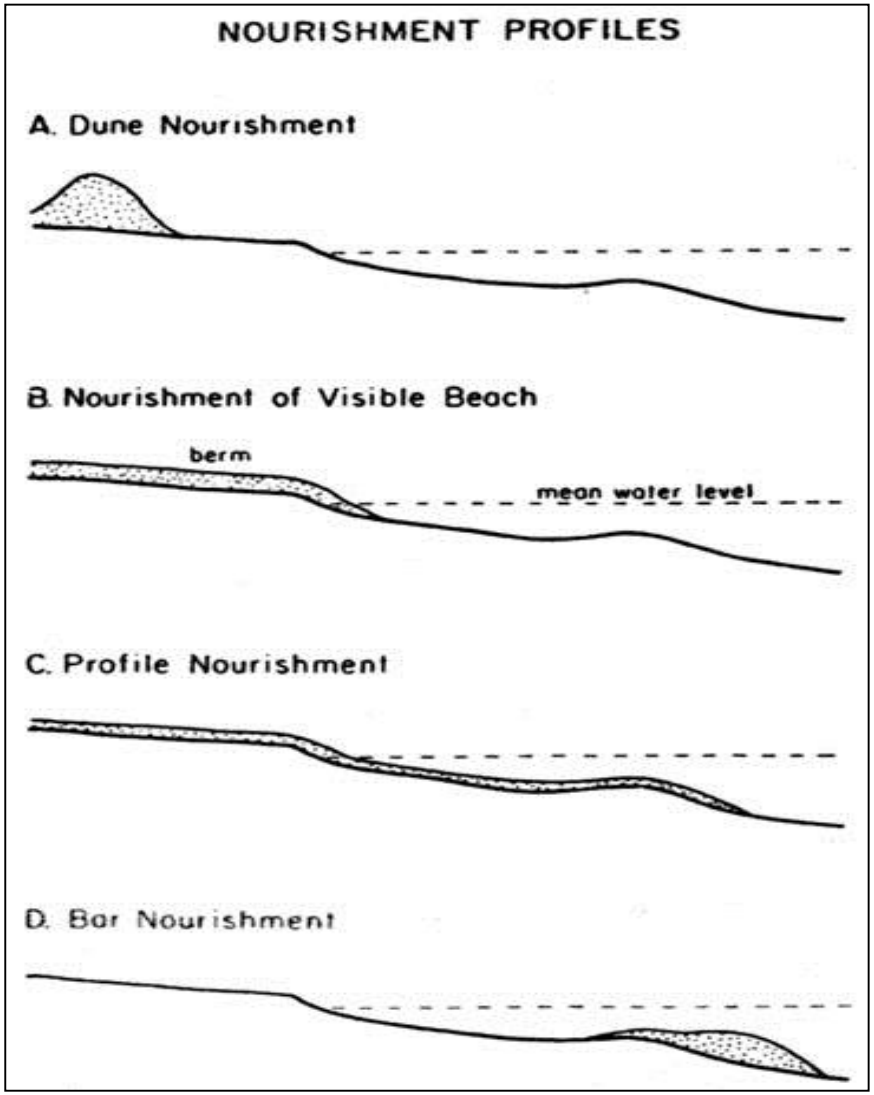
Hard structures

- **Seawalls**
- **Revetments**
- **Groins and Jetties**
- **Breakwaters**

Soft solutions

- ***Nourishment***

Beach nourishment



Borrow sand can be deposited on the..

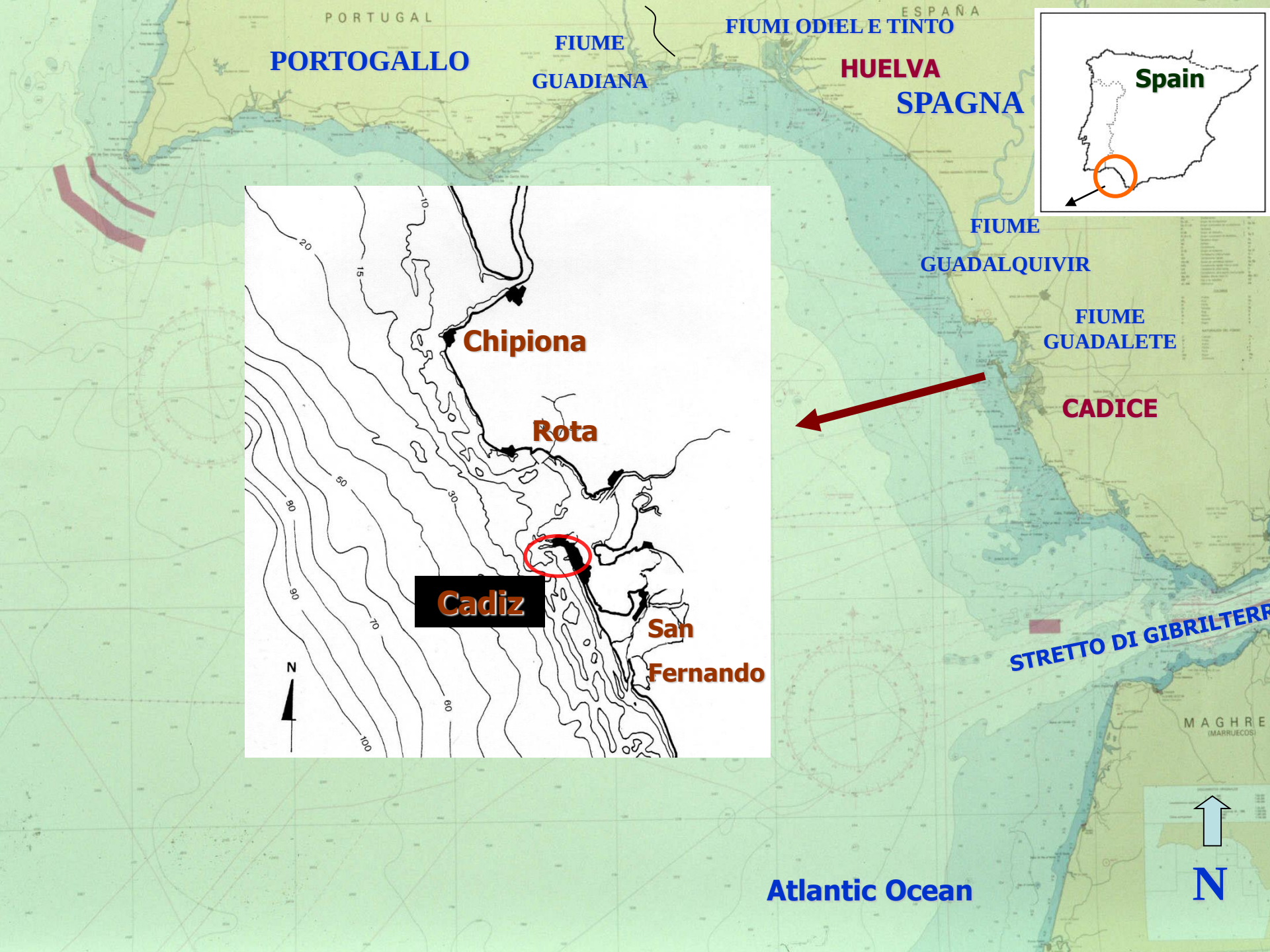
- **Dune**
- **Dry beach**
- **Dry beach and foreshore**
- **Longshore bar**

SPAIN

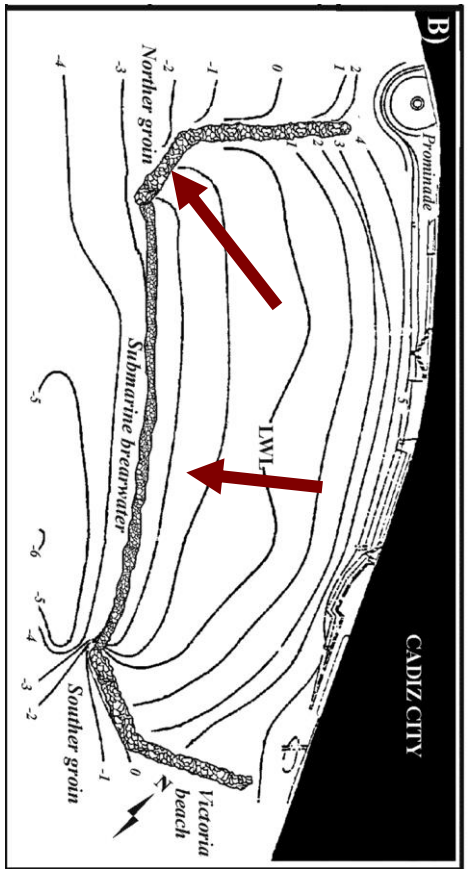
NOURISHMENT STUDY CASE: SANTA MARIA DEL MARE (CADIZ)

The example is representative of all nourishment works on the

Atlantic side of Cadiz Province

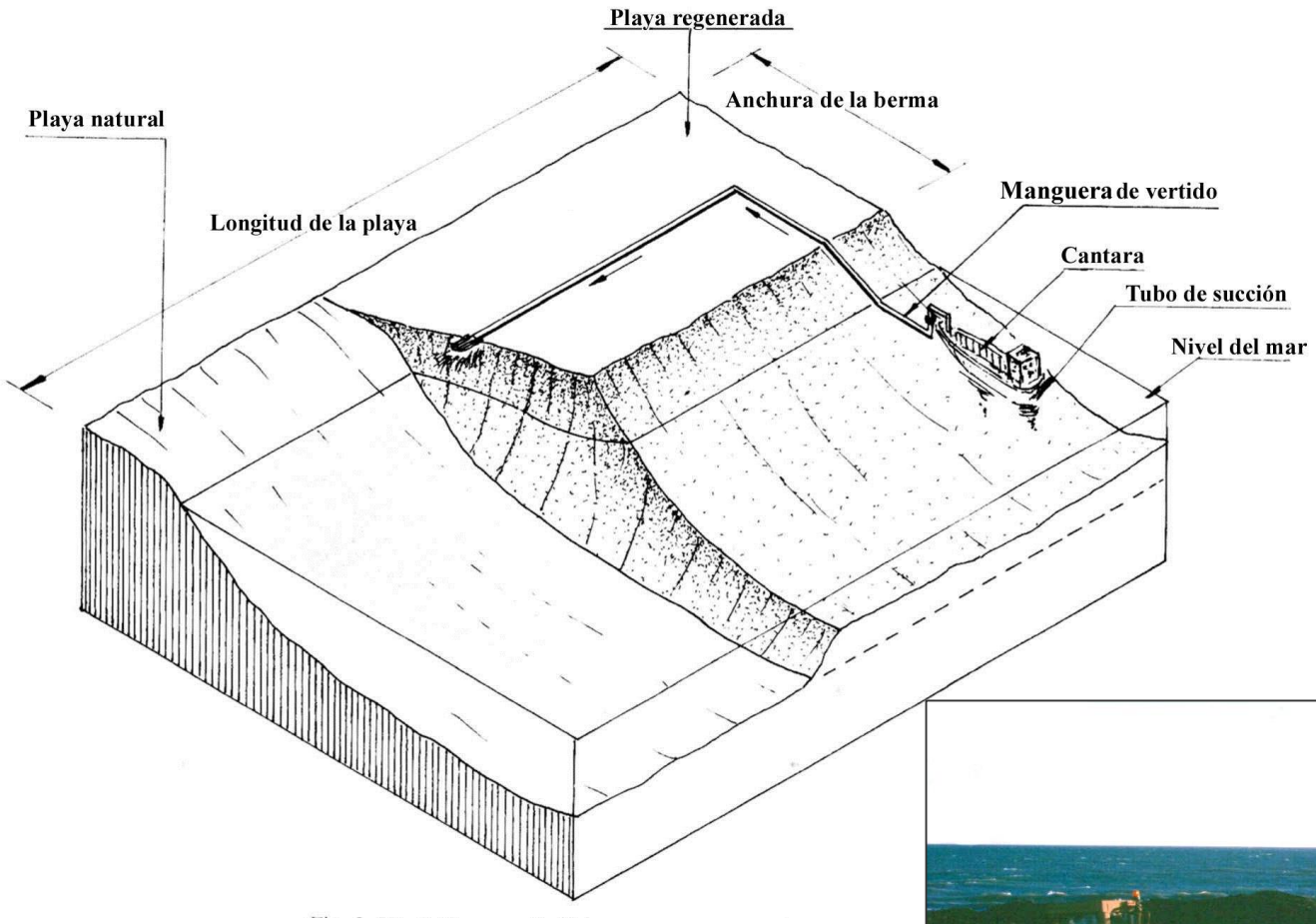

PORTUGAL
PORTOGALLO
FIUME
GUADIANA
ESPAÑA
FIUMI ODIEL E TINTO
HUELVA
SPAGNA
Spain
FIUME
GUADALQUIVIR
FIUME
GUADALETE
CADICE
Chipiona
Rota
Cadiz
San
Fernando
STRETTO DI GIBRILTERR
MAGHRE
(MARRUECOS)
Atlantic Ocean
N
10
20
15
50
30
80
90
70
60
100
N

Protection and Nourishment works



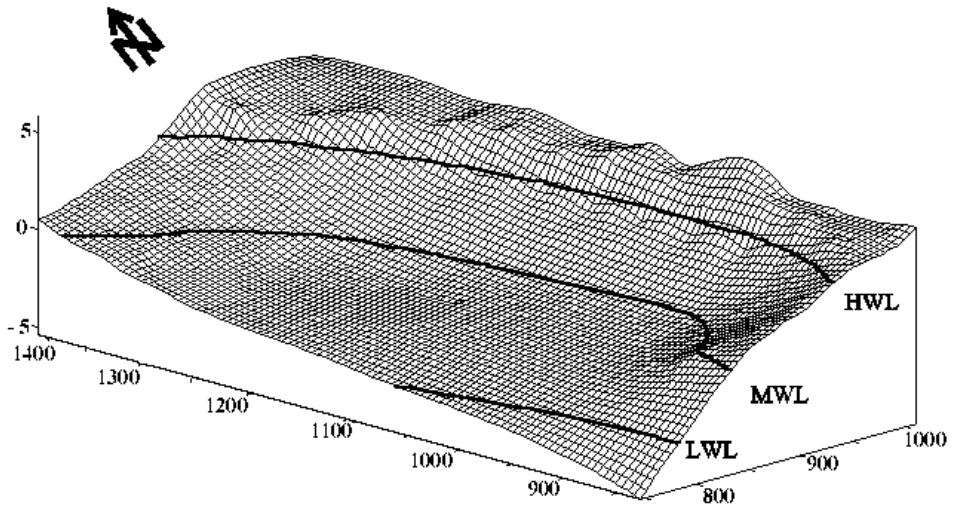
- **Different groins and a submerged breakwater were emplaced**
- **Several nourishments, 300,000 m^3 in 1999 and in 2001 a new nourishment 80.000 m^3**
- **Enlarge the dry beach**

Nourishment works



Nourishment works

- **A great artificial berm was formed**
- **The initial dissipative profile was transformed into a reflective one**
- **Borrow sand was coarser than natural one but with many shell fragments (20%)**



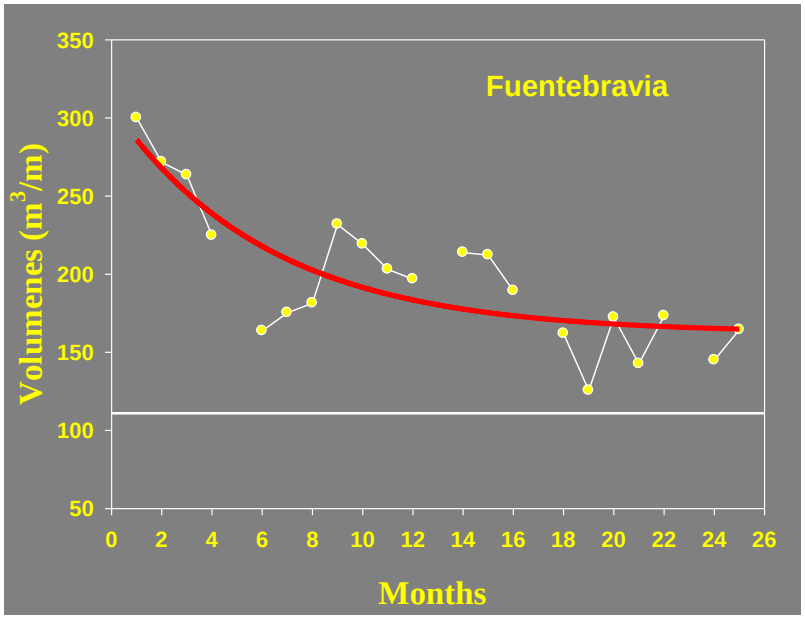
Morphology

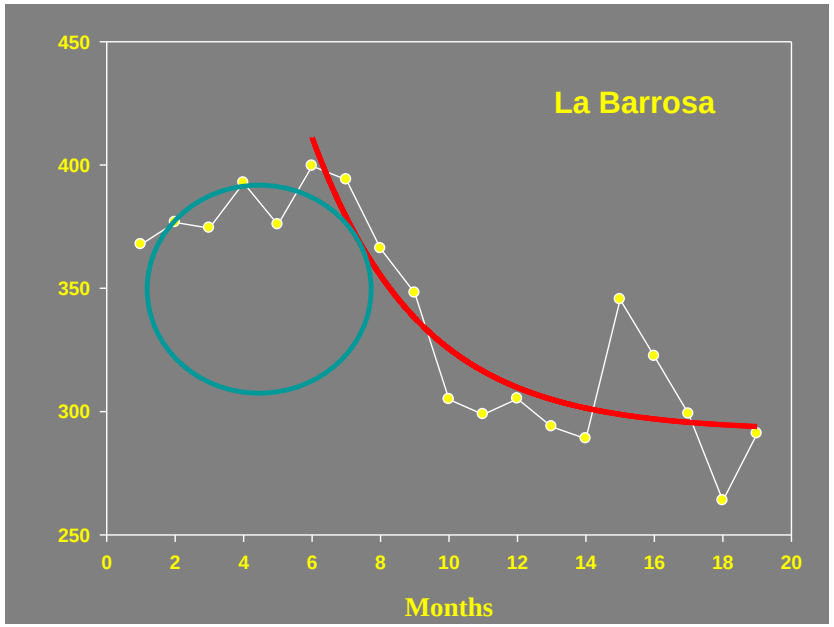
PROVINCE OF CADIZ (SW SPAIN)

Beach characteristics	La Costilla	Fuentebravia	Aculadero	La Barrosa
Dry beach (m)	5	52	0	60#
Foreshore (m)	85	30-40	5	120-130
Slope (%)	1-2	3	--	2
Profile	Dissip.	Dissip.	--	Dissip.
Granulometry (mm)	0.35	0.20	0.47	0.20
Nourishment	9/96	9/96	9/96	9/94
Volumes (m^3)	95000	135000	160000	460000
Volum per profile per m^3/m	113	129	111	652#
Length (m)	500	700	750	800
Increase of dry beach (m)	55	22	47	100#
Foreshore slope (%)	5	4.7	7.8	5
New beach profile	Reflective	Inter. Reflec.	Inter.Reflec	Reflective
Sand source	Port	Port	Port	Offshore
Granulometry of borrow (mm)	0.36	0.22	0.31	0.26

Nourished beach evolution

$$V(t) = y_0 + ae^{-kt}$$





Mediterranean Andalusia littoral

- Hard structures were emplaced from the 70s
- In recent decades they were removed or reshaped and nourishment carried out

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Decadal evolution of coastline armouring along the Mediterranean Andalusia littoral (South of Spain)

Giorgio Manno [a], Giorgio Anfuso [b,*], Enrica Messina [a], Allan Thomas Williams [c,d], Miguel Suffo [e], Vincenzo Liguori [a]

Data from the Mediterranean coast of Andalusia

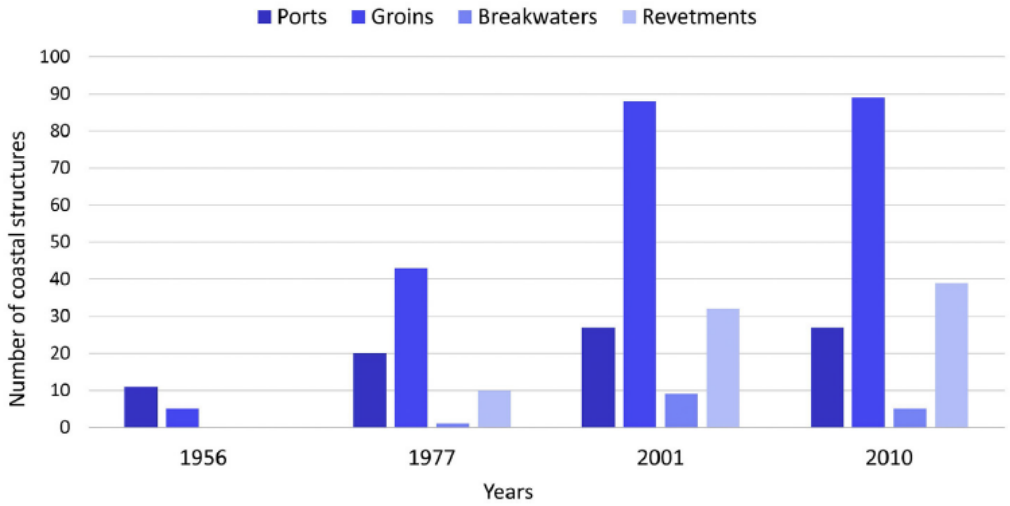
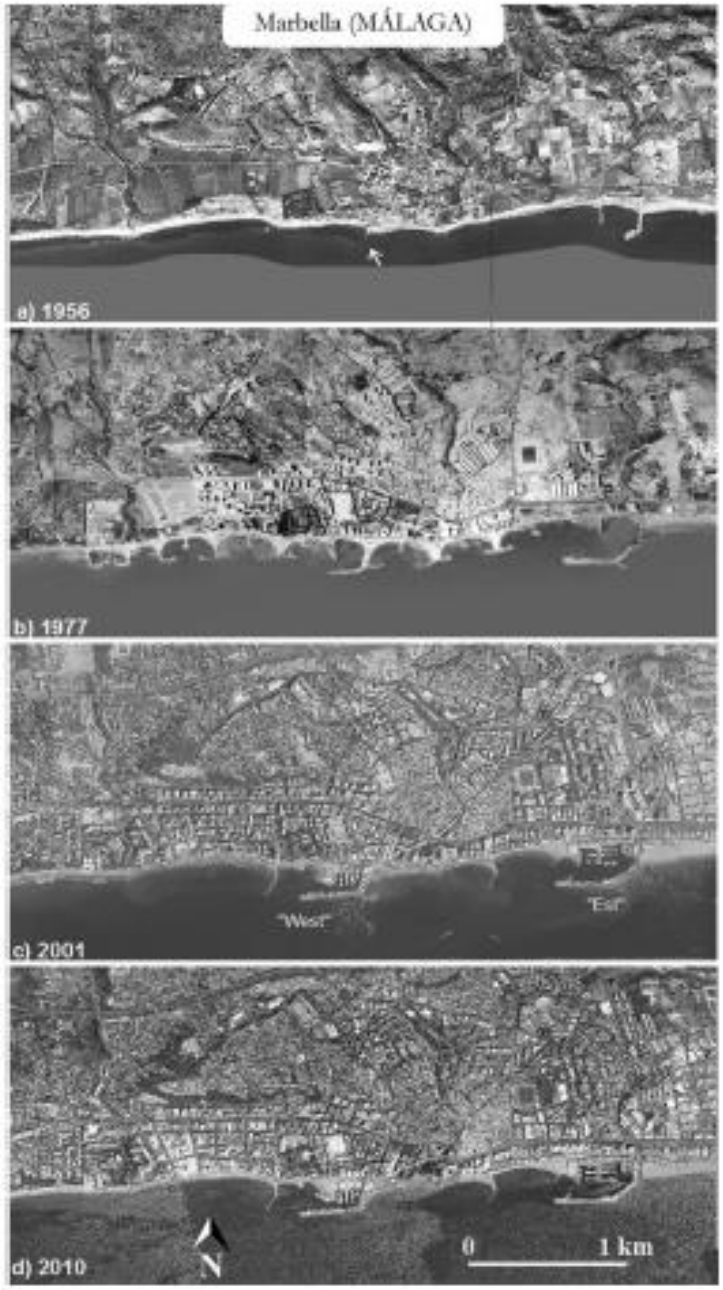


Fig. 2. Total number per year of ports, groins, breakwaters and seawalls/revetments. The number of structures does not coincide with data presented in Table 2 that shows coastal structures length per sectors, which often is the sum of different structures.



Coastal structures' evolution at Marbella

ITALY

Location


Zagreb
Croacia
Belgrad
Serbia
Sarajevo
Montenegro
Podgorica
Italia
Isola d'Elba
Mar Adriático
Corse (Corsica)
Roma
Tirana
Albania
Isola Maddalena
Isola d'Ischia
Isola di Capri
Kerkyra
Cala Gonone
Mar Tirreno
Sardegna (Sardinia)
Isola Lipari
Mar Jónico
Sicilia (Sicily)
Túnez
Malta
© 2016 Basarsoft
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US Dept of State Geographer
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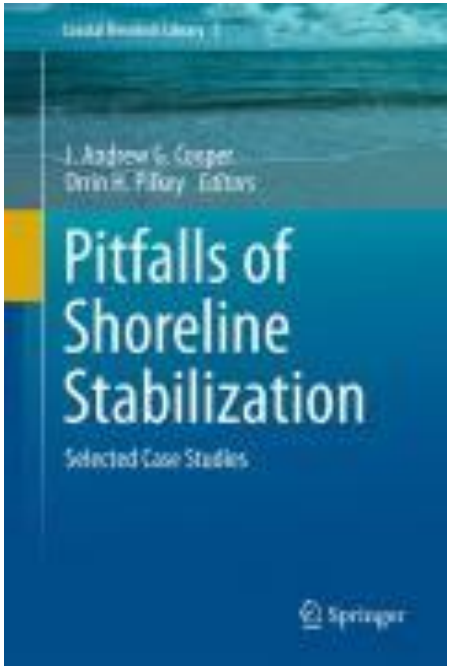
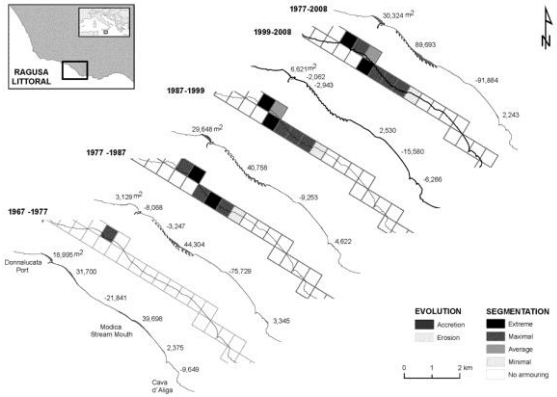
Guía turística
Fecha de las imágenes: 12/14/20





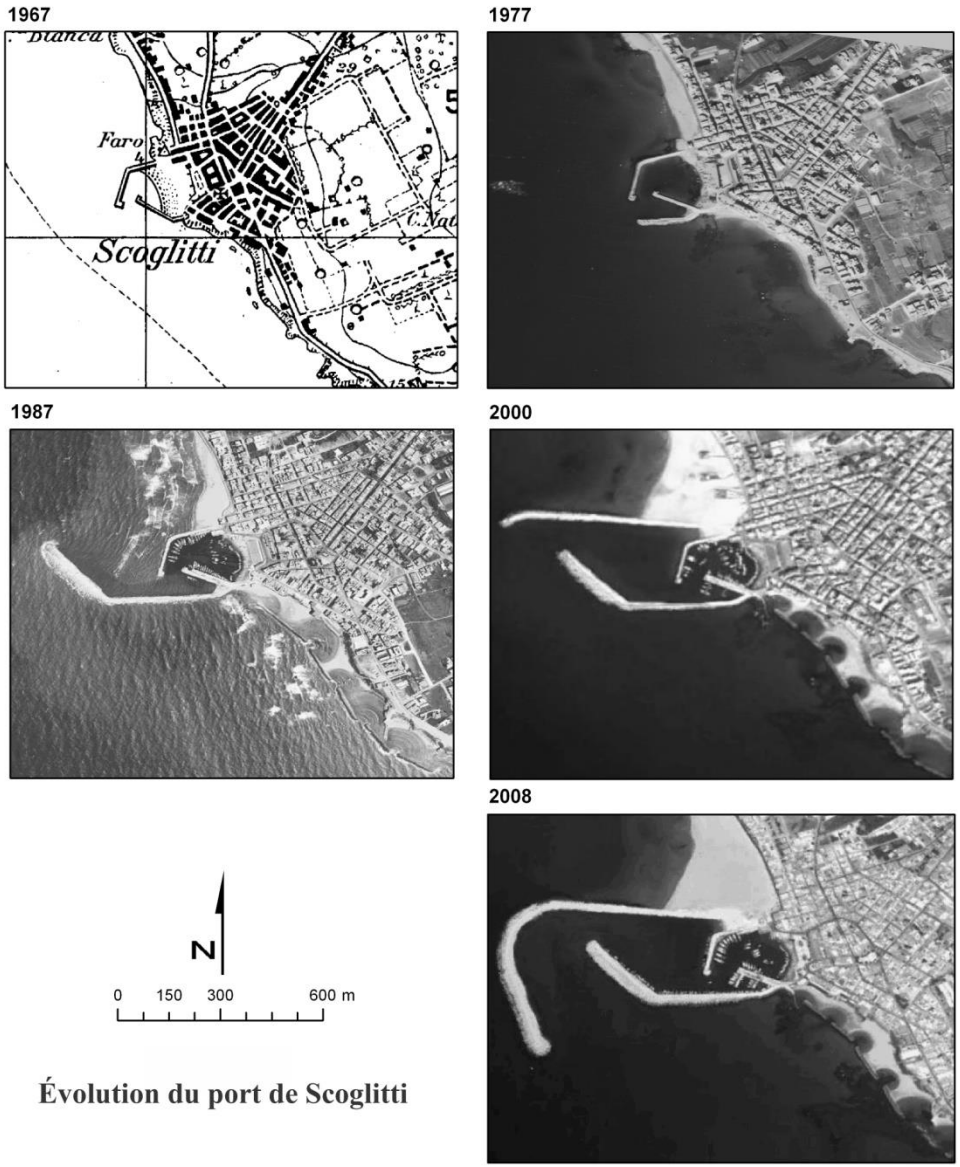
13. Bad practice in erosion management: the Southern Sicily case study

Anfuso, G., Martínez, J.A. y N. Rangel





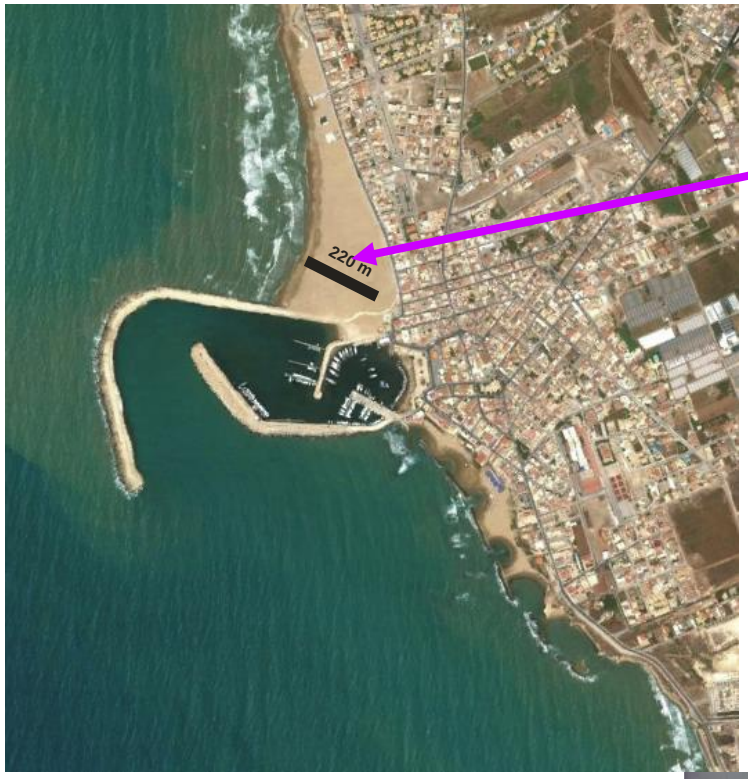
Evolution 1967-1999 at Scoglitti harbour – a common situation close to port structures



Évolution du port de Scoglitti

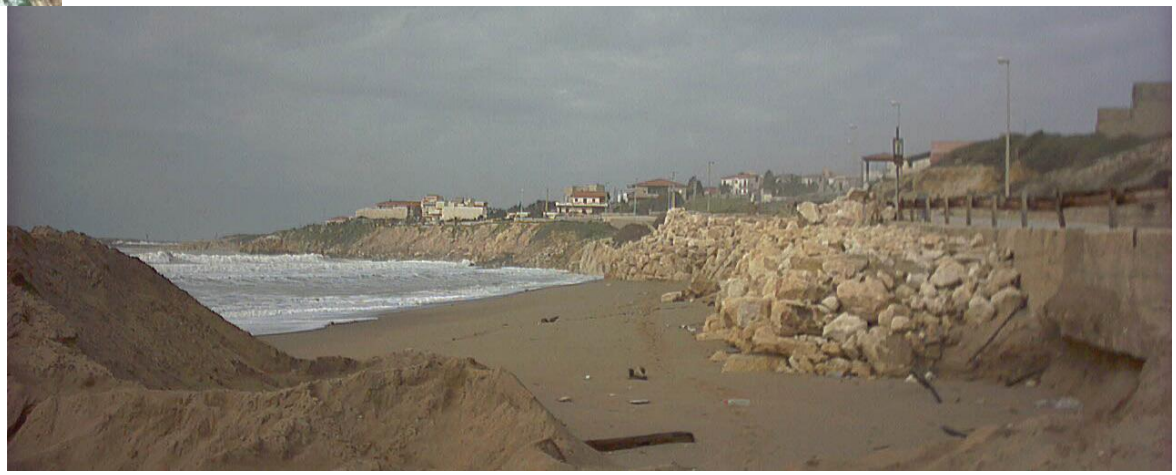
Last works in 2010,
10 mil of euro

Evolution 1967-1999 at Scoglitti harbour – a common situation close to port structures



220 m, small dunes migrating landwards

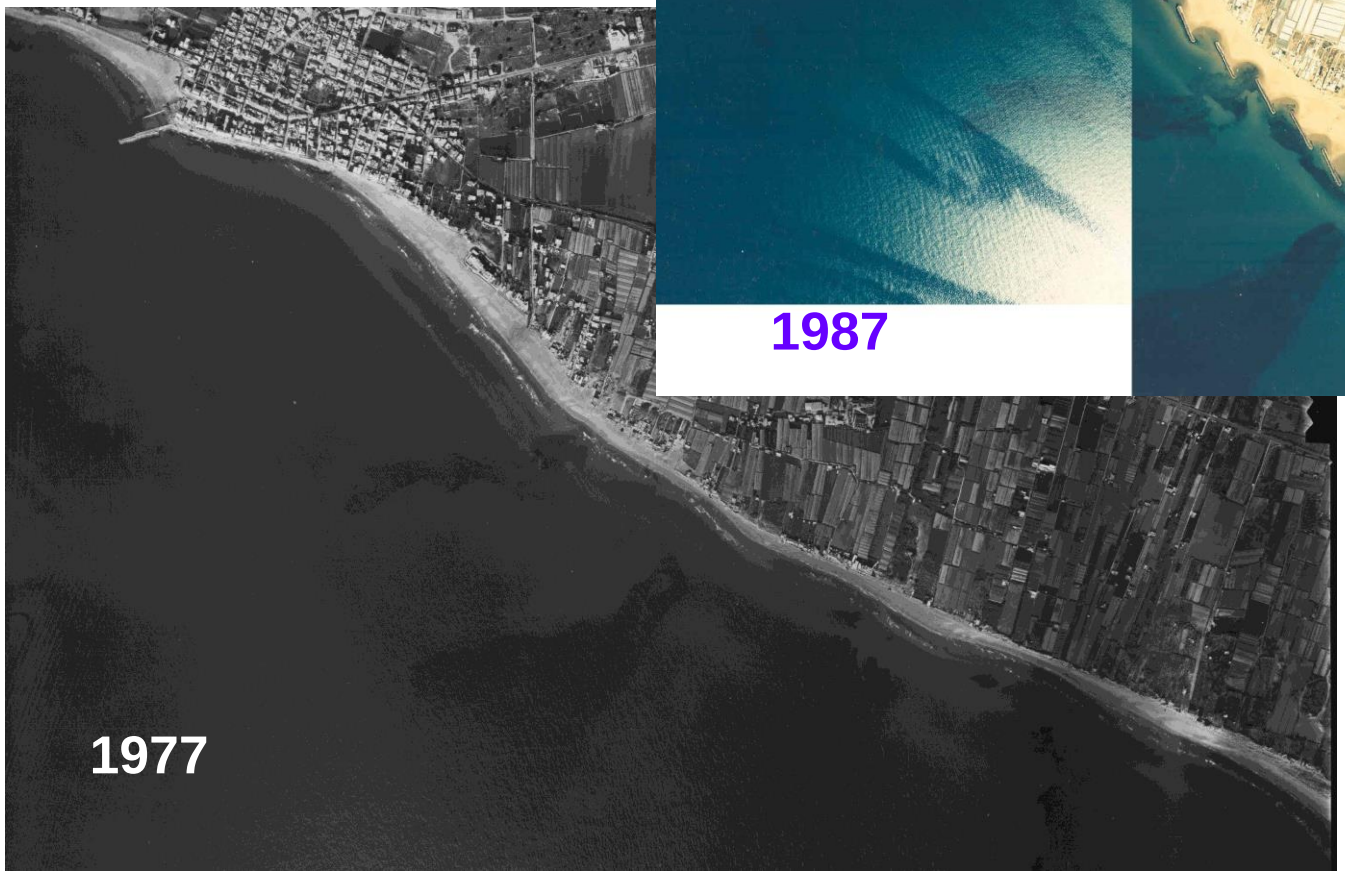
Downdrift Erosion



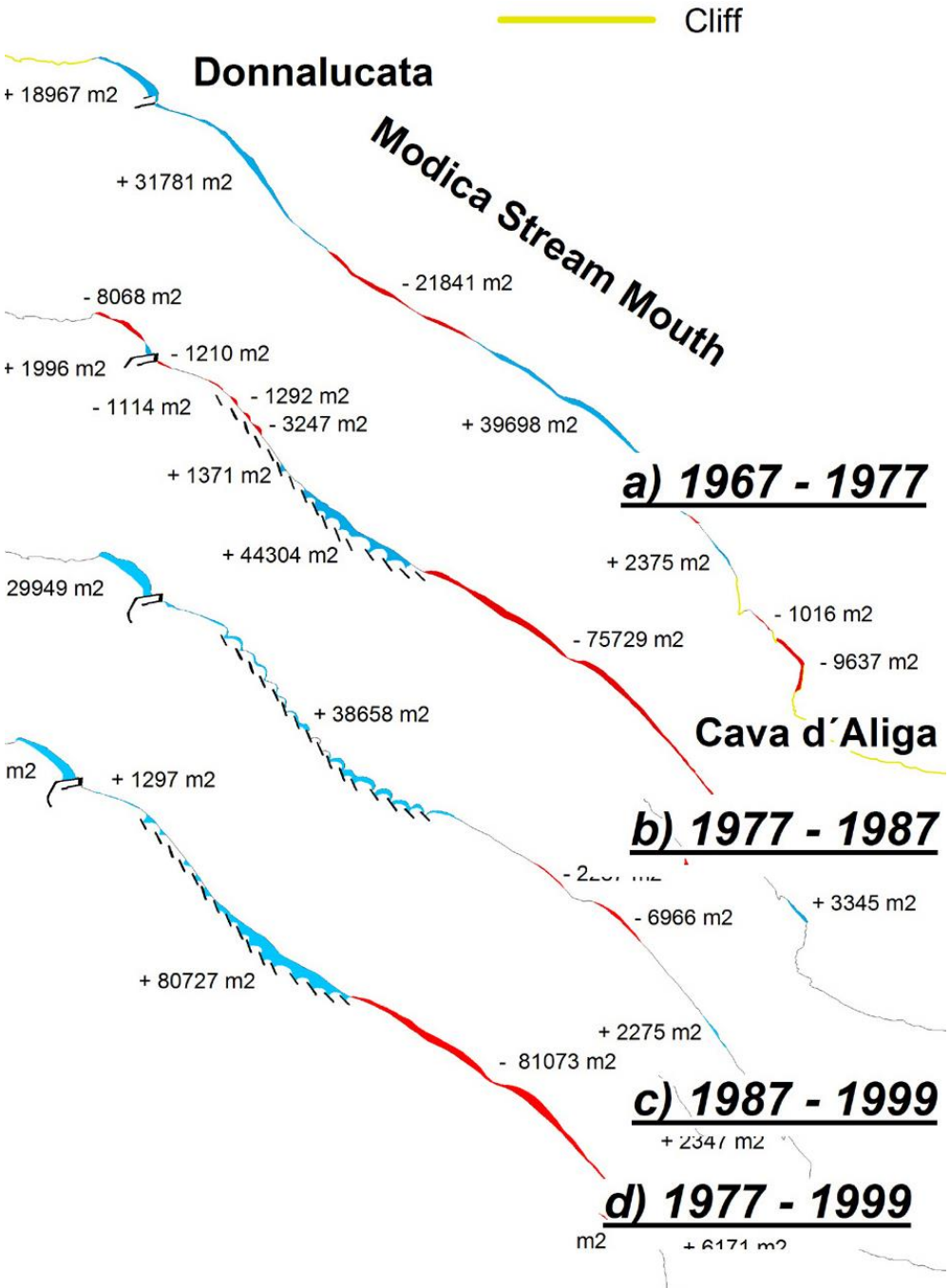
Donnalucata

Donnalucata – Filippa-Arizza

1987



1977



Donnalucata – P. Bruca

Great impact of ports: construction of breakwaters

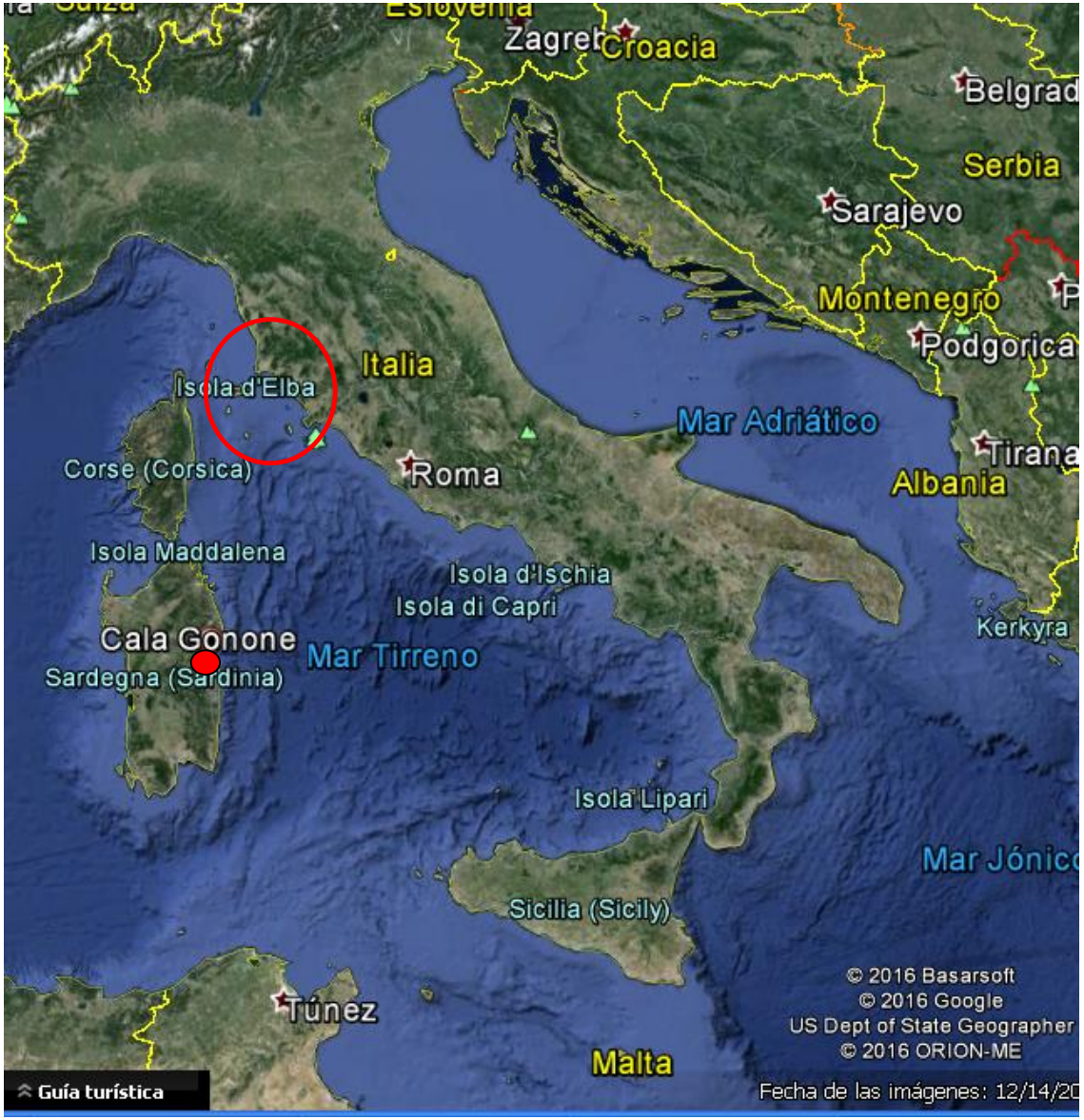
Structures shift erosion downdrift and new structures are emplaced….domino effect

¡16!

Beach nourishment at Caucana (Ragusa Province)

70,000 cubic meters of gravel from land and small structures

Location


Zagreb
Croacia
Belgrad
Serbia
Sarajevo
Montenegro
Podgorica
Italia
Isola d'Elba
Mar Adriático
Corse (Corsica)
Roma
Tirana
Albania
Isola Maddalena
Isola d'Ischia
Isola di Capri
Kerkyra
Cala Gonone
Mar Tirreno
Sardegna (Sardinia)
Isola Lipari
Mar Jónico
Sicilia (Sicily)
Túnez
Malta
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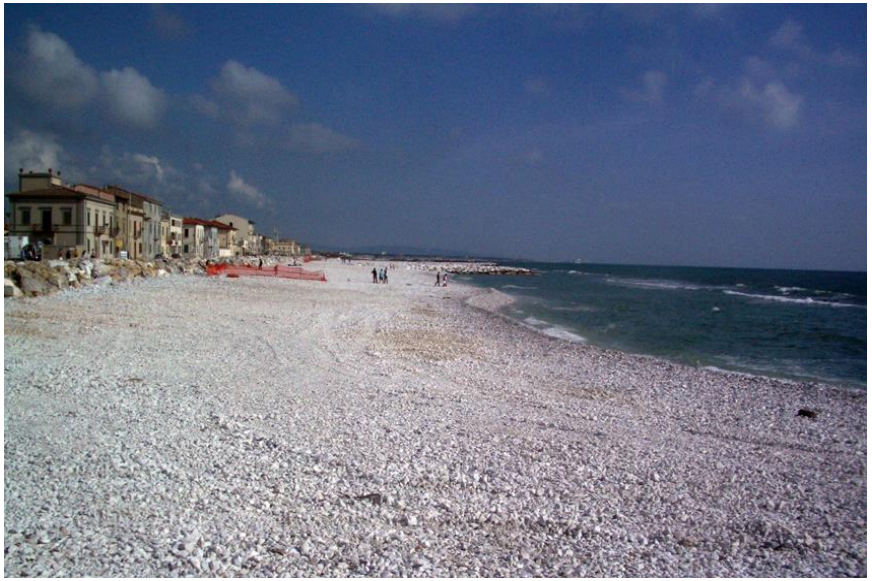
Guía turística
Fecha de las imágenes: 12/14/20

Shore protection projects

Enzo Pranzini

University of Florence

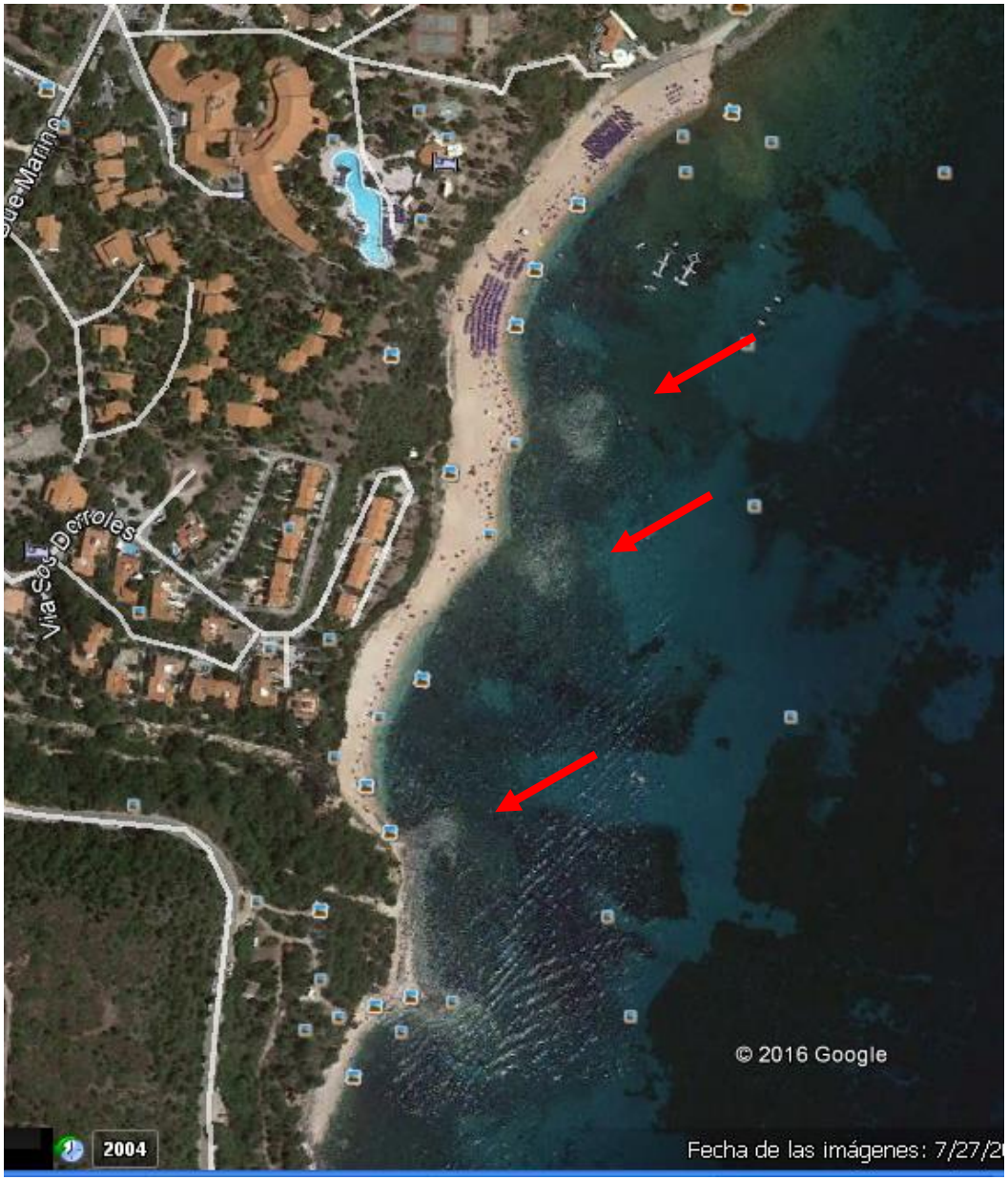
epranzini@unifi.it



Cala Gonone, Sardegna (1994-1996)

New beach creation with quarried granules, stabilized by semi-natural shoals with rounded stones

Cala Gonone, Sardegna (1994-1996)



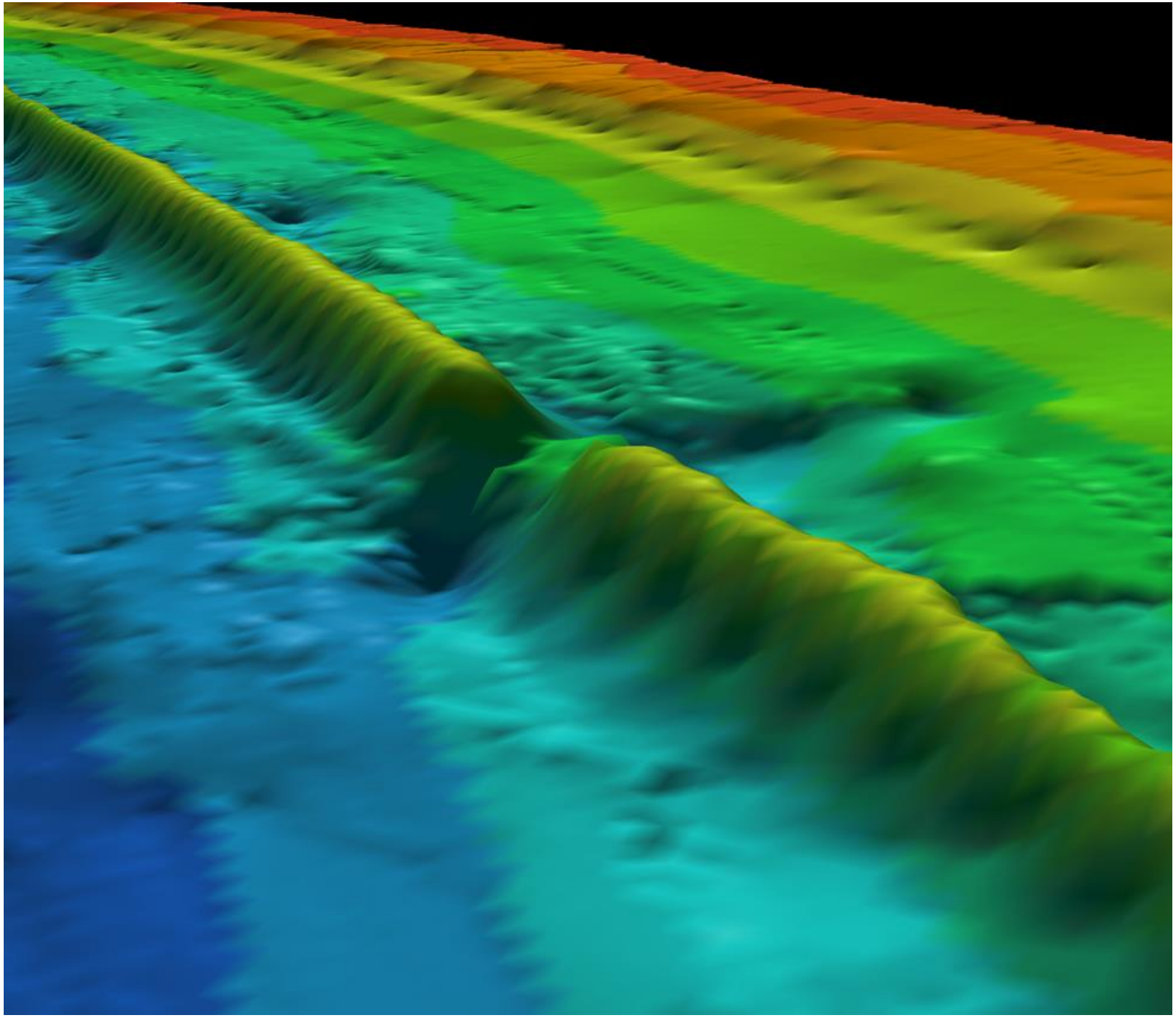
Original

1 yr later

Marina di Pisa, Italy

Marina di Pisa (2007)

Detached breakwater lowering at -0.5 m
Gravel beach creation



Cecina Mare, Livorno (1990)

Small beach nourishment and extension of two old groins with short submerged segments.

Macchiatonda, Grosseto (2009)

Geotextile submerged groins.
Beach nourishment with nearshore sand.

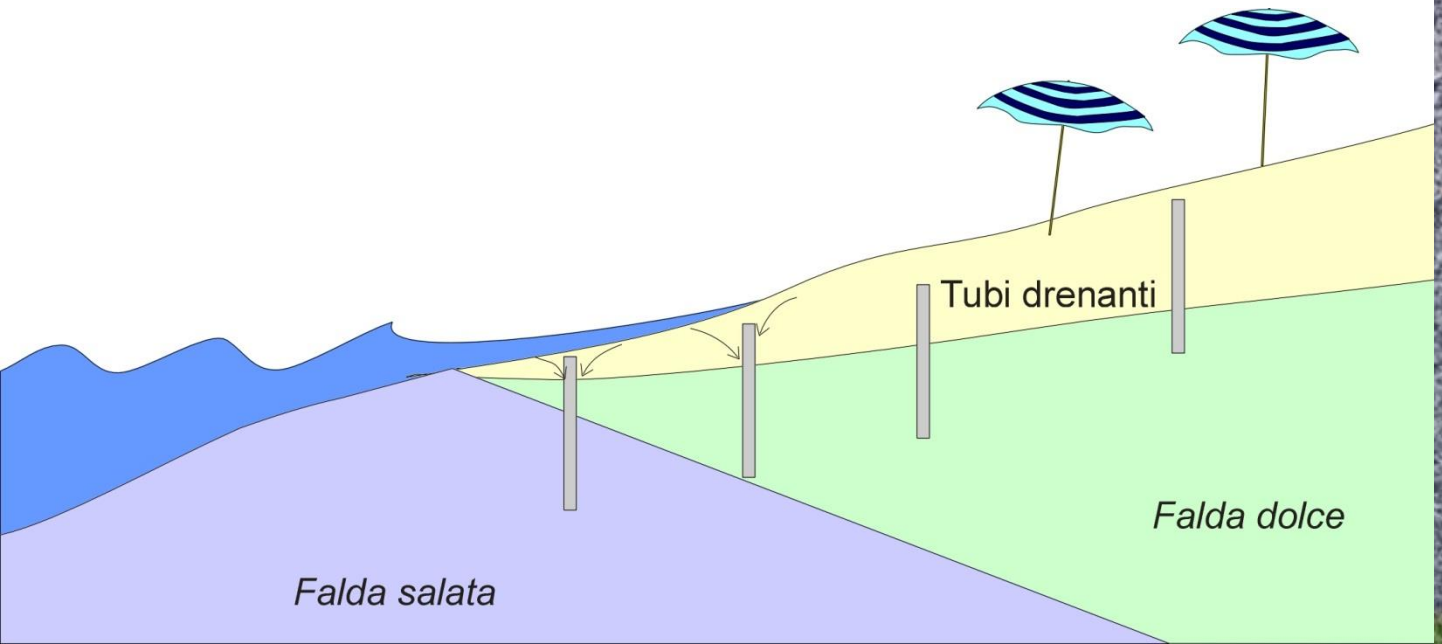
Cecina Mare, Livorno
(2012-2015)

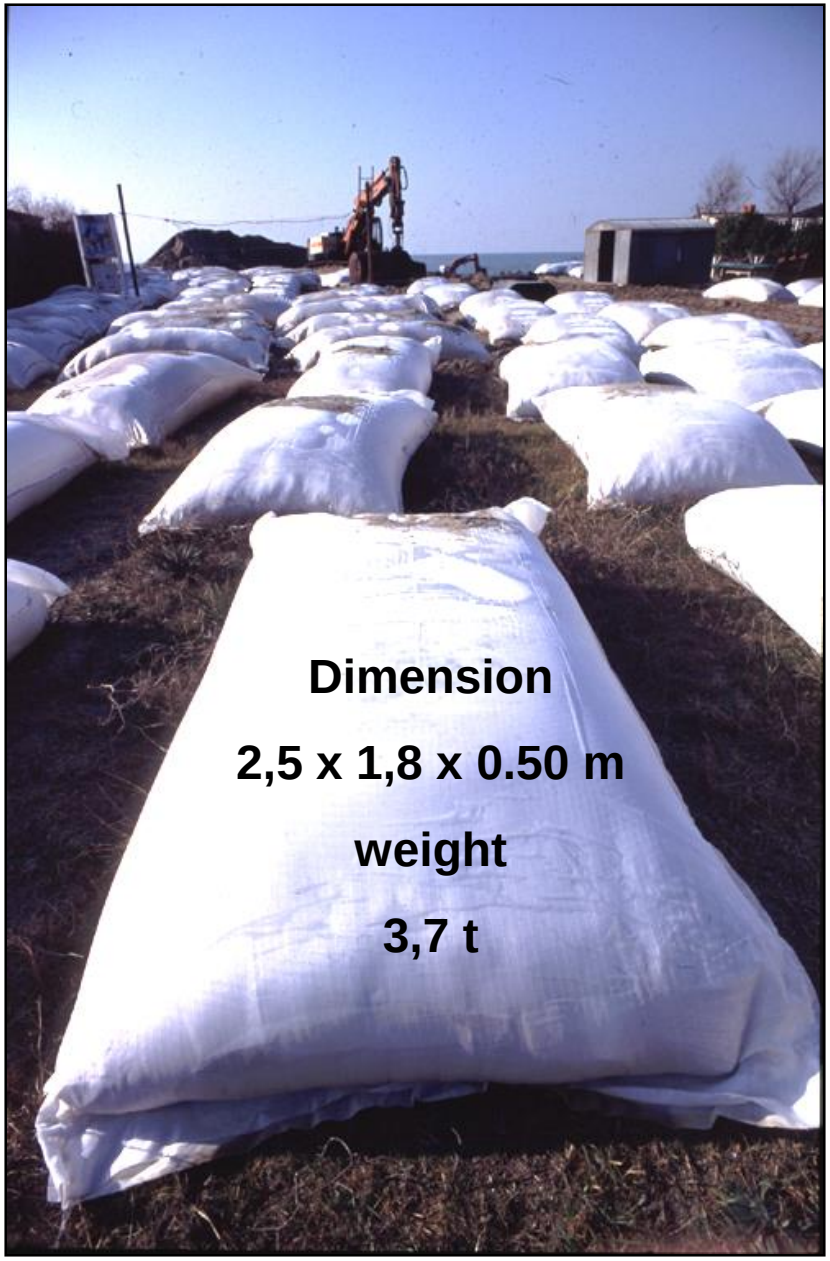
Improvement of the old 1990 project.
Groins reshaping and extension with submerged segments.
Nourishment with sand coming from the excavation of a basin.

Alassio, Italy

R. Rossetti


SIC, DK


Tubi drenanti
Falda dolce
Falda salata

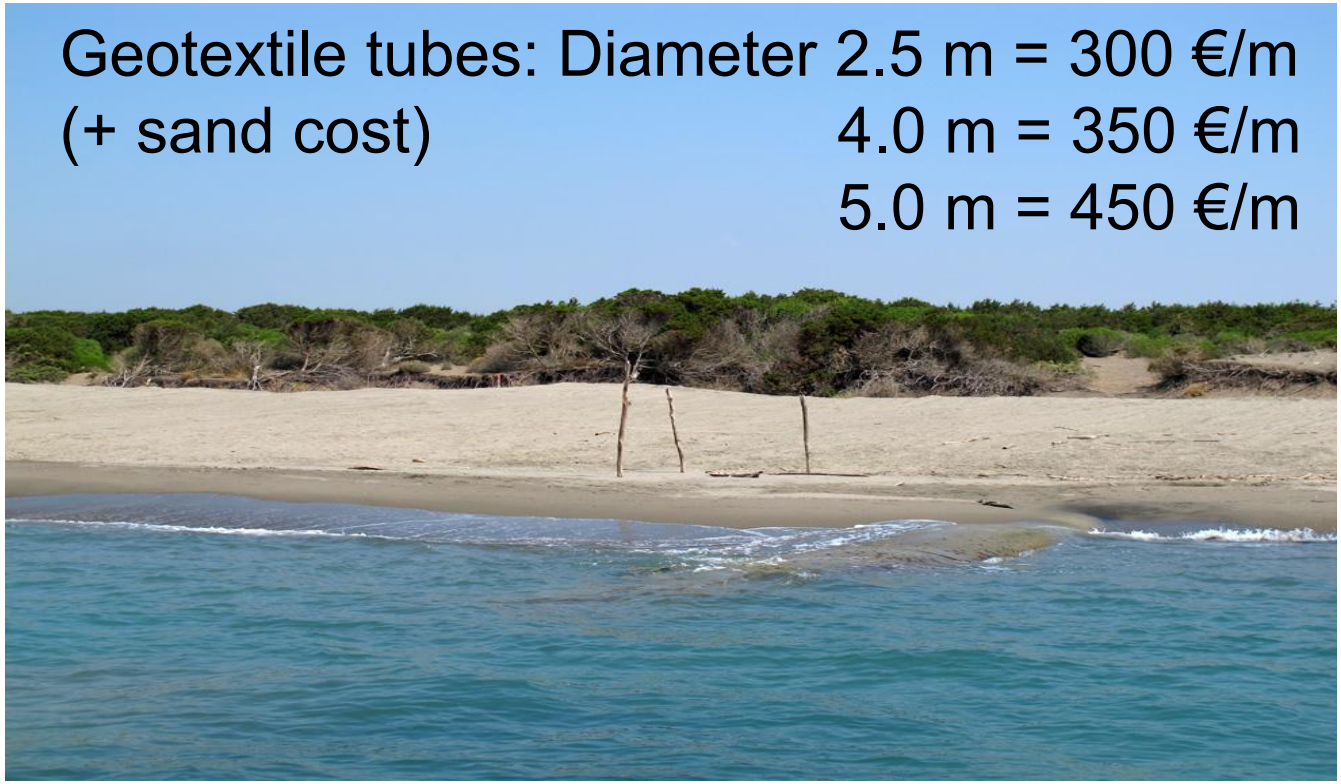


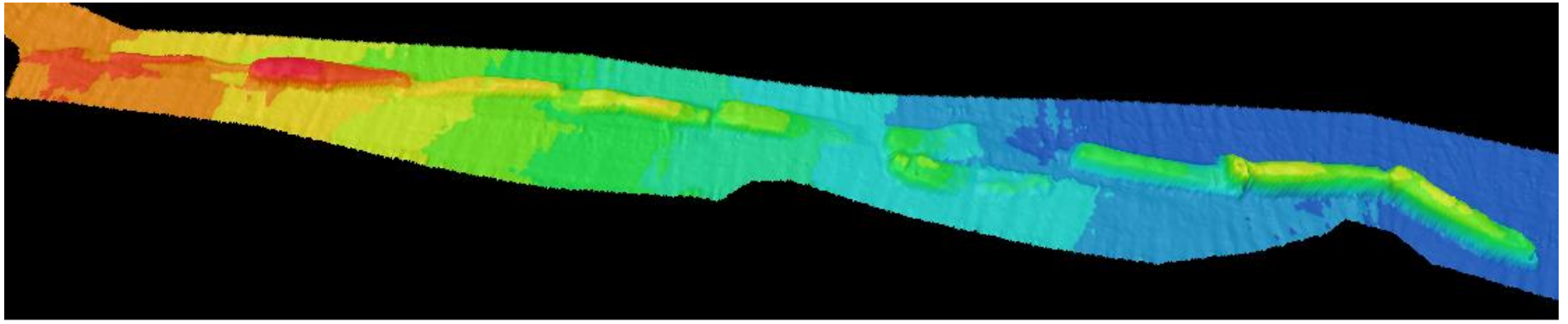
Marina di Massa, Italy

Marina di Massa, Tuscany







Geotextile tubes: Diameter 2.5 m = 300 €/m
(+ sand cost) 4.0 m = 350 €/m
5.0 m = 450 €/m




Thank you!