RAPPORT TECHNIQUE-PHASE B

Sous Projet: GESA

GEstion des stocks **SA**bleux interceptés par les ouvrages côtiers.
Récupération du transport solide.

Chef de File: B. Alonso
ICM-CSIC, Barcelona

Conférence "Phase B"
Barcelona, June 29, 2007

PHASE B — 8 Partners

GESA

1. Cdf ICM
- **Instituto de Ciencias del Mar**
CSIC-Barcelona
R. Catalunya

P. 2 UB
- **Univ. de Barcelona**
Barcelona
R. Catalunya

P. 3 DISTART
- **Univ. de Bologna**
Dip. Di Ingegneria dell Strutture, dei Transporti, Delle Aque, del Rileva-mento del Territorio
Bologne
R. Emilia-Romagna

P. 4 UFL
- **Univ. de Florence**
Dip. Di Ingegneria Civile
Univ. Degli Studi di Firenze
Firenze
R. Toscana

P.5 RID
- **Registro Italiano Dighe**
Roma
R. Lazio

P. 6 LEGEM
- **Univ. de Perpignan**
Laboratoire d´etudes des Géo-Environnements Marins-LEGEM
Perpignan
R. Languedoc-Roussillon

P. 7 DUTH
- **Univ.Democritus de Thrace**
Laboratoire de l´hydraulique et des Traveaux Hydrauliques
R. East Macedonia-Thrace

P. 8 FORTH IACM
- **Foundation pour la Recherce et La Technologie / Inst. De Mathé matiques Appliquées**
R. Crete

Multidisciplinary and Integrated Study

PHASE A

Problem

Rivers are often not able to provide enough sediments to the coast

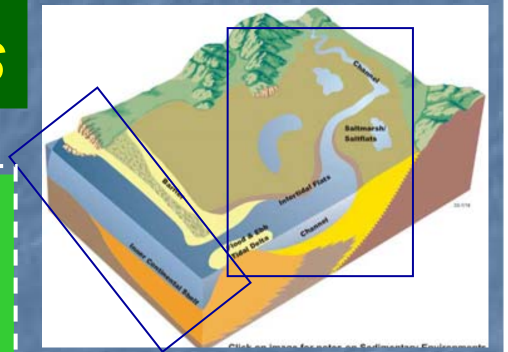
Main causes are: dams and weirs, land uses and climate

- Recover sediments from rivers
- Keep the sedimentary cycle stable

Main goals

Accumulation areas with high hydraulic risk

Sediments entrapped by dams



HYDROGRAPHIC BASIN & RIVER

Multidisciplinary and Integrated Study

GESA

PHASE A

Problem

Infrastructure plays an important role in altering coastal processes

Sand usually accumulates on one side of the port and erodes on the other

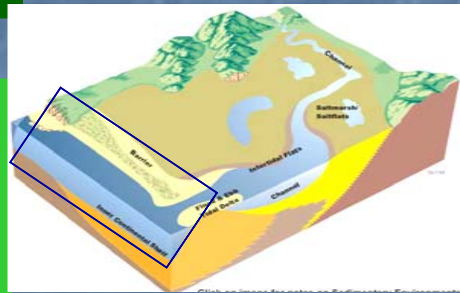
Periodical dredges

Beach nourishment

Main goals

Morphodynamic evolution

Sand stocks availability

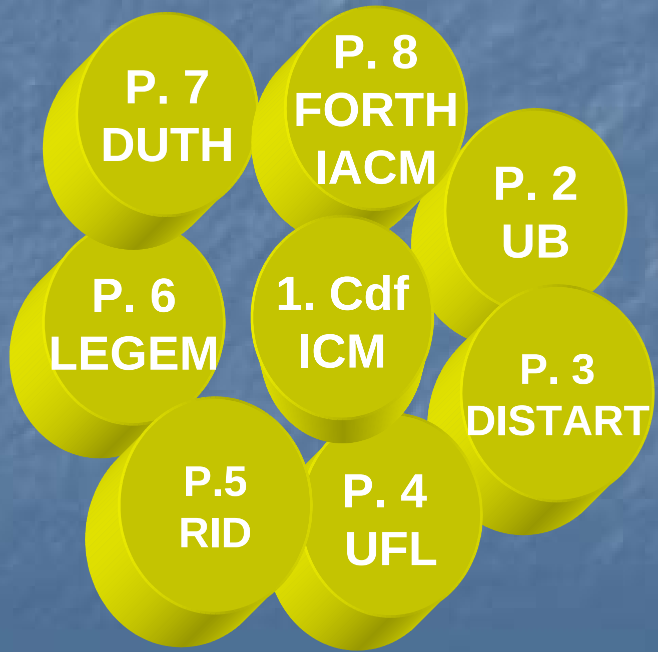


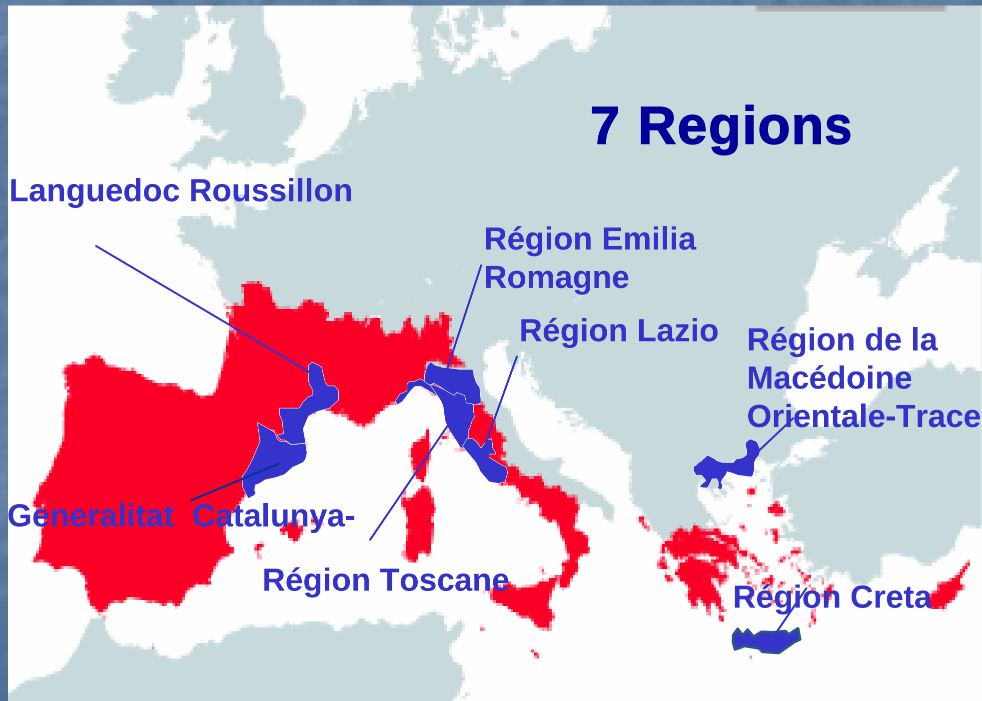
COASTAL AREA

PHASE B

- *Coordination/uniformities of the methodologies*
- *Establishment of the research strategies*
- *Cruise planned*
- *Elaboration of common data archive*

8 Partners





RESULTATS - PHASE B: Layout

I. RESEARCH STRATEGIES

- HYDROGRAPHIC BASINS
- COASTAL AREA

II. METHODS

III. COMMON DATA ARCHIVES

HYDROGRAPHIC BASIN & RIVERS

PHASE B

Problem

Rivers are often not able to provide enough sediments to the coast

Main causes are: dams and weirs, land uses and climate

- Recover sediments from rivers
- Keep the sedimentary cycle stable

Main goals

- Accumulation areas with high hydraulic risk
- Sediments entrapped by dams

Strategy

- Analysis of sediments (laboratory)
- Quantification of sediments and possible re-use
- Quantification (numerical models)

IA.- RS to the study hydrographic basin

I. RESEARCH STRATEGIES

- Reduction to fluvial inputs by accumulation in the hydrographical basins
- Reduction to fluvial inputs by anthropogenic factors (dams)
- Reduction to fluvial inputs by turbidity currents
- Recovery of sediments in reservoirs (dams)
- River contribution from deltaic systems

UB- P2
UFL- P4
RID- P5
DUTH- P7

• Reduction to fluvial inputs by accumulation in the hydrographic basins

(Ia). RS to the study hydrographical basin

➢ *Analysis of accumulated sediments in the River Magra watershed*

U.FLOR-P4

Identification of sediments (Phase B)

Local sediment accumulation

↓

18 samples at 9 locations

↓

Sieve analysis

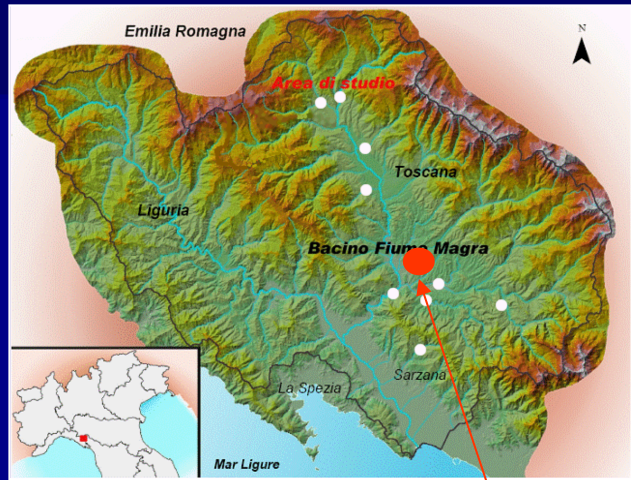
↓

Grading curves

↓

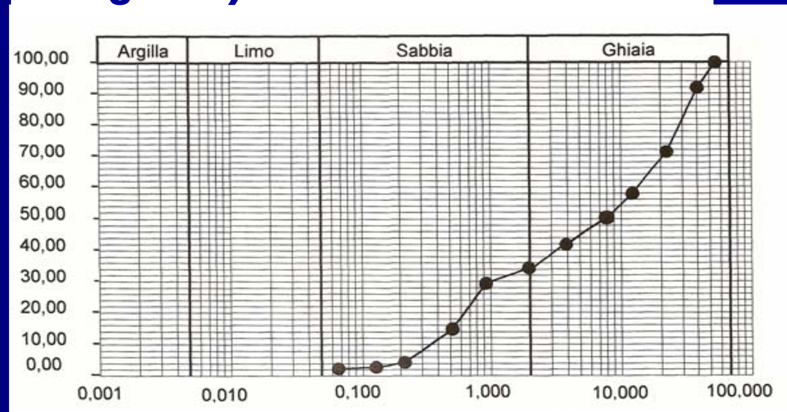
All gravel and sand

Magra watershed: location map



Grading curve (T. Lucido, Loc. Gragnola)

Passing fraction [%]



Diameter [mm]

• Reduction to fluvial inputs by antropogenic factors (dams)

DUTH P7

(Ia). RS to the study hydrographical basin

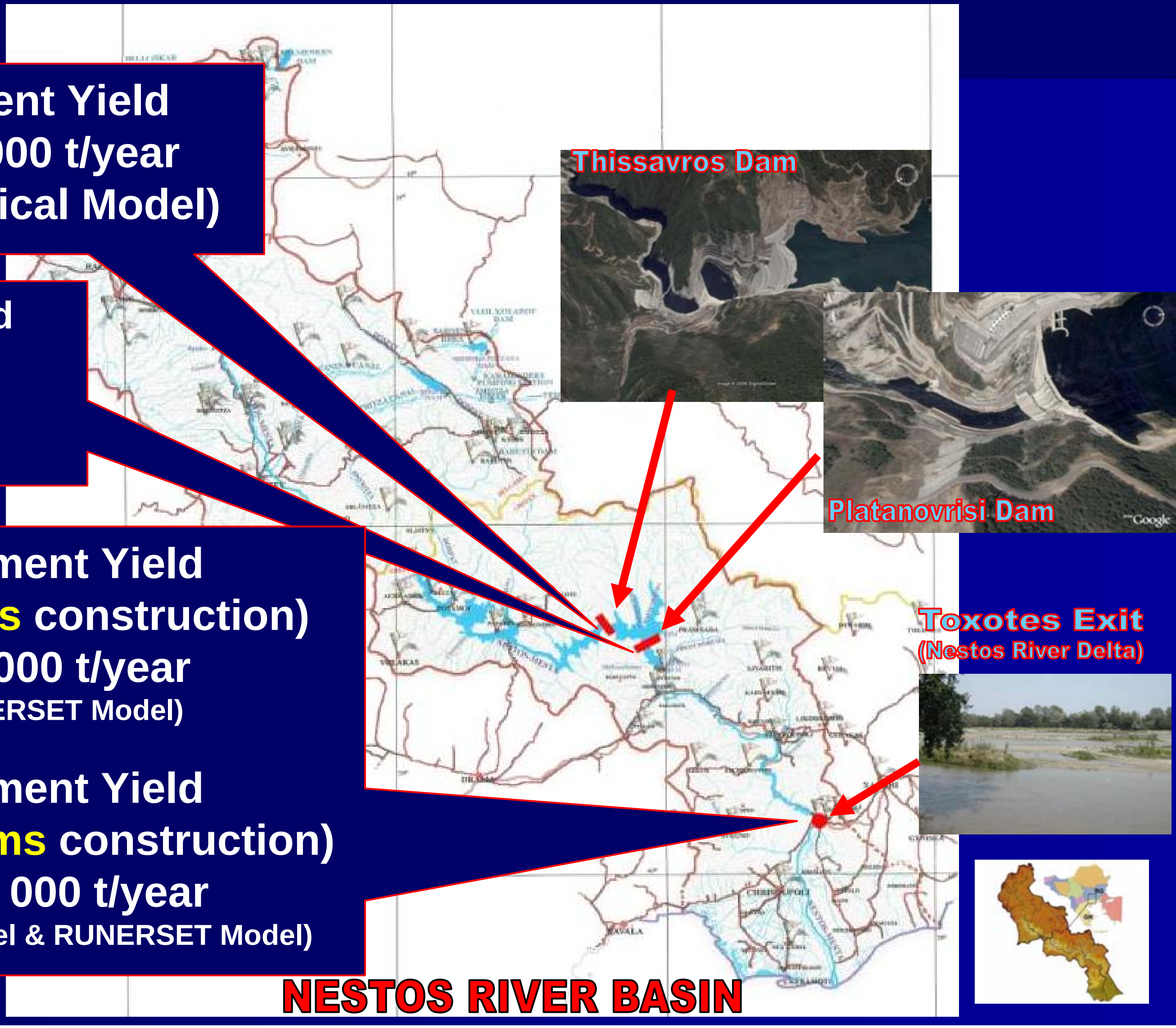
➢ *Elaborate the appropriate methodologies in order to calculate the reduction of the sediment yield at the mouth of rivers due to construction of dams.*

Sediment Yield
1 800 000 t/year
(Empirical Model)

Sediment Yield
300 000 t/year
(RUNERSET Model)

Sediment Yield
(after dams construction)
300 000 t/year
(RUNERSET Model)

Sediment Yield
(before dams construction)
2 400 000 t/year
(Empirical Model & RUNERSET Model)



Ia. RS to the study hydrographical basin

• Reduction to fluvial inputs by turbidity currents

DUTH-P7

➢ *Simulation of TC generated during floods at the rivers mouths (loss of sediment)*

• Simulation of hyperpycnal flows after extreme flood events using FLUENT (A robust CFD- Computational Fluid Dynamics- Solver).

Nestos River Delta

• Possible **formation of Hyperpycnal flows** (Turbidity currents) during extreme flood events in Nestos river discharge into **Aegean sea.**

Evros River Delta

• Possible **formation of Hyperpycnal flows (Turbidity currents)** during extreme flood events in Evros river discharge into Aegean sea.

➢ *Examine in particular the importance of TC of R. Nestos & Evros* in the overall morphodynamics of the continental shelf

• Recovery of sediments in reservoirs (dams)

RID-P5

Ia. RS to the study hydrographic basin

➢ *Control of sedimentation in the artificial reservoirs and to evaluate the reservoirs effective capacity (lost during the time due to the filling phenomenon)*

Intervention strategies | **Objectives**

- "Active" Defense → • To reduce the sedimentation (control the process of erosion & sediments transport to the reservoirs)

Techniques:
Sediment routing (manage the route of sediments: sluicing/passing);
Venting and flushing –"hydraulic drain"

- "Passive" Defense → • Recovery of the effective capacity removing the settled material

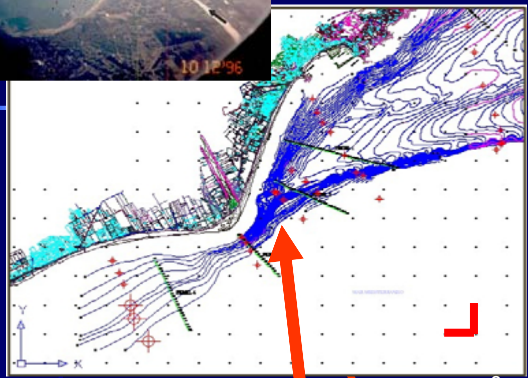
Techniques:
Consists in the hydraulic/mechanical removal of sediments

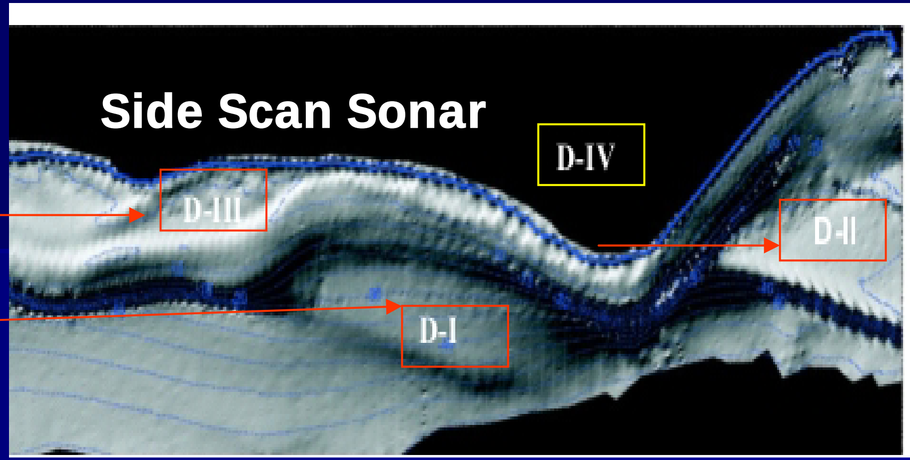
• River contribution from deltaic systems

UB-P2

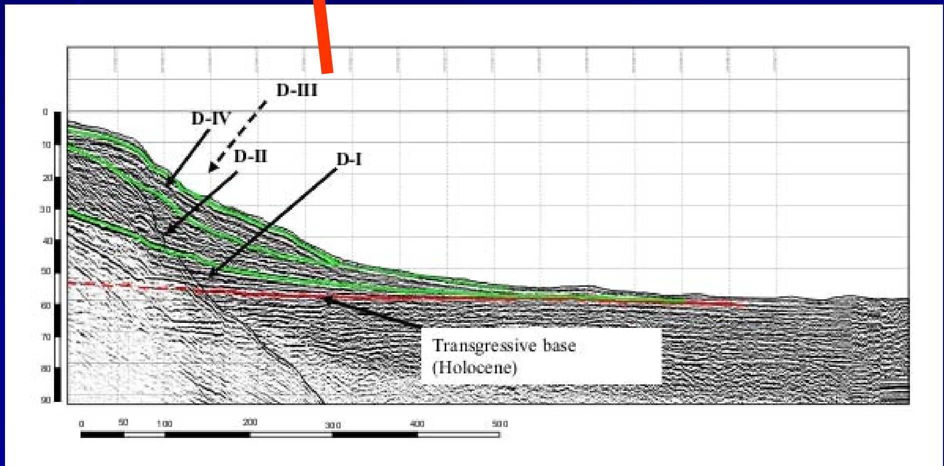
Ia. RS to the study hydrographical basin

Tordera Delta





➢ *Morphology, structure & quantified sand volume*



- Presence relict deltas

3 Relict deltas
- D 1- 50 m-9,000 yrs
- D II 30 m-7,500 yrs
- D III 15 m

D IV present

- An important value to stocked sands on those relict bodies
- At least a volume of sand 38 millions of cubic meters

COASTAL AREA

PHASE B

Problem

- Infrastructure plays an important role in altering coastal processes
- Sand usually accumulates on one side of the port and erodes on the other.
  - Periodical dredges
  - Beach nourishment

Main goals

- Morphodynamic evolution
- Sand stocks availability

Strategy

- **Infralittoral wedge** (HRS, bathymetry, vibrocorer)
- **Sand intercepted by coastal structures** (HRS, bathymetry, vibrocorer)
- **Sedimentary dynamic** (physical & numerical models)

IB.- RS to the study coastal area

I. RESEARCH STRATEGIES

- Evaluate the sand stocks availability
- Define the best methodology for nourishment
- Understand of the morpho-dynamic and shoreface nourishment evolution

ICM- P1
UB- P2
DISTART-P3
UFL- P4
LEGEM- P6
DUTH- P7
IACM- P8

• Evaluation the sand stocks availability

ICM-P1

(Ib). RS to the study coastal area

GOALS

Sand stocks availability

- *Infralittoral wedge*
- *Sand intercepted by coastal structures*

RESEARCH STRATEGY

Infralittoral wedge	Sand intercepted by coastal structures
Bathymetry (nov'06)	Bathymetry (march'06, jun'06, nov'06, april'07)
HRS (march'07)	HRS (march'07)
Vibro-corers (april'07)	Vibro-corers (april'07)
	Topography **(march'06, jun'06, nov'06, april'07)**

Masnou

Geopulse

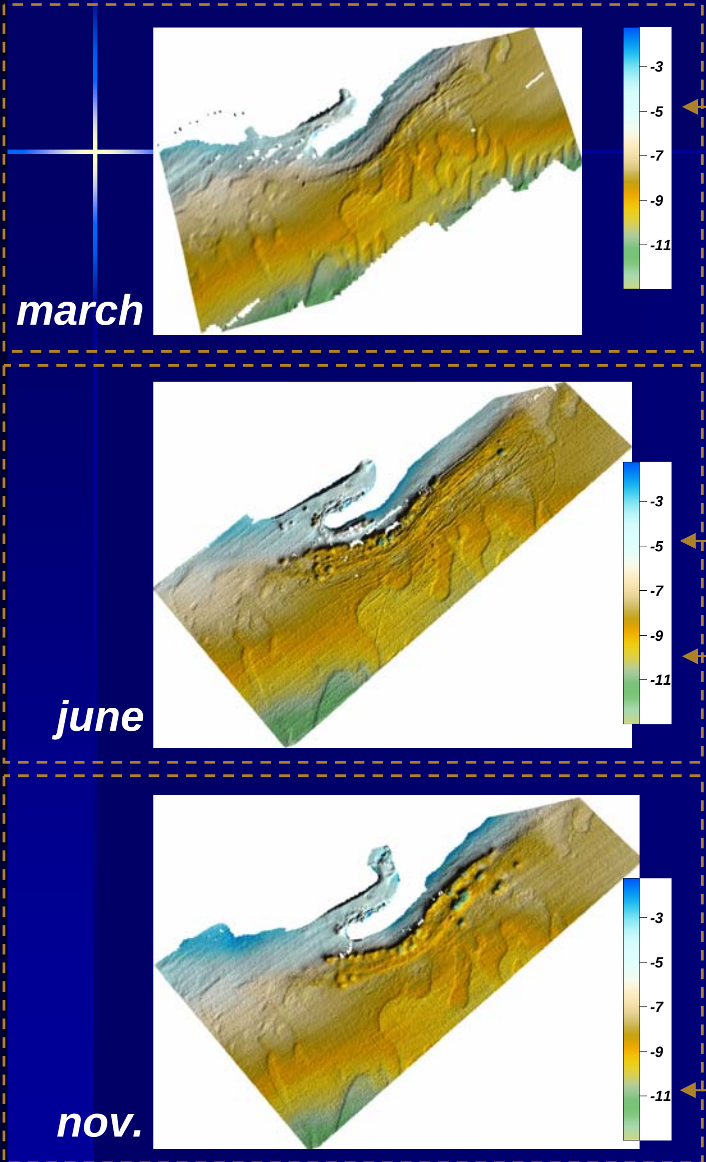
Vibrocorer

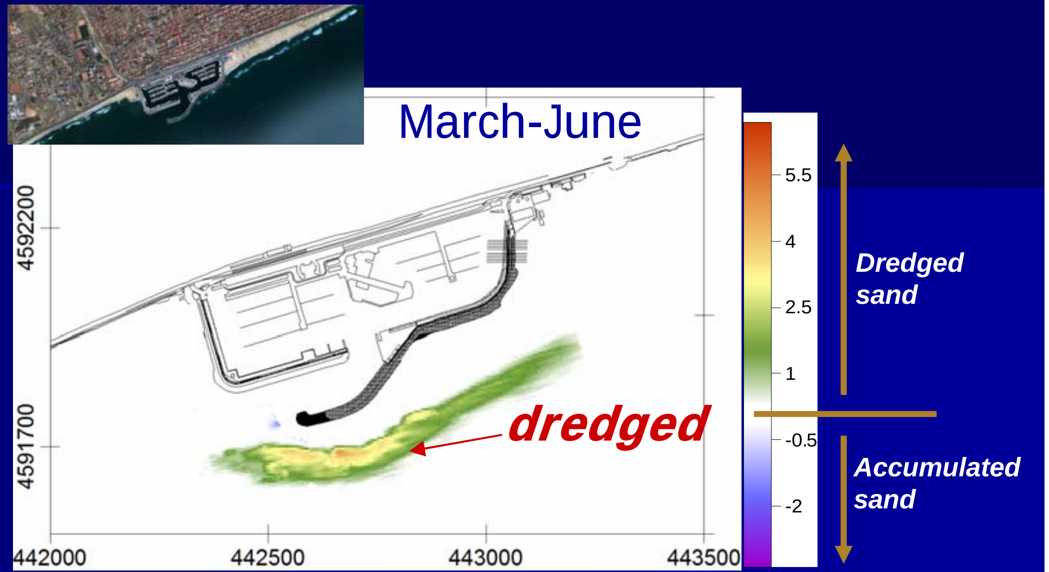
• Evaluation the sand stocks availability

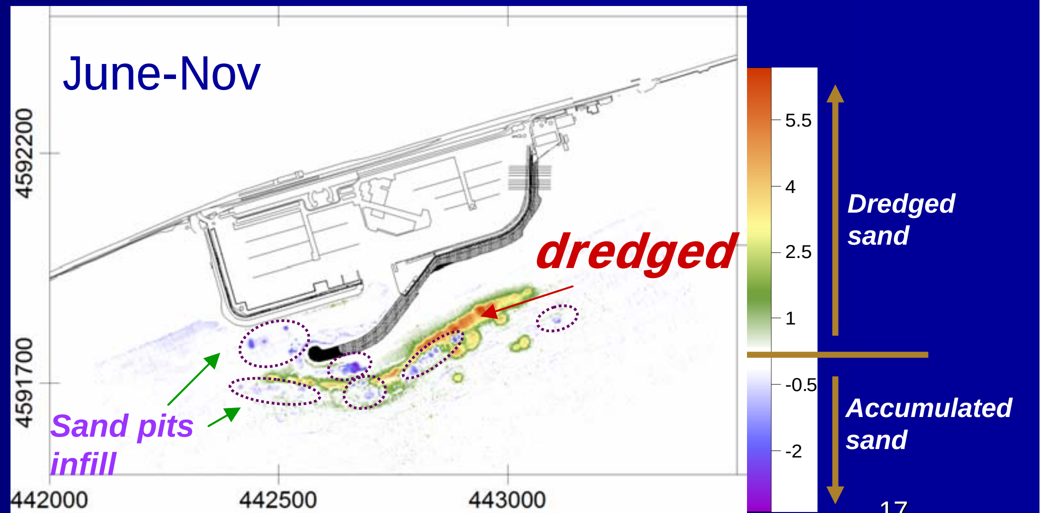
ICM-P1

(Ib). RS to the study coastal area

Dredged area evolution





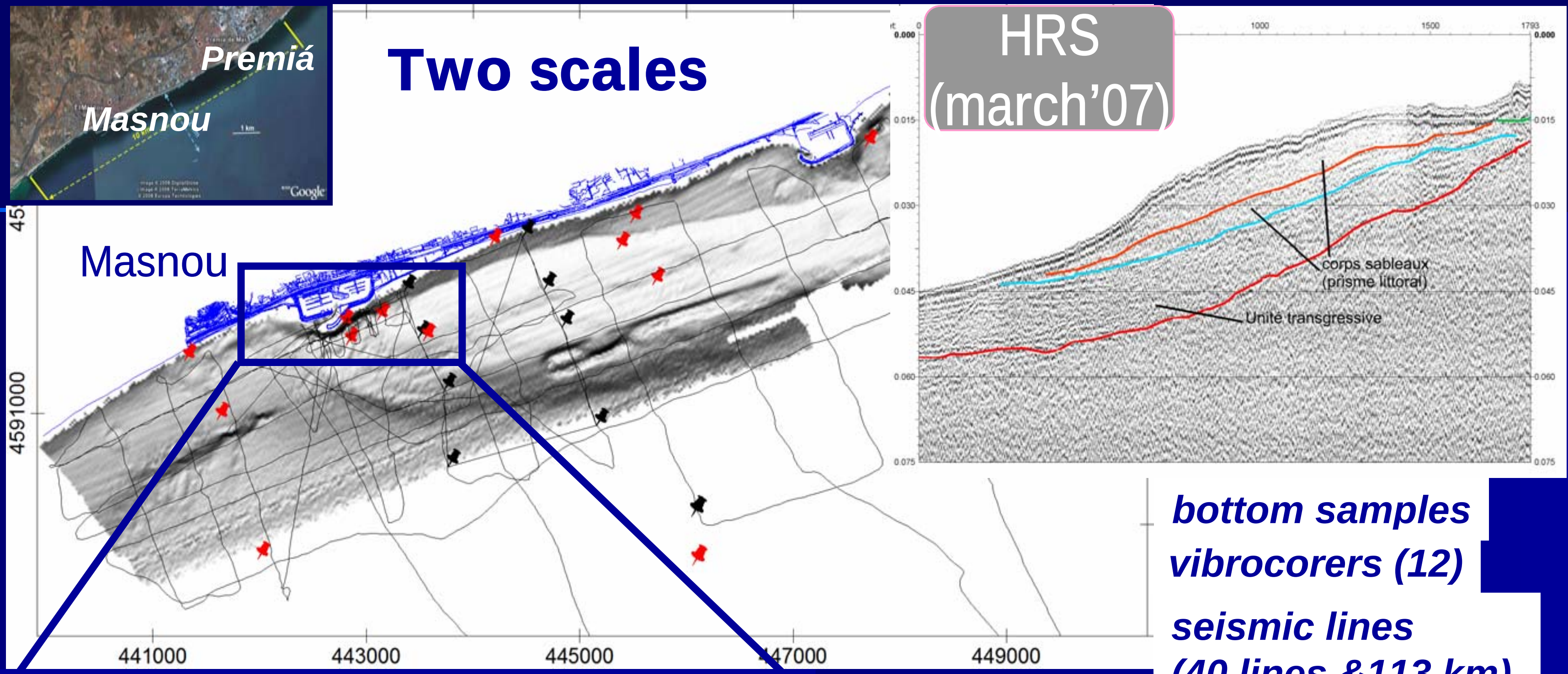


(Ib). RS to the study coastal area

• Evaluation the sand stocks availability

ICM-P1

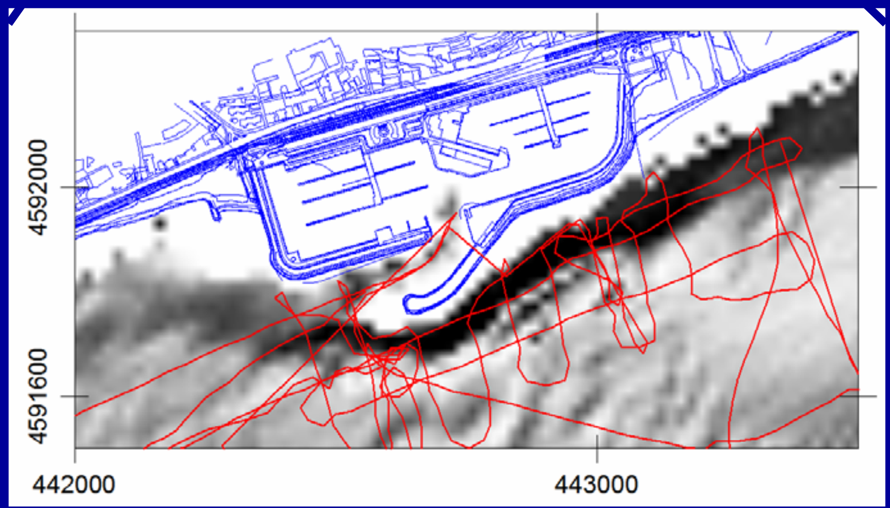
Two scales



bottom samples

vibrocorers (12)

seismic lines
(40 lines &113 km)



1. Large scale
(Masnou littoral)

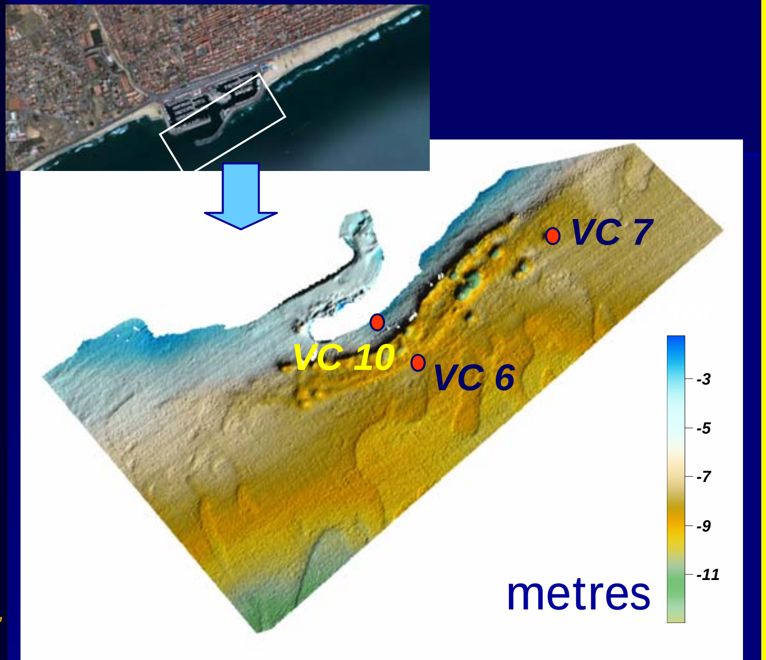
2. Small scale
(Dredged area)

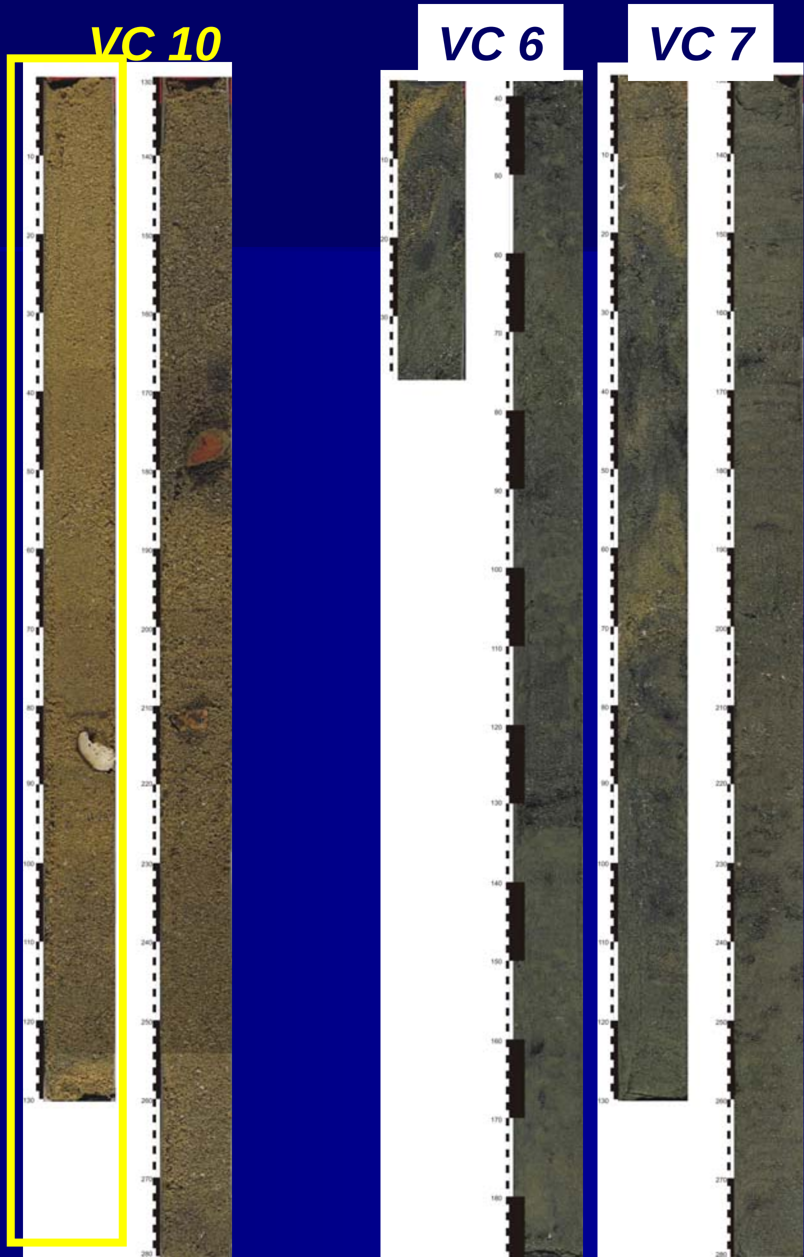
• Evaluation the sand stocks availability

ICM-P1

(Ib). RS to the study coastal area

nov.





- Yellow medium-coarse sand- quartz) in front the harbor Similar to the beach

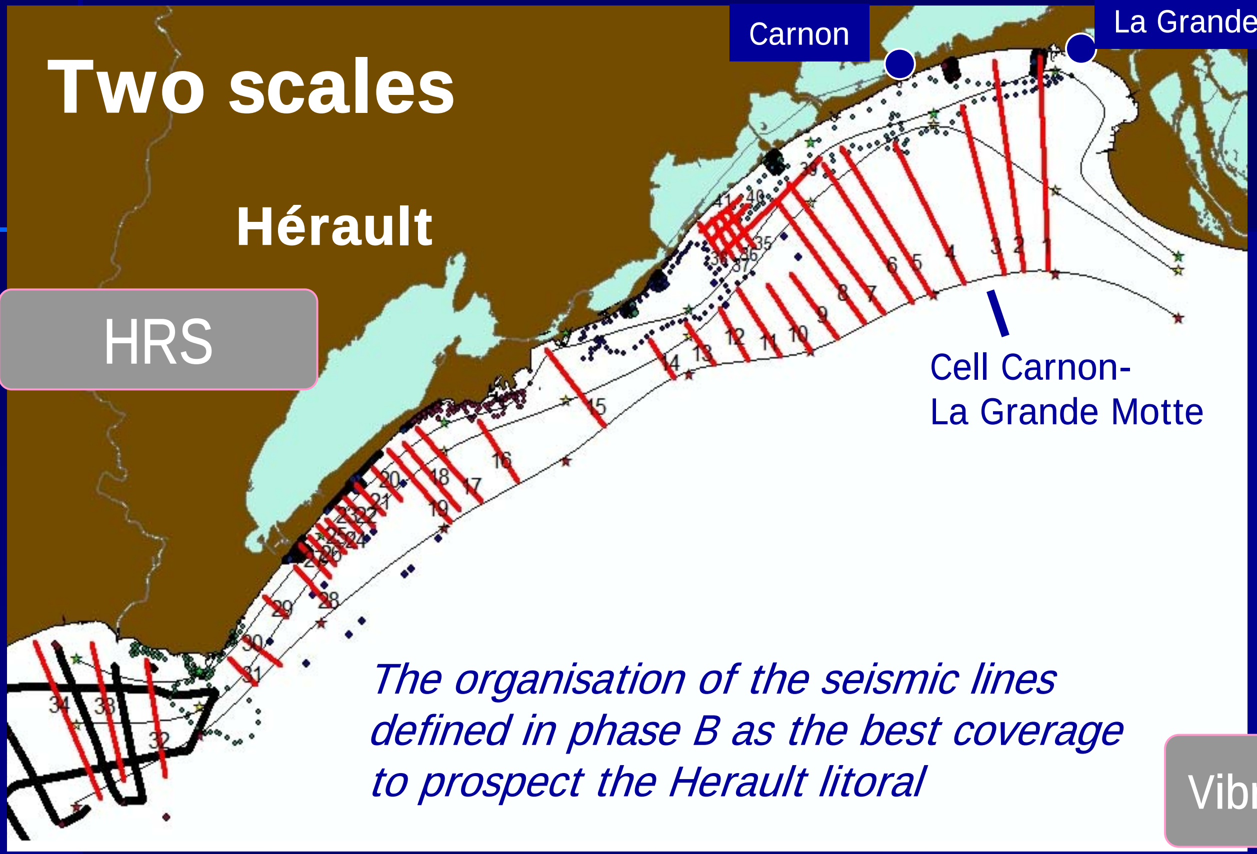
- Underlay and surrounding sediments are finer- dark - mica

(Ib). RS to the study coastal area

• Evaluation the sand stocks availability

LEGEM-P6

Two scales



The organisation of the seismic lines defined in phase B as the best coverage to prospect the Herault litoral

1. Large scale
Hérault littoral

2. Small scale
Cell Carnon-La Grande-Motte (3 sectors)

1
To obtain for the Hérault littoral
the depth of geological substrate
a map of the sedimentary layers above

2
To have a precise estimation of sandy volume (quasi 3D image of the layers)

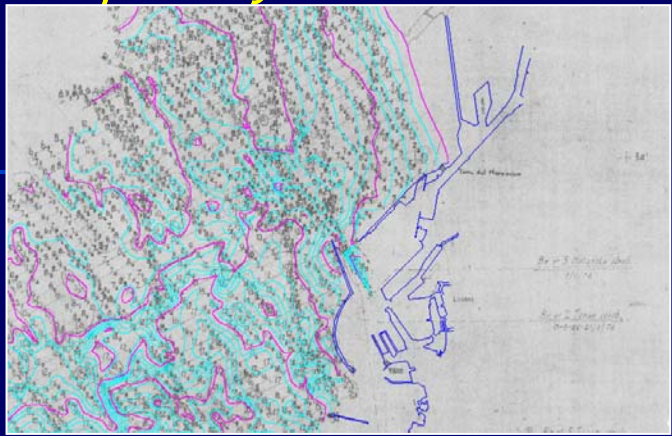
• Evaluation the sand stocks availability

UFLOR-P4

(Ib). RS to the study coastal area

➢ *Intercepted by Tuscan harbours*

Livorno (1976)



Old maps & recent bathymetric surveys

↓

Georeference

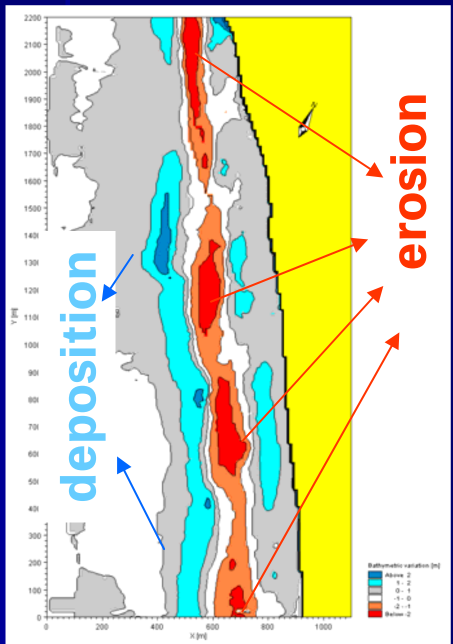
↓

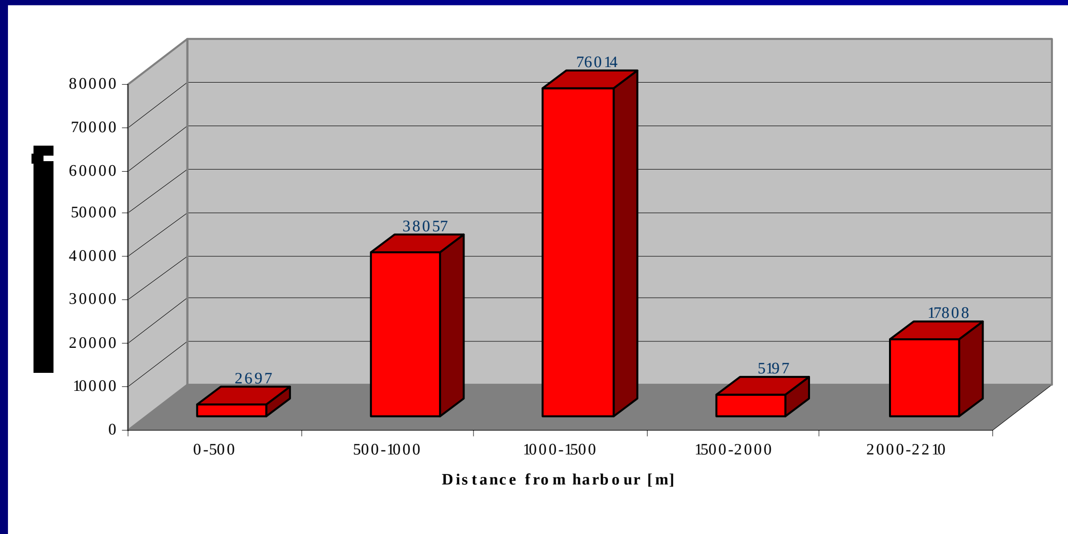
Comparable bathymetric domains

↓

Estimate of accumulated volumes

Viareggio 1997-2005





Accumulated sediments: 139.000 m^3 → **Accumulated sediments per year**: Around 17.000 m^3

(Ib). RS to the study coastal area

• Definition the best methodology for nourishment

DISTART-P3

➢ This preliminary investigation allows document and evaluate the effectiveness of the three identified methods.

Dredging & Transport
(Traditional method)

Temporary deposit
off-shore
(recently performed)

Onshore pumping of the water-sand mixture
(Traditional method)

NOURISHMENT IN LIDO DI SPINA

Temporary deposit

- This method proved to be efficient
- Although it has some disadvantages/problems

(Ib). RS to the study coastal area

• Definition the best methodology for nourisment

DISTART-P3

• **Temporary deposit** of dredged sand

What are the possible problems?

Structural problem

Can the structure fail? what risks are associated?

METHOD to be used are :
Commercial Finite Element Models suited to Sheet Piling

Environmental impact / efficiency

Increased turbidity – loss of material

METHOD to be used are :
User defined Finite Element Model accounting for Shallow water Equations and Dispersion

Simulations

(Ib). RS to the study coastal area

I. RESEARCH STRATEGIES

- *Shoreface nourishments appear to be a good solution for fighting erosion, but how to optimize them?*

↓

- **Physical modelling (laboratory test) of sand and gravel beach profile evolution**
- **Numerical morpho-dynamic and shoreface nourishment modelling**

• Physical modelling (laboratory test)

LEGEM-P6

(Ib). RS to the study coastal area

- Accretion phases are poorly described
- If we want a good evaluation of shoreface nourishment strategies,

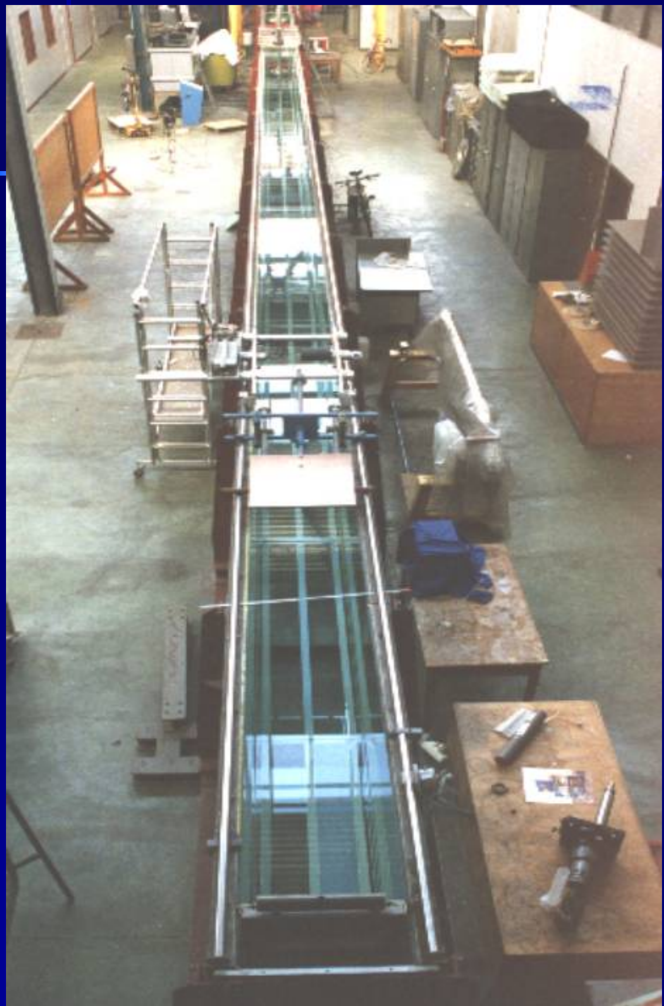
- It seems necessary to understands better these accretion phases

In this way, experiment studies in Sediment Flume are a good alternative (not much used)

(Ib). RS to the study coastal area

• Physical modelling (laboratory test)

LEGEM-P6



➢ *To test of offshore nourishment scenarios on beach profiles in similitude with nature*

Experiments:

• A flume of 36 m long with irregular waves.

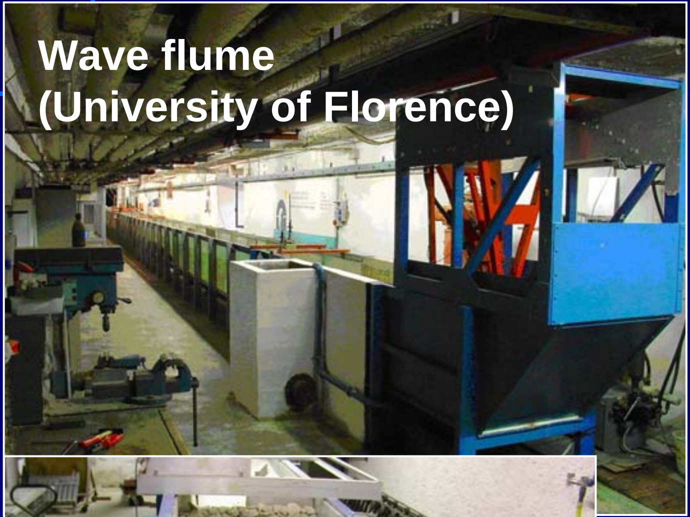
• Reproduce correctly phenomenon on nature, in particular order magnitude for Hydrodynamic and Sediment Transport.

• Effect of short waves on sediment transport but also long-wave impact will be considerate.

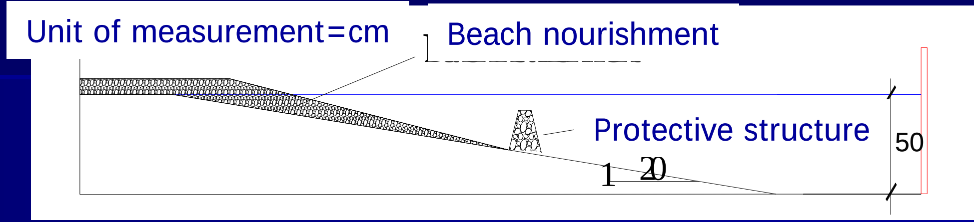
• Physical modelling (laboratory test)

UFLOR-P4

➢ *Test of offshore gravel nourishment*



Section of the flume with test layout



<u>Tests (24 tests planned):</u>

- 6 wave attacks
- **2 gravel sizes**
- 2 beach profiles (with and without protective structures)

<u>Measures and measuring devices</u>:

- Wave heights (wave gauges)
- Reflection coefficients (wave gauges)
- Beach profile (video-camera and bottom profiler)

<u>Expected results:</u>

- Understanding the influence of submerged structure on the time to reach the equilibrium shape.

(Ib). RS to the study coastal area

• Numerical morpho-dynamic and shoreface nourishment modelling

GESA

➢ *To used a numerical model to estimate the efficiency and the durability of a shoreface nourishment on beaches.*

• A validation of these results with the in-situ data will also be done

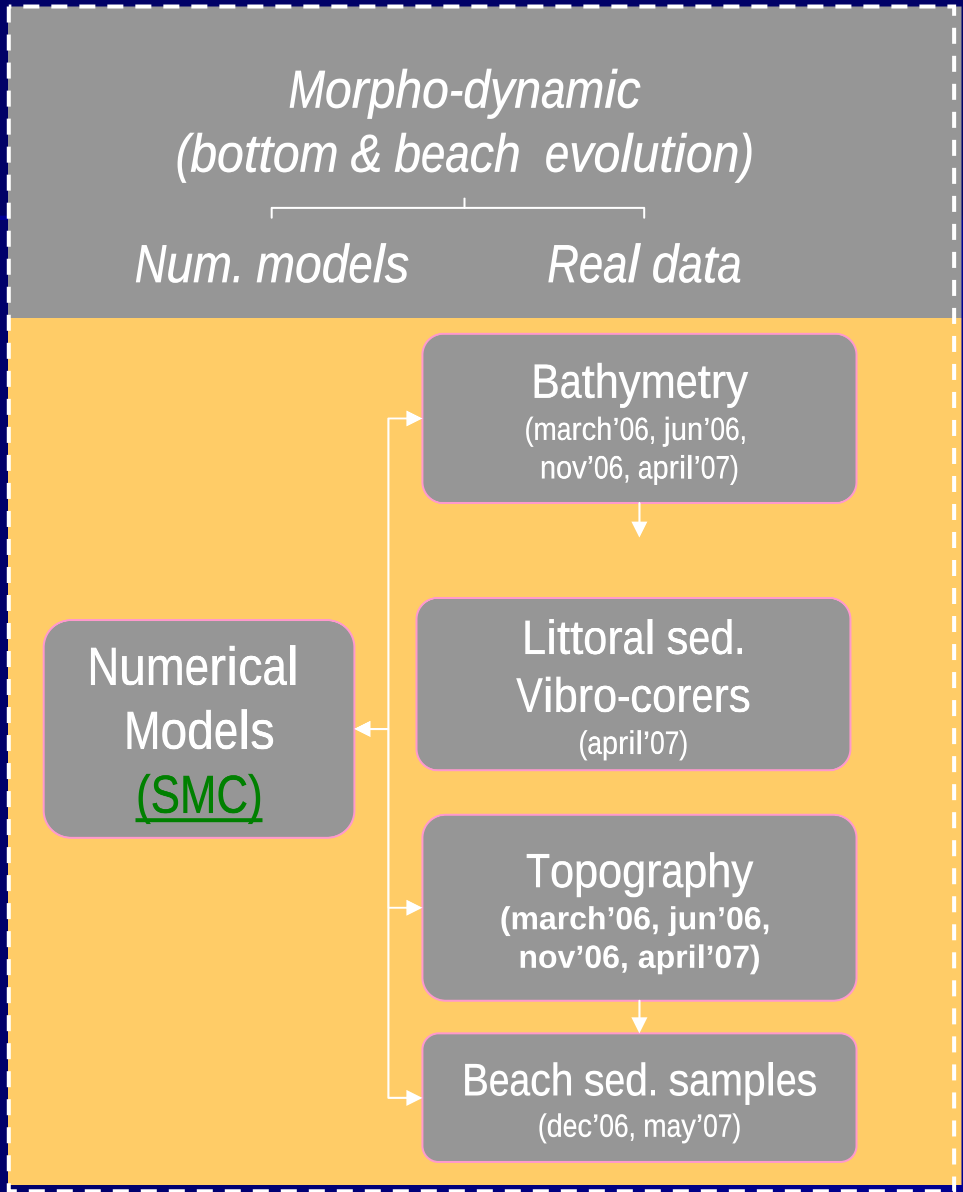
SMC (Coastal Modelling System)
TELEMAC-model multi 1-DH&2DH
MODHYS
S-BEACH
MIKE 21
CEDAS (GENESIS)
Model ALS
sub-model Wave –L
sub-model CIRC-L

ICM-	P1
UB-	P2
DISTART-	P3
UFL-	P4
LEGEM-	P6
DUTH-	P7
IACM-	P8

• Numerical morpho-dynamic and shoreface nourishment modelling

ICM-P1

(Ib). RS to the study coastal area

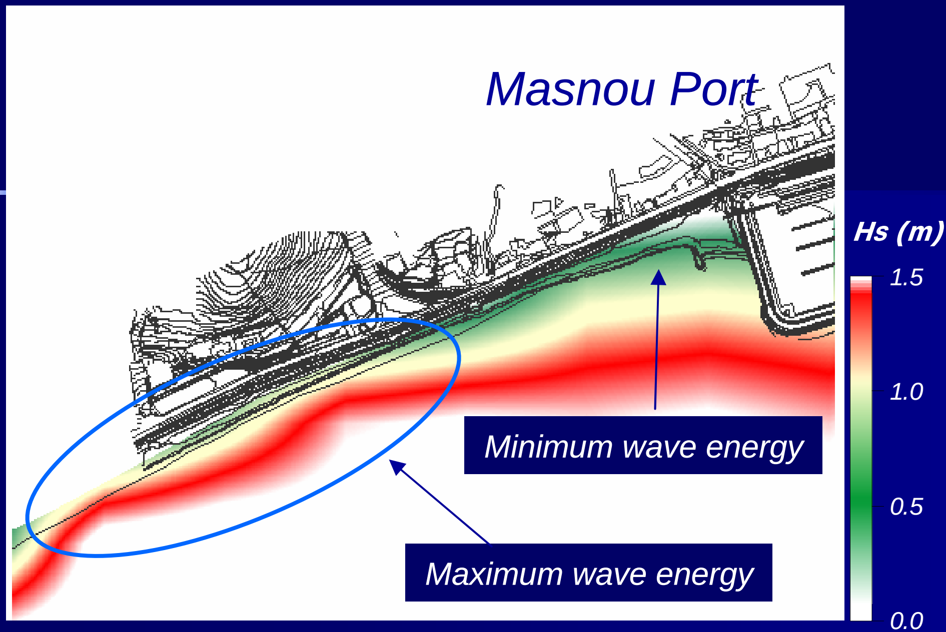


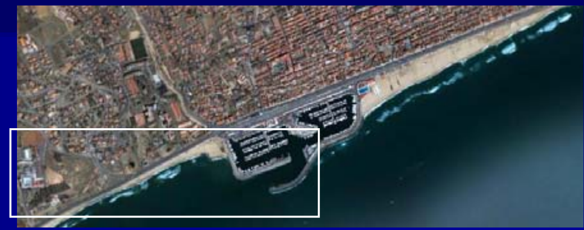
• Numerical morpho-dynamic and shoreface nourishment modelling

ICM-P1

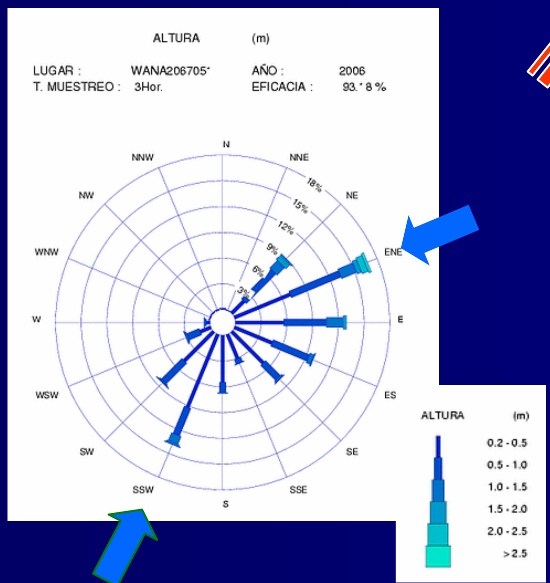
(Ib). RS to the study coastal area

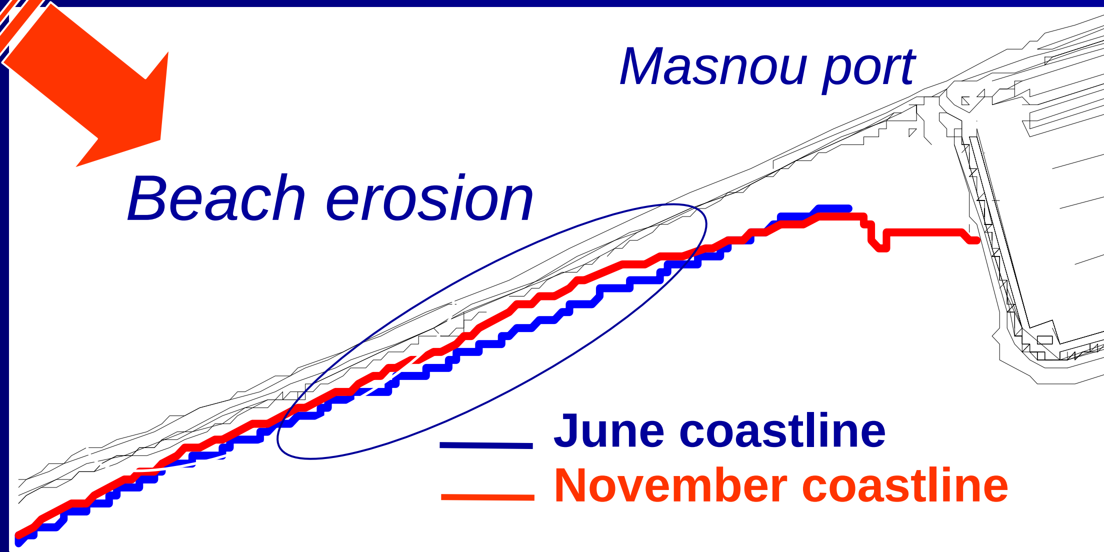
SMC. propagations





Hs: 3.5 m T: 9 s
ENE wave direction





• Numerical morpho-dynamic and shoreface nourishment modelling

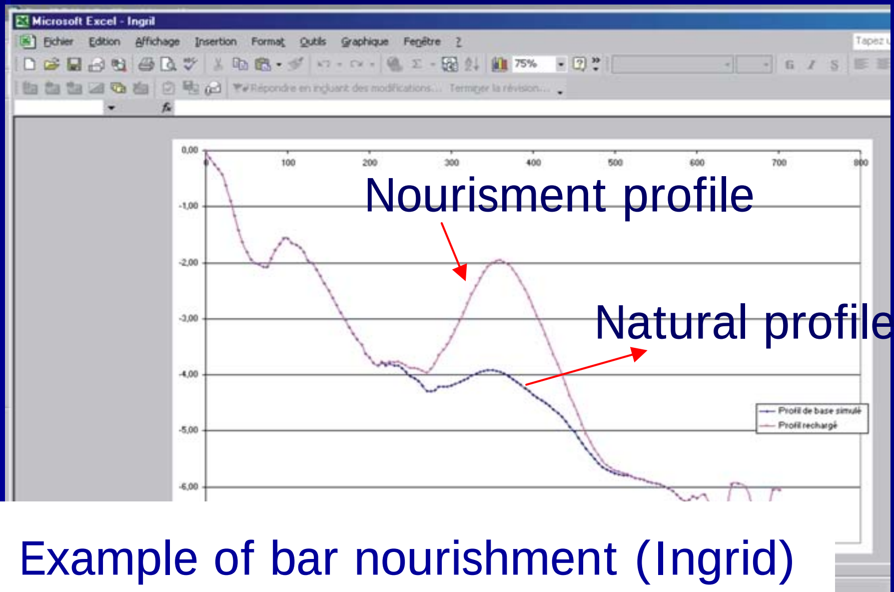
LEGEM-P6

(Ib). RS to the study coastal area

- *Different scenarios (*Littoral Bar , Troughs) *are defined*
- Four numerical models are used: TELEMAC & the multi 1-DH model (LEGI). MODHYS (IMFT), S-BEACH 2D model (CEREGE).

They require in-situ data

- Natural beach profile
- Incoming waves characteristics



Example of bar nourishment (Ingrid)

	Hs,o (m)	Ts (s)
Exceptional storm ES	4	10 s
Classical storm CS	2,5	7 s
Waning storm conditions WS	1	6,5

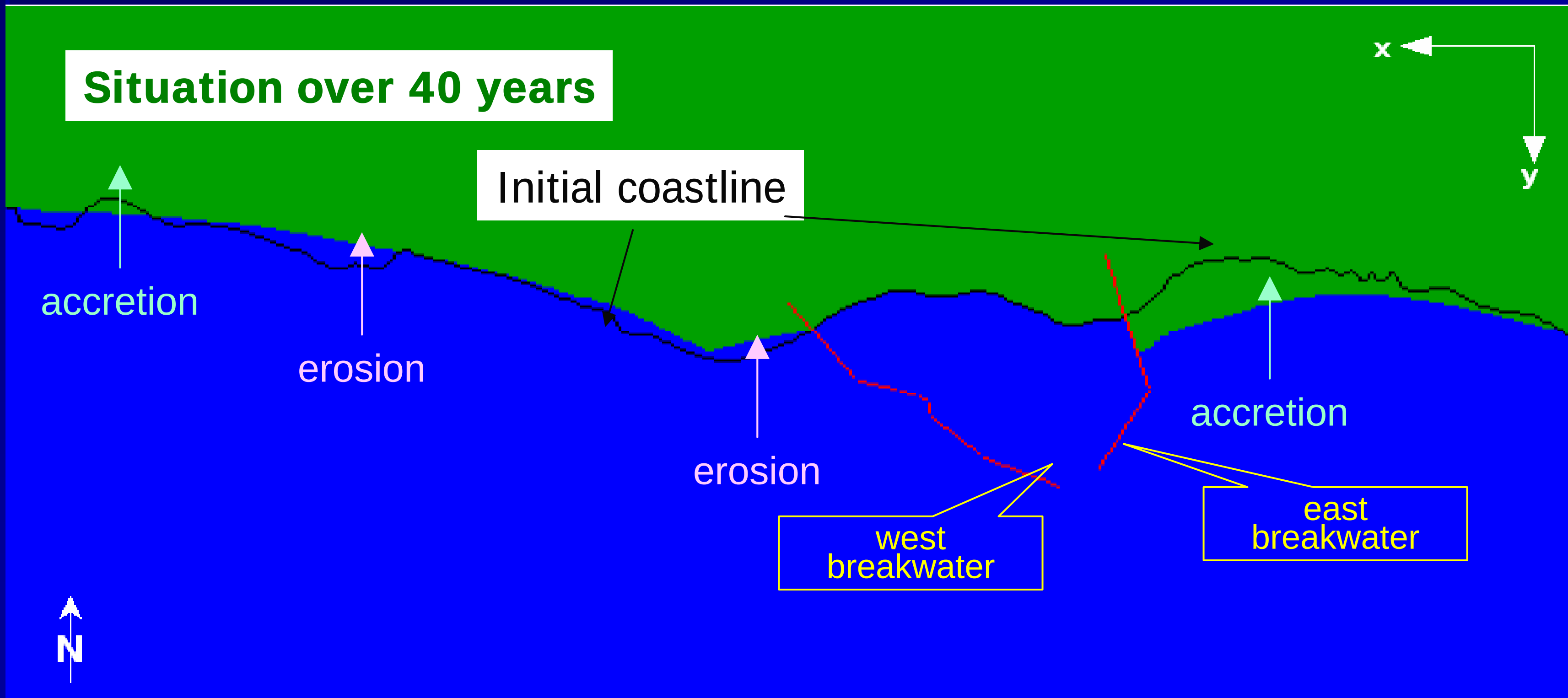
e.g. Natural beach profile and the incoming waves characteristics.

• Numerical morpho-dynamic and shoreface nourishment modelling

DUTH-P7

➢ *Prediction of shoreline change in Thrace using CEDAS (GENESIS) software .*

- Due the construction of large dams or coastal structures.
- Simulated time period is 40 years
- Calculated volumetric change due to the construction of Alexandroupolis port (west of river Evros) : $+1.67\times10^{6}$ m^3 (accretion)



(Ib). RS to the study coastal area

• Numerical morpho-dynamic and shoreface nourishment modelling

IACM-P8

(Ib). RS to the study coastal area

➢ *Model ALS (two submodels) is used for sediment transport monitoring and the methodology followed has been analysed*

- They are base on the shoreline change models.

- These models have advantage of being very fast, and they can predict **long-term** shoreline changes very well after suitable calibration.

- But they cannot accurately predict the impact of morphological changes in the vicinity of coastal structures that are due to **short-terms** storms.

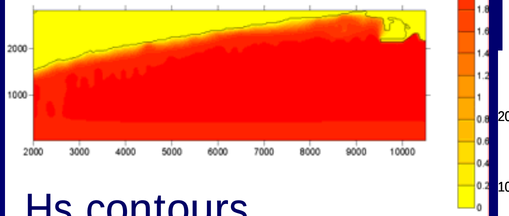
• Numerical morpho-dynamic and shoreface nourishment modelling

IACM-P8

(Ib). RS to the study coastal area

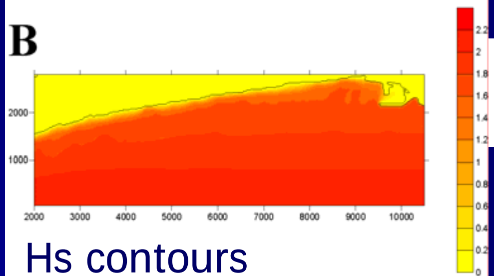
• The wave sub model-WAVE-L and sediment transport sub-model CIRC-L have been applied for the Region Rethimo (N. Crete)

A Current status



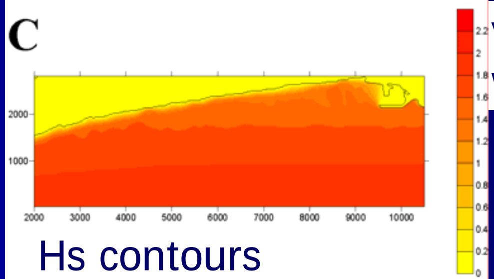
Hs contours

B



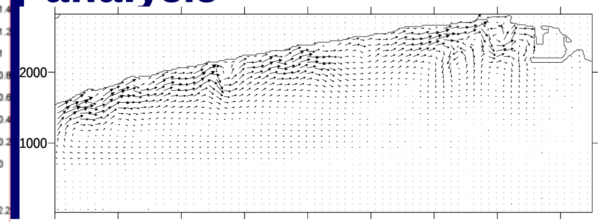
Hs contours

C

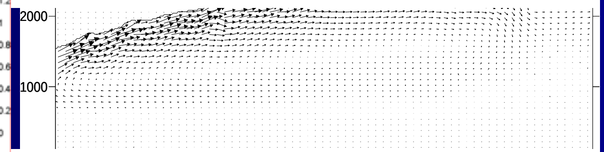


Hs contours

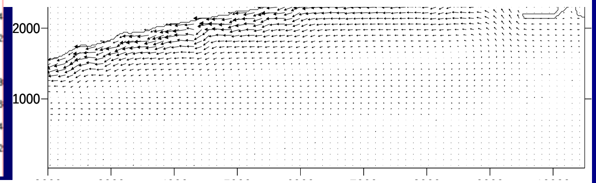
Wave induced current analysis



Velocities for North direction winds



Velocities for North-East direction winds



Velocities for North-West direction winds

In order to determine:

- the wave climate and
- the current pattern

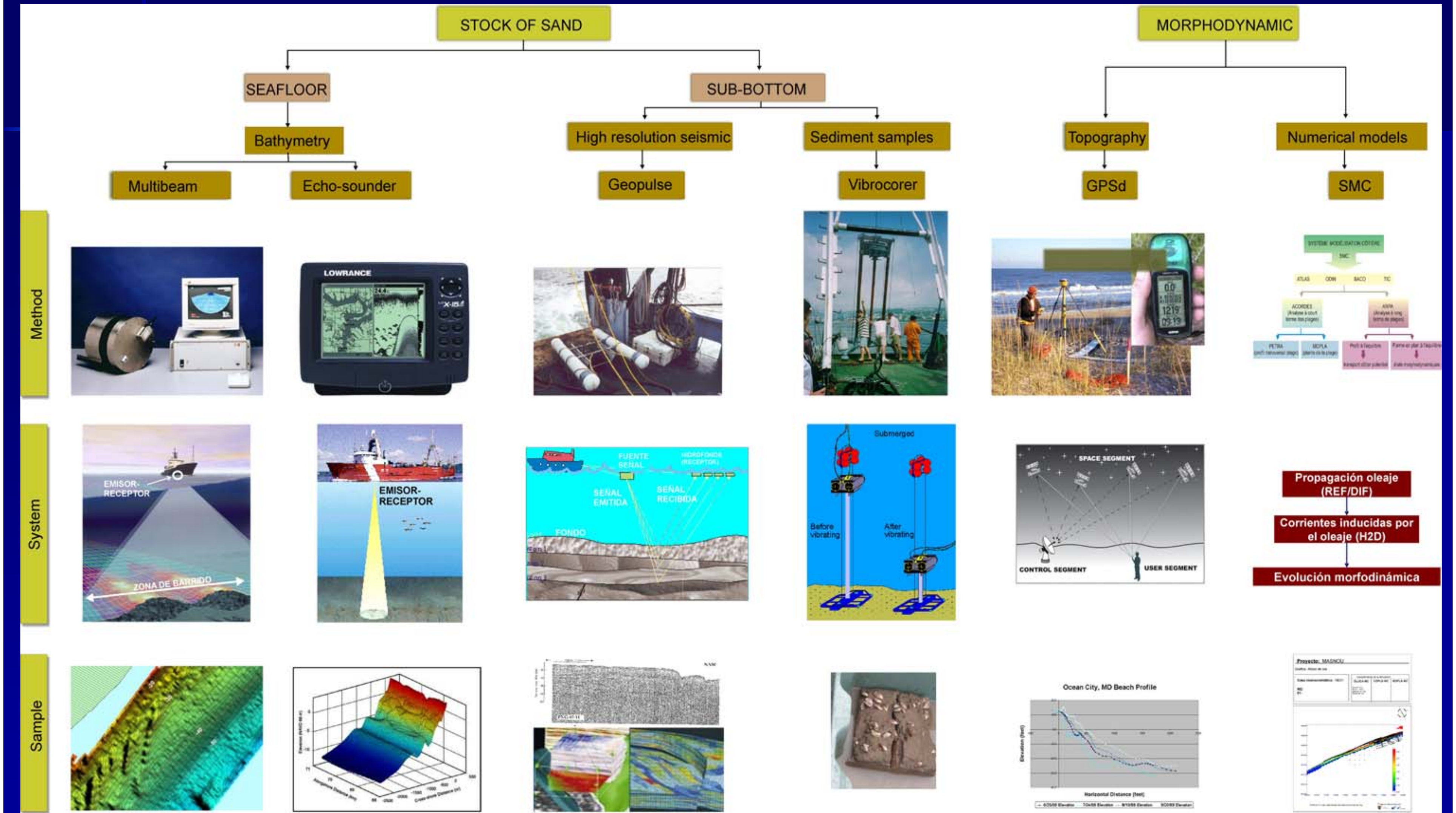
• **Sediment balance** of the coast is significantly influenced by the harbour on the west corner of the beach.

II. METHODS-TECHNIQUES

GESA

- ✓ BATHYMETRIC
- ✓ TOPOGRAPHIC
- ✓ SEDIMENT SAMPLES
- ✓ SEISMIC
- ✓ MODELS: PHYSICAL & NUMERICAL

II. METHODS-TECHNIQUES



II. METHODS-TECHNIQUES

	Seismic reflexion	Single beam	Multibeam	Side scan sonar	Dredges	Box corer	Vibrocorer	Topography	Aerial photos	Wave-climate	Dredging data	Physical models	Numerical models
Catalunya	X	X	X		X		X	X	X	X	X		X
Emilia-Romagna								X	X	X			X
Toscana		X	X			X			X	X	X	X	
Languedoc-Roussillon							X					X	X
Macédonia l´Est													X
Crète										X			X

III. COMMON DATA ARCHIVE

- **GESA has contributed to compilation of some coastal data:**

  Bathymetry

  Aerial photos

  Dredging

  Wave climate

  New data acquisition

- **Integrated central-access on GESA Page web**

- **Dissemination of data between the partners**

III. COMMON DATA ARCHIVE

BATHYMETRIC DATA GESA (2006-2008) Beachmed-e								
Partner/ Institution	*Country*	*Region*	*Harbour*	*Year*	*Date*	*Information*	*Technique*	*Water depth*

METEO-MARINE CLIMA DATA GESA (2006-2008) Beachmed-e							
Partner/ Institution	*Country*	*Region*	*Area*	*Register Years*	*Ondemetre*	*Nº Bouye*	*Geographic coordenates*

AEREA PHOTOS DATA GESA (2006-2008) Beachmed-						
Partner/ Institution	*Country*	*Region*	*Area*	*Year*	*Date*	*Additional information*

DREDGING DATA GESA (2006-2008 Beachmed-e						
Partner/ Institution	*Country*	*Region*	*Year*	*Dredging Area*	*Recharge Area*	*Source*

MASNOU PORT

CATALUNYA

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Port Masnou

THANK YOU
MERCI
GRAZIE
GRACIAS

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