

**apa**  
portuguese  
environment  
agency



# Sediment Management in Portugal

SedNet Conference 2023

06/09/2023

Teresa Álvares

Head of Division

[teresa.alvares@apambiente.pt](mailto:teresa.alvares@apambiente.pt)



**REPÚBLICA  
PORTUGUESA**

ENVIRONMENT AND  
CLIMATE ACTION

# Portuguese Territory

## Mainly coastal geography and use

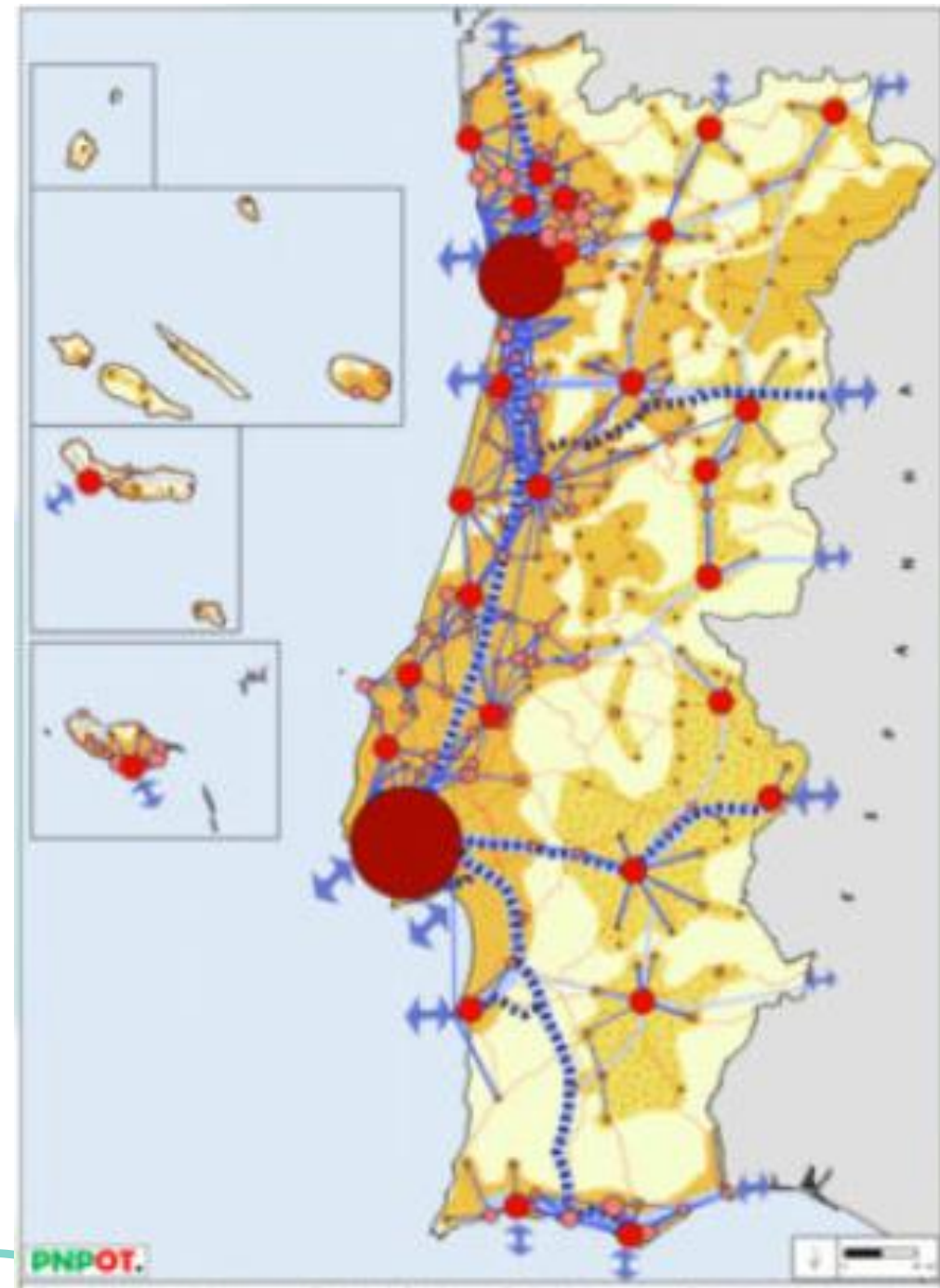
Total coastline ~ 2500 km

Continental coastline 987 km

One of the largest exclusive economic zones in the world with over 1.7 Mkm<sup>2</sup>

Unique cultural and natural heritage

Great diversity of natural resources



National Spatial Planning Policy Program

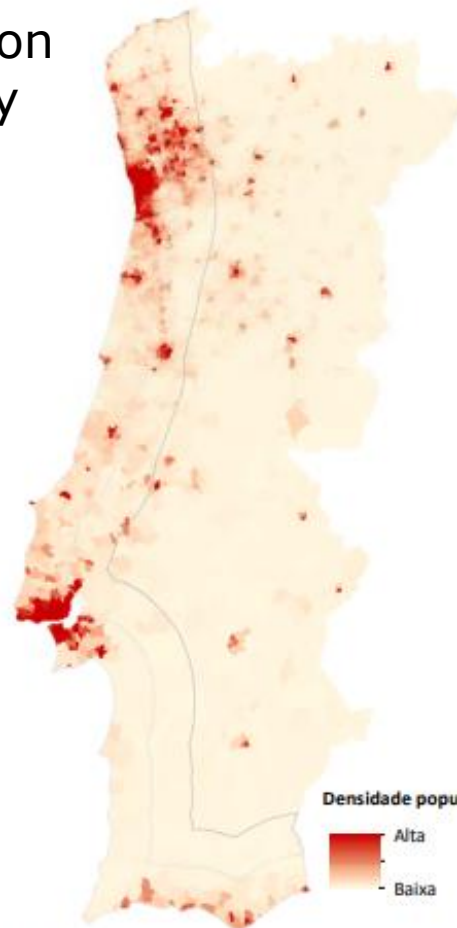
# Portuguese Territory



População residente (n.º habitantes)

- Mais de 100 000
- Até 100 000
- Até 50 000

Population Density



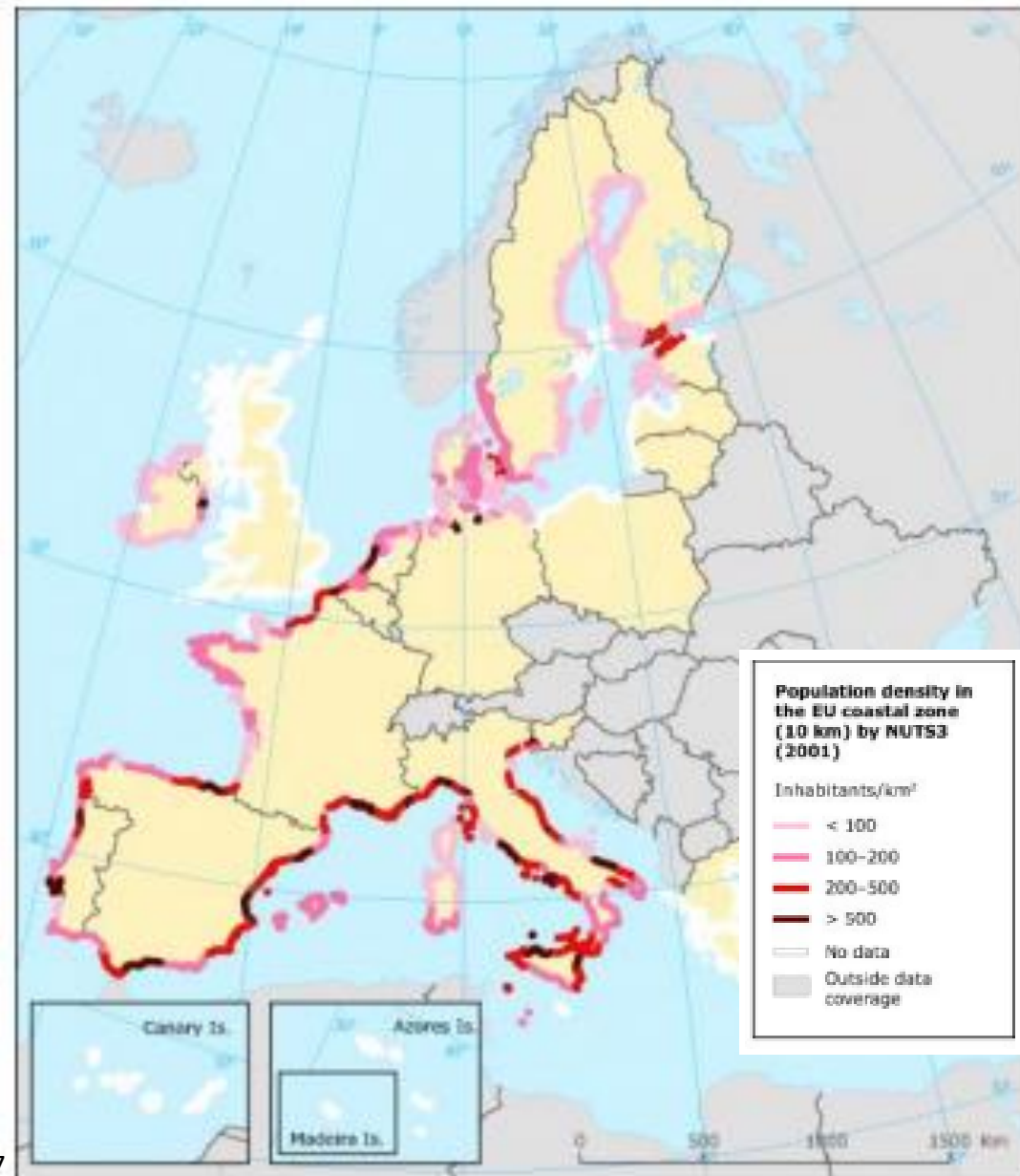
Densidade populacional (N.º hab/Km2)

- Alta
- Baixa

- Distância à costa - 25km
- Distância à costa - 50km

EEA, 2009 in

National Program for Territorial Cohesion, 2017



Population density in the EU coastal zone (10 km) by NUTS3 (2001)

Inhabitants/km<sup>2</sup>

- < 100
- 100-200
- 200-500
- > 500
- No data
- Outside data coverage



# Portuguese Territory



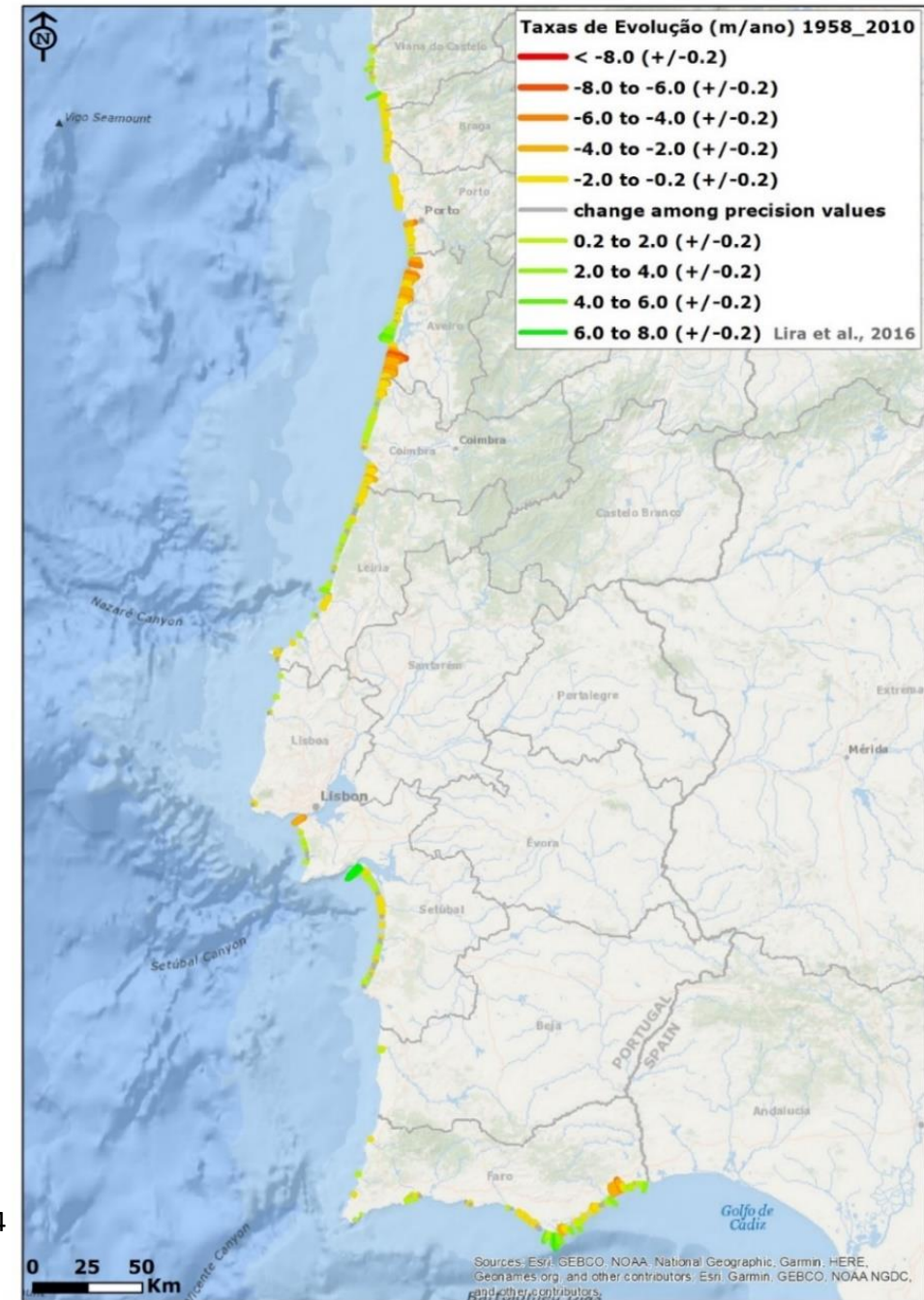
180 km of eroding coastline (≈ 20%)

**13 km<sup>2</sup> of territory loss** (1958 – 2020)

14% artificialized coastline (spurs, adherent structures, seawalls, ports)

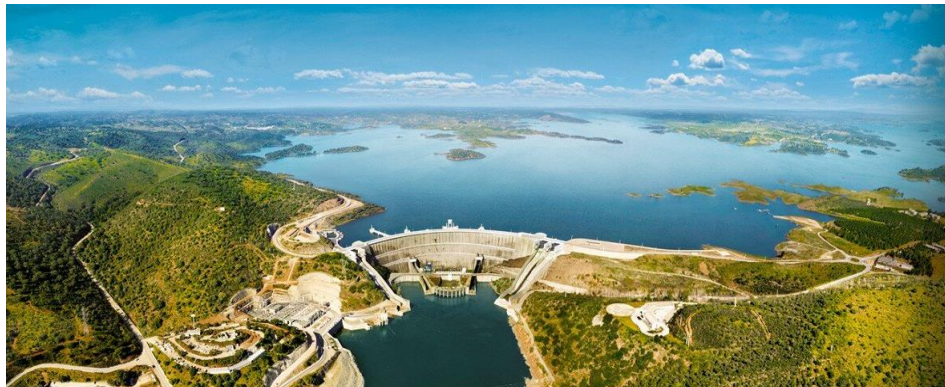
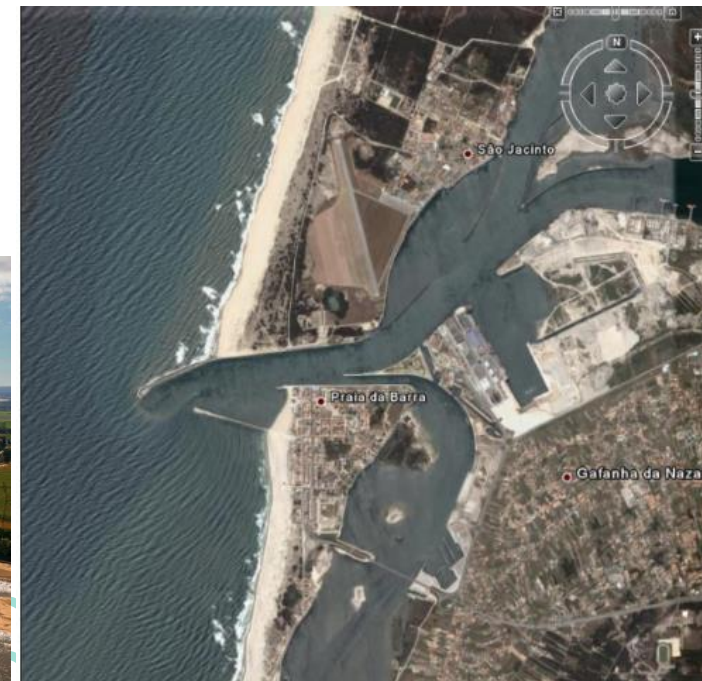
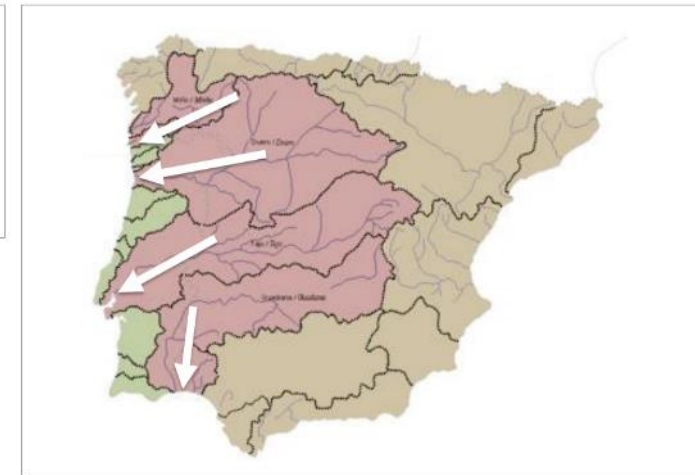
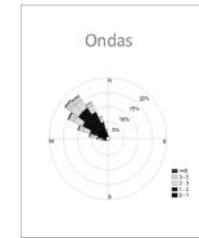
GTL - Santos *et al.*, 2014

SIAM II, Santos, F.D. & Miranda, P, 2006



# Why we need Integrated Sediment Management?

1. Contribute to flow management that guarantee river *continuum* and flood and erosion control
2. Restore coastal sediment balance
  - Potential of river basins contribution
  - Beach nourishment
  - High magnitude shots



# Strategic Framework

- Water Framework Directive (DQA)
- Water Law (Portuguese Law N<sup>o</sup>. 58/2005 - LA)
- River Basin Management Plans (PGRH)
- National Strategy for Integrated Management of Coastal Zones (ENGIZC)
- National Maritime Strategy (ENM)
- National Strategy for Adapting to Climate Change (ENAAC)
- Coastline Working Group (GTL)
- Sediment Working Group (GTS)
- Action Plan Littoral XXI (PAL XXI)
- Integrated sediment management. Guidelines and good practices in the context of the Water Framework Directive



# Sediment Network

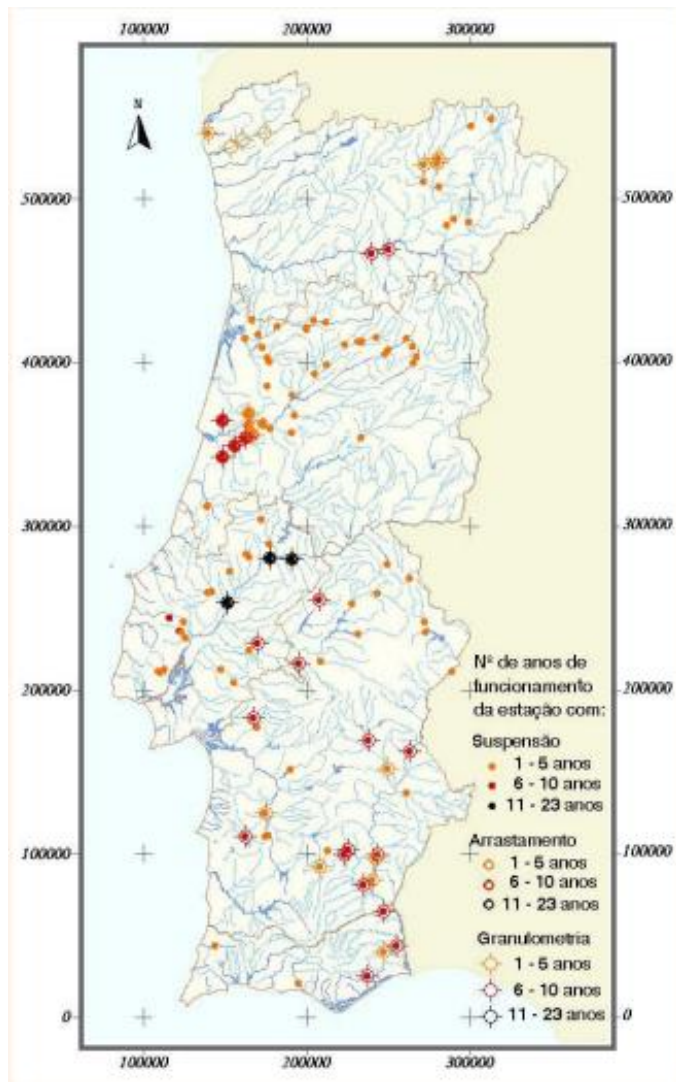


Presently disabled – 1980/81 to 1993/94.  
 Allowed to study Sediment transport in Portugal, namely in the Tagus and Guadiana river basins.

River basin – Stations (n.º):  
 Douro - 12  
 Vouga - 12  
 Mondego - 21  
 Tejo - 32  
 Sado - 8  
 Guadiana - 18



# Sediment Network – WFD



## Existing Network until 1993/94

**112** Stations in watercourses

**10** Reservoirs with bathymetric surveys

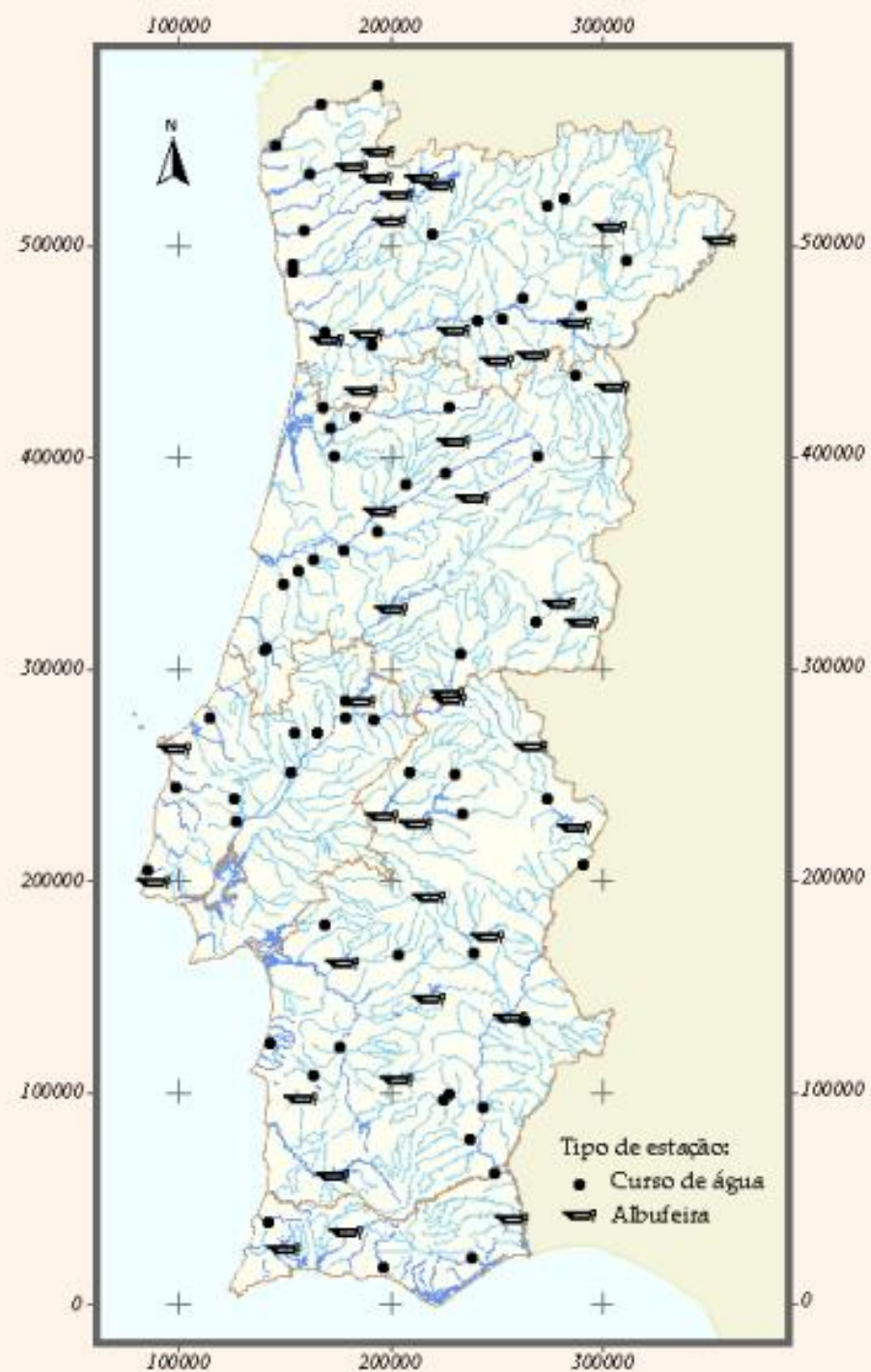
**109** Stations with suspended sediment load

**28** Stations with bottom sediment samples

## Proposed Network – 1998/2000

**66** Stations in watercourses

**45** Stations in reservoirs

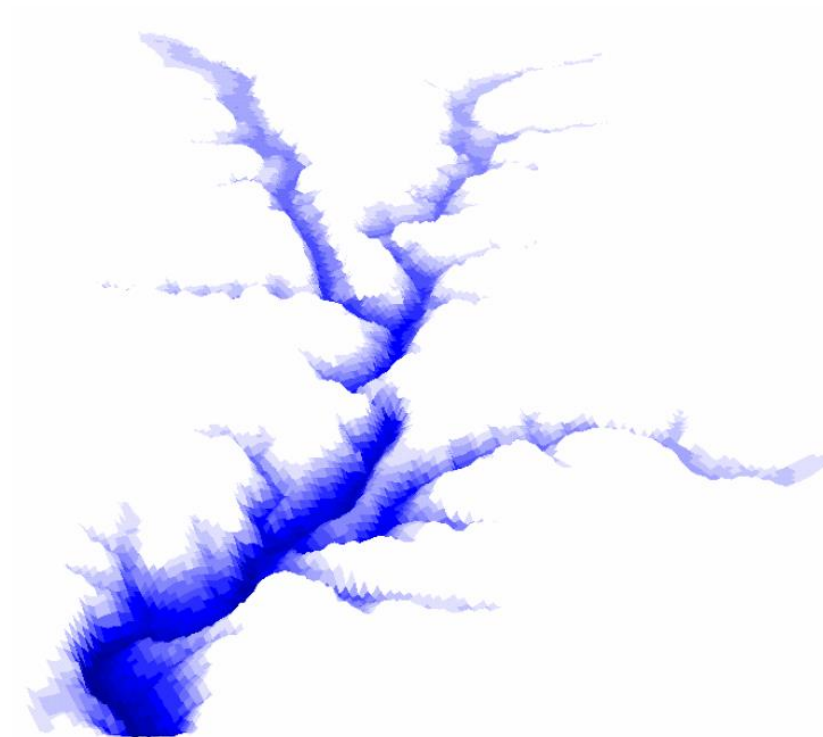
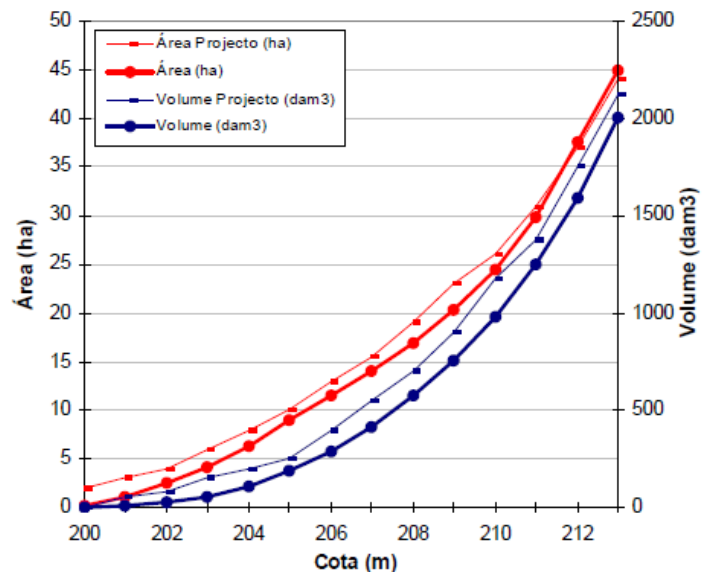




# Sediment Network – WFD

Due to high costs for:

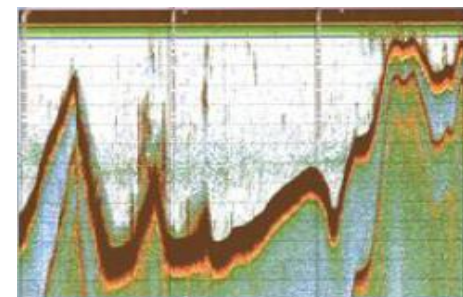
- Equipment
- Laboratory
- Maintenance
- Human Resources



Sediment transport network in watercourses was not implemented

Some bathymetric surveys were carried out

Boat  
Single beam echosounder  
RTK GPS



# Sediment Extraction Management

WFD/Portuguese Water Law changed the paradigm regarding sediment extraction from watercourses.

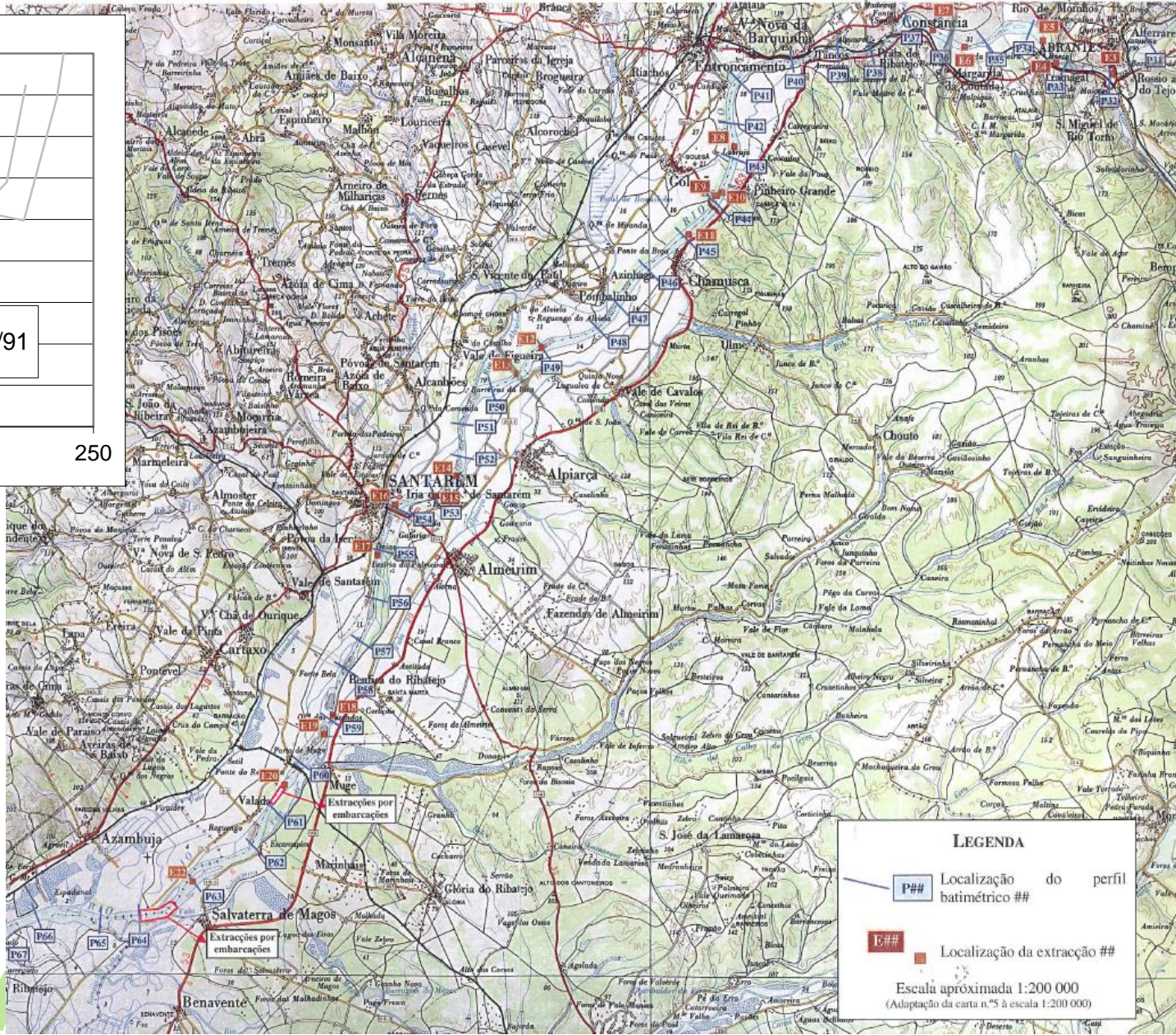
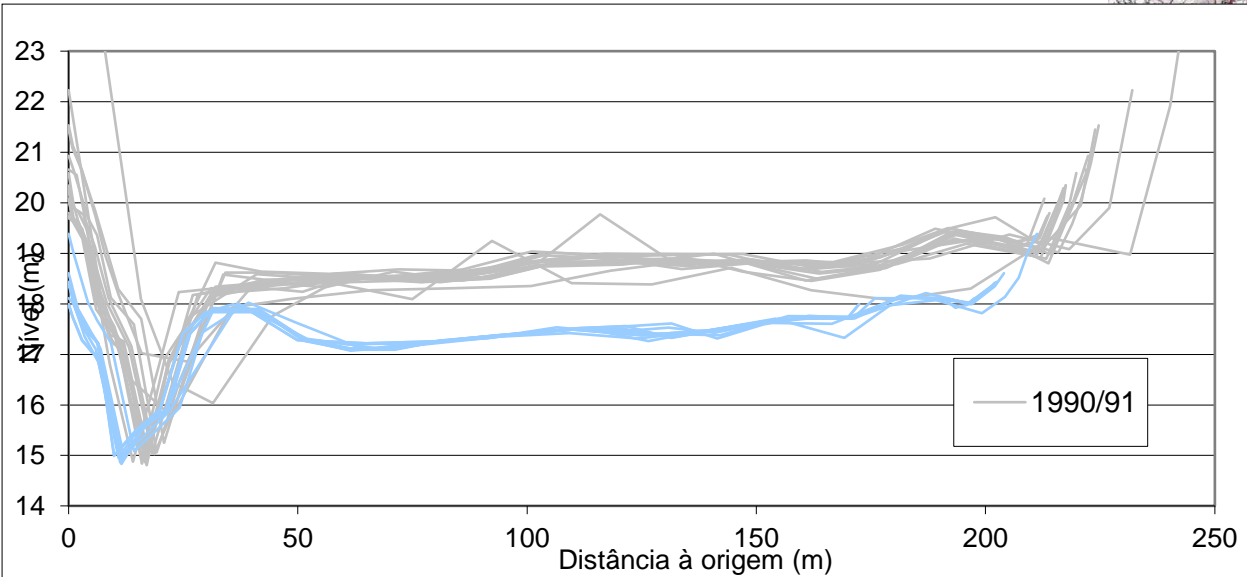
No longer allowed as an economic activity.

Only authorized as a conservation and rehabilitation measure for the river network and riverside areas (Water Law - article 33).

Until WFD, sediment management in river basins was carried out basin by basin according to specific plans.



# Sediment Extraction Management



**P##** Bathymetric profile
   
**E##** Sediment Extraction
   
 Escala aproximada 1:200 000
   
 (Adaptação da carta n.º 5 à escala 1:200 000)

**LEGENDA**
  
  
**P##** Localização do perfil batimétrico ##
   
**E##** Localização da extração ##
   
 Escala aproximada 1:200 000
   
 (Adaptação da carta n.º 5 à escala 1:200 000)



# Sediment Yield – Model Estimates

For natural regime

Rivers	Total (x10 <sup>3</sup> m <sup>3</sup> /y)	Bed load (x10 <sup>3</sup> m <sup>3</sup> /y)	Suspended load (x10 <sup>3</sup> m <sup>3</sup> /y)
Minho	1 734,4	185,2	1 549,2
Lima	126,8	13,0	113,8
Cávado	163,7	16,8	146,9
Ave	169,8	16,6	153,2
Douro	11 243,8	1 646,2	9 597,6
Vouga	374,5	42,2	332,3
Mondego	1 396,4	230,8	1 165,6
Mira	284,5	30,2	254,3
Guadiana	7 196,1	763,7	6 432,4
Algarve streams	1 036,2	110,0	926,2

After dam construction

Rivers	Total (x10 <sup>3</sup> m <sup>3</sup> /y)	Bed load (x10 <sup>3</sup> m <sup>3</sup> /y)	Suspended load (x10 <sup>3</sup> m <sup>3</sup> /y)
Minho	284,6	30,4	254,2
Lima	119,5	12,3	107,2
Cávado	81,9	8,4	73,5
Ave	140,9	12,6	128,3
Douro	2 248,7	329,2	1 919,5
Vouga	351,4	39,6	311,8
Mondego	483,3	79,9	403,4
Mira	155,1	16,5	138,6
Guadiana	2 074,6	220,2	1 854,4
Algarve streams	394,8	41,9	352,9

Didn't include Tagus and Sado basins

Magalhães, 1999



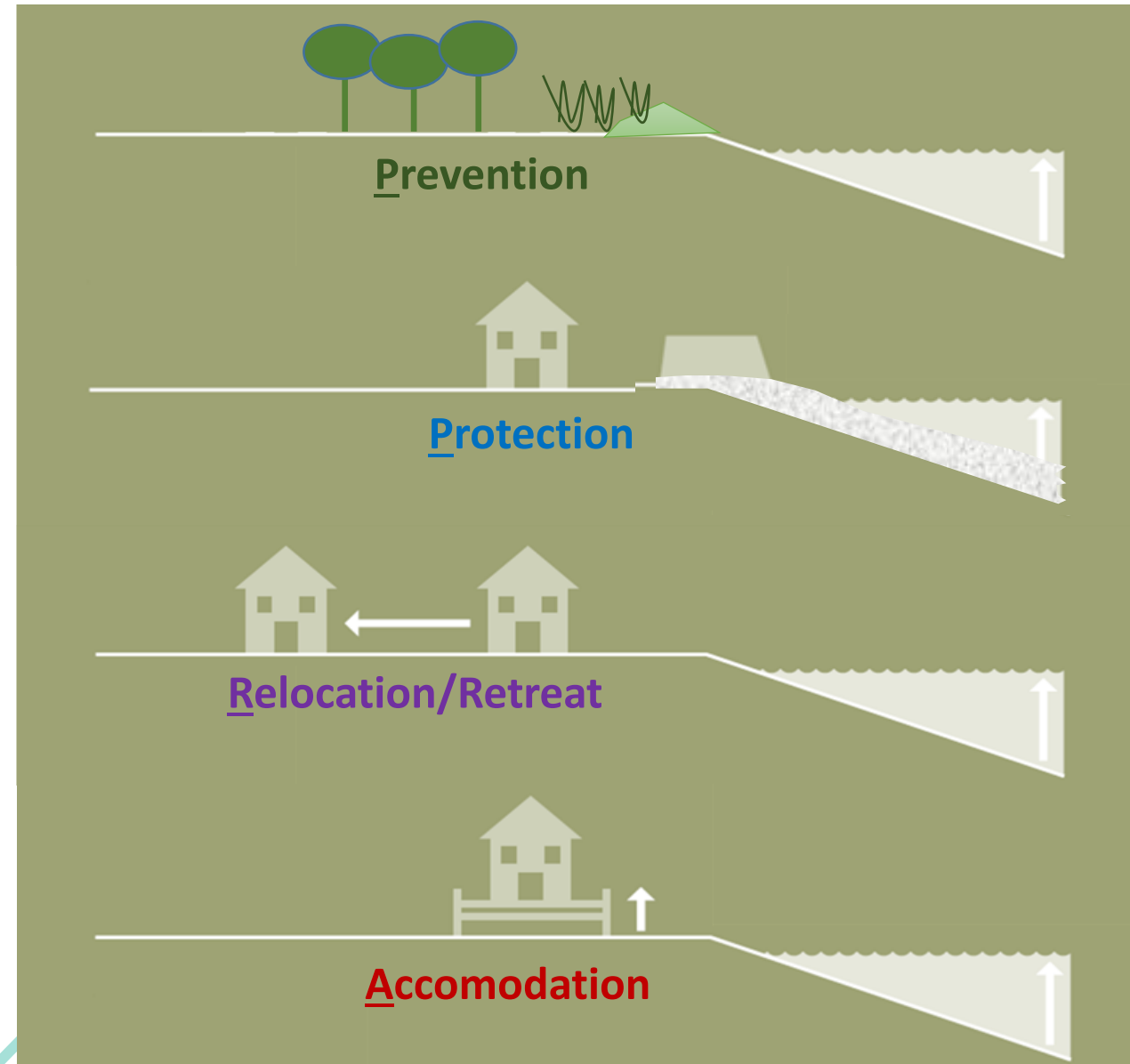
# Coastal Planning Policy

**Restrict new occupations in risk areas**  
(Coastal Plans/Programs – POC)

**Soft / Green or/and Hard / Grey**  
**measures**

**Planned retreat / construction removal**

**Live with the flood**

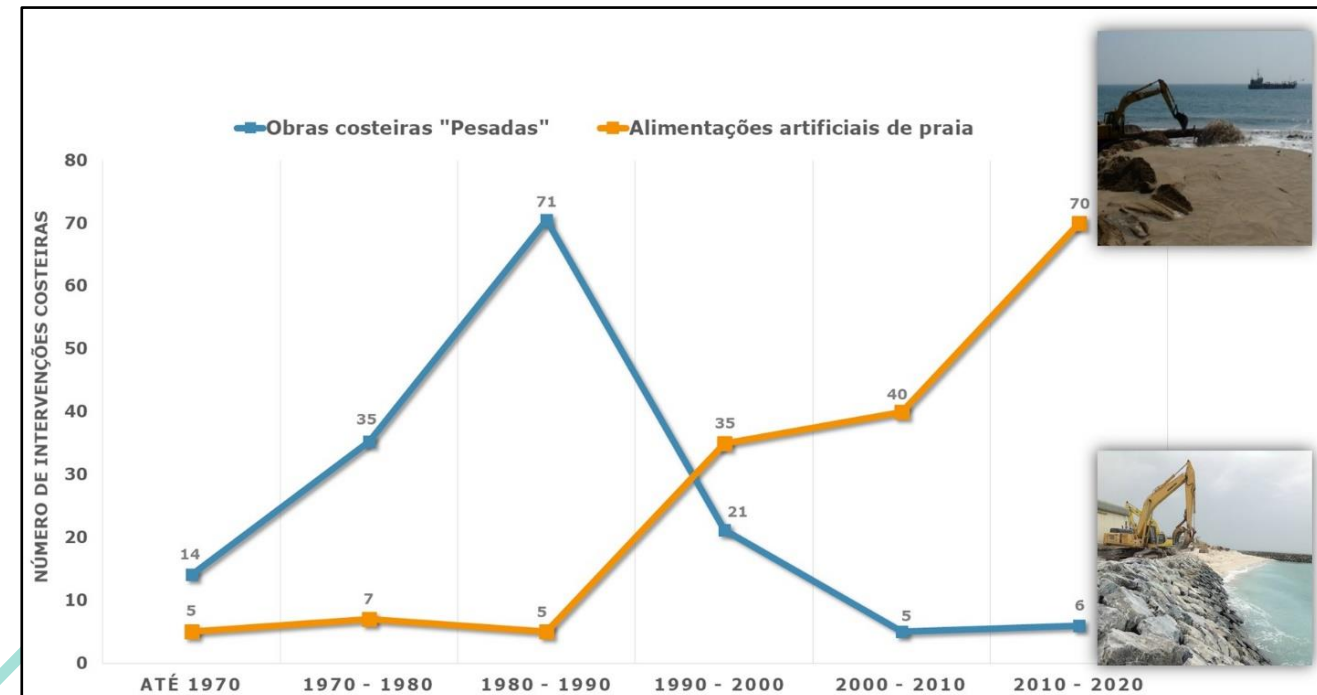


# Coastal Protection

- **Soft / Green measures**
  - Beach Nourishment (Alimentações artificiais)
  - Dune restoration
- **Hard / Grey measures** (Obras “Pesadas”)
  - Adherent structure
  - Breakwater
  - Rubble spur
  - Seawall



REDUNA  
Almada Municipality project



# Artificial Beach Nourishment

In the last decades, “soft” measures (artificial beach nourishments) have been progressively used to protect the coast.



Nova Beach, Algarve (2015)



# Harbour Dredging and Beach Nourishment



Caparica Beach (2019)

Lisbon Harbour dredging

1 Mm<sup>3</sup>





# Harbour Dredging and Beach Nourishment

Aveiro Harbour  
Dredging of ZALI (Zone of Logistic Activities)

2,3 Mm<sup>3</sup>



Vagueira Beach (2020)



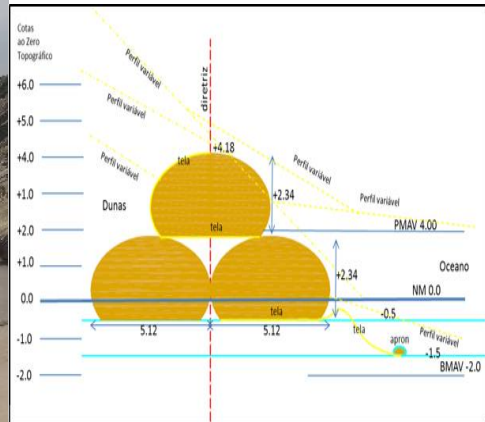
# Harbour Dredging and Beach Nourishment



Monitoring  
with tracers  
2021/2022

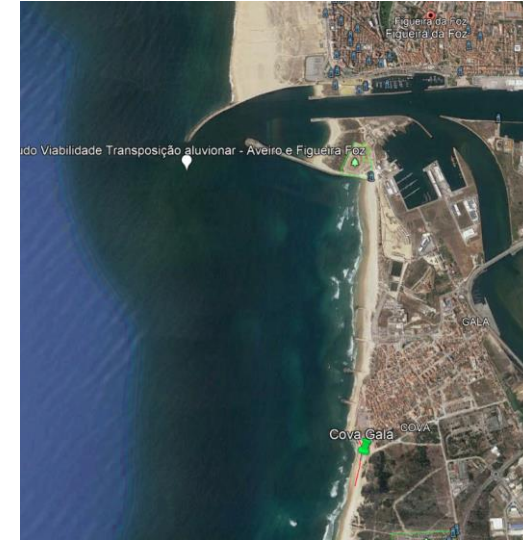


# Emergency Intervention



**Geocylinder Placement**  
**Dune restoration**

**Beach nourishment**



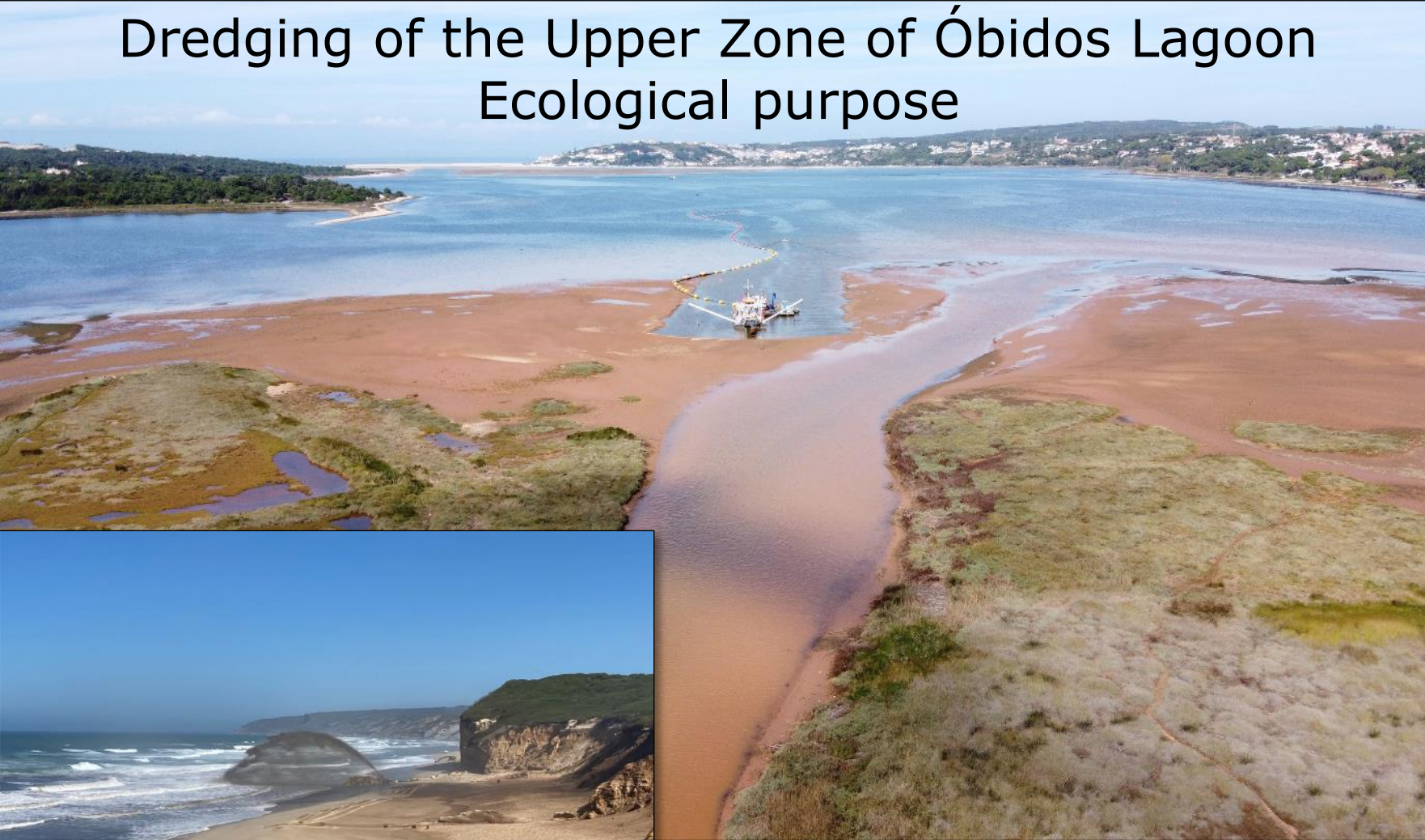
Cova Gala Beach (may/june 2019)



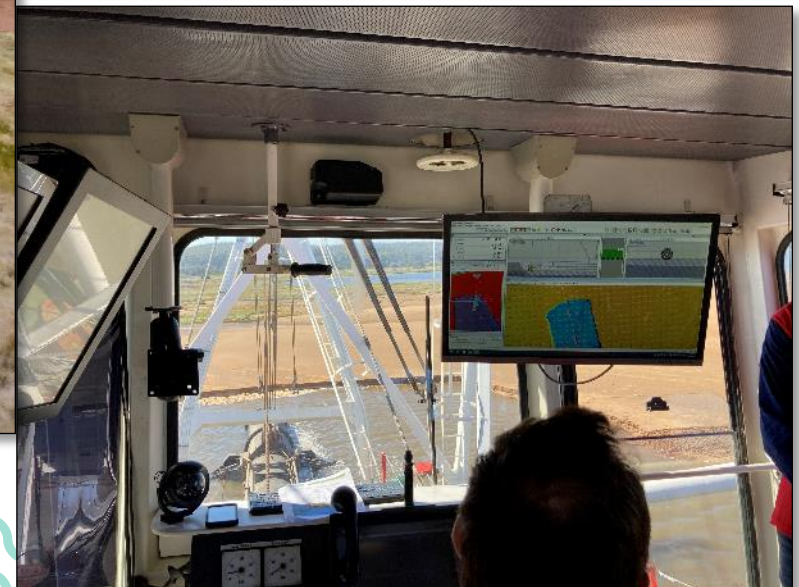
# Lagoon Dredging

875.000 m<sup>3</sup>

Dredging of the Upper Zone of Óbidos Lagoon  
Ecological purpose



Rei do Cortiço Beach (2021/2022)



# Planned retreat

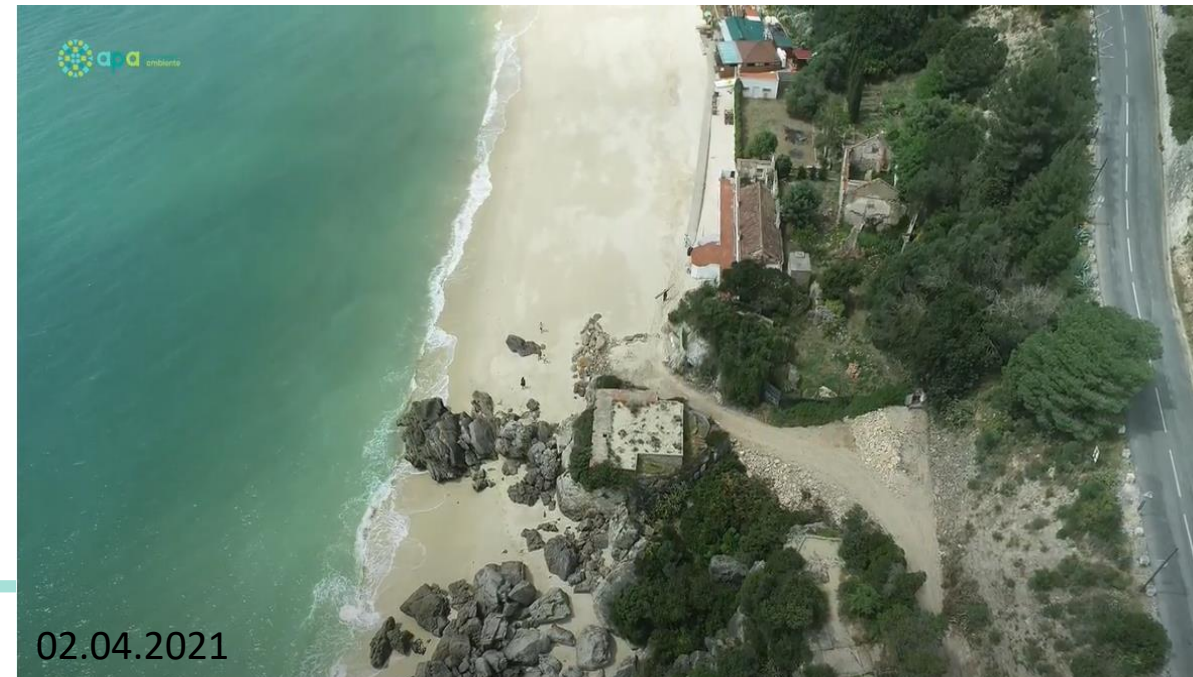
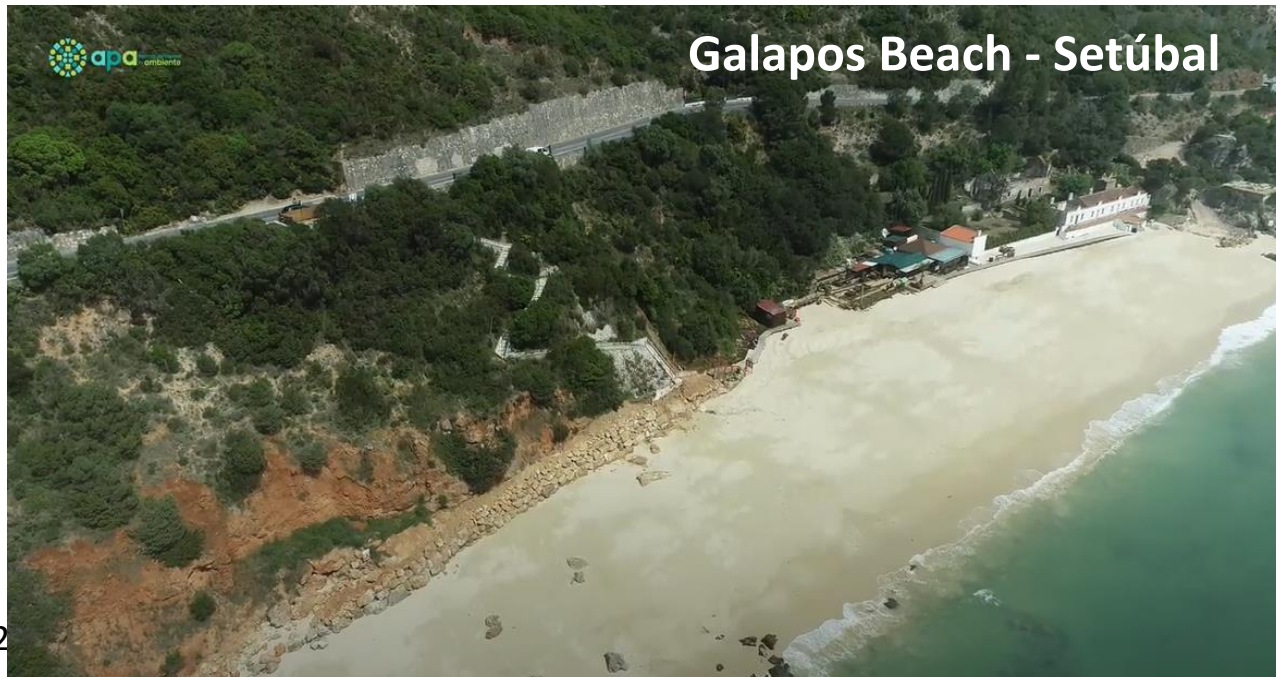
## S. Bartolomeu do Mar (Esposende)

Recuo planeado



# Construction removal

Removal of illegal construction

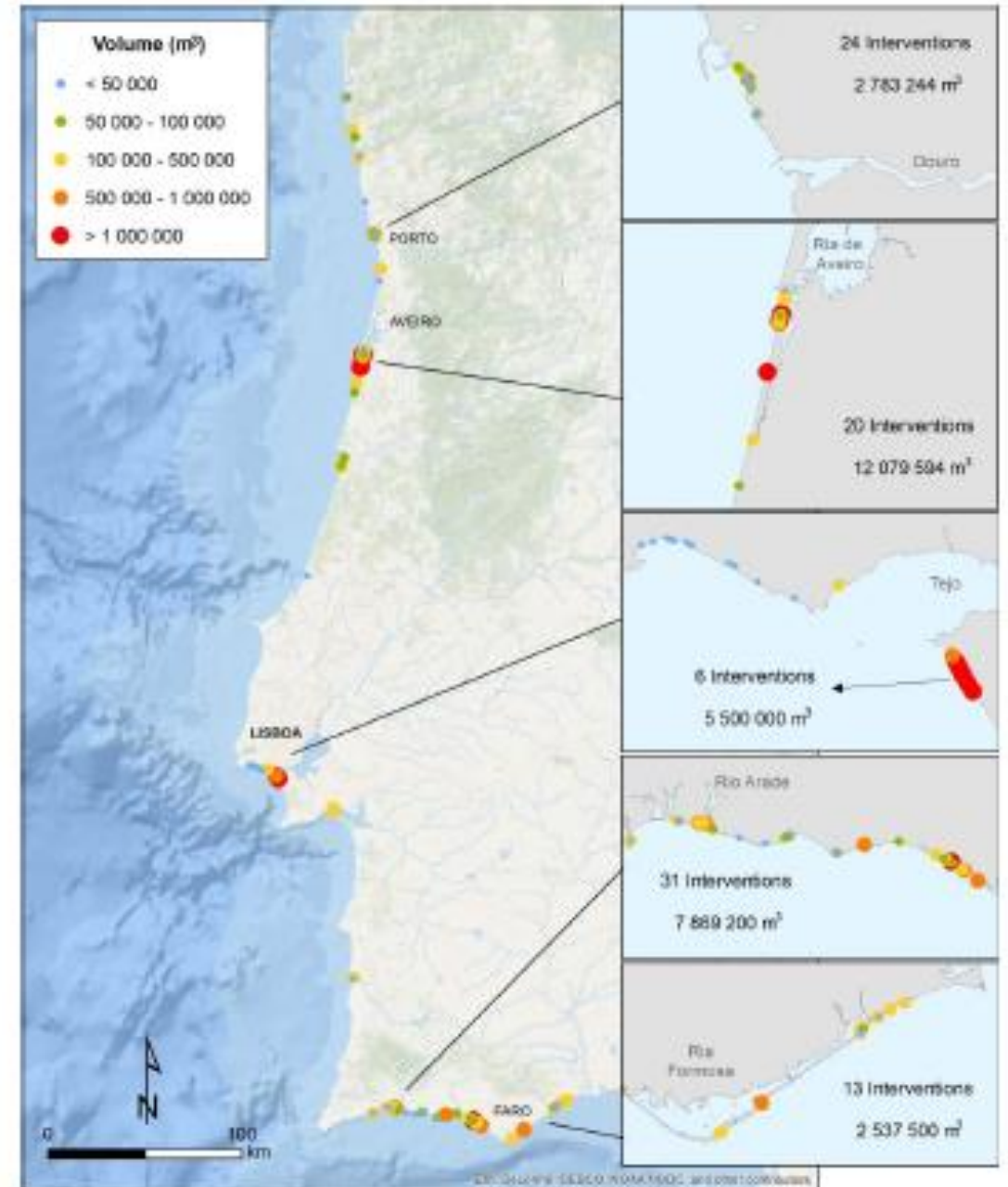


# Artificial Beach Nourishment

134 operations between 1950 and 2017

Objectives	
General	Specific
Mitigation of costal erosion and risk	1 Improvement of shoreline stability
	2 Reduction of the vulnerability to coastal overwash/flooding
	3 Protection of coastal structures
Improvement of the recreational use and value of the coast	4 Increase of beach width for recreational use
	5 Protection of natural/cultural resources

Pinto *et al.*, 2020



# Artificial Beach Nourishment

## Borrow areas:

- Dredging related to harbour and port activity;
- Inner continental shelf.

Limiting factors: depth; grain size; composition

## Negative impacts:

- Possible changes in coastal dynamics and sedimentary transport patterns
- Direct and indirect impacts on biological communities (benthic organisms, larvae, birds)





# Artificial Beach Nourishment

Borrow areas in the continental shelf  
(Sediment Work Group)

## CHIMERA project

multibeam, sub-bottom profiler, seismic  
126 surface sediment samples and 72 vibrocores

Results indicate the existence of significant  
sedimentary resources (3m depth) to be used  
in a strategy of restoring sedimentary balance

It is also important to assess the potential of  
hydrographical basins in supplying sediments  
to the coastal area



Pinto *et al.*, 2019; Mil-Homens *et al.*, 2020

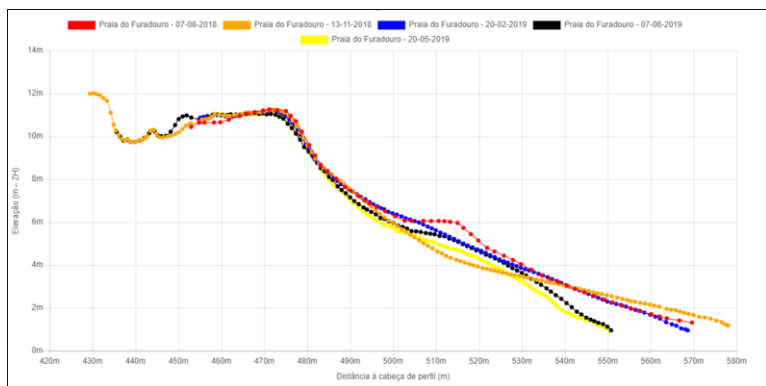
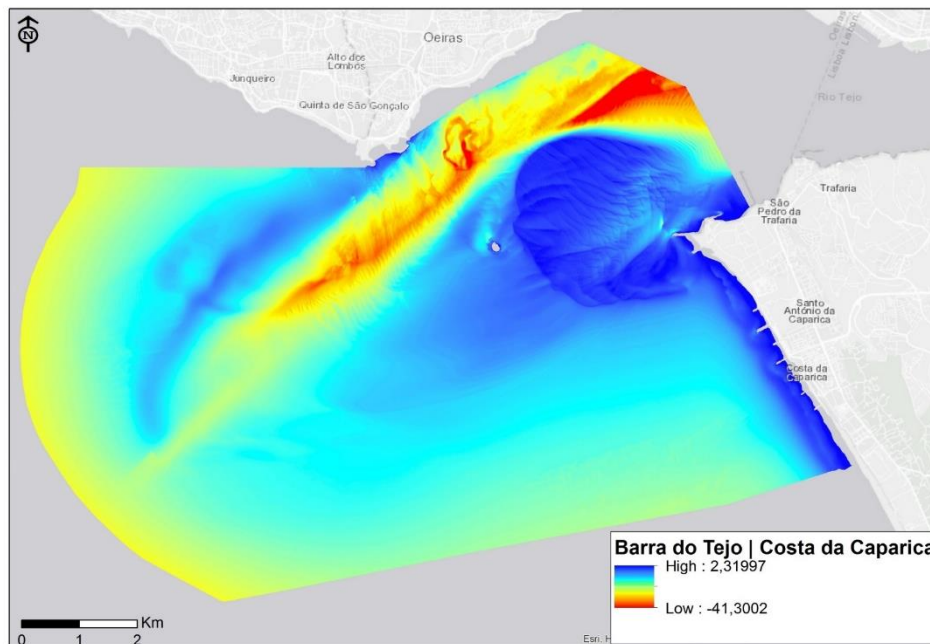
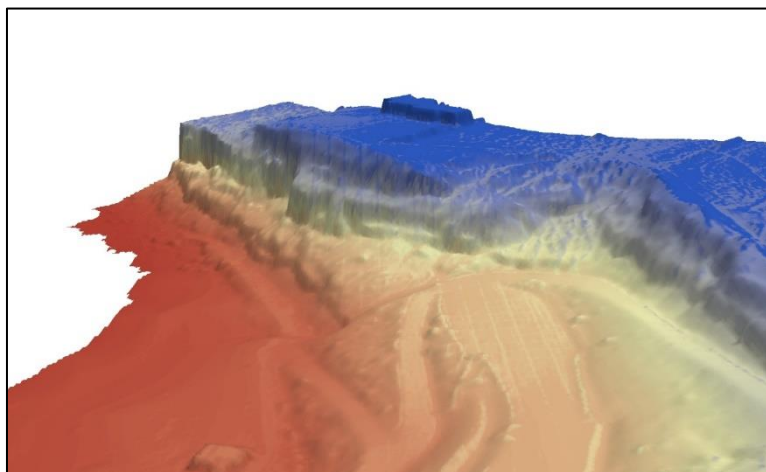


# Other Projects adopted in Portugal

2018-2021

<https://cosmo.apambiente.pt/>

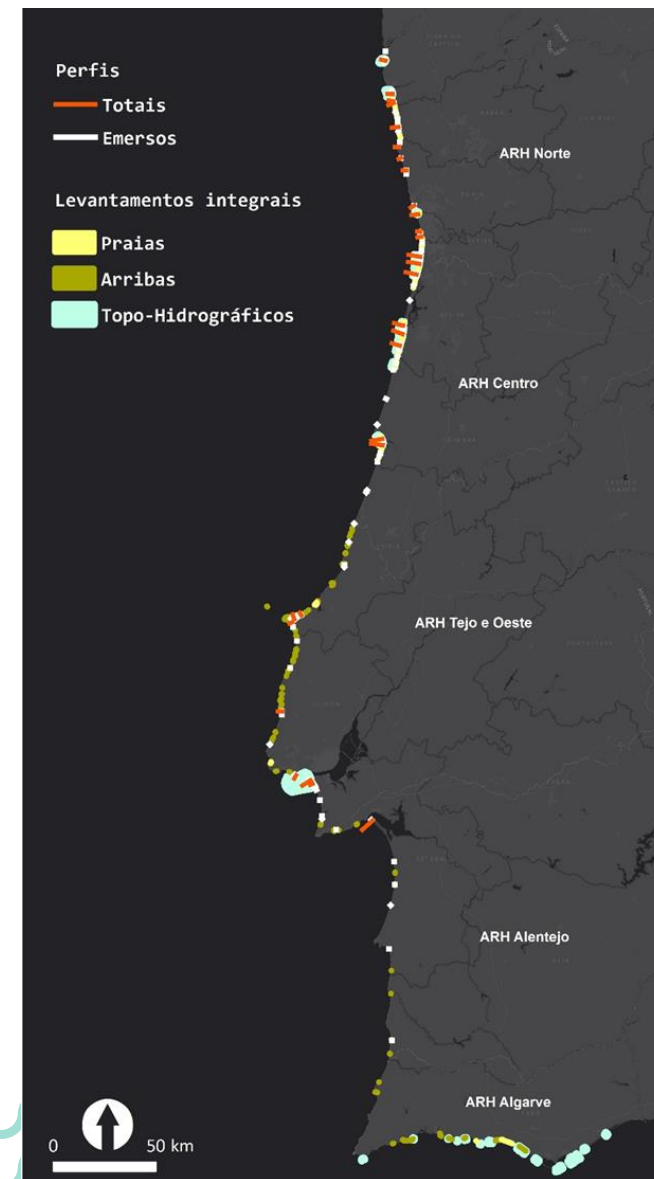
## COSMO – Portuguese COaStal MOnitoring Program



COSMO 2.0

Contracting underway

Pinto, 2019



# Other Projects adopted in Portugal

**The new SIARL (ongoing)** - Collaborative platform to support management

## Modules:

- Water Domain
- Interventions
- Occurrences
- Land Use Management
- Adaptation Strategy
- Documents (several formats)
- Actors
- Indicators

## Geoviewer



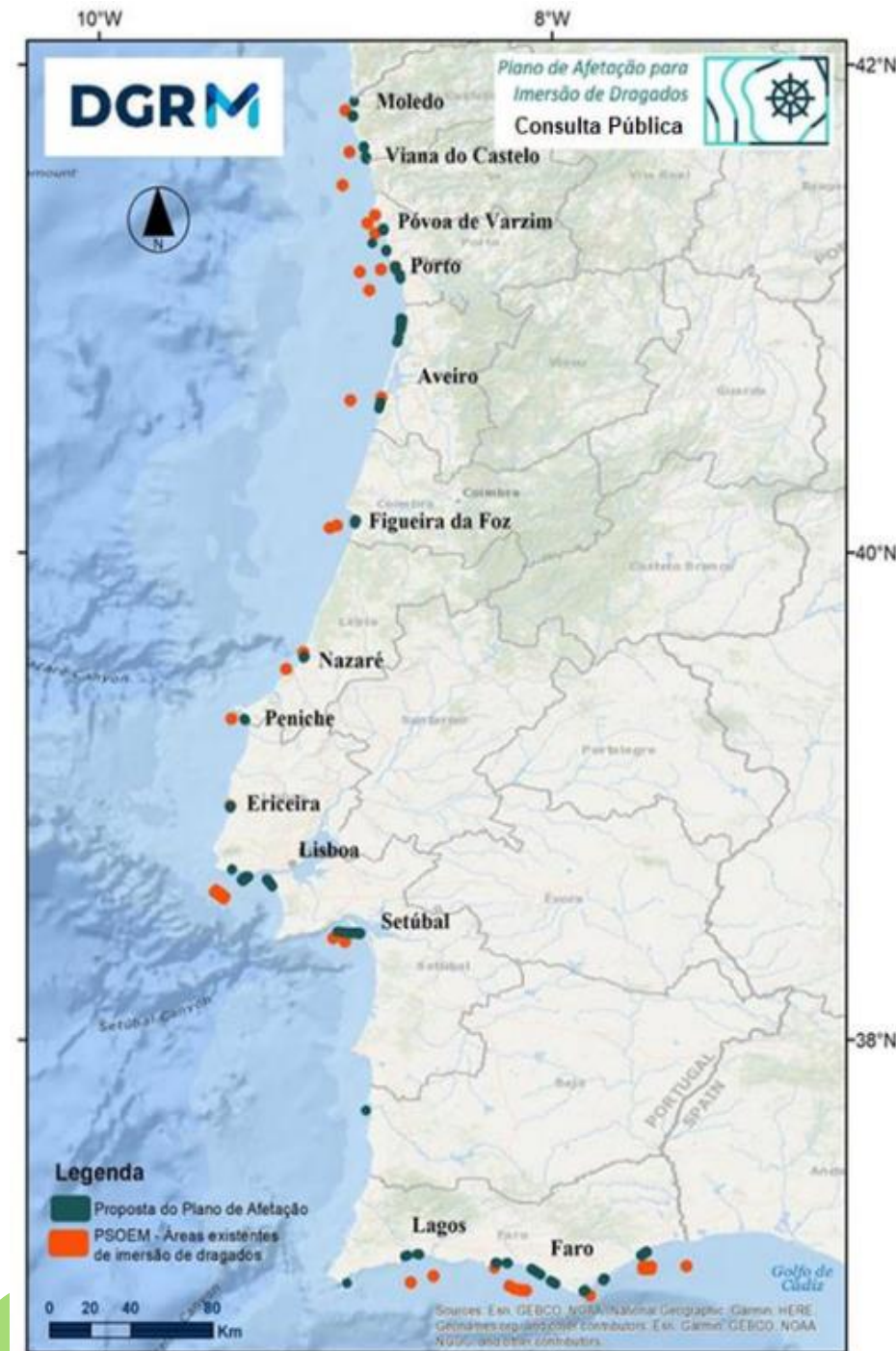
Precision Drones for photogrametry

# Other Projects adopted in Portugal

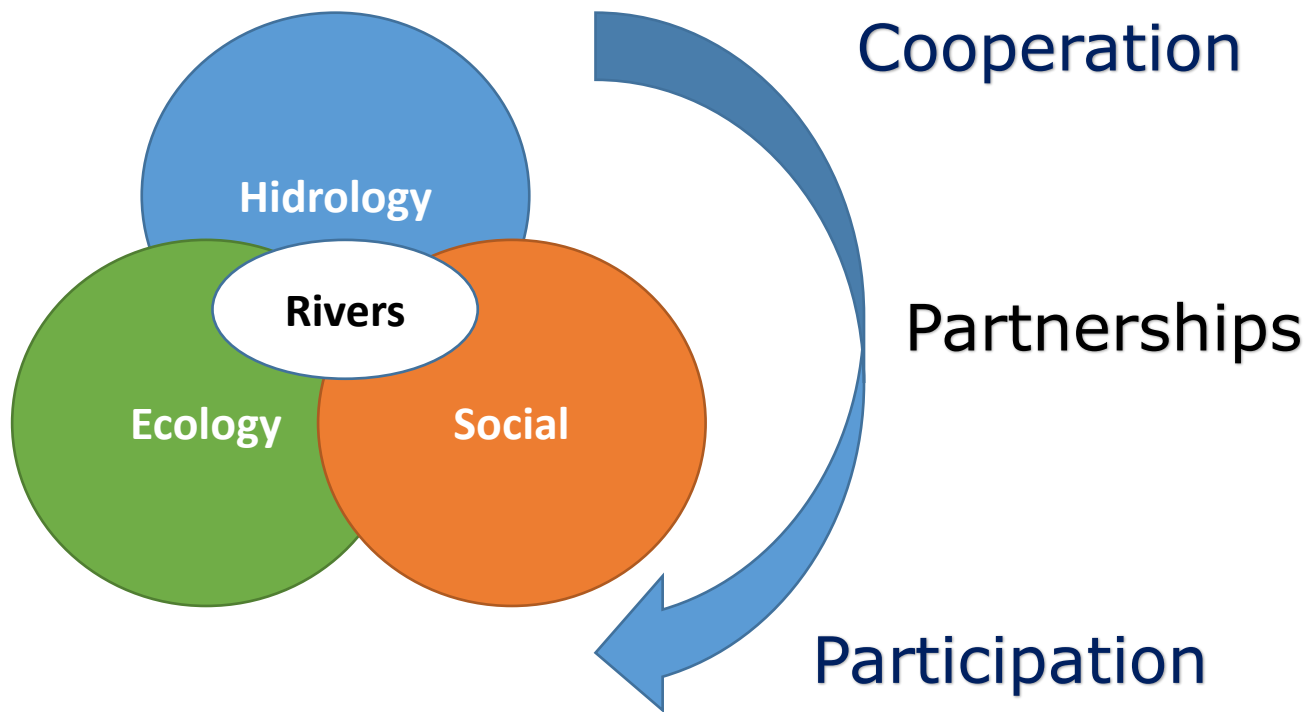
## Allocation Plan for Sediment Immersion (PAID) of Maritime Spatial Plan

The aim is to minimize the impacts of ports as potential sediment sinks from the coastal system and contribute to the sediment balance in sections where the areas are most affected by the effects of maritime transgression.

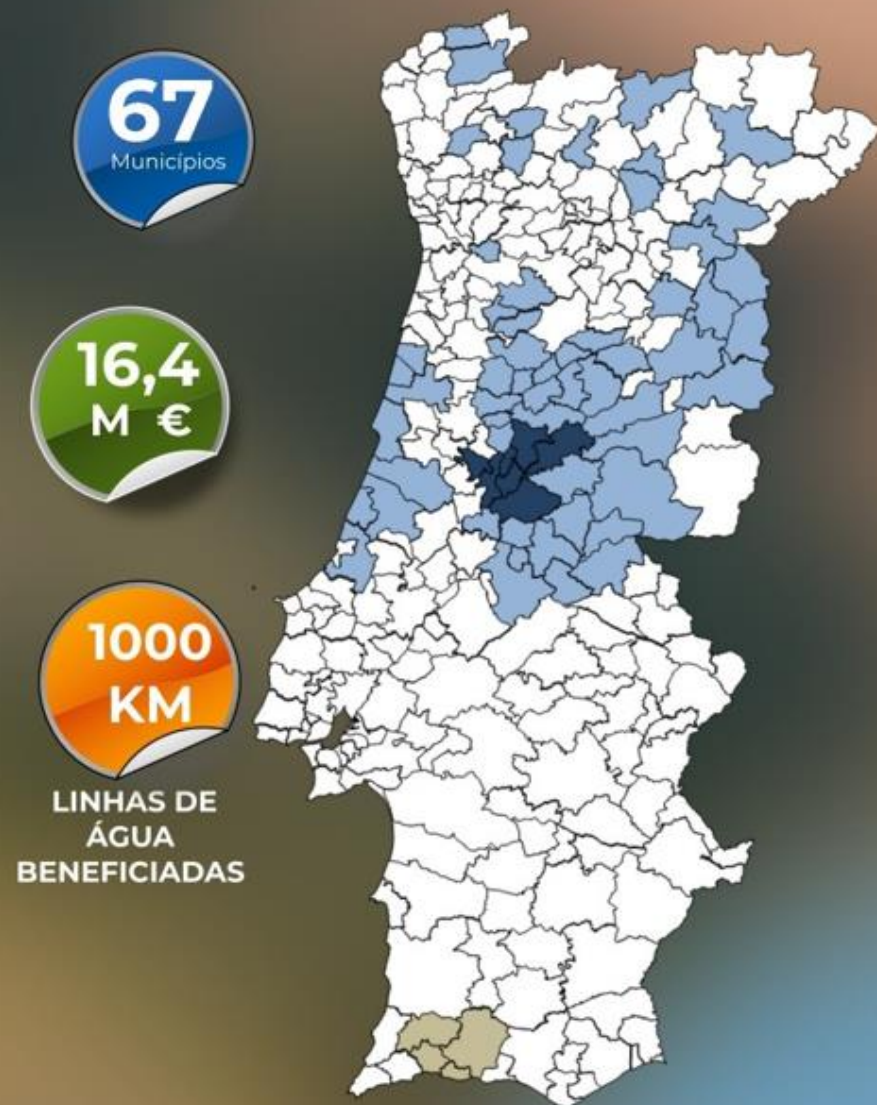
DGRM project in close collaboration with APA  
General Directorate of Natural Resources, Security and Maritime Services



# Other measures - River restoration



# Other measures - River restoration after 2017 fires



# Other measures - River laboratory - Penela

Travessão



Biorolos



Muro vivo



Entrançado vivo



# Other measures - River laboratory - Águeda



"CASA DOS RIOS"

Rib<sup>a</sup> Aguieira e Rio Marnel





# Other measures - River restoration

Rehabilitation of river Este

EXEMPLO



RENATURALIZAÇÃO DO RIO ESTE (Braga)  
Troço entre o Laboratório Ibérico Internacional de Nanotecnologia (INL) e o Hotel Meliá

# Other measures – Flood control

Esposende flood risk protection and management interception channel



# Sediment Management Challenges / Opportunities

**Increase knowledge about sedimentary dynamics and ensure a monitoring network**

The better you know the system, the better you can manage it.

Monitoring contributes to a greater rationality and sustainability of decisions.



Understand

Magalhães, 2020, TAIEX Workshop



# Sediment Management Challenges / Opportunities

## Reduce costs

Innovative solutions that promote a continuous and cost-effective sediment monitoring

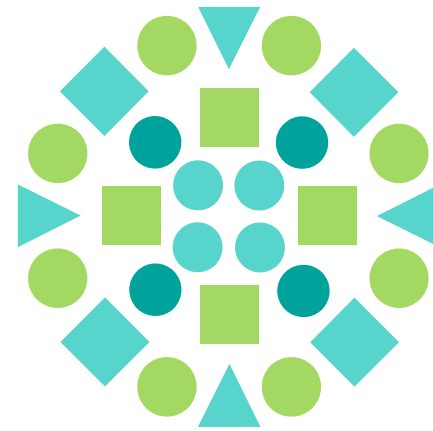
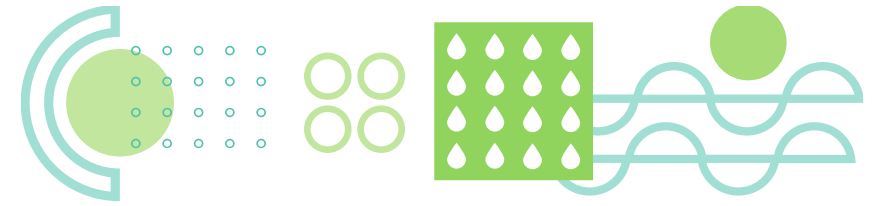
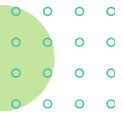
Cost-benefit and cost-effectiveness analysis of different alternatives to restore sediment balances (eg., river basins, dredging of ports and navigation channels or continental shelf)



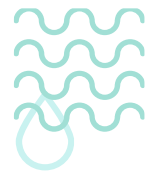
# Sediment Management Challenges / Opportunities

**Promote partnerships,  
information sharing,  
multidisciplinary and  
multilevel cooperation,  
...**





[apambiente.pt](http://apambiente.pt)



**Thank You**



**apa**  
portuguese  
environment  
agency