IHcantabria
INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

I Workshop Nacional del Equipo de Apoyo al Plan de Acción del Atlántico

Cambio Climático y Energías Renovables de Origen Marino en el Instituto de Hidráulica Ambiental

Iñigo Losada

Director de Investigación IHCantabria

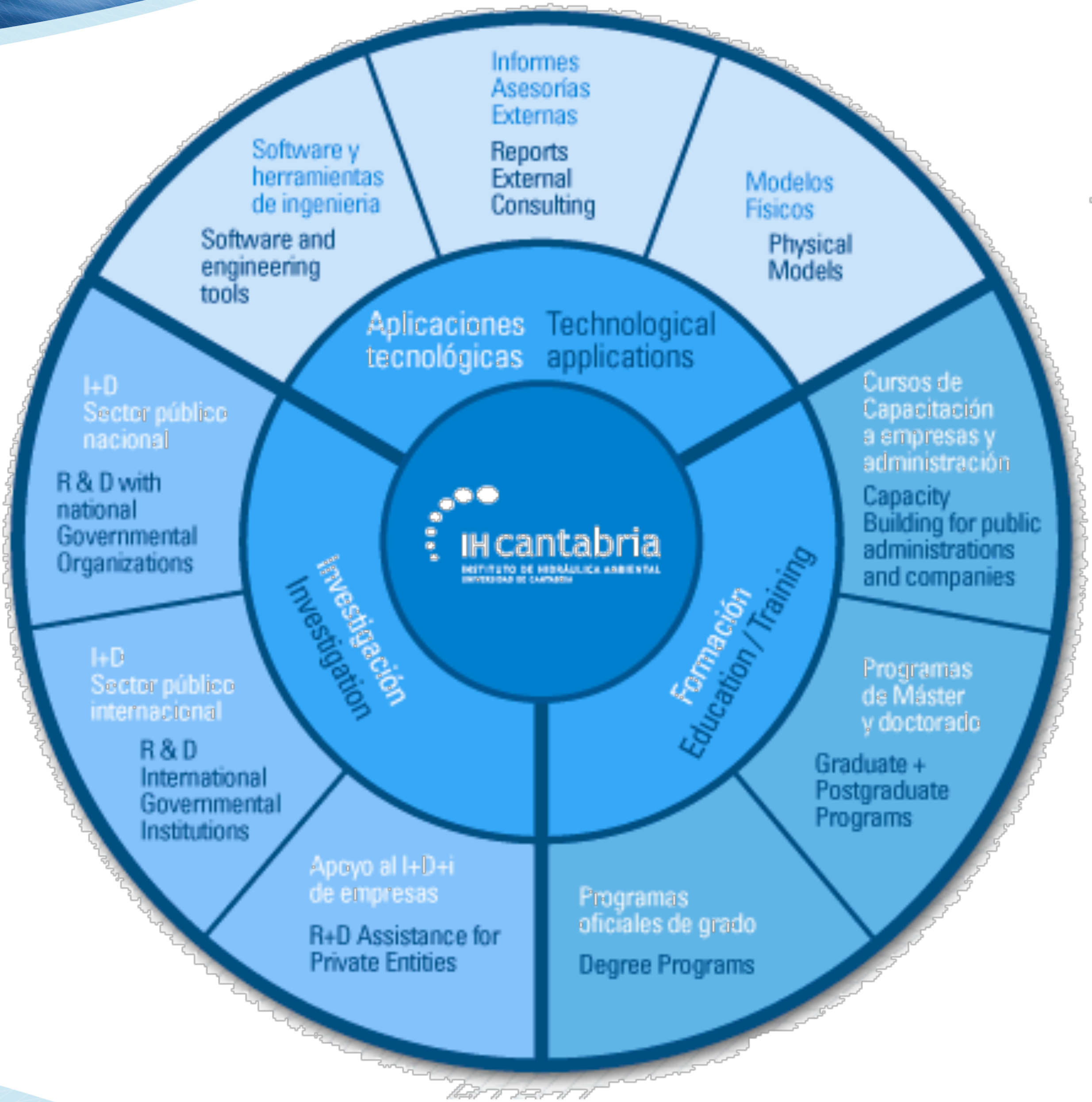
Coordinador Área de Agua y Energía

Cantabria Campus Internacional

FUNDACION IH · UC Universidad de Cantabria · UIMP Universidad Internacional Menéndez Pelayo · Cantabria Campus Internacional

IH Cantabria

IH Cantabria es un **instituto mixto de investigación**, especializado en la investigación básica y aplicada y el desarrollo de metodologías y herramientas para la gestión de los ecosistemas acuáticos.


Informes
Asesorías
Externas
Reports
External
Consulting
Software y
herramientas
de ingeniería
Software and
engineering
tools
Modelos
Físicos
Physical
Models
Aplicaciones
tecnológicas
Technological
applications
I+D
Sector público
nacional
R & D with
national
Governmental
Organizations
Cursos de
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a empresas y
administración
Capacity
Building for public
administrations
and companies
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Investigation
Formación
Education / Training
I+D
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internacional
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International
Governmental
Institutions
Programas
de Máster
y doctorado
Graduate +
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Programs
Apoyo al I+D+i
de empresas
R+D Assistance for
Private Entities
Programas
oficiales de grado
Degree Programs

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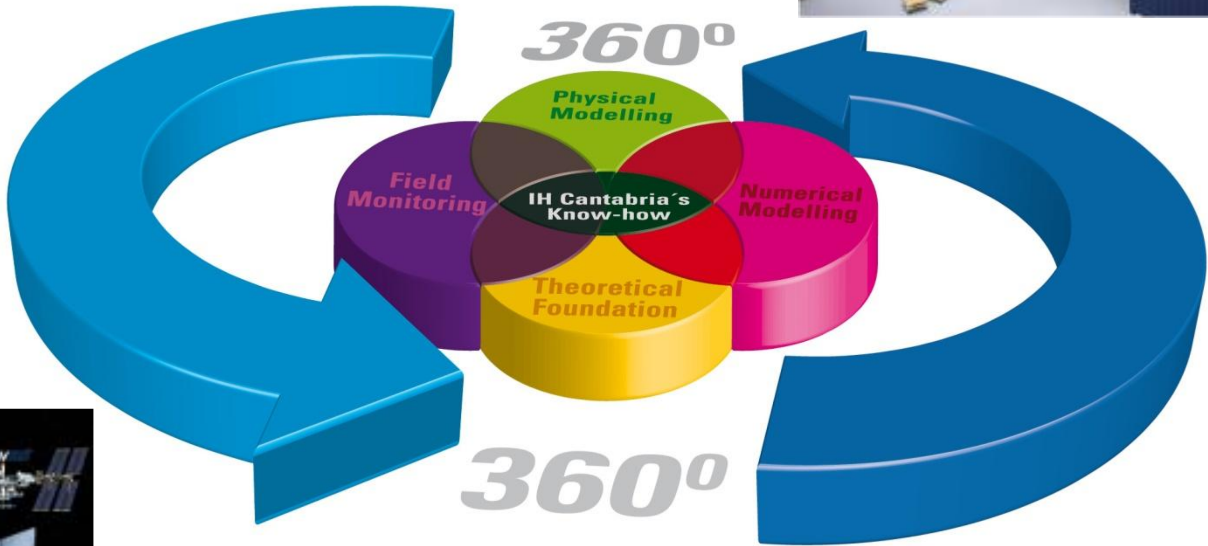

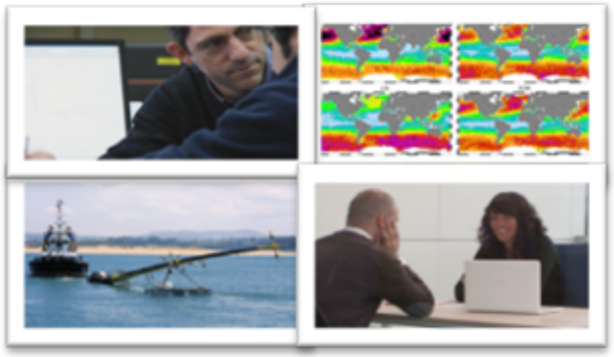

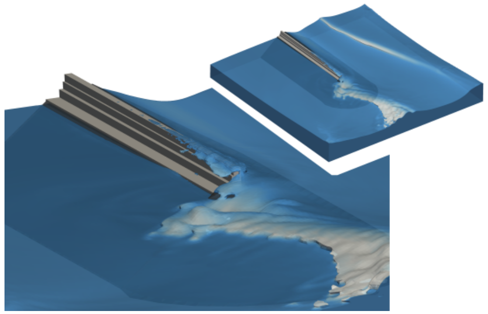

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Organigrama del Instituto.
Grupos de Trabajo

IH Lab

- IH Lab Bio
- IH Lab Hidro
- IH Lab Computing

Hidrobiología y Gestión ambiental

- Ecosistemas litorales
- Ecosistemas Continentales

Clima, Energía e Infraestructuras

- Clima Marino y Cambio Climático
- Energía e Ingeniería Offshore
- Hidrodinámica e Infraestructuras Costeras

Ingeniería Hidráulica y de Costas

- Ingeniería Hidráulica
- Ingeniería y Gestión de la Costa
- Oceanografía, estuarios y calidad de agua

Transferencia Tecnológica

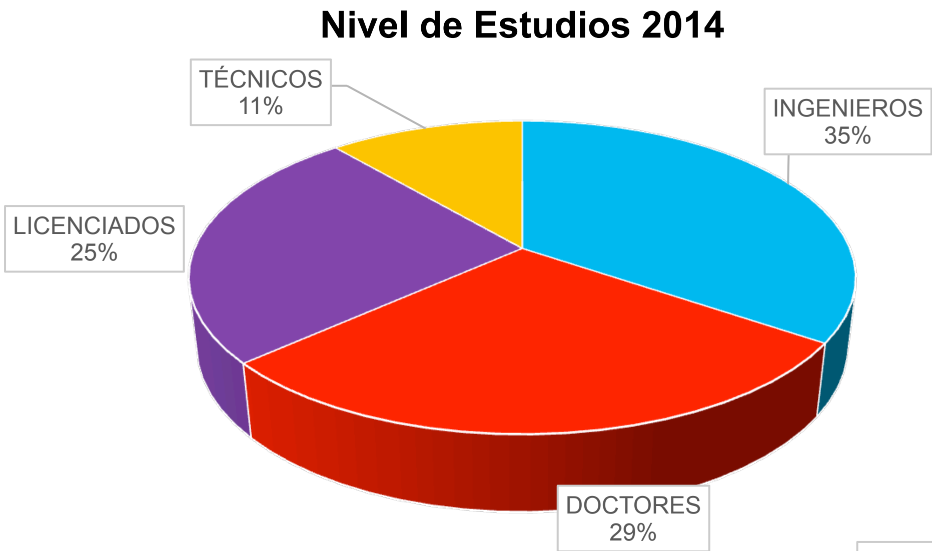
- Tecnología de la Información

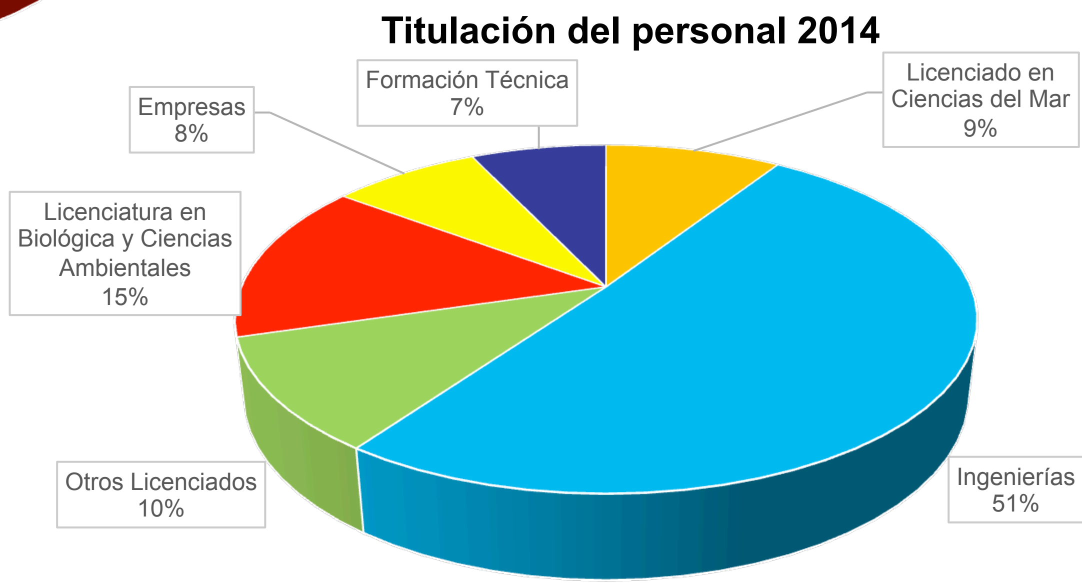
Administración y Dirección

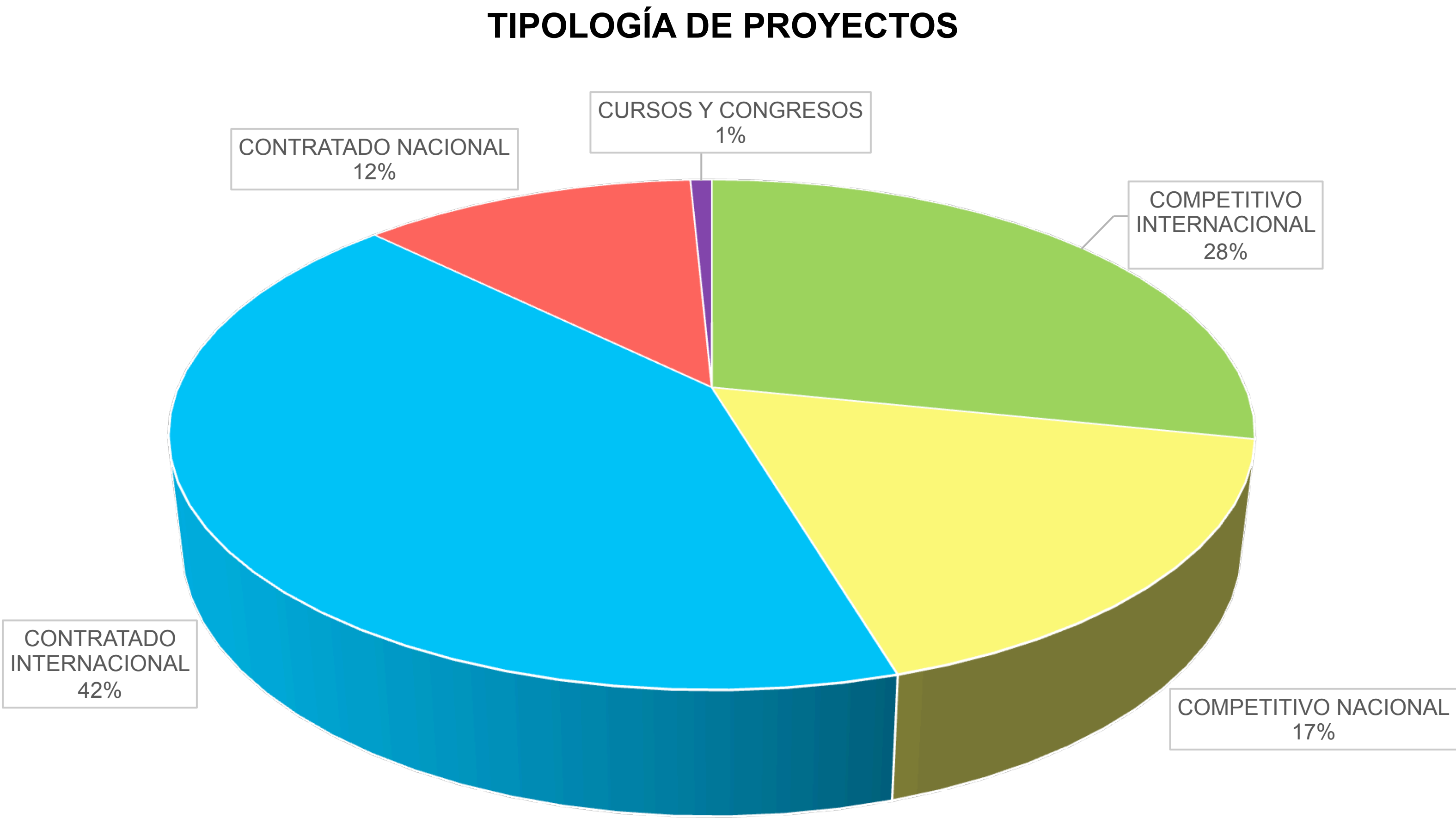
- Administración General

ESTADÍSTICAS

Personal 2014



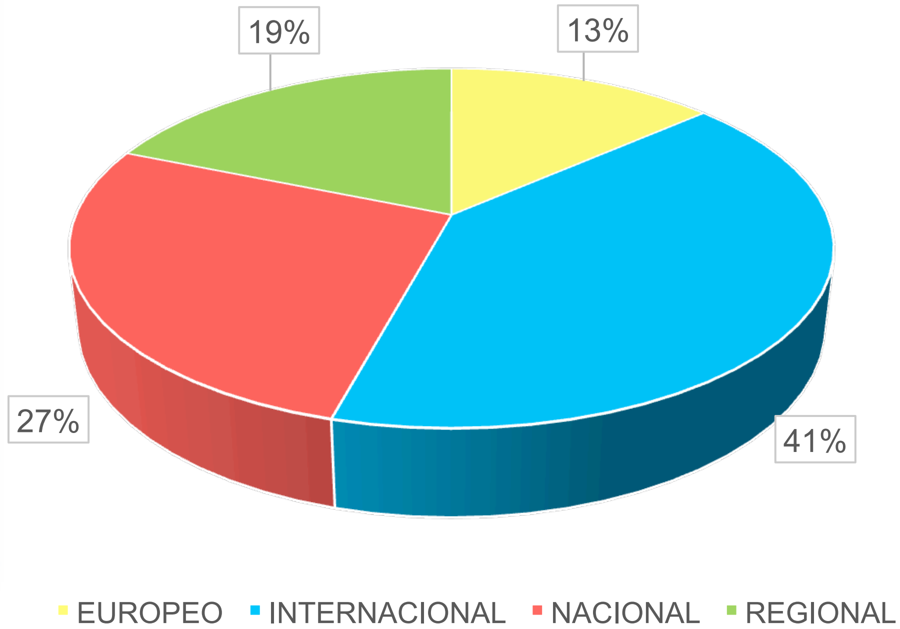



TIPOLOGÍA DE PROYECTOS
CURSOS Y CONGRESOS 1%
CONTRATADO NACIONAL 12%
COMPETITIVO INTERNACIONAL 28%
CONTRATADO INTERNACIONAL 42%
COMPETITIVO NACIONAL 17%

TRANSFERENCIA

Internacionalización

LOCALIZACIÓN GEOGRÁFICA DE LOS PROYECTOS 2014



•2013-2014: Túnez, Egipto, Qatar, Oman, Ecuador, El Salvador, Chile, Brasil, Perú, Barbados, Bruselas, Colombia, Costa Rica, Italia, Francia, Australia, Canadá, Kuwait, México, Guatemala, Singapur, Marruecos, Canadá, Estados Unidos, Paraguay, Guayana, Cuba, Honduras, India, Uruguay, Venezuela, Vietnam.

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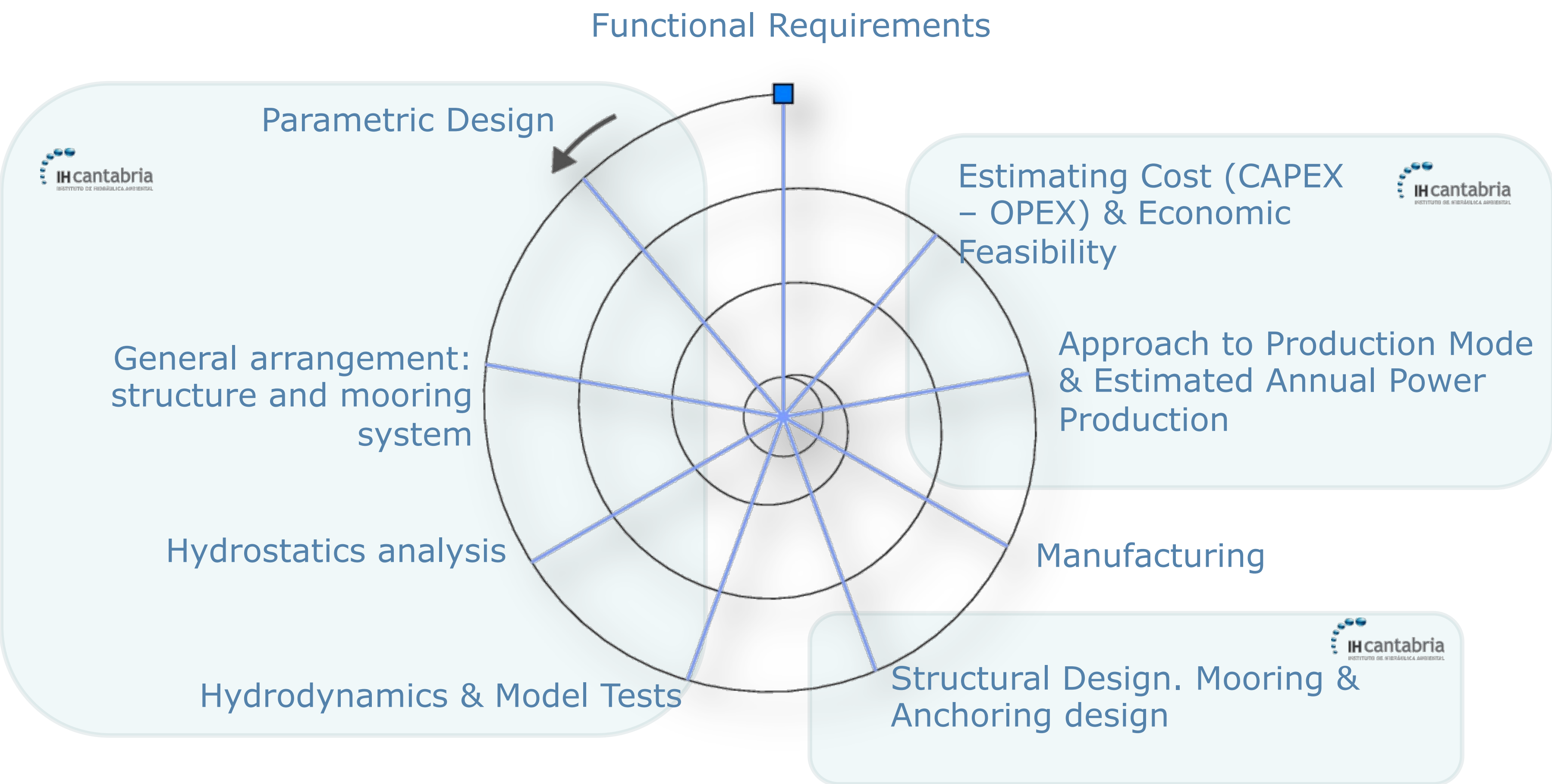
Energías Marinas

Design Methodology

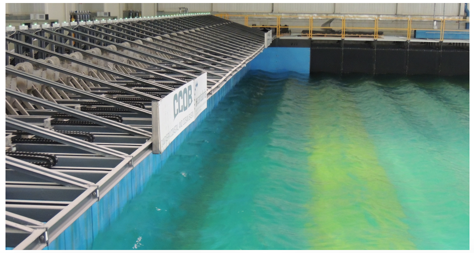


CCOB
CANTABRIA COASTAL AND OCEAN BASIN

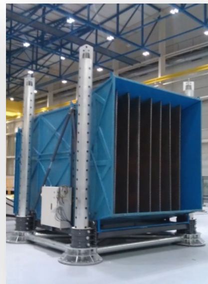
Wave / Currents / Wind

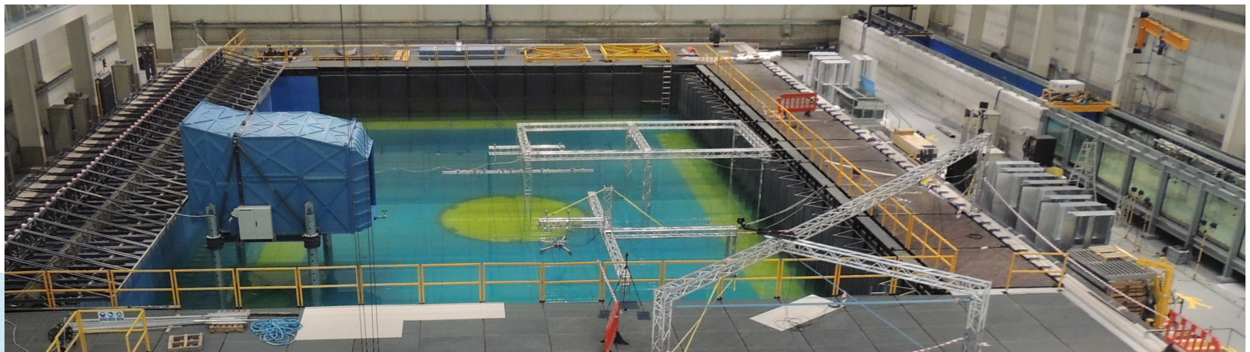
Main dimensions: 30 m x 44 m x 3.2 m

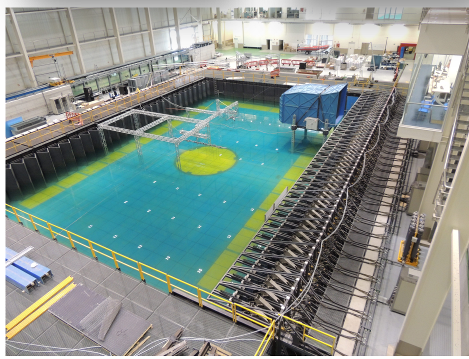
Central pit: 6 m (diameter), 8 m (depth)



- Basic hydrodynamic
- Wave-structure interaction
- Offshore structure
- Sea foundations
- Mooring systems
- Floating structures
- Wave energy converters
- Fixed and floating wind turbines
- Coastal engineering
- Port and harbor engineering
- Marine structure installation
- Submerged vehicles design
- Sea monitoring devices
- Etc.







Offshore Engineering & Ocean Energy
Group Competences

Commercial Software

SESAM
GeniE, HydroD,
Simo-Riflex, etc.

OPEN FOAM

FAST

AUTOCAD

RHINOCEROS

In House models (IH CANTABRIA)

CFD models

IH2VOF

IH3VOF

IHFOAM

Wave propagation

SMC - MOPLA

MANOLO

IH - BOUSS

Floating bodies

WAVE2WIRE

WAVE2WIRE

International standards

DNV

GL Group

BUREAU VERITAS 1828

IEC

Offshore Engineering & Ocean Energy
Group Competences

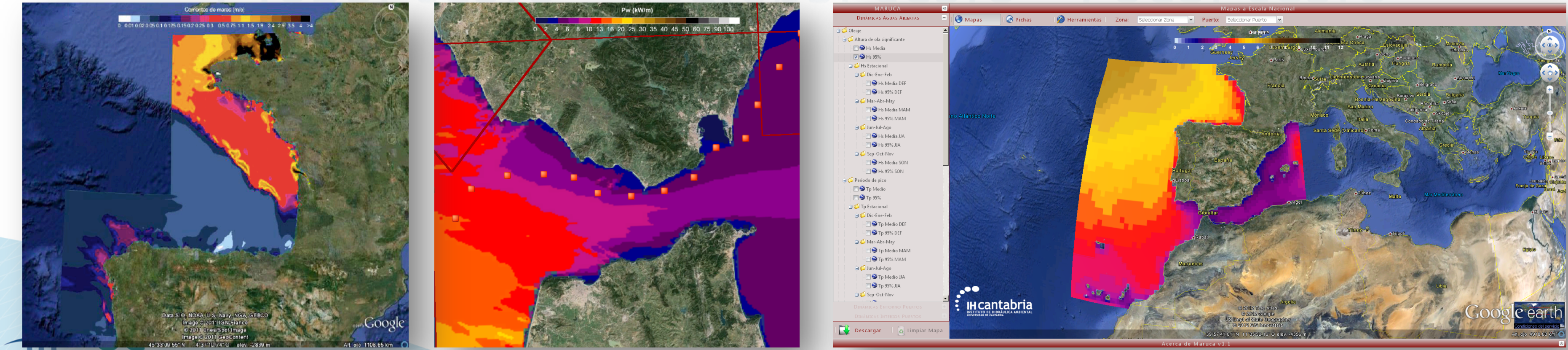
Long term data bases

- Wind
- Wave
- Currents
- Sea level

Advanced studies

- New technologies
- Innovative strategies
- New developments
- Risk assessment

Global scale – Regional scale - Local scale



http://www.enola.ihcantabria.com

Metocean conditions

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Long term data bases

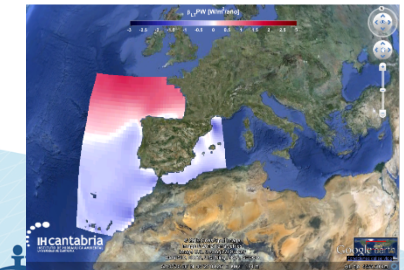
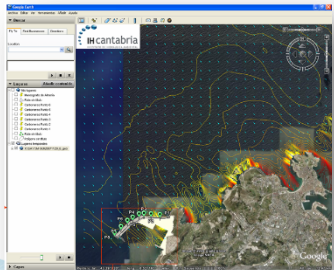
- Wind
- Wave
- Currents
- Sea level
- Temperature
- Rain

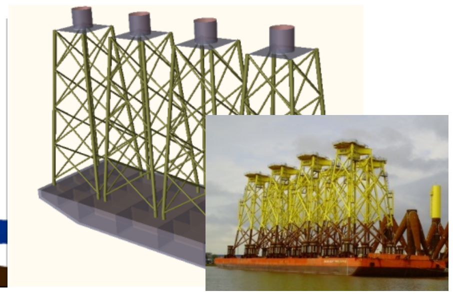
Prediction

- Short term (24-96h)
- Mid term (1-3 meses)

Projections

- Climate change

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IH Cantabria

Environmental Hydraulics Institute of Cantabria

Research and Development topics

-Wind energy-

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Floating platforms – Wind energy

The acquired experience on design, modeling and testing of offshore floating structures, combined with the most advanced tools give to IH Cantabria a high capacity in the offshore wind sector and becomes in a reliable R&D partner.

•Frequency and time domain analysis

•Design loads assessment

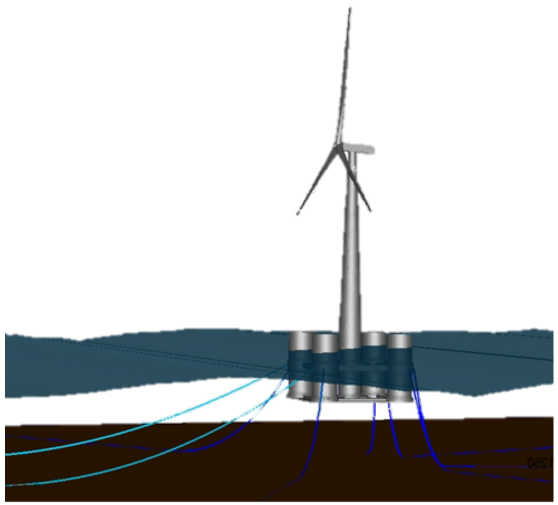
•Mooring system performance analysis

•Design optimization.

•Production assessment: short and long term

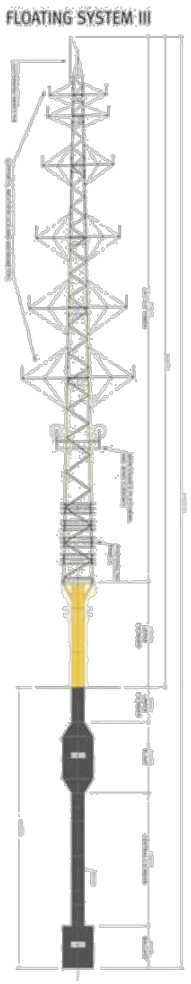
References:

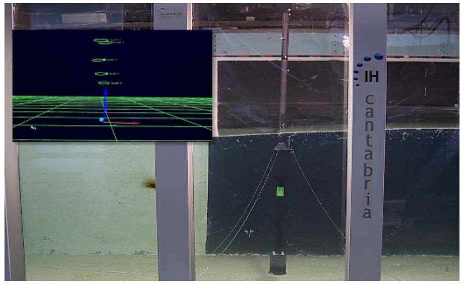
- *Project: EMERGE*
- *Project: AZIMUT*
- *Project: Idermar*

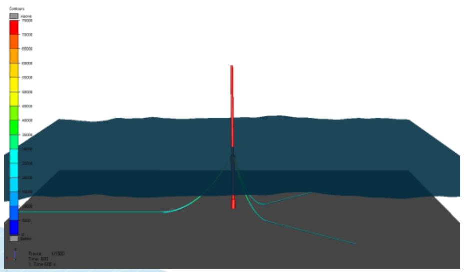


Offshore Engineering & Renewable Energy

Topics: Wind energy







<u>IH Cantabria participation</u>

Numerical modeling:

1. SESAM - DNV
2. Predesign, design and certification:
   - Wave-currents-wind loads and structure interaction
   - Mooring system analysis

Physical modeling:

1. 8 laboratory campaigns: 338 tests
2. Movements and mooring system monitorization
3. Numerical model calibration
4. Deployment procedure test

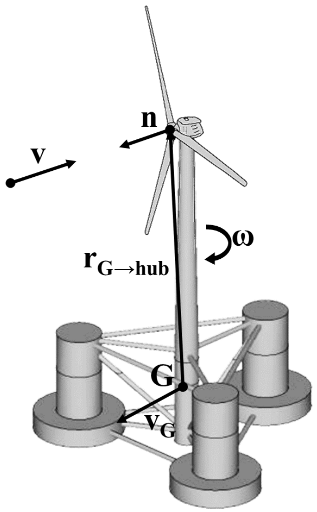
Design certification

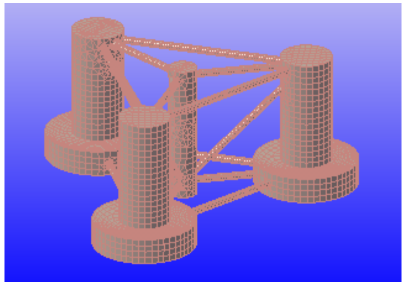
1. Environmental loads assessment
2. Hydrostatic analysis
3. Mooring system design: extreme conditions and fatigue analysis
4. Dyamic analysis of the structure

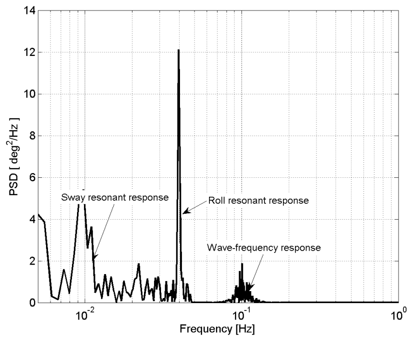
19th December 2011
- H_s=3 m
- T_p=10 s
- V_m (z=10m)=14 m/s

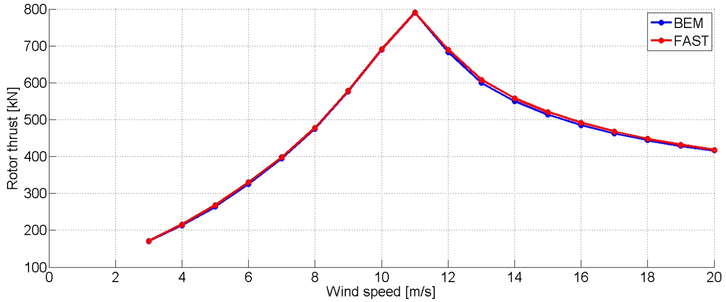
Floating platforms – Wind energy

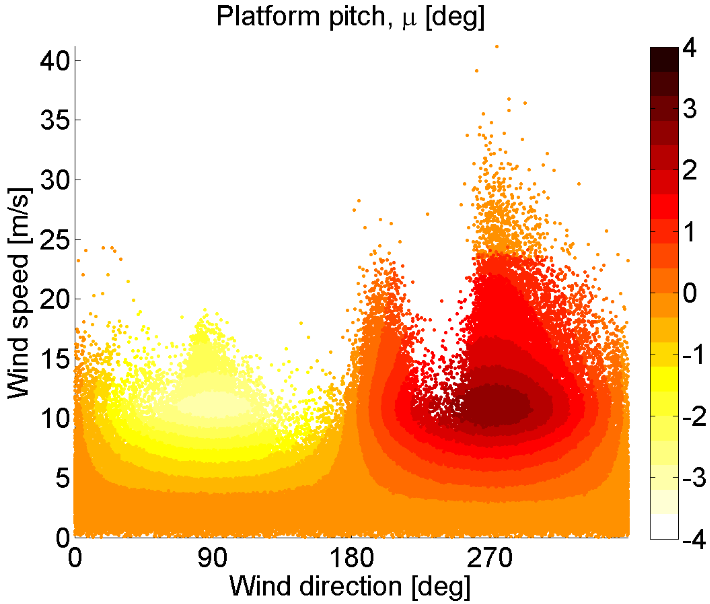
Performance assessment

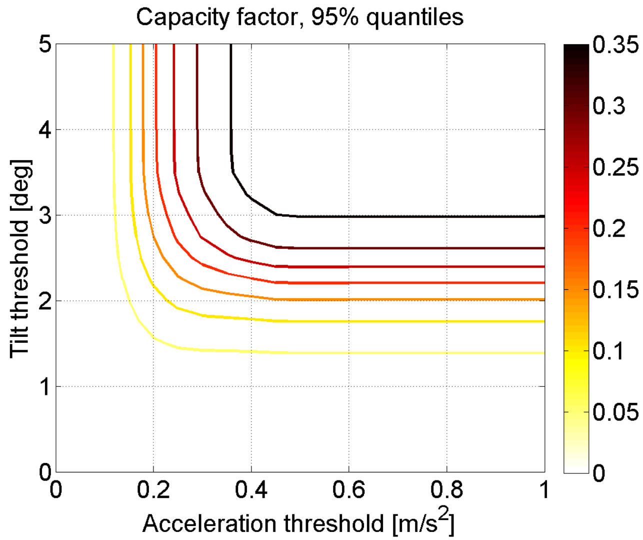








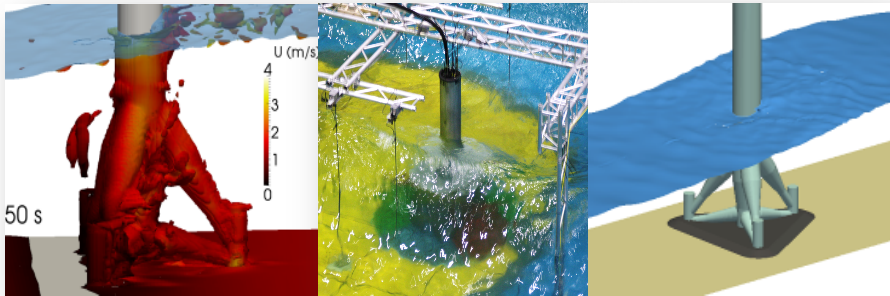


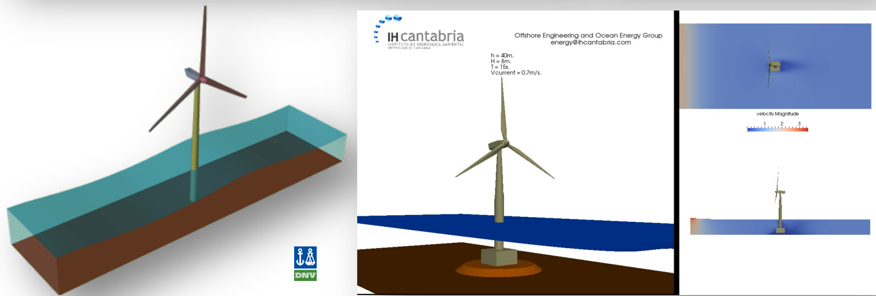


Fixed platforms

Thanks to CFD modeling capacities developed by IH Cantabria, tools that have been previously calibrated and validated, IH Cantabria is able to analyze wave, current and wind interaction over almost all the fixed foundation available in the literature: GBF, Jackets, monopiles, …).

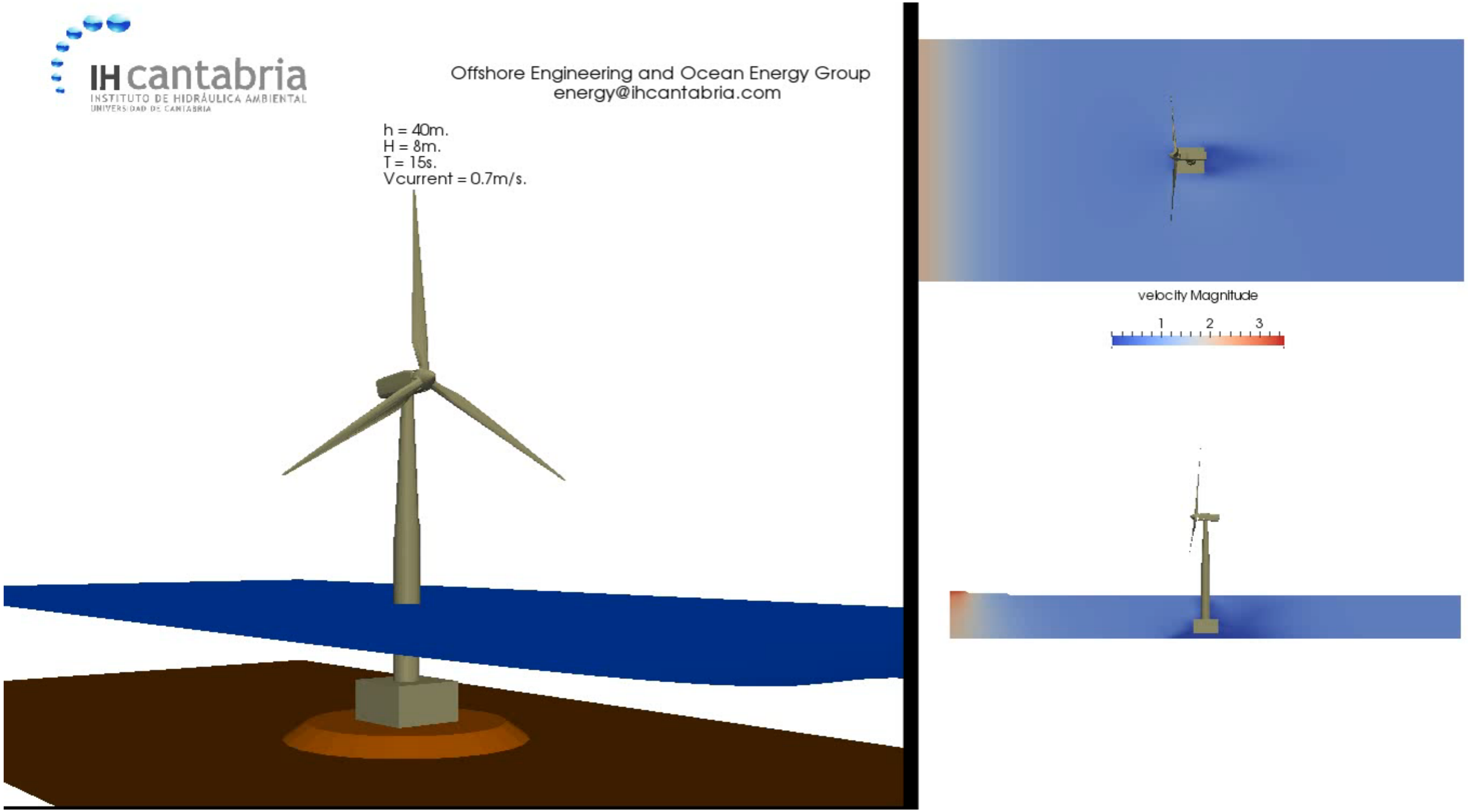
- Wave and current structure interaction
  - Simplified models: potential flow
  - CFD models
- Frequency domain and time domain models
- FEM models: structure design
- Scour assessment





References:

- *Project: CEO*
- *Project: OCOA*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Offshore Engineering and Ocean Energy Group
energy@ihcantabria.com
h = 40m.
H = 8m.
T = 15s.
Vcurrent = 0.7m/s.
velocity Magnitude
1
2
3

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Research and Development topics

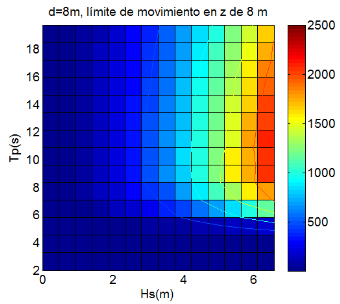
-Wave energy-

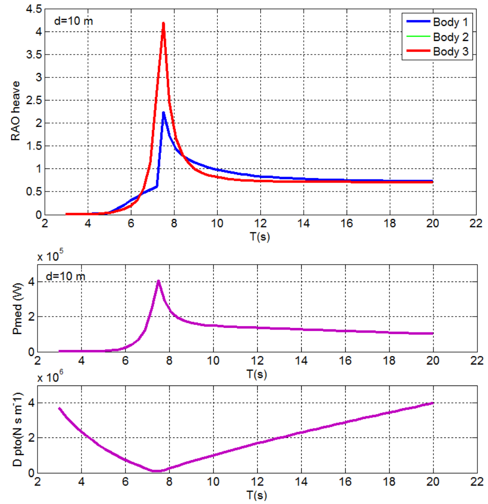
Floating platforms – Wave energy

Wave energy converters need a high flexibility in terms of numerical models and test capacities. Each device has its own challenges that have to be accordingly faced.

IH Cantabria uses commercial software up to the state of the art. But also develops in-house numerical tools capable to model any kind of converter.

- Frequency and time domain modeling
- Design loads assessment
- Mooring system design
- Design optimization
- Production assessment
- Power take off optimization
- Multi-body systems





References:

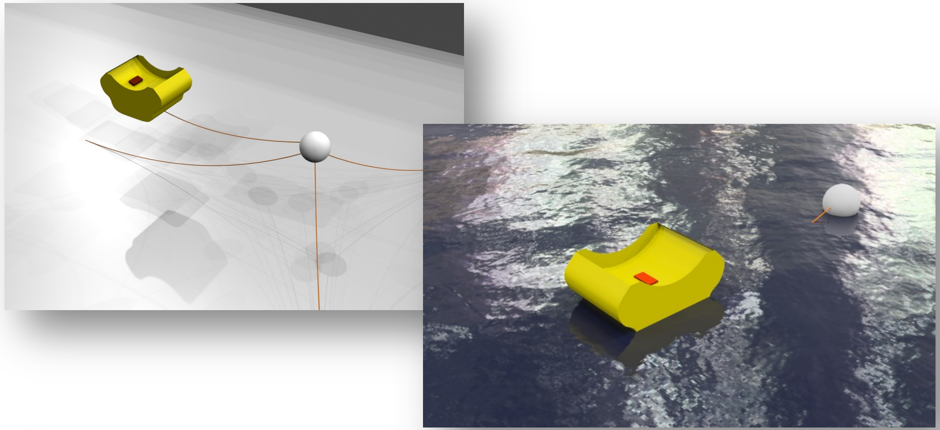
-Project: Catair

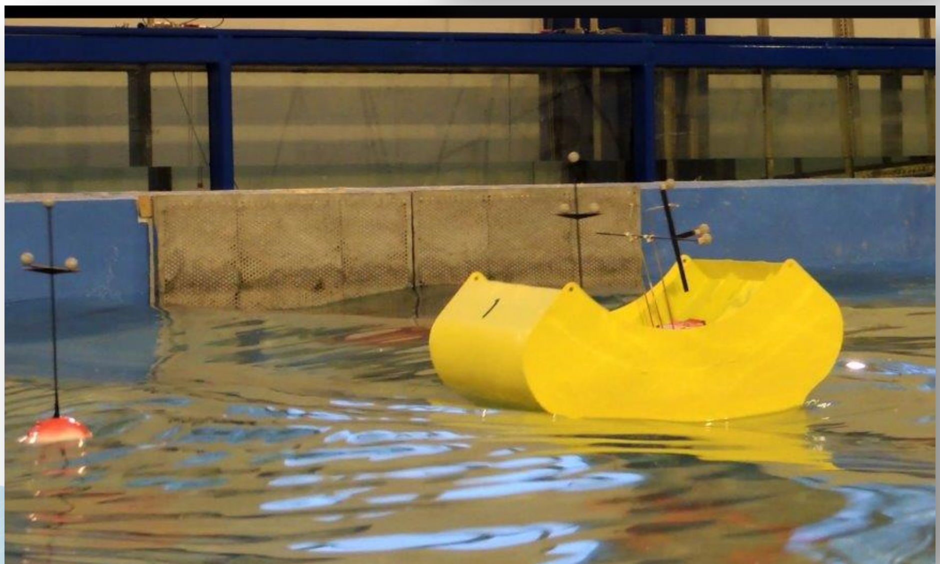
-Project: IISIS

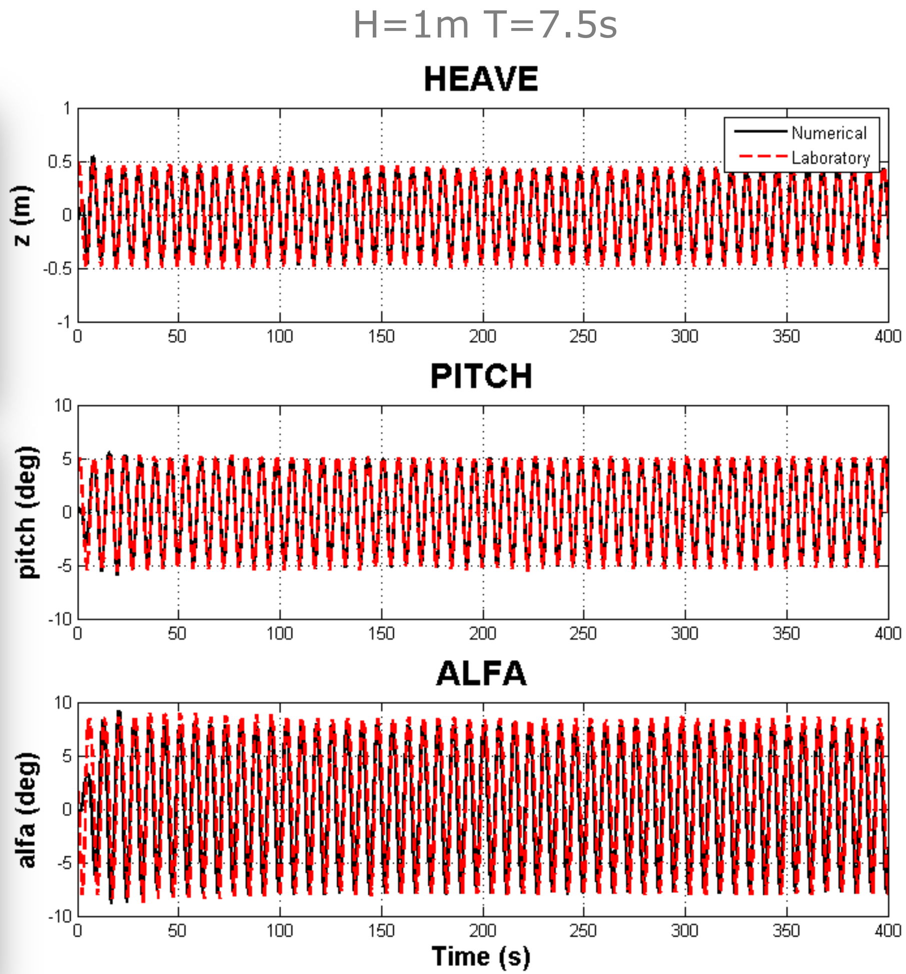
-Project: Undienergía. Leading Enterprises

-Project: Undigen.

Experiments vs numerical modeling







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Renewable energies and offshore engineering

Life cycle analysis on time domain numerical modeling basis

Hindcast data: waves

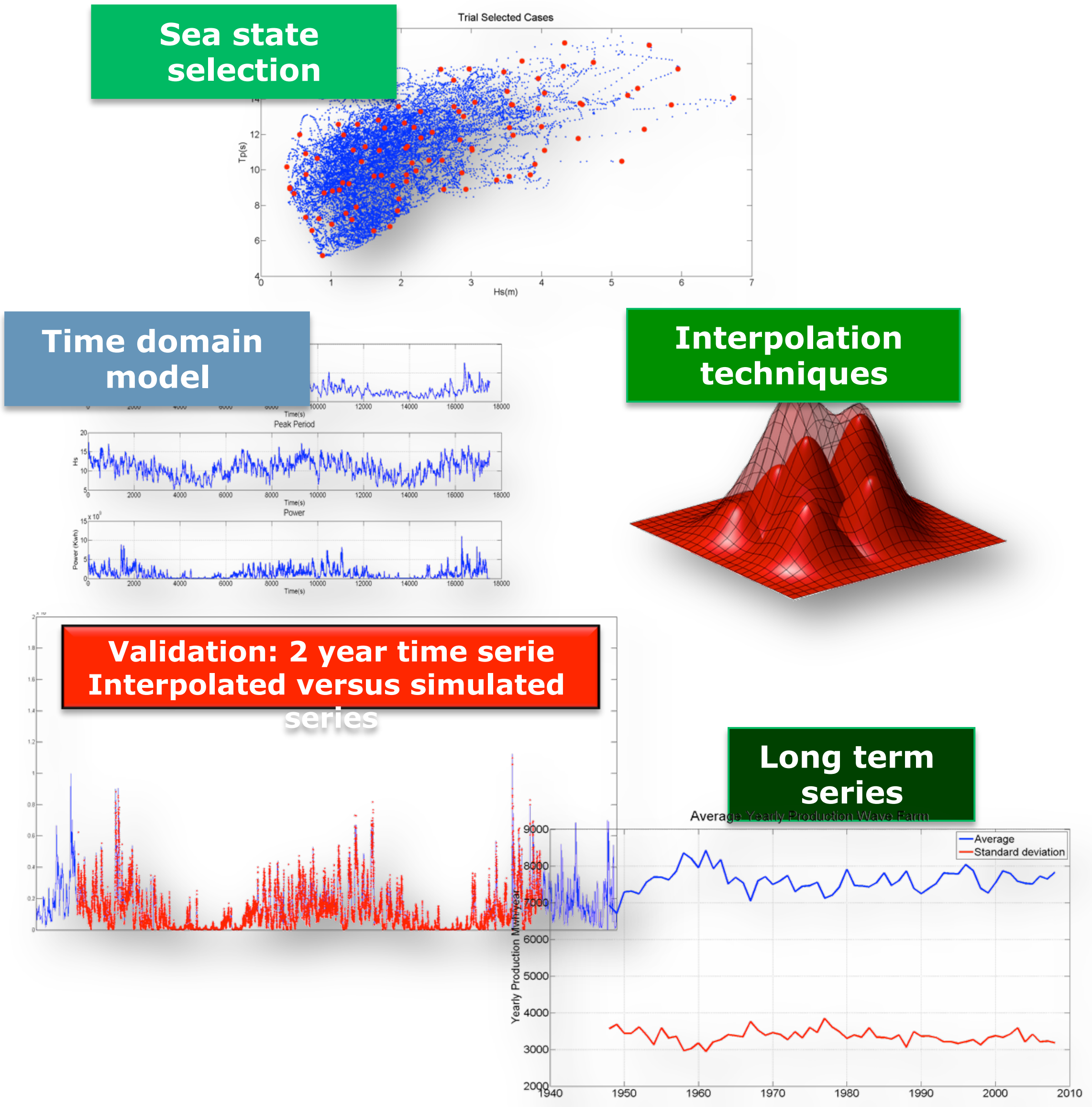
Time domain model

Advanced sea state selection techniques

Non linear interpolation techniques

Long term series

- Performance
- Production
- Life cycle analysis



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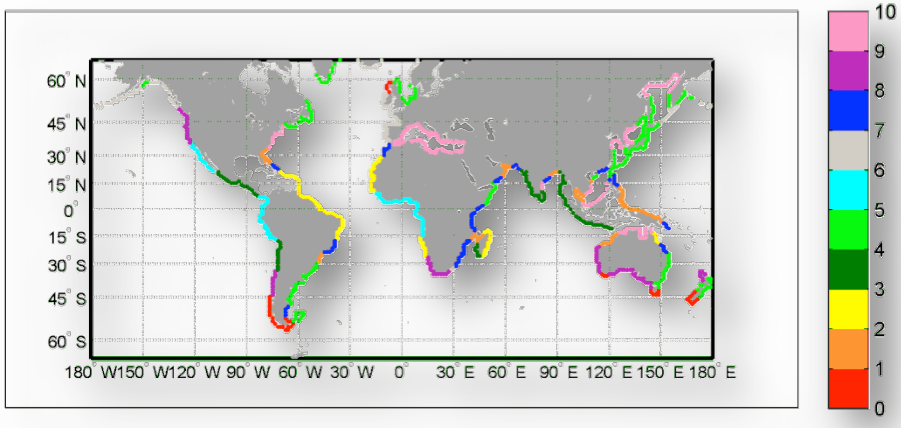
Renewable energies and offshore engineering

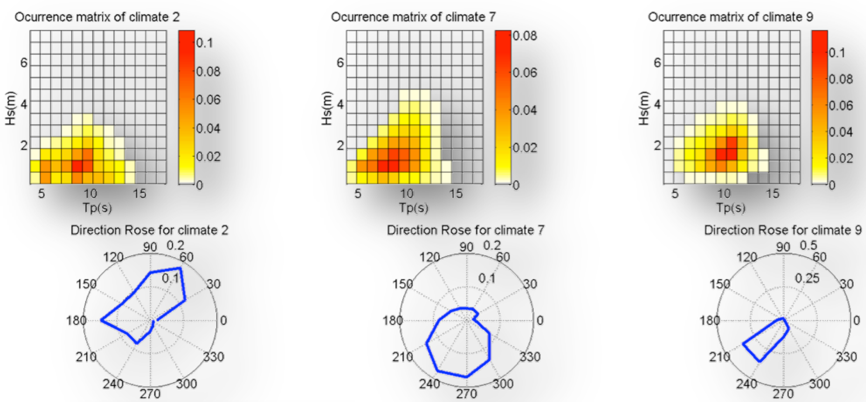
Wave farm assessment: Global perspective

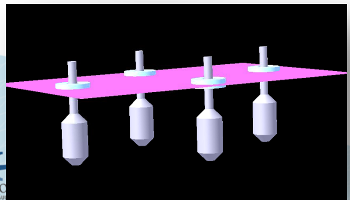
Climate classification for wave farm analysis

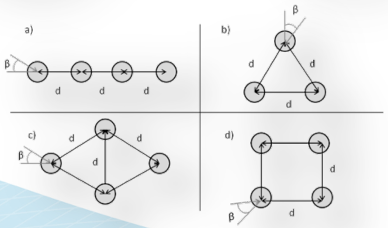


Camus et al 2011a; Camus et al 2011b ;De Andres et al (2012)

Examples:

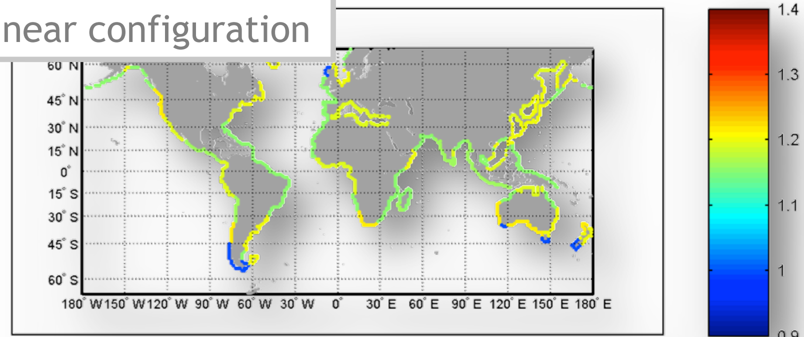




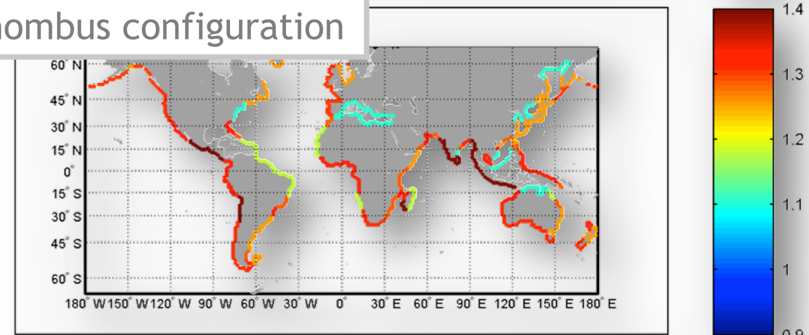


Wave farm performance: gain factor

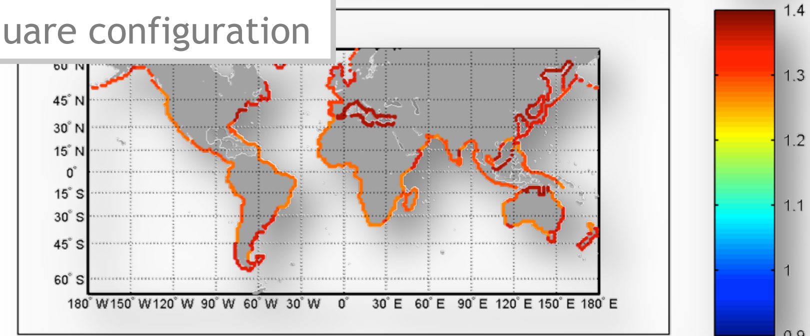
Linear configuration



Rhombus configuration



Square configuration



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Research and Development topics

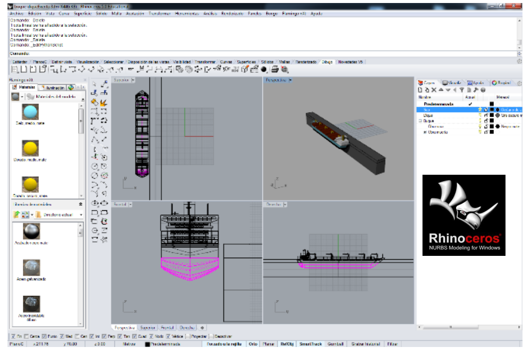
IH Cantabria

Renewable energies and offshore engineering

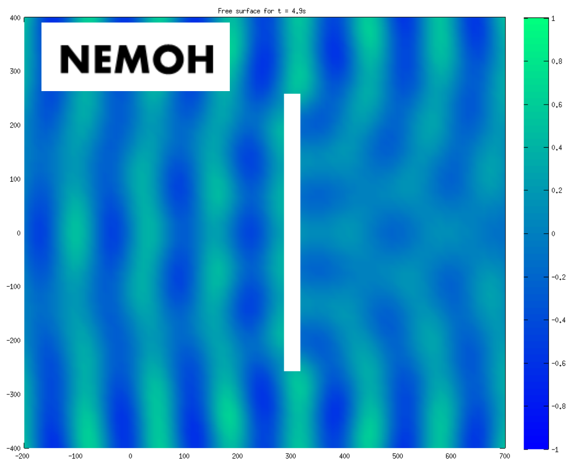
Ship-port interaction

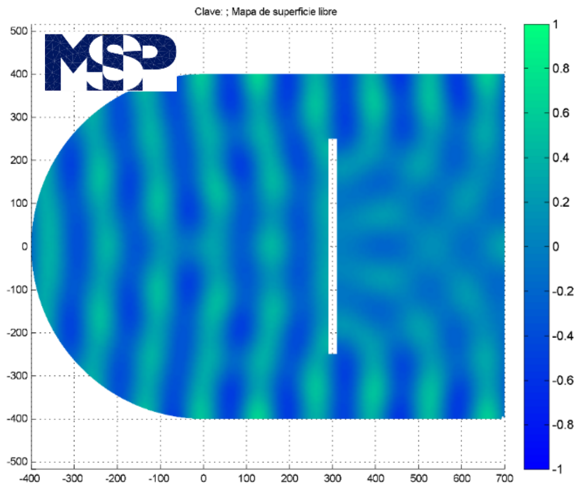
IH3MOOR

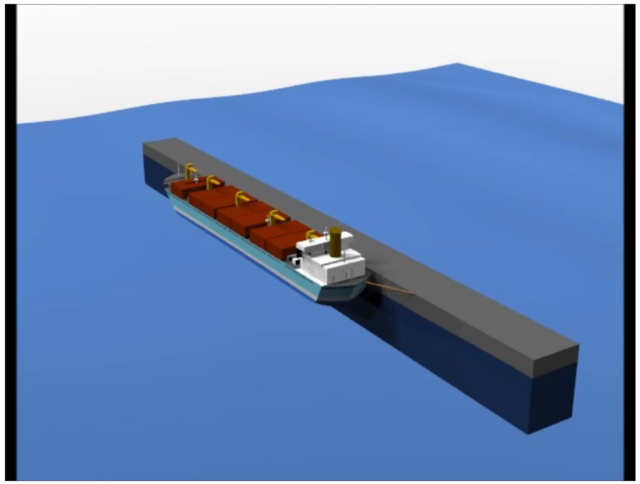
PREPROCESO	Rhinoceros	Generación de la geometría
PREPROCESO	Rhinoceros, GMSH	Mallado
HIDRODINÁMICA	NEMOH	Cálculos hidrodinámicos Dominio de la frecuencia
DOMINIO DEL TIEMPO	IH3MOOR	Modelado en el dominio del tiempo

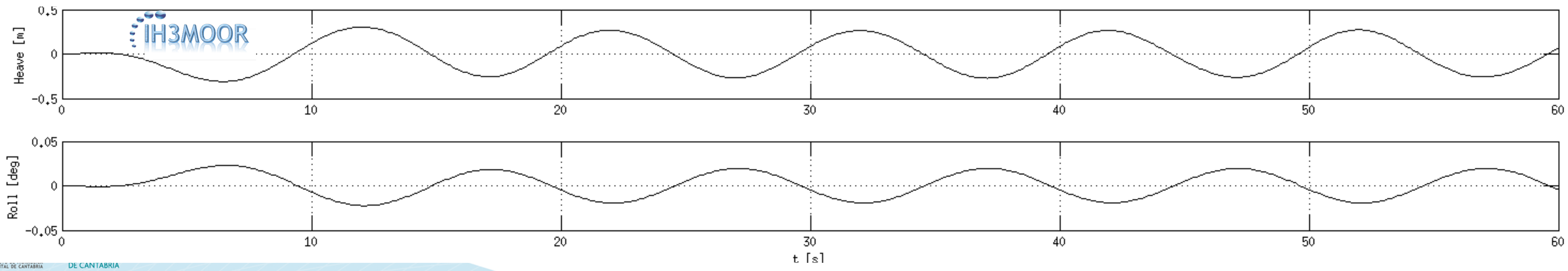


H=2m T=10s





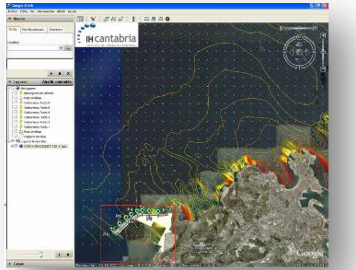




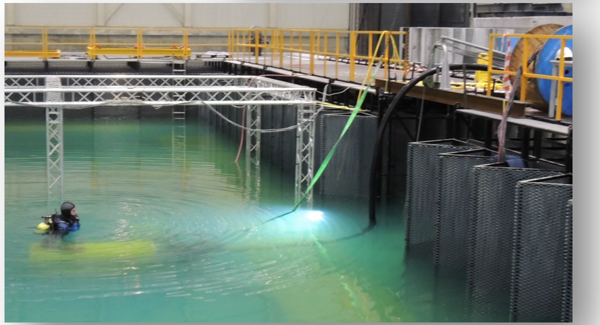
Transport, deployment and marine operations

Thanks to a deep knowledge marine dynamic and metocean conditions and based on numerical and physical tests, IH Cantabria has acquired expertise in design and execution of marine operations.

Operational systems have been developed based on short and long term weather forecast. Based on them, logistics, operation and maintenance, as well as, special transports.



- Decision Support systems applied to marine operations
- Operational systems based on nowcast y forecast schemes(short y long term):
- Logistics uncertainty assessment due to climate variability
- Design and optimization of marine operations



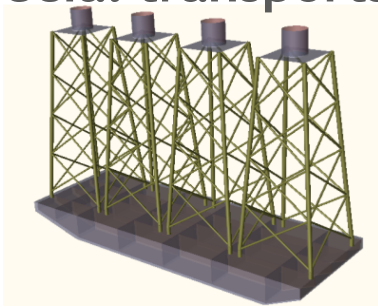
References:

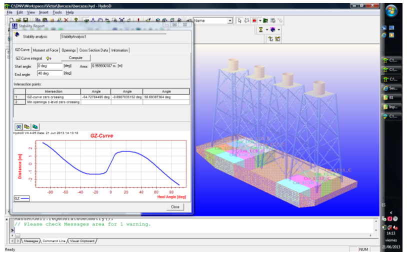
-Project: Puerto de Langosteira, Dragados

-Project Oceanlider, Prysmian.

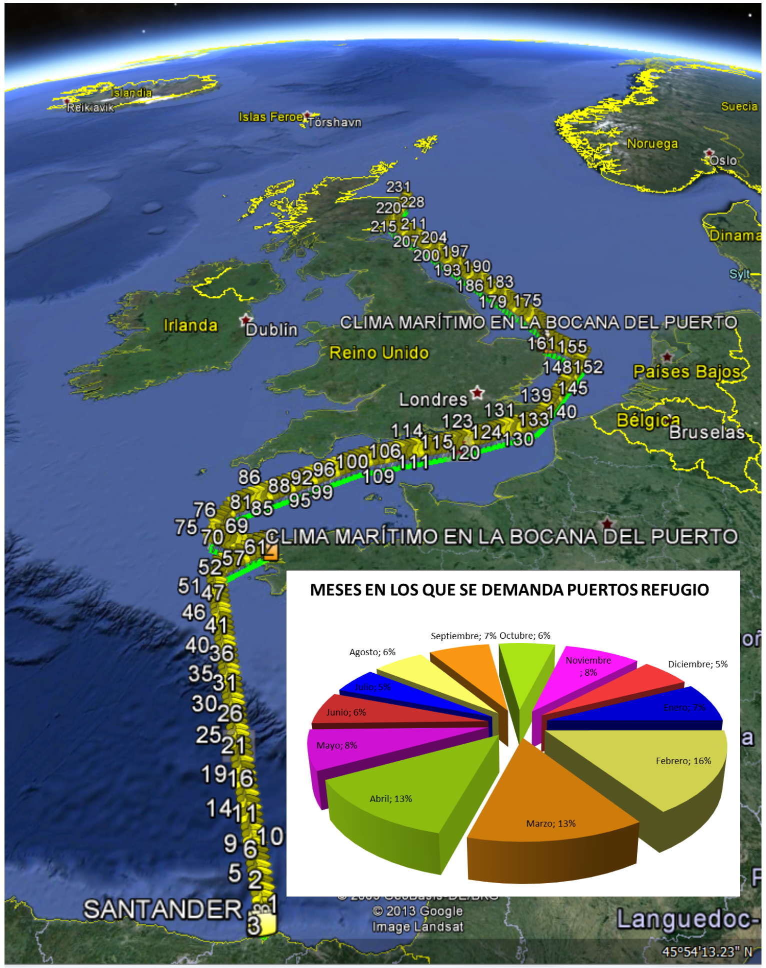
-Project Puerto Açu (Brasil), FCC

Ship routes: special transports and transport risk assessment





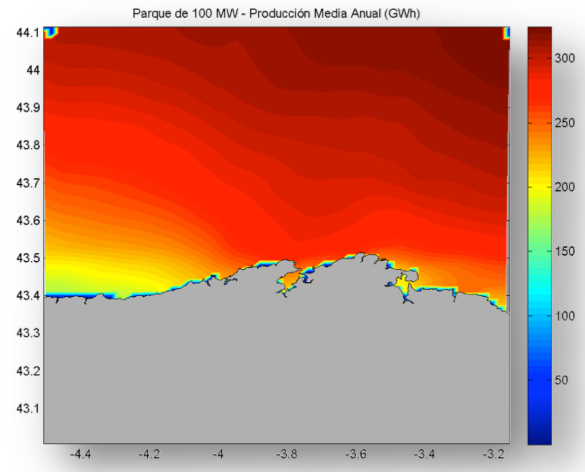
- Shipping routes modeling
- Operation and functional thresholds
- Met-ocean conditions influence over shipping routes
- Risk assessment of marine special transports
- Optimization and identification of best shipping routes.



Long term analysis of Santander - Aberdeen ship route

Economic feasibility assessment

Marine renewable concepts are in a incipient stage, therefore economic studies and business model design have to be conveniently designed with a limited amount of information and high levels of uncertainties.

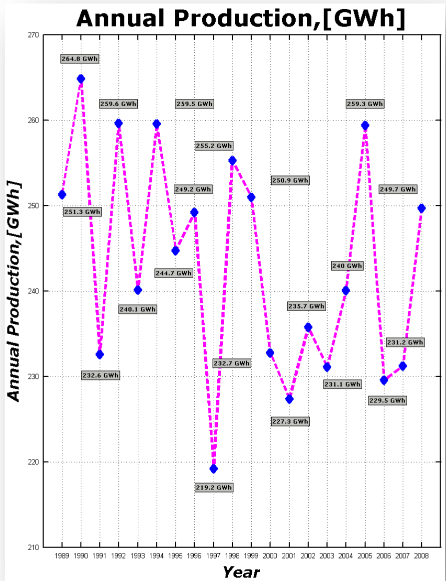


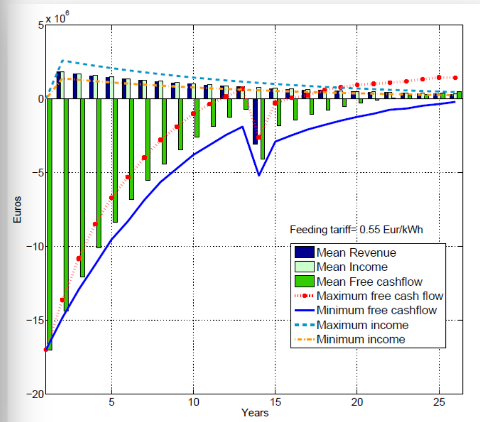
Wave and wind energy layout optimization

1. Local resource assessment
2. Device-device interaction (power production losses)
3. Power production maximization

Power production assessment

1. Short term
2. Mid term
3. Long term





Business model uncertainties analysis

Financial risk assessment

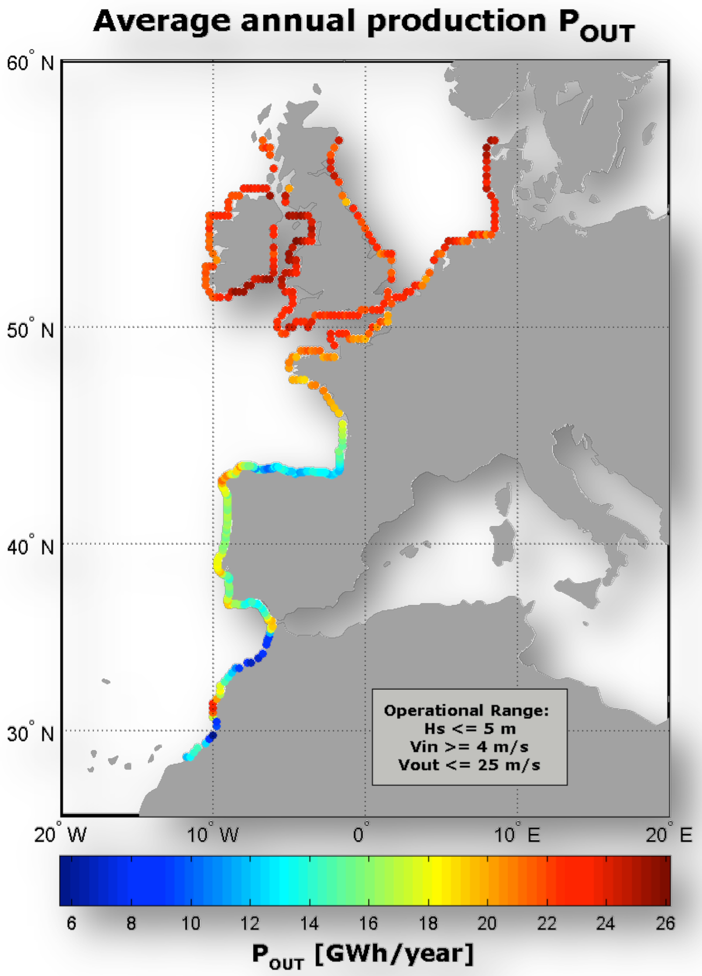
References:

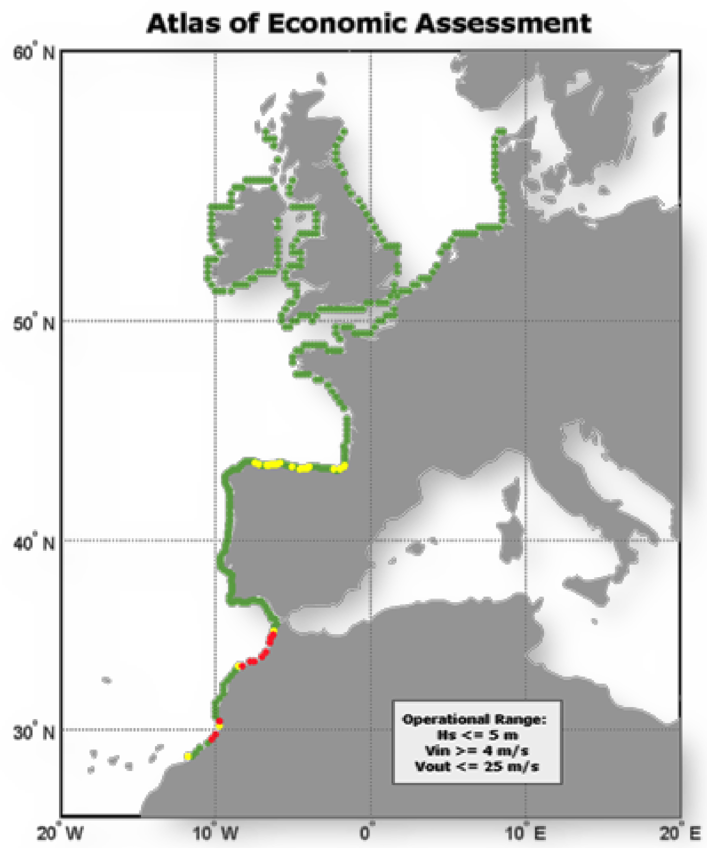
-Fundación Iberdrola 2012

-Guanche et al(2014), del Jesus et al(2014), de Andres et al(2014)

Offshore Engineering & Renewable Energy

Topics: Economic feasibility





- *Excellent*
- *Requires detailed study*
- *Inadvisable*

Environmental Impact Assessment

Marine renewable industry development, as well as other marine uses, show environmental impacts that have to be conveniently addressed. IH Cantabria participates in the most important European projects related with offshore environmental.

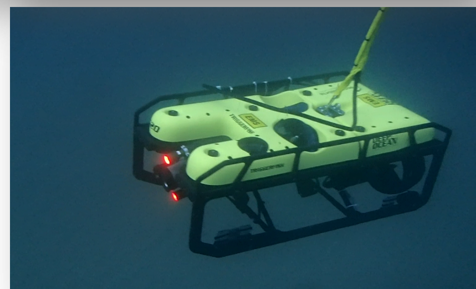
Environmental impact issues

- Effect and impact over biodiversity
- Visual impact
- Fisheries
- Sediments
- Morph-dynamic impacts
- Etc.

Cost-benefit analysis

Local community impacts

Social impacts and participatory design



Referencias:

- *European Project: Mermaid*
- *European Project: Maren*
- *European Project: Coconet*

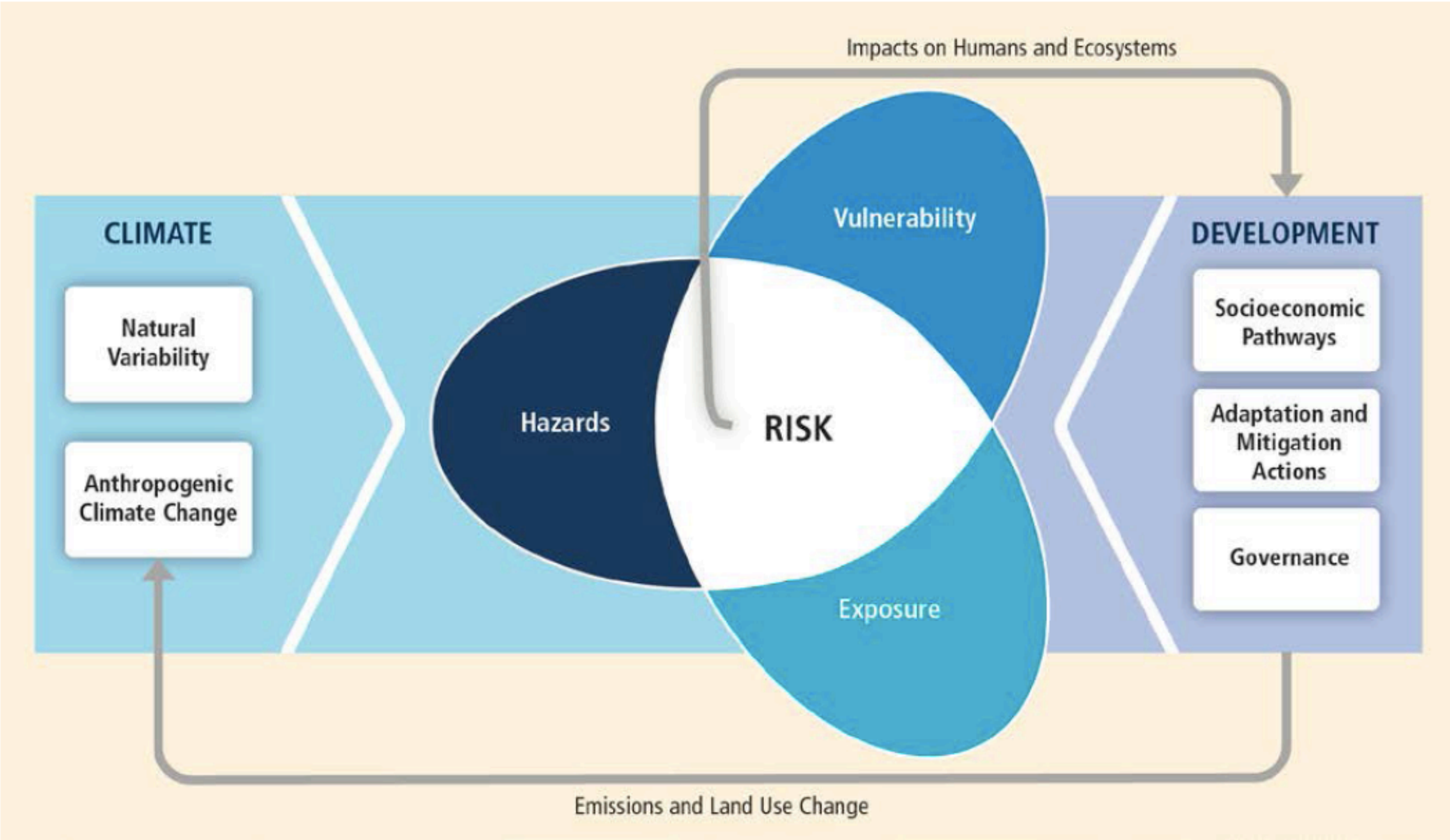
IH Cantabria

Environmental Hydraulics Institute of Cantabria

Clima y Cambio Climático

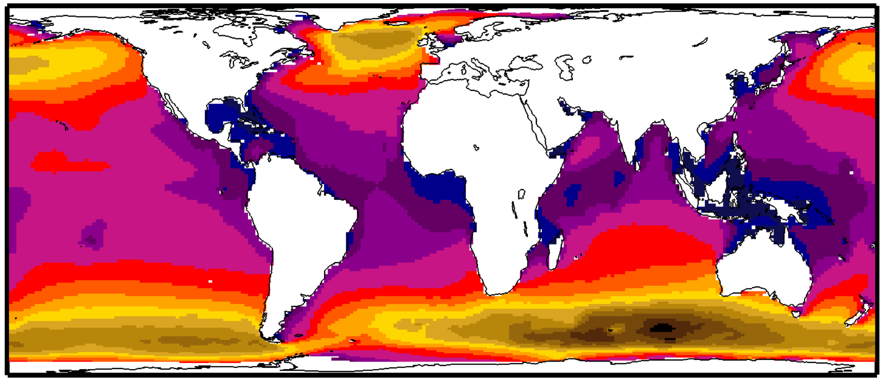
Objetivo general

Promover y facilitar una mejor gestión de los riesgos asociados a la variabilidad climática y al cambio climático y de la adaptación al cambio climático, mediante el desarrollo y la incorporación de observaciones y modelos climáticos, con base científica, en la planificación, políticas y buenas prácticas, a escala global, regional y local.

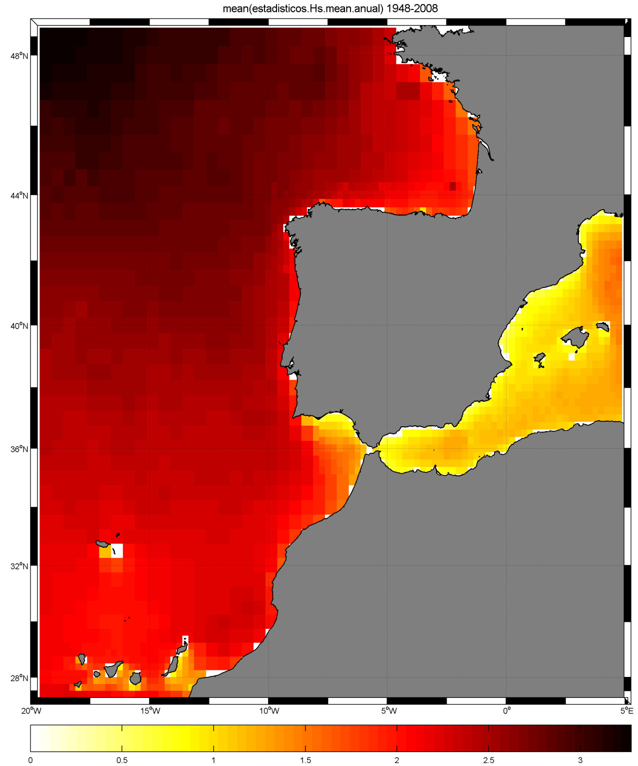

Impacts on Humans and Ecosystems
CLIMATE
Natural Variability
Anthropogenic Climate Change
Hazards
RISK
Vulnerability
Exposure
DEVELOPMENT
Socioeconomic Pathways
Adaptation and Mitigation Actions
Governance
Emissions and Land Use Change

Spatial scales

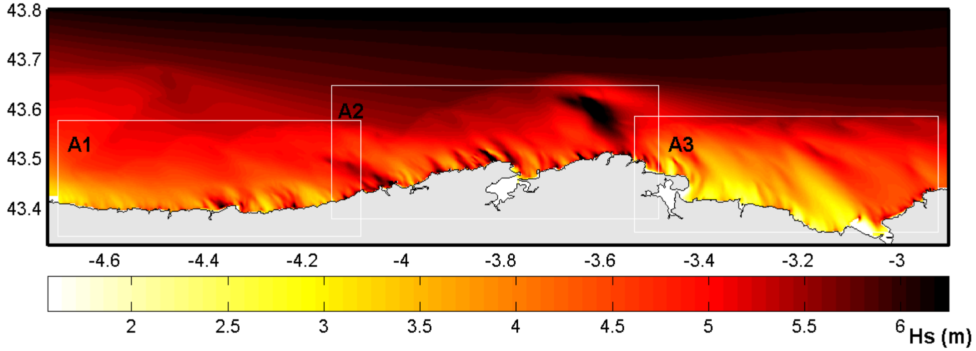
Global



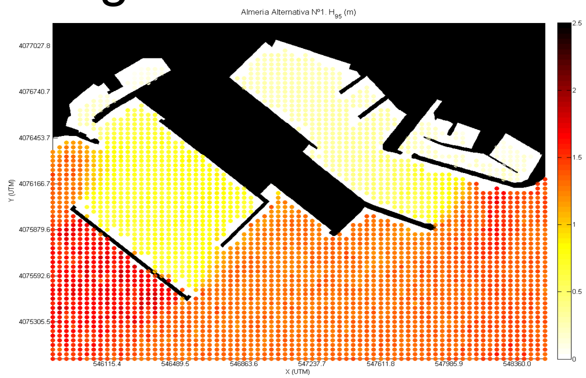
Regional



Local



High Resolution



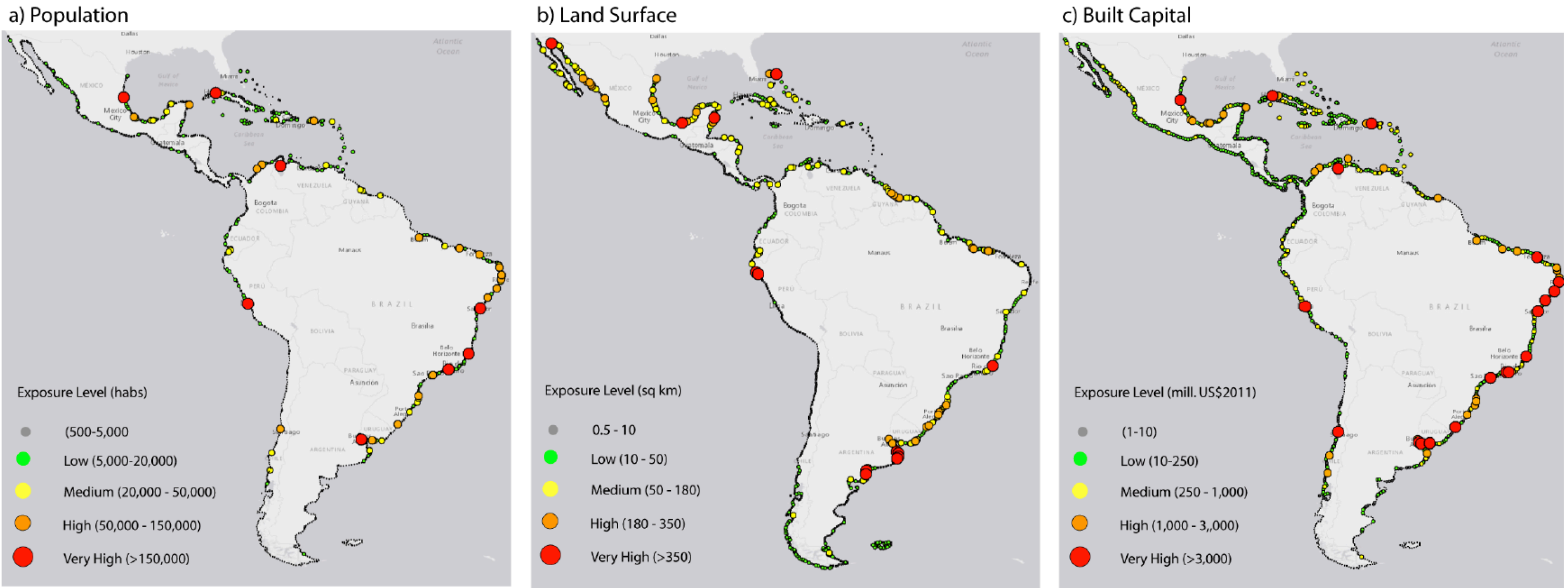


Figure 4. Present 1-in-100-yr flooding exposure from present 1-in-100-yr extreme sea level. (a) Population; (b) land surface and (c) built capital at 2011 reference values.

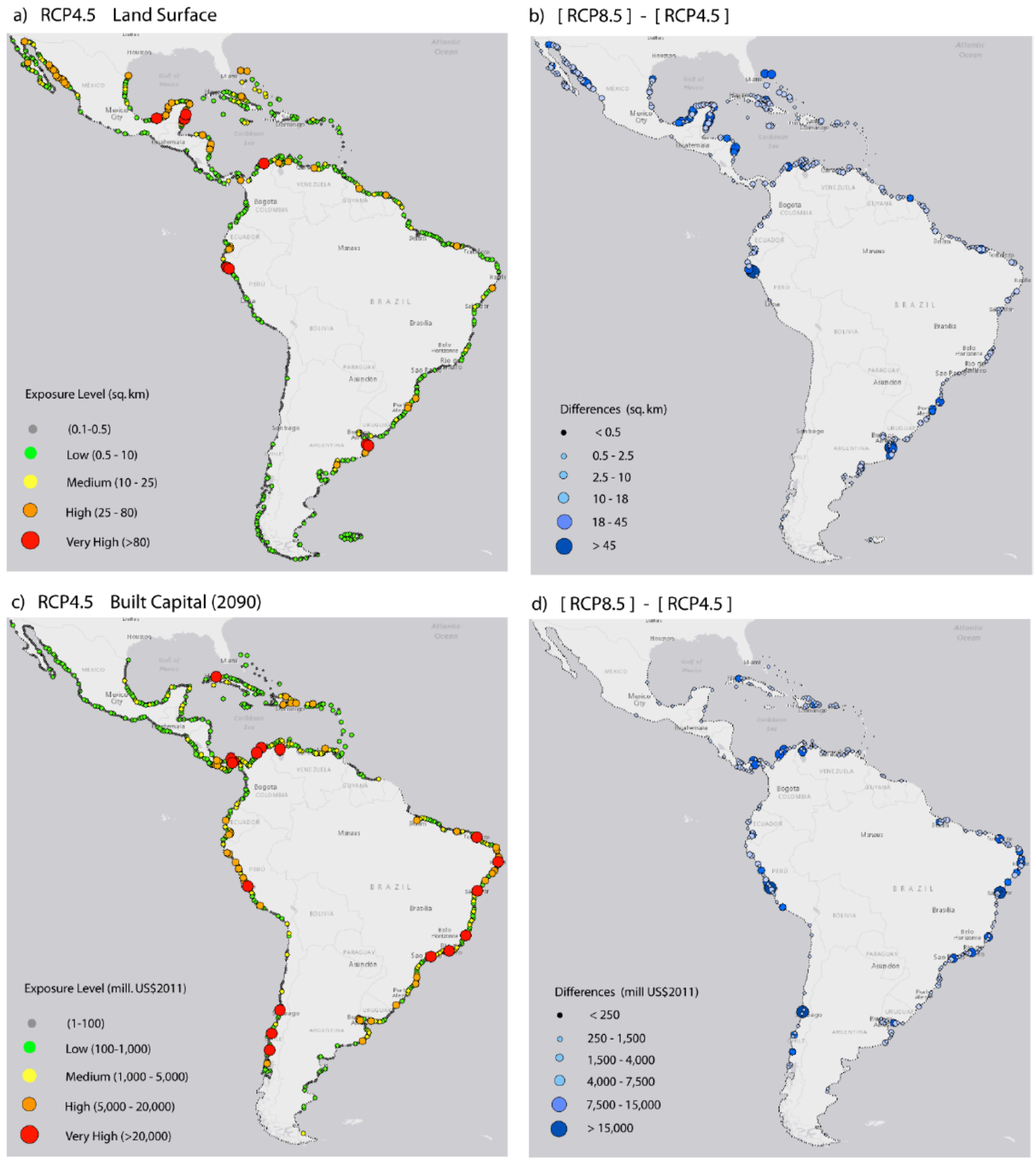
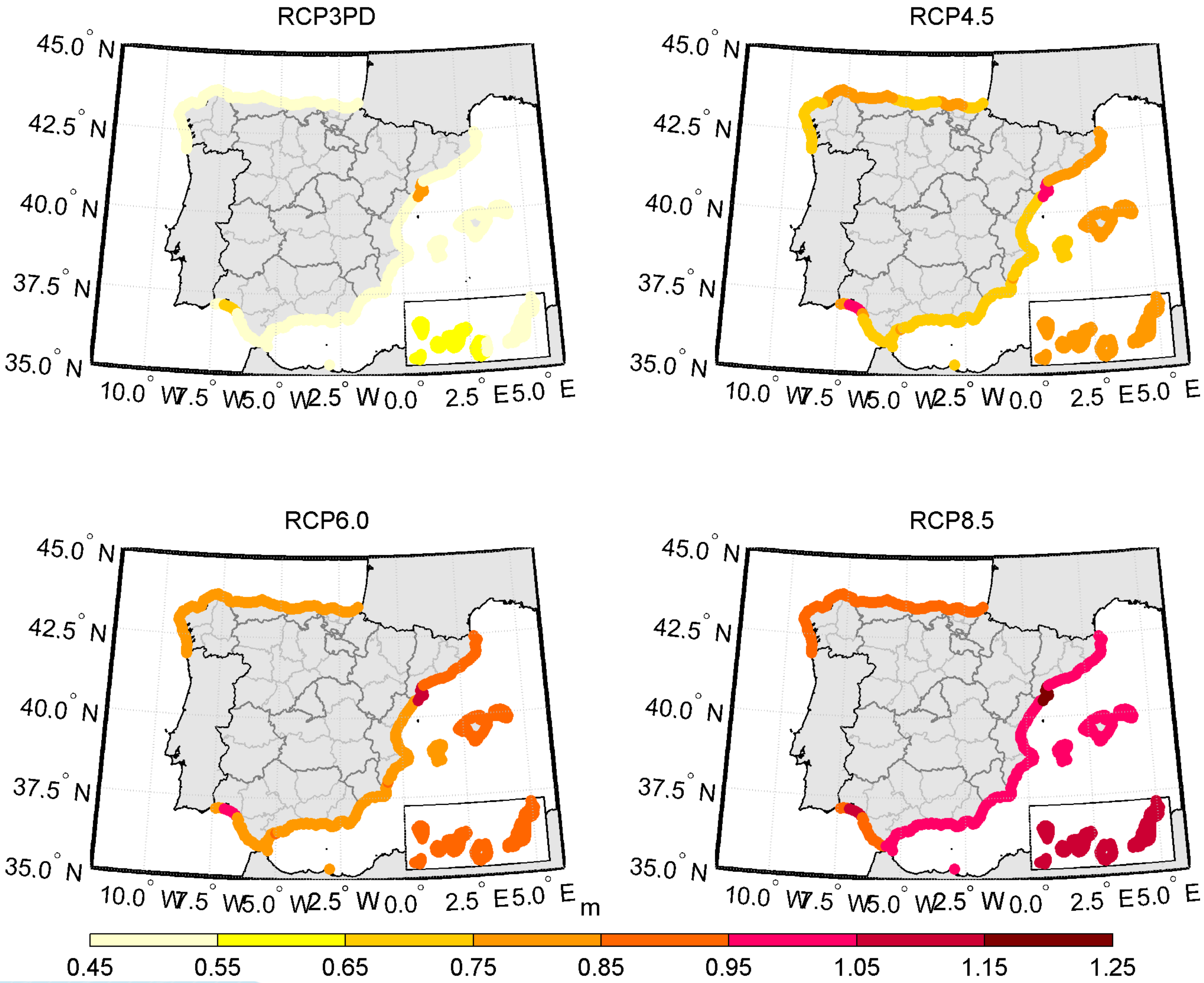
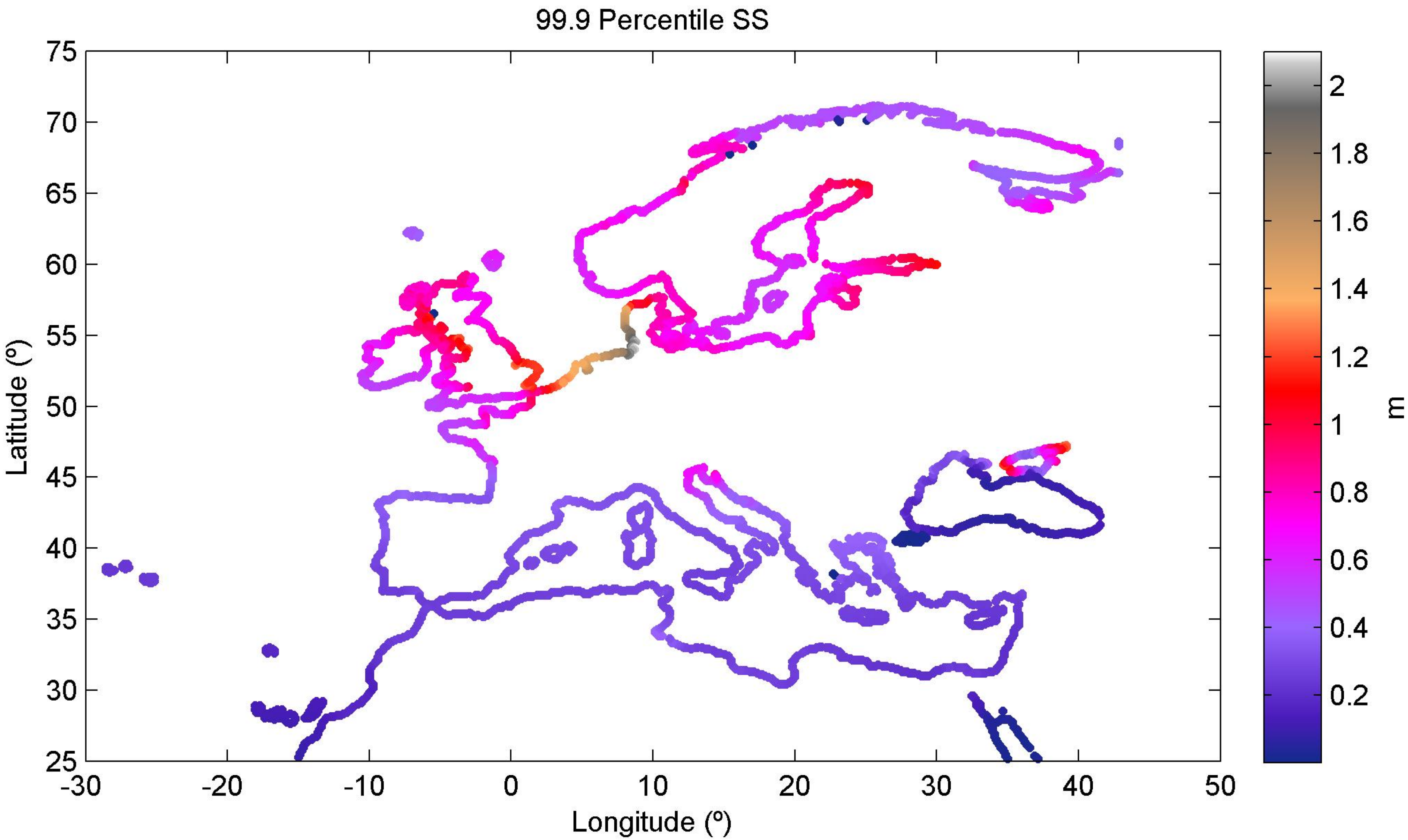


Figure 2. Exposure of land surface (upper panels) and Built Capital (lower panels) to sea-level rise scenarios. (a) Exposure levels for land inundated by sea-level rise for RCP4.5 (b) Difference between RCPs for land inundated (c) Exposure levels for built capital inundated by sea-level rise for RCP4.5 (d) Difference between RCPs for land inundated.

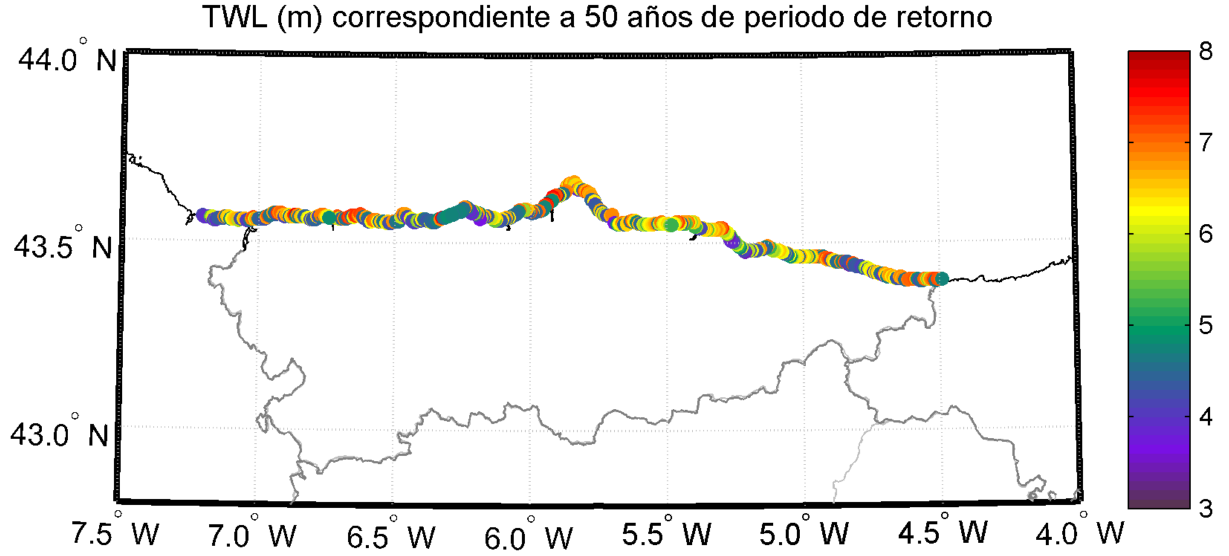
RSLR = RMSLR + local uplift/subsidence

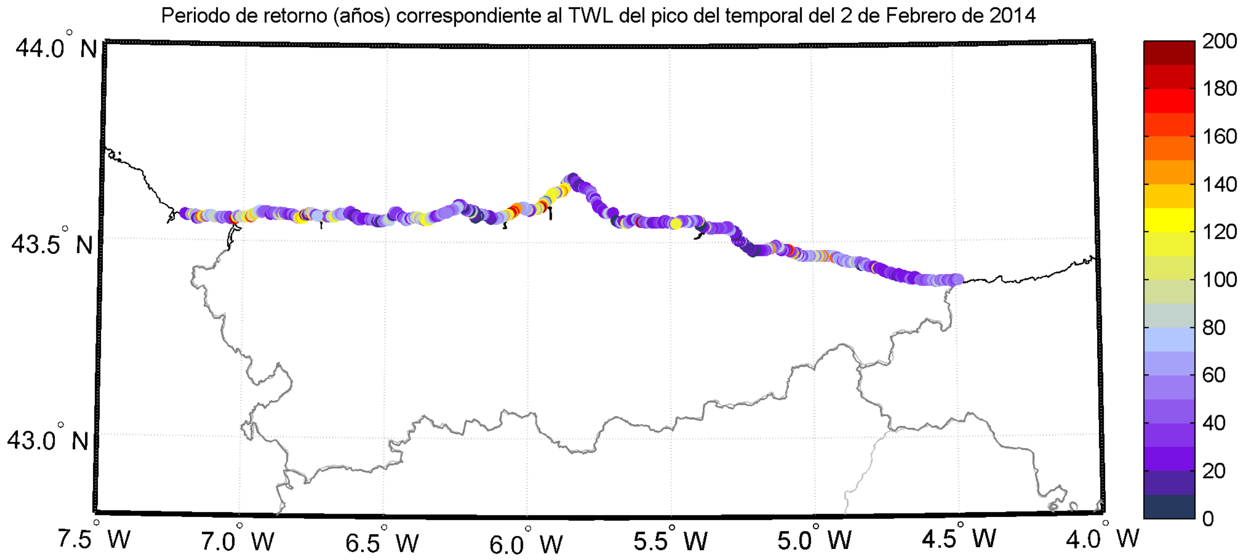


Contributors to flooding: Storm surge extremes



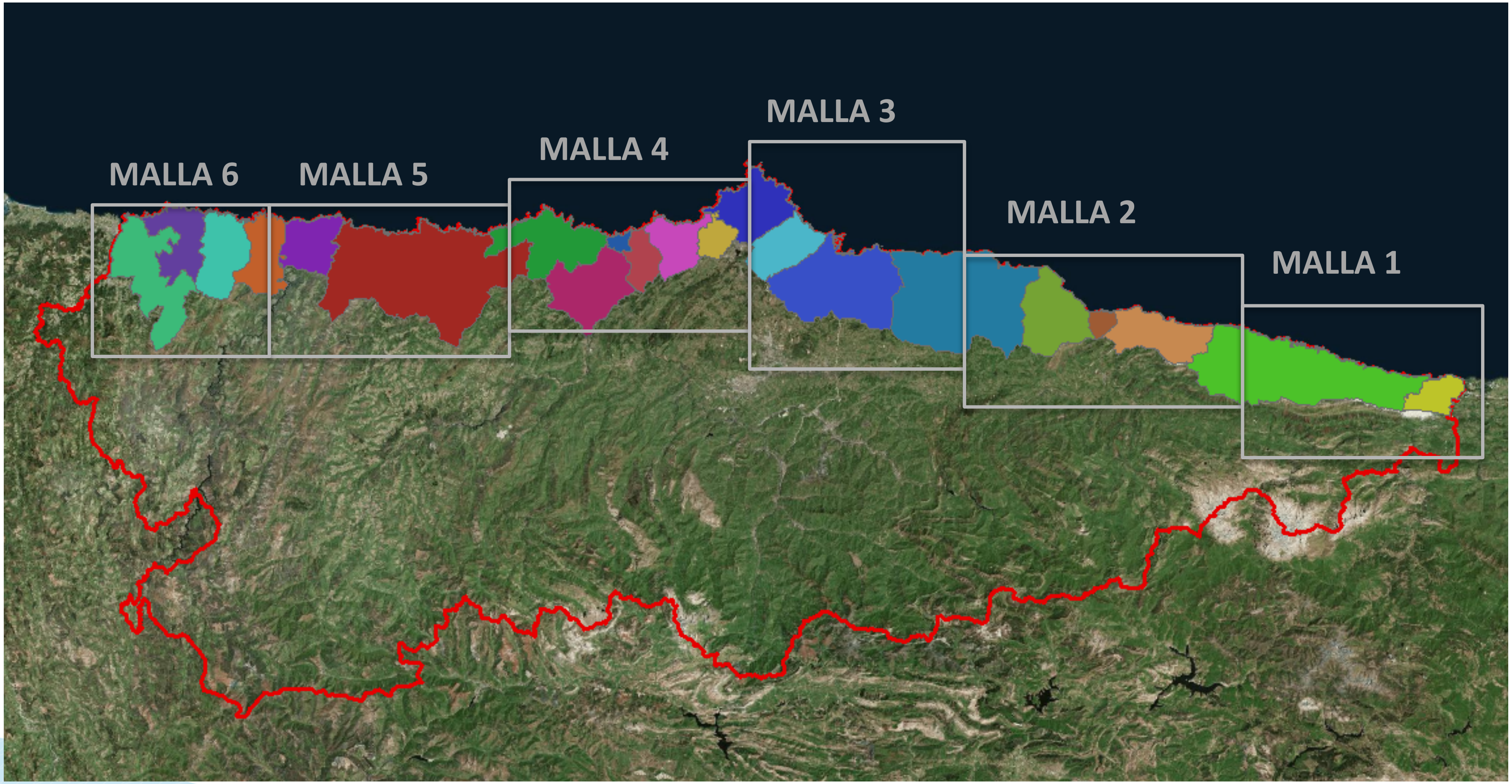
(Total Water Level in Asturias)





FLOODING HIGH RESOLUTION MODELLING

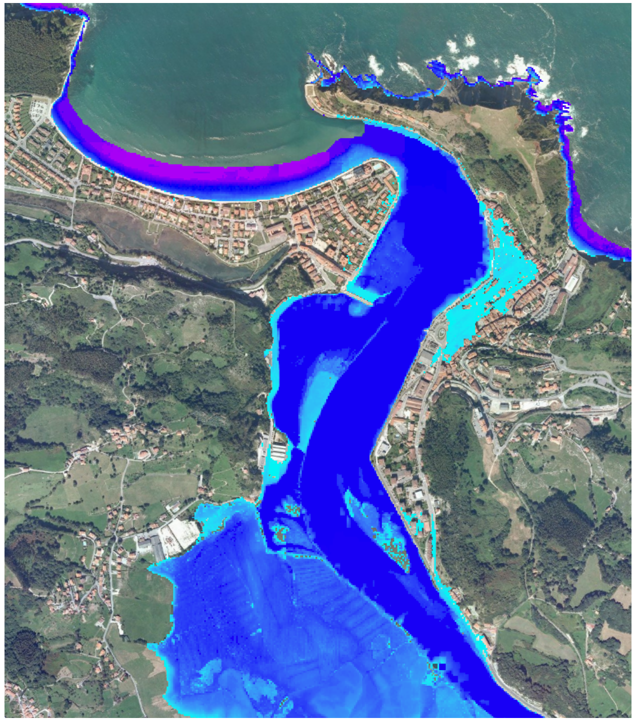
PRINCIPADO DE ASTURIAS FLOODING MESHES 400 KM (RESOLUTION 5 M)



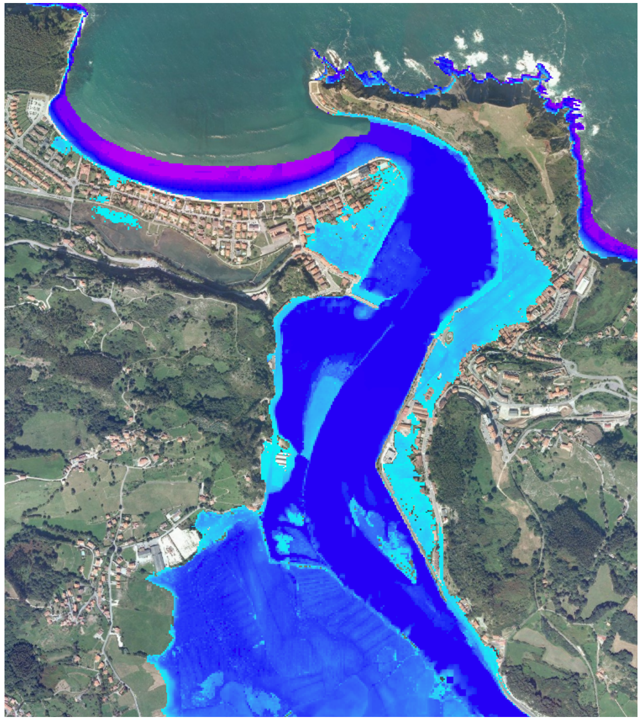
RIBADESELLA

Extreme Events including Climate Change

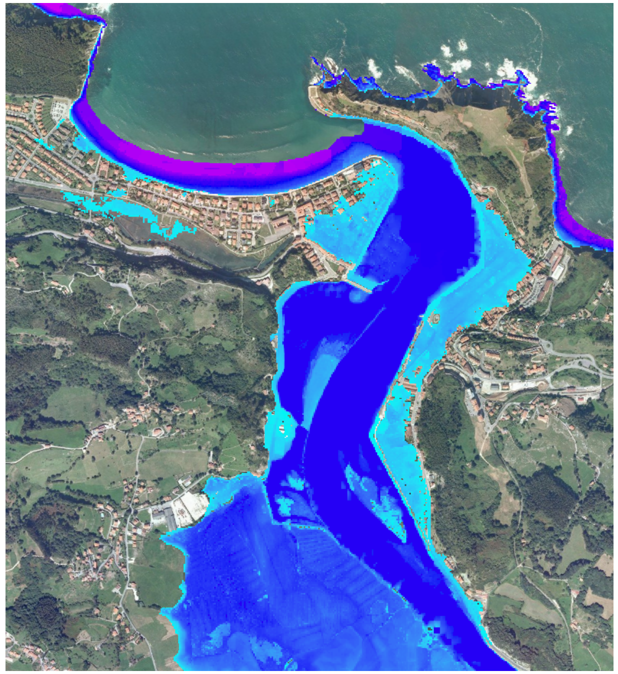
Escenario 2.- Clima presente Tr=500



Escenario 6.- SLR=0.45 Tr=500



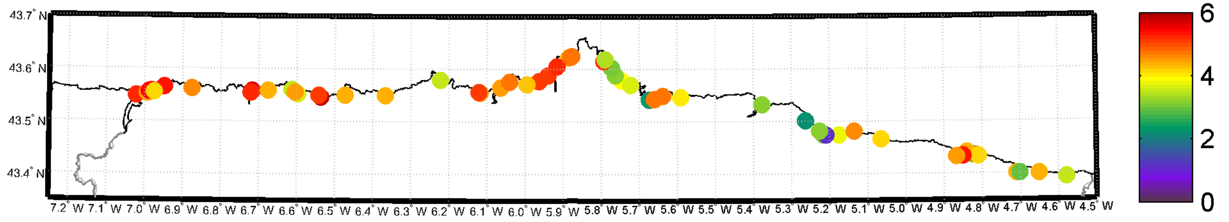
Escenario 9.- SLR=0.65 Tr=500



EROSION due to Sea Level Rise

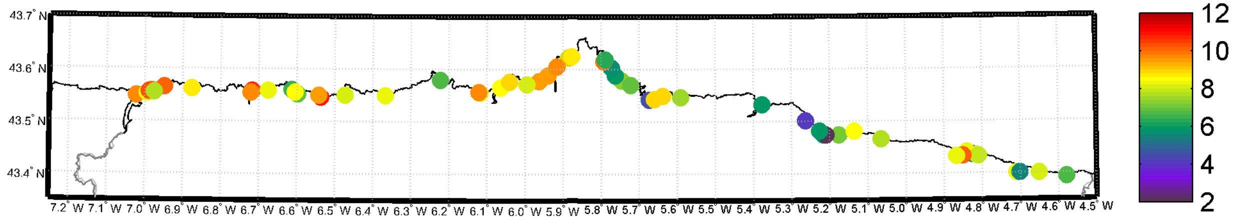
Horizonte 2050

Retroceso debido a un aumento del nivel del mar de 0.24 m

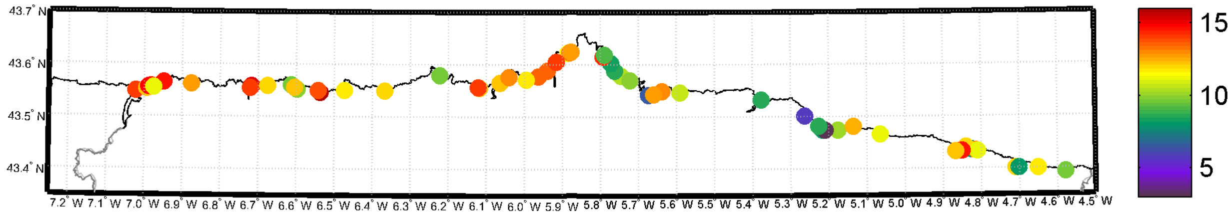


Horizonte 2100

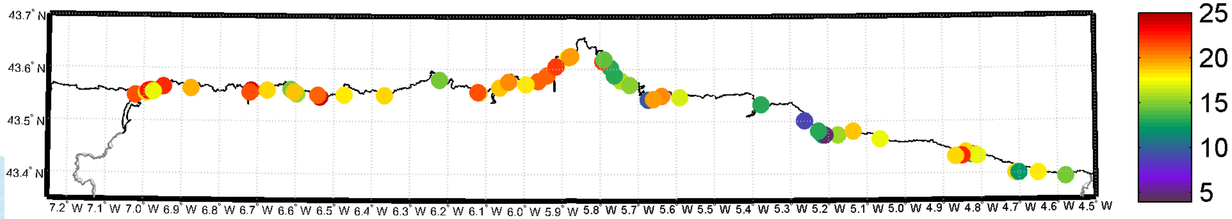
Retroceso debido a un aumento del nivel del mar de 0.45 m



Retroceso debido a un aumento del nivel del mar de 0.65 m

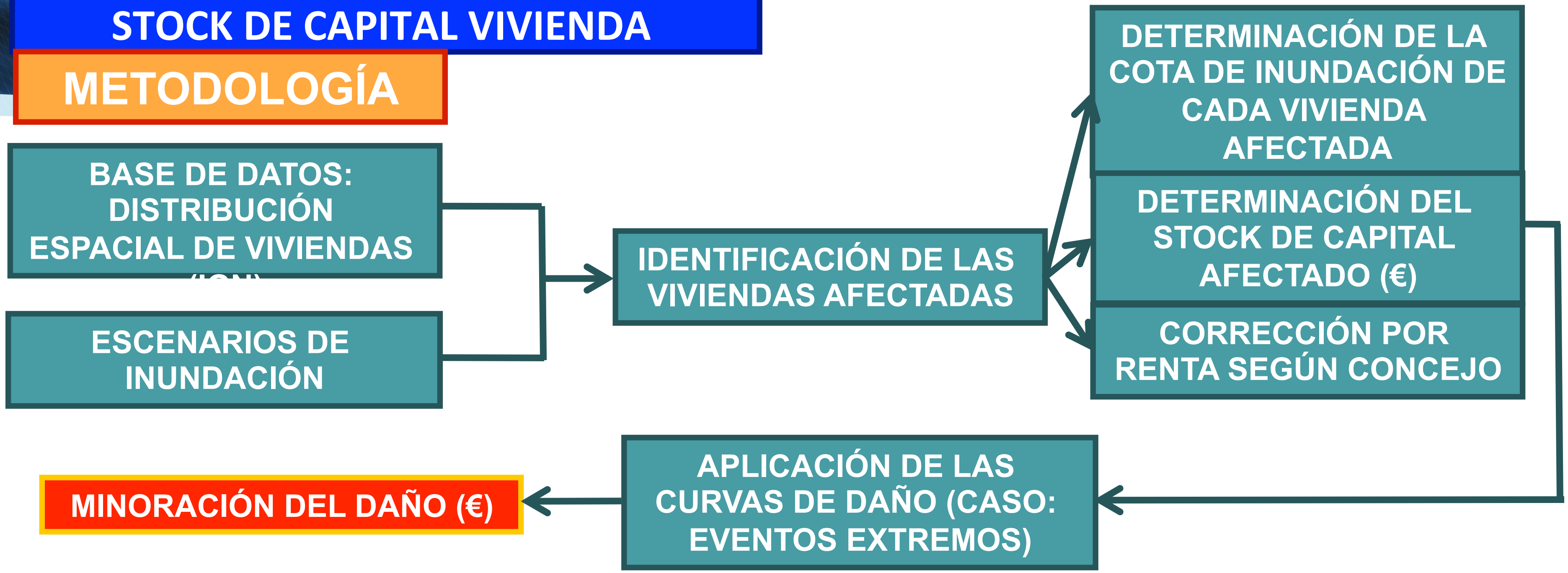


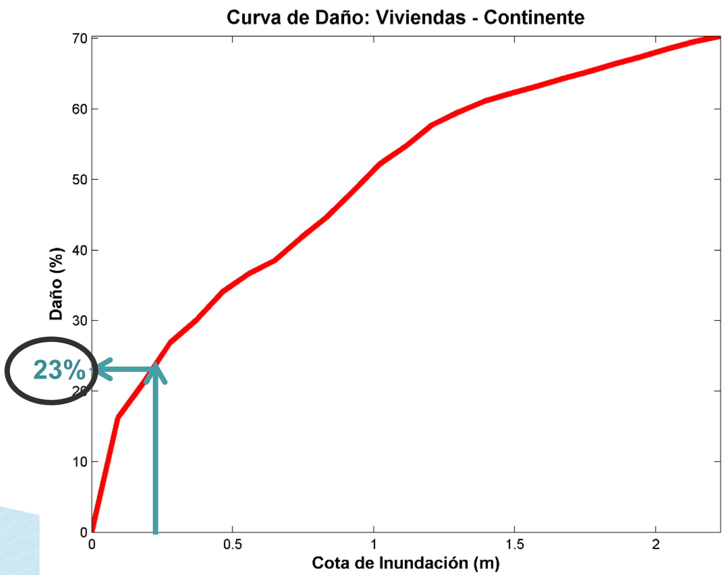
Retroceso debido a un aumento del nivel del mar de 1 m

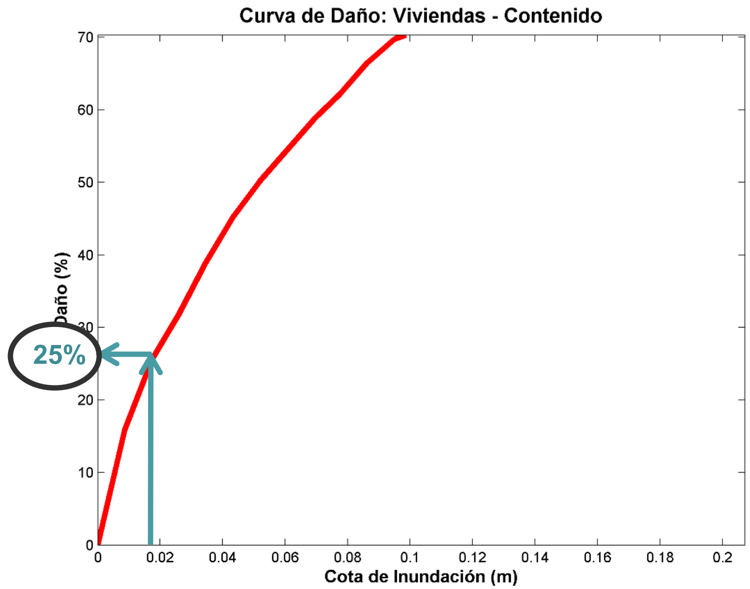


STOCK DE CAPITAL VIVIENDA

METODOLOGÍA





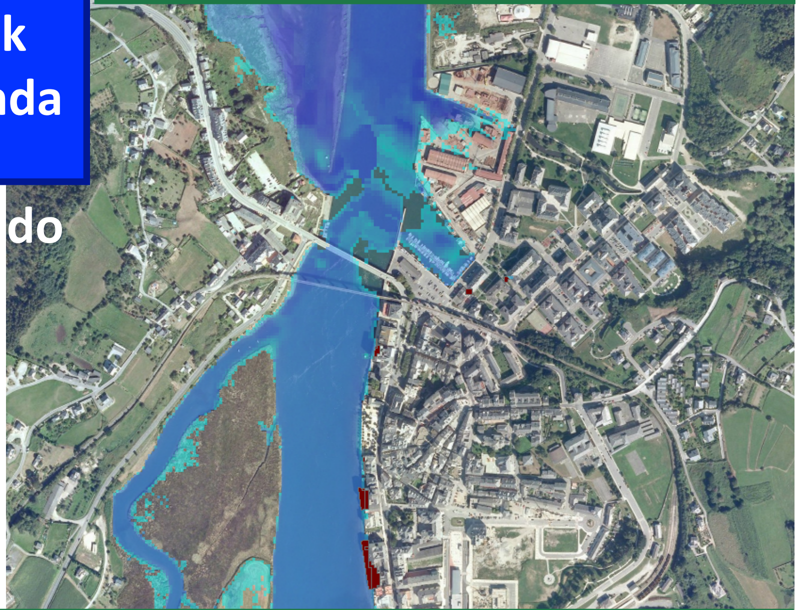


NAVIA

Stock Viviendas

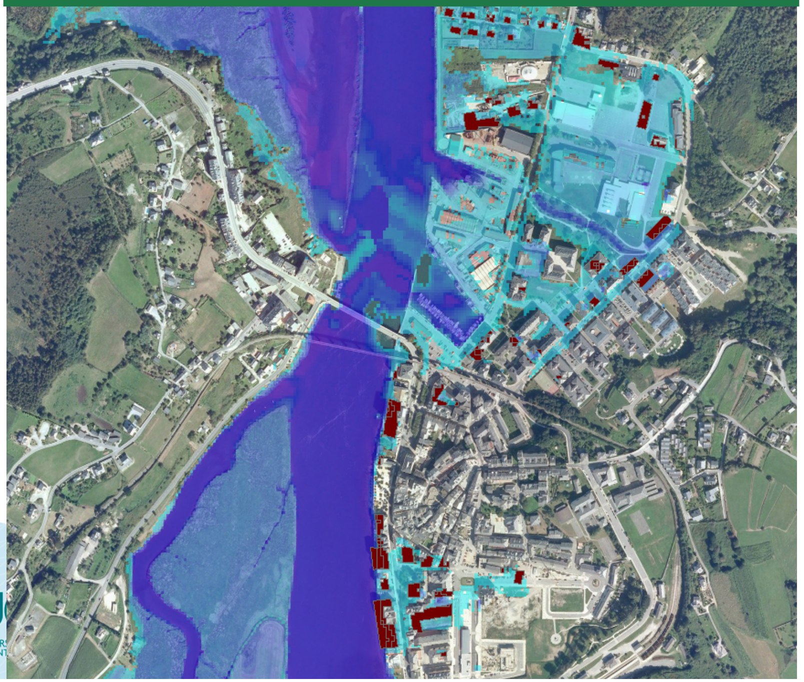
do

Escenario 1.- CLIMA PRESENTE Tr=100

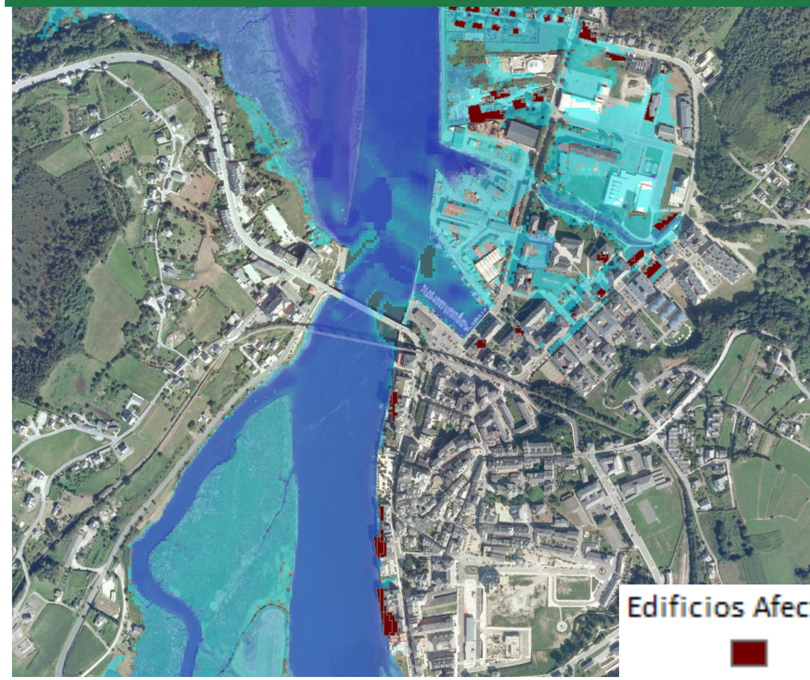


Escenario 4.- MEDIO PLAZO SLR=0.24 m + Tr=100

Escenario 9.- LARGO PLAZO SLR=1.5 m



Escenario 11.- LARGO PLAZO SLR=0.65 m + Tr=100



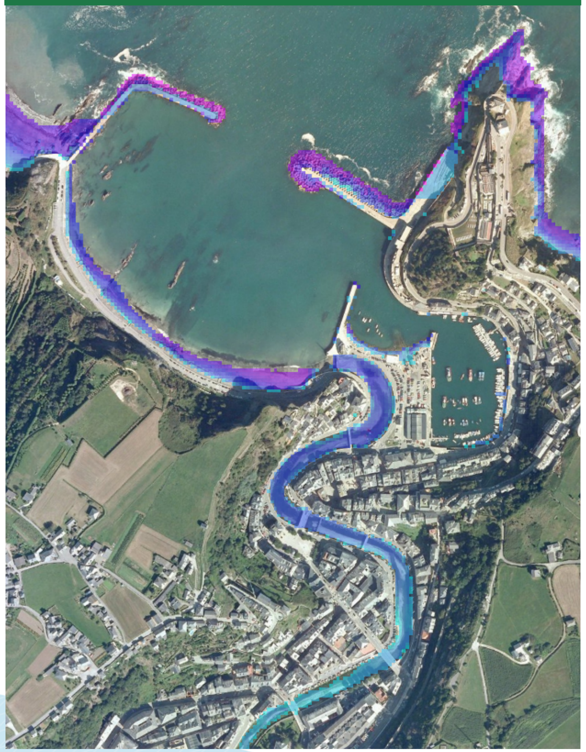
Edificios Afectados

LUARCA

Stock Vivienda
s

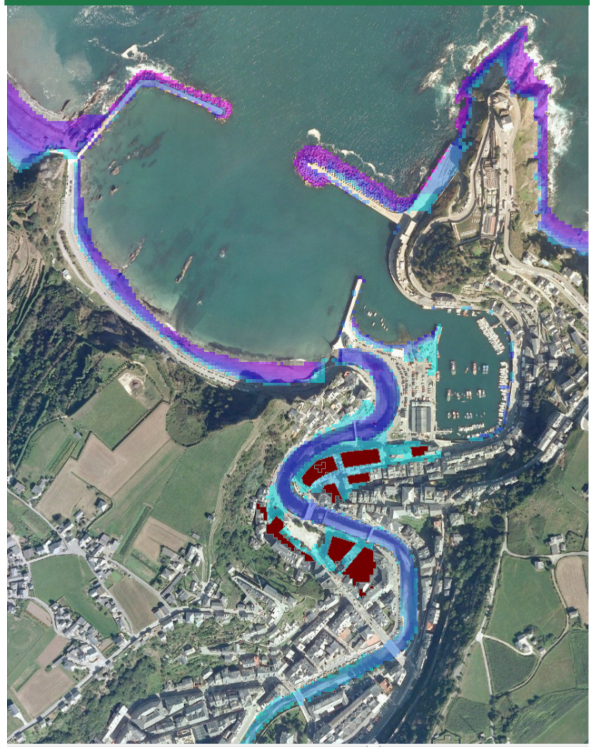
Influencia de la combinación de Eventos Extremos y Subida del Nivel del Mar a Medio y Largo Plazo

Escenario 1.- CLIMA PRESENTE
Tr=100



Escenario 4.- MEDIO PLAZO
SLR=0.24 m + Tr=100

Escenario 11.- LARGO PLAZO
SLR=0.65 m + Tr=100



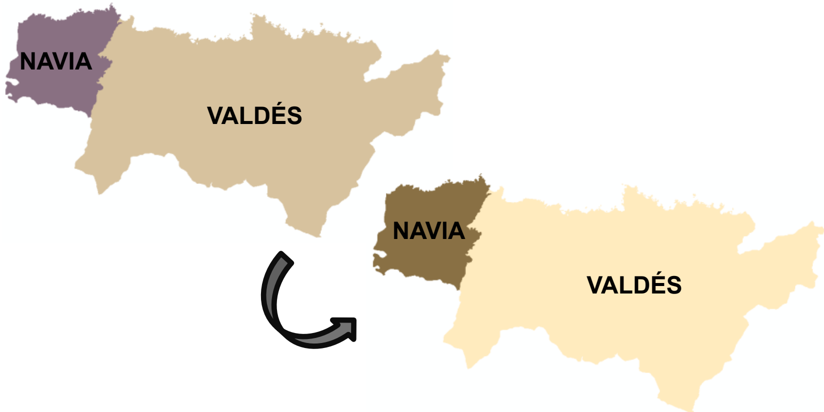
Edificios Afectados

STOCK DE CAPITAL VIVIENDA

Escenario 1.- CLIMA PRESENTE
Tr=100

CONTINENTE

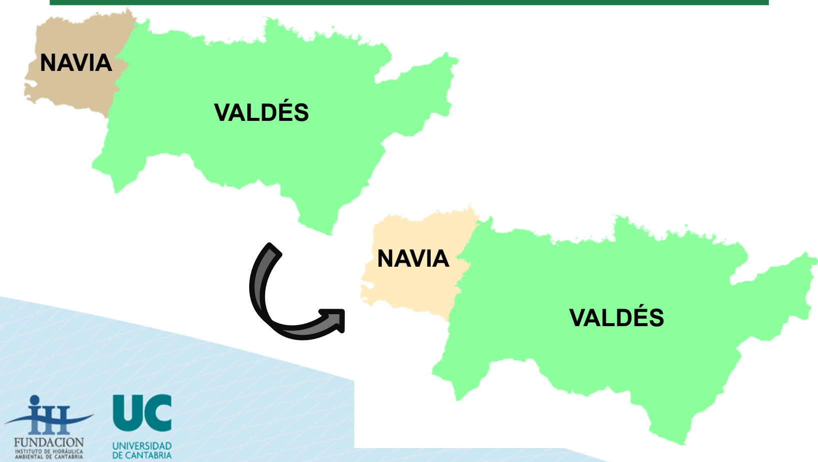
CONTENIDO



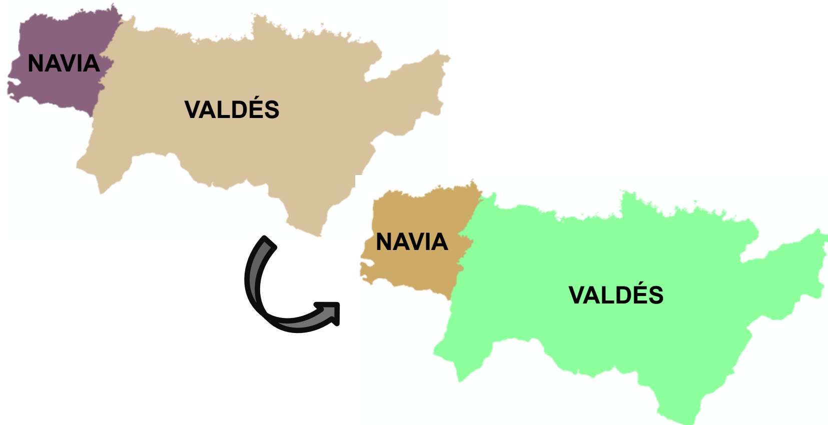
Función de Daño

Escenario 4.- MEDIO PLAZO
SLR=0.24 m + Tr=100

CONTINENTE



CONTENIDO



Relativo al Stock de Capital de 2011

STOCK DE CAPITAL VIVIENDA

Escenario 9.- LARGO PLAZO
SLR=1.5 m

CONTINENTE

CONTENIDO

Escenario 11.- LARGO PLAZO
SLR=0.65 m + Tr=100

CONTINENTE

CONTENIDO

Relativo al Stock de Capital de 2011

IH cantabria
INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

I Workshop Nacional del Equipo de Apoyo al Plan de Acción del Atlántico

Cambio Climático y Energías Renovables de Origen Marino en el Instituto de Hidráulica Ambiental

Iñigo Losada
Director de Investigación IHCantabria
Coordinador Área de Agua y Energía
Cantabria Campus Internacional