UNFCCC expert meeting on methods and tools and on data and observations under the Nairobi work programme on impacts, vulnerability and adaptation to climate change

Mexico City, Mexico, 4-7 March 2008

A methodology for impact, vulnerability and adaptation assessment in the coastal zone

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Outline

1. Motivation and objectives
2. Global Framework
3. Methodologies to obtain regional vulnerability indices
4. Methodologies to assess detailed studies of coastal vulnerability and adaptation
5. Projection of coastal dynamics to the XXIst century
6. Conclusions

1. Motivation and Objectives

- **Analysis and evaluation of climate change impacts and adaptation assessment on beach, estuary, lagoon, deltas and dune morphodynamics; coastal erosion; flooding risk assessment and impacts on the functionality and stability of coastal infrastructures**

Impact, vulnerability and adaptation assessment in the coastal zone

Outline

2. Preliminary concepts

- Impact assessment of climate change on coastal areas depends directly on changes in atmospheric and ocean forcings

- The effect of these forcings on coastal areas is highly dependent on local characteristics

- The main agent considered during the last decades has been sea level rise

- Sea level rise is not the only effect to be considered. Wave climate, storm surges, winds and currents, river discharge and run-off have to be considered

- Coastal areas are highly vulnerable since they are the interface between ocean and land.

Impact, vulnerability and adaptation assessment in the coastal zone

2. Preliminary concepts

- Coastal areas show a high geographical, socioeconomic and environmental variability, i.e., impact analysis, vulnerability and adaptation measures may change substantially even at the local scale

- High resolution information is required to address impact assessment and adaptation measures

Consequently we need

- High resolution forcings/pressures at local scale
- New integrated indices not only sea level rise
- High resolution vulnerability information

2. Preliminary concepts

•An accurate adaptation strategy is only possible if it's based on quantitative local resolution assessment

Impact, vulnerability and adaptation assessment in the coastal zone

2. Preliminary concepts

Starting with downscaled global climate models the regional and local impacts of future climate pressures including sea level rise, changes in storm surges and wave climate are investigated in a series of linked models following two different procedures:

Long-term trends analysis + statistical models

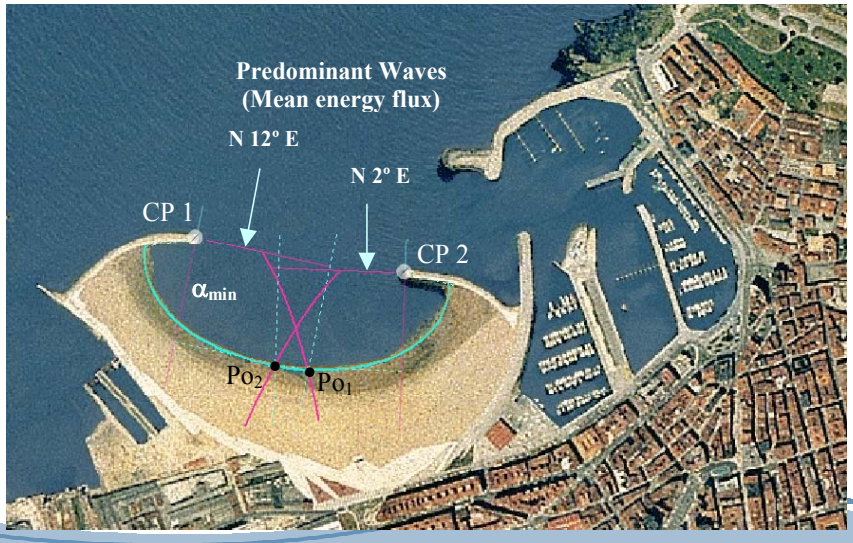
Scenarios based numerical modelling

1. Motivation and Objectives

Coastal flooding

1. Motivation and Objectives

Beach planform depends on the mean energy flux



1. Motivation and Objectives

Port operations

Impact, vulnerability and adaptation assessment in the coastal zone

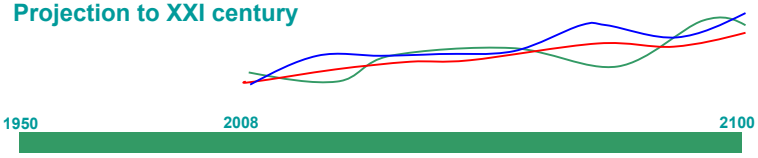
1. Motivation and Objectives

Structure stability

2. Global Framework

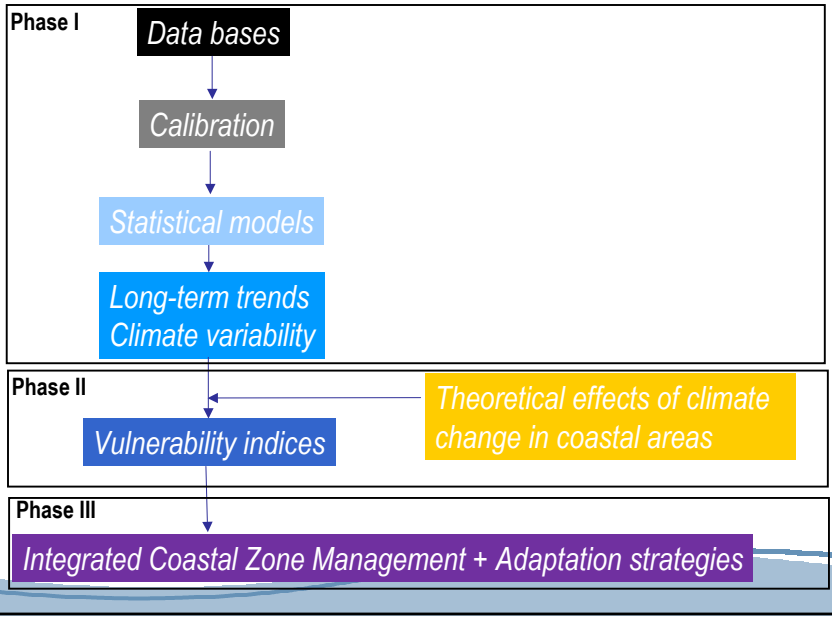
Historical analysis of long-term trends

Projection to XXI century



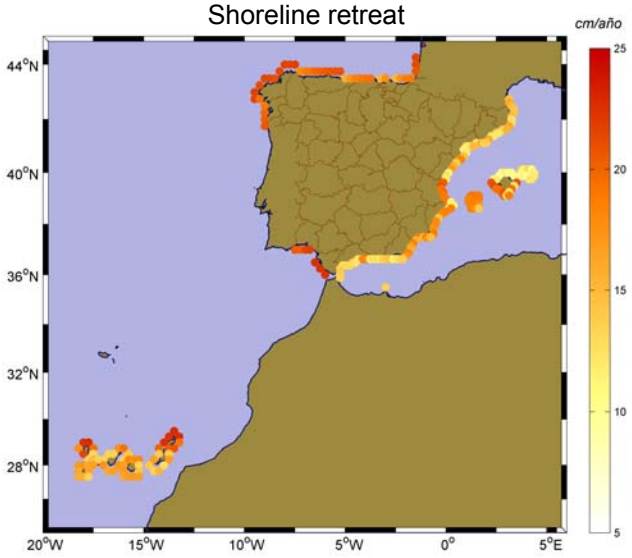
Impact, vulnerability and adaptation assessment in the coastal zone

3. Methodologies to obtain regional vulnerability indices



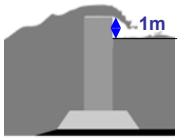
3. Methodologies to obtain regional vulnerability indices

Shoreline retreat



Impact, vulnerability and adaptation assessment in the coastal zone

3. Methodologies to obtain regional vulnerability indices



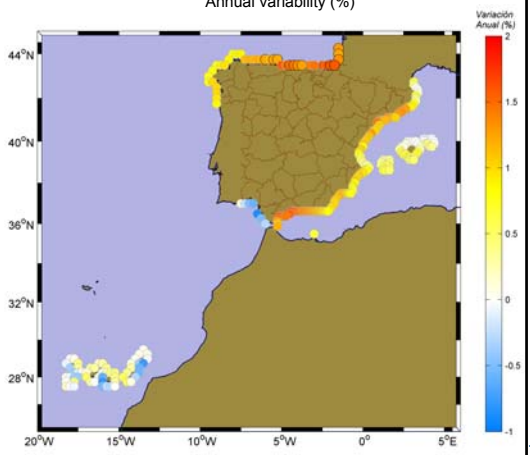
¡ We consider a vertical breakwater with R_c =1 m along the spanish coast!

- **All around the Spanish coast an increase of the overtopping is expected.**

- In Málaga and in Algeciras the biggest increase will be obtained (250 %)

REPRESENTATIVE DATA		
Mediterranean coast	Galician and Cantabria coast	Islands
↑ 150-250 %	↑ 100 %	↑ 35 %

Annual variability (%)

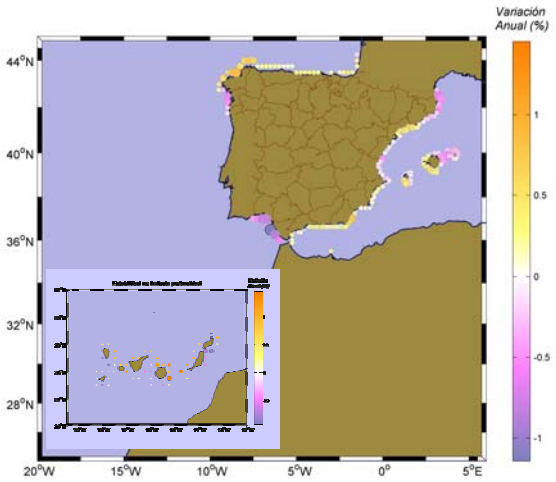


3. Methodologies to obtain regional vulnerability indices

Rubble-mound block sizes variation

Non depth-limited wave!

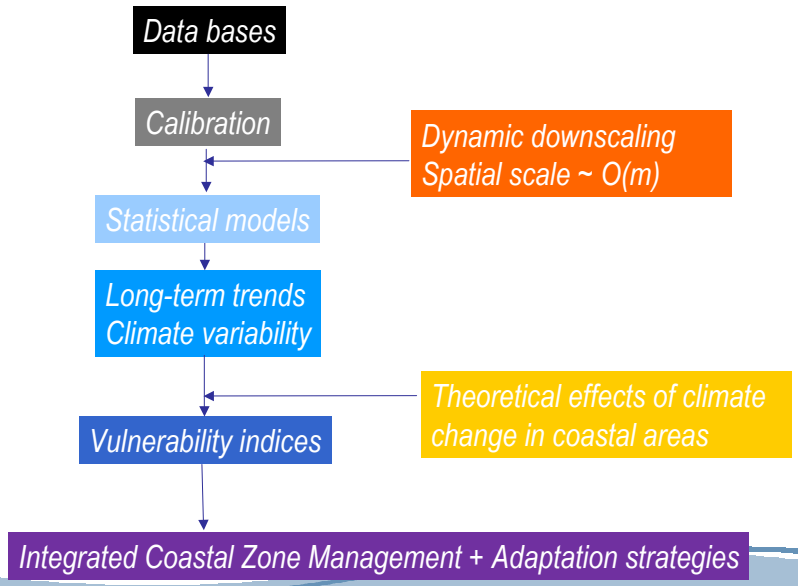
REPRESENTATIVE DATA		
Galician North Coast and Canarian North coast	Mediterranean coast	Cadiz Gulf
↑ 40 %	-10/10 %	↓ 40 %



Horizon year: 2050

Impact, vulnerability and adaptation assessment in the coastal zone

4. Methodology to assess detailed studies



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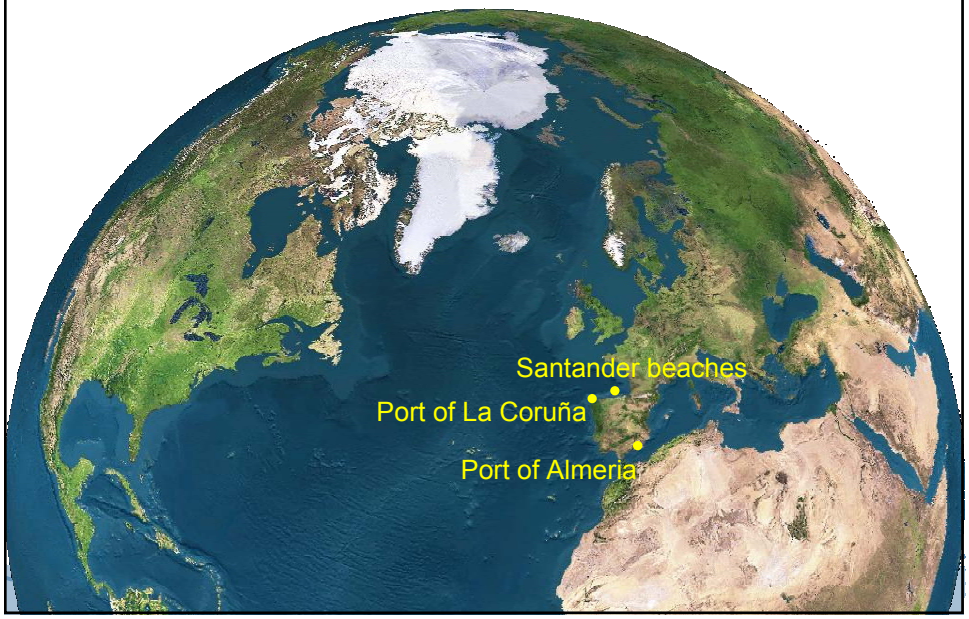

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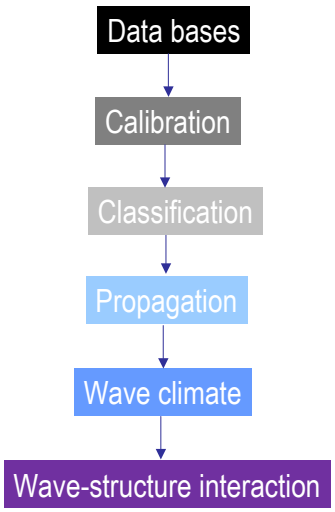
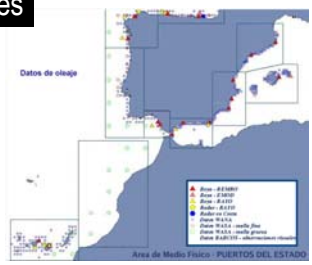
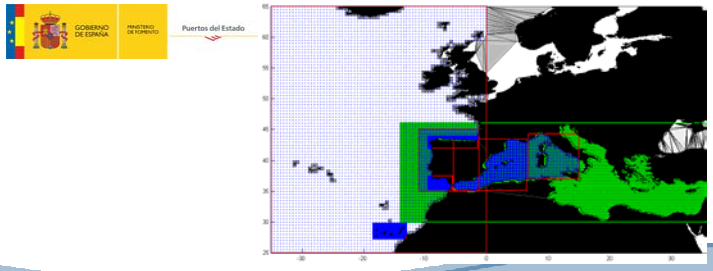


4. Methodology to assess detailed studies

Data bases

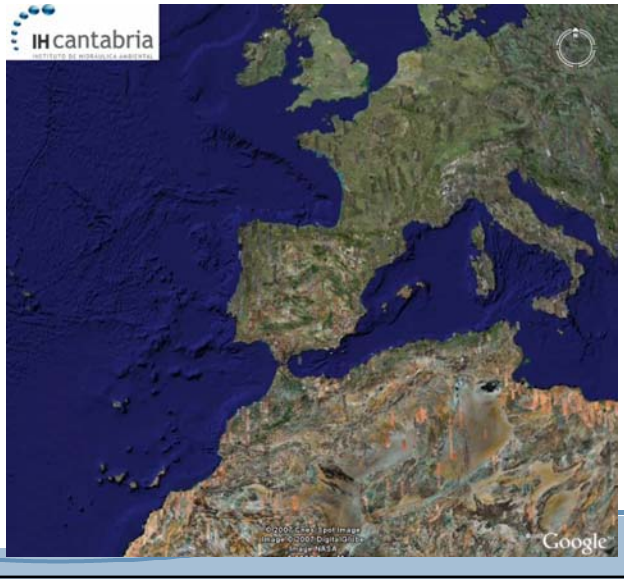




4. Methodology to assess detailed studies

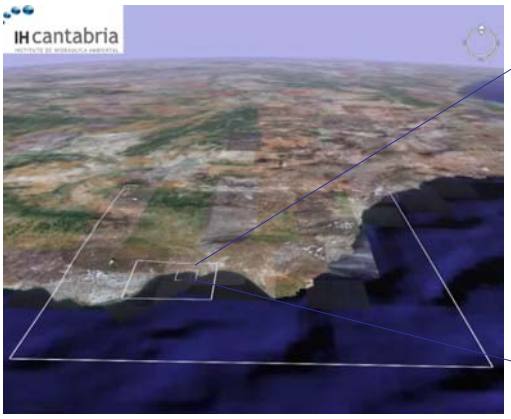
Classification

Propagation



4. Methodology to assess detailed studies

Propagation. Agitation



SWAN model

MSP / MANOLO models

7. Methodology to assess detailed studies

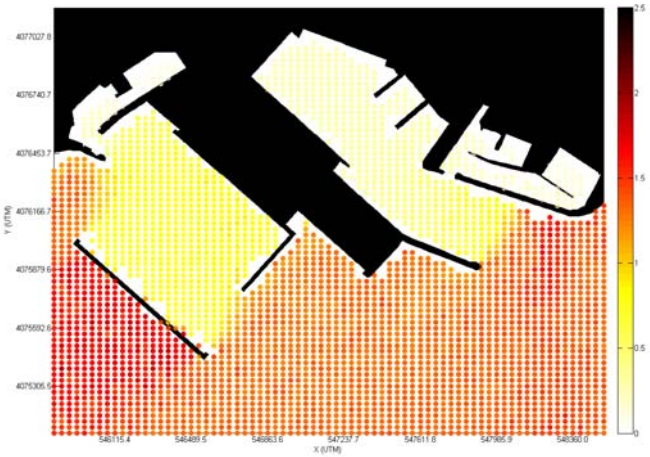
Propagation. Agitation

Hs=0.43 m; Tp = 4.64 s; Θ=S33E

4. Methodology to assess detailed studies

Propagation. Agitation

95% percentile of significant wave height

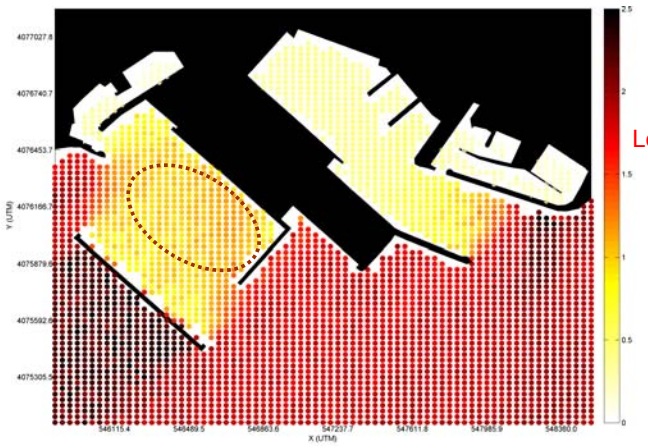


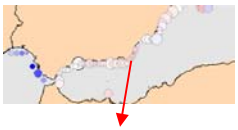
Impact, vulnerability and adaptation assessment in the coastal zone

4. Methodology to assess detailed studies

Propagation. Agitation

95% percentile of significant wave height





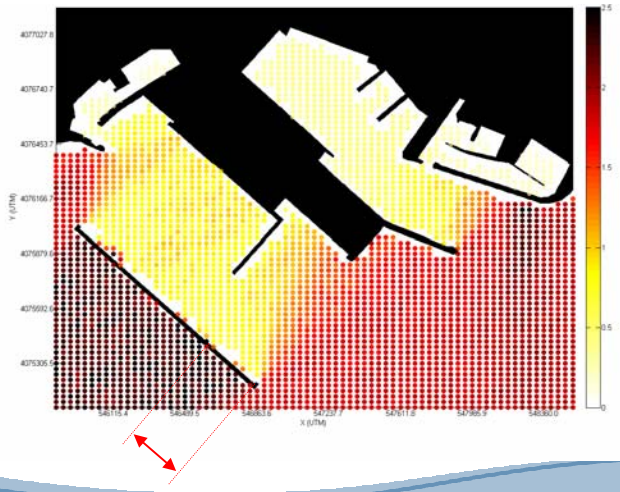
Long-term trends of wave climate at 2050
ΔH=30 cm

sea level rise at 2050
$\Delta\eta$=15 cm.

Reduction of harbor operation time
200 hours/year
Losses 0.5M€/year

4. Methodology to assess detailed studies

Adaptation



Objective: reestablish current situation

Action: Increase vertical breakwater length.. caissons

200 m length
15 m wide
25 m vertical

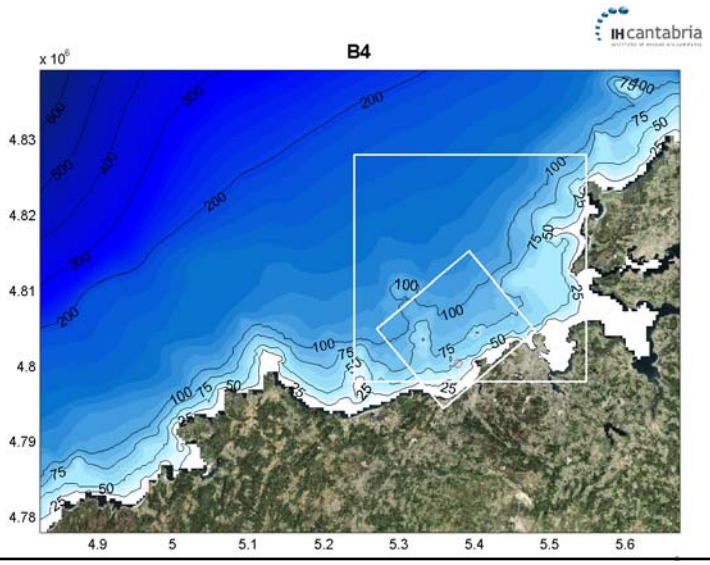
30 €/m3

2.3 M€

Impact, vulnerability and adaptation assessment in the coastal zone

4. Methodology to assess detailed studies

Propagation

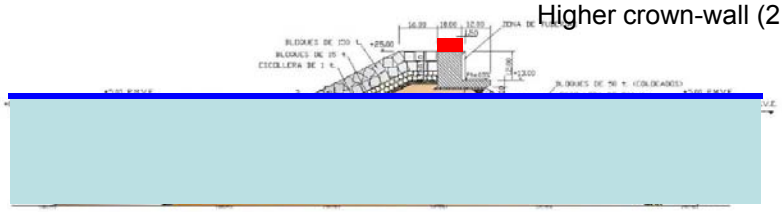


4. Methodology to assess detailed studies

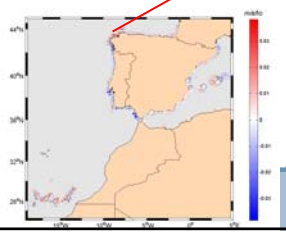
Adaptation

Increase of overtopping

Higher crown-wall (2 m)



Example: Sea level rise at 2050 $\Delta\eta$=15 cm
+ increase of storminess at 2050 (wave height ΔH=80 cm)



Impact, vulnerability and adaptation assessment in the coastal zone

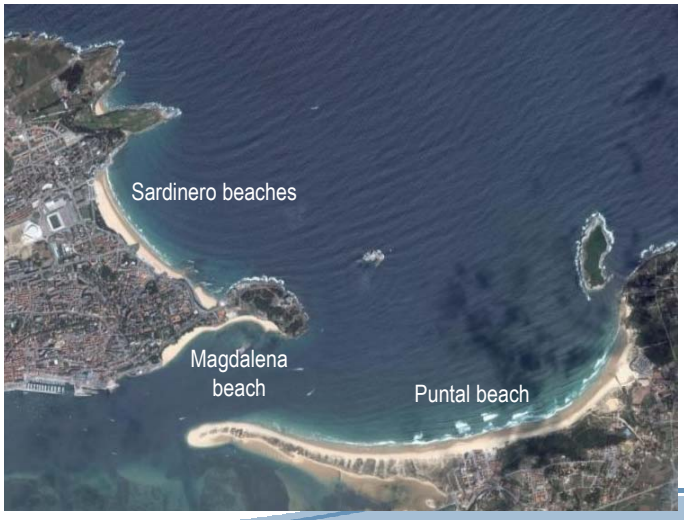
4. Methodology to assess detailed studies

Adaptation

Objective: reestablish operations, reliability and security current conditions

Action: higher crown wall

4. Methodology to assess detailed studies



Impact, vulnerability and adaptation assessment in the coastal zone

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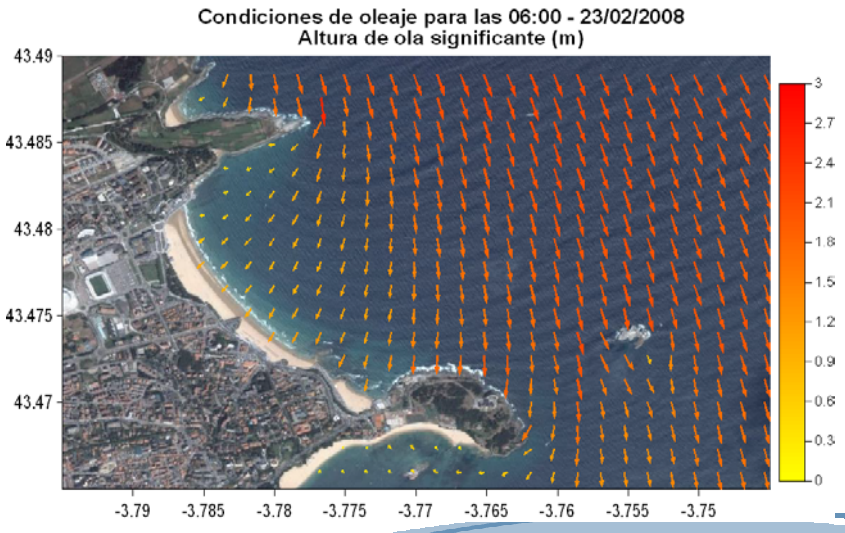

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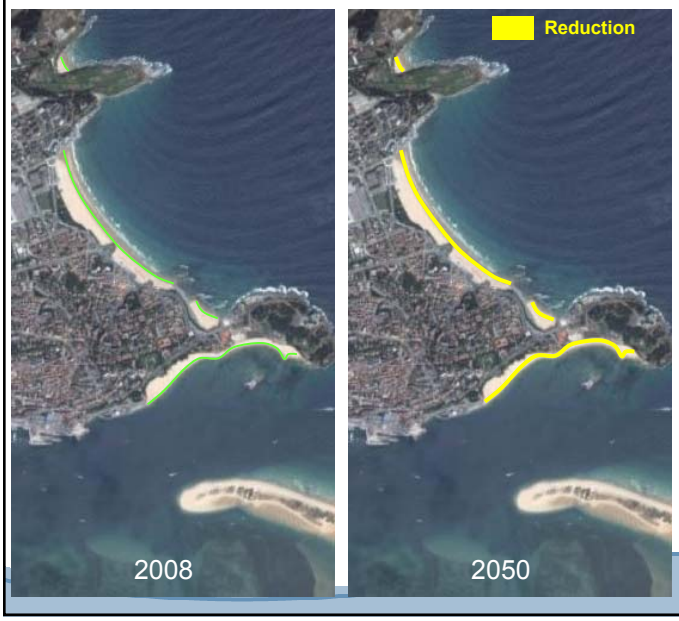
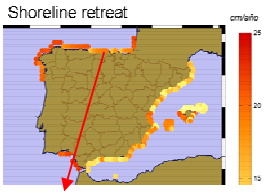
Adaptation





Shoreline retreat at 2050 = 8 m

Impact: Reduction of 30% occupational Area

Objective: reestablish current situation

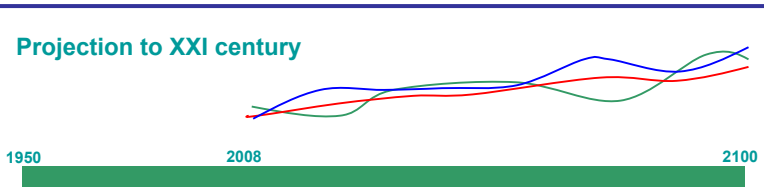
Action: Beach nourishment

8 m x 2500 m x 10 m
Sand 10€/m³
2 M€

5. Projection of Coastal Dynamics to the XXI century

Historical analysis of long-term trends

Projection to XXI century

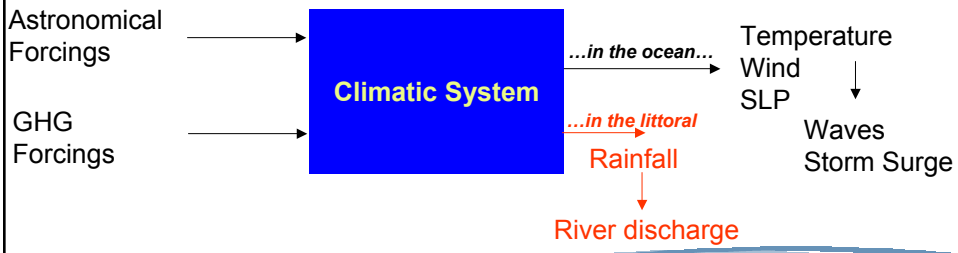


5. Projection of Coastal Dynamics to the XXI century

1950 — 2007 — 2100

Wind waves and Storm surge ? River discharge?

(AOGCM - **Atmosphere-Ocean General Circulation Model**)



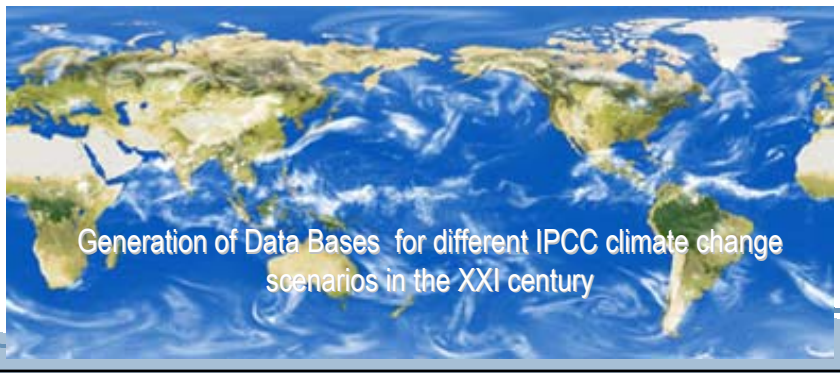
Impact, vulnerability and adaptation assessment in the coastal zone

5. Projection of Coastal Dynamics to the XXI century

1950 — 2007 — 2100

6-hourly SLP data bases available

CCSM-NCAR (Community Climate System Model - National Center for Atmospheric Research, USA)
CNRM-MeteoFrance (Centre National de Recherches Meteorologiques, Francia)
CERA, World Data Center for Climate (Max-Planck-Institute for Meteorology, Alemania)
CGCM 3.1 (Environment Canada)



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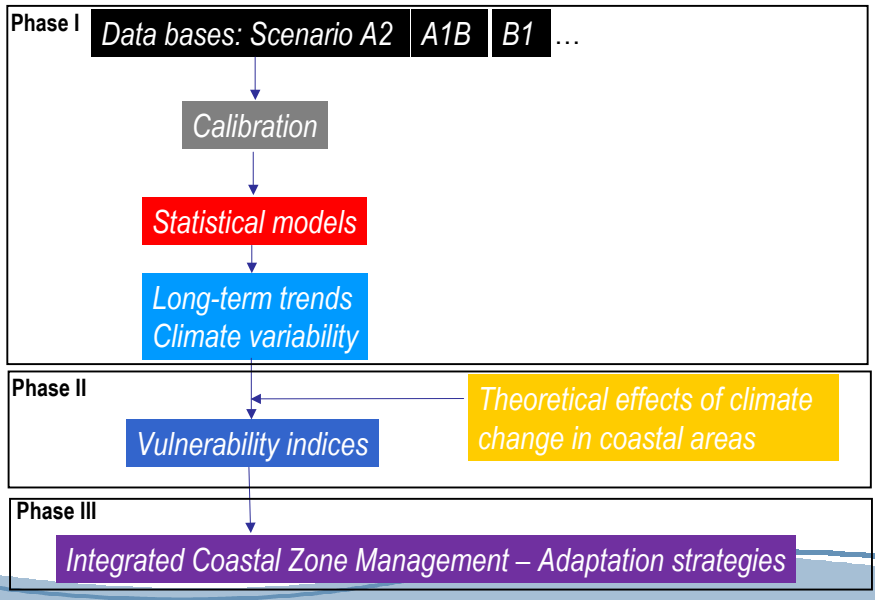

Impact, vulnerability and adaptation assessment in the coastal zone

5. Projection of Coastal Dynamics to the XXI century

To take into account:

Hurricane projections in the XXI century (statistical and dynamic downscaling)

For each scenario…
- Different models
- Different ensembles

Probabilistic approach… ensemble projections