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Enhancing access to information on climate change, natural disasters and coastal vulnerability in the Caribbean region workshop: leaving no one behind
Saint Lucia- 26 August 2015

“Effects of climate change on the coasts of Latin America and the Caribbean”

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Chief, Unit of Sustainable Development Policies, SDHSD, ECLAC

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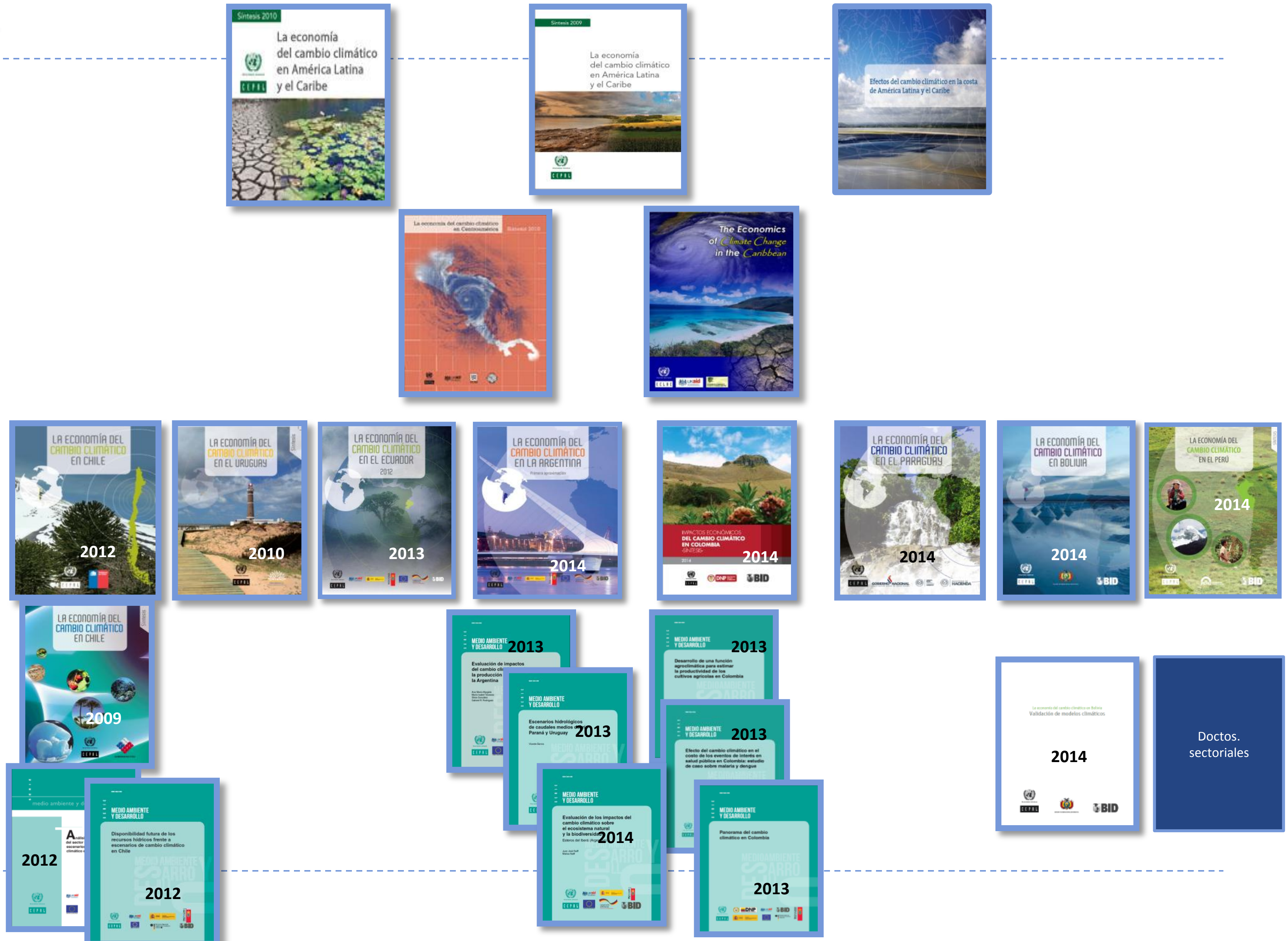
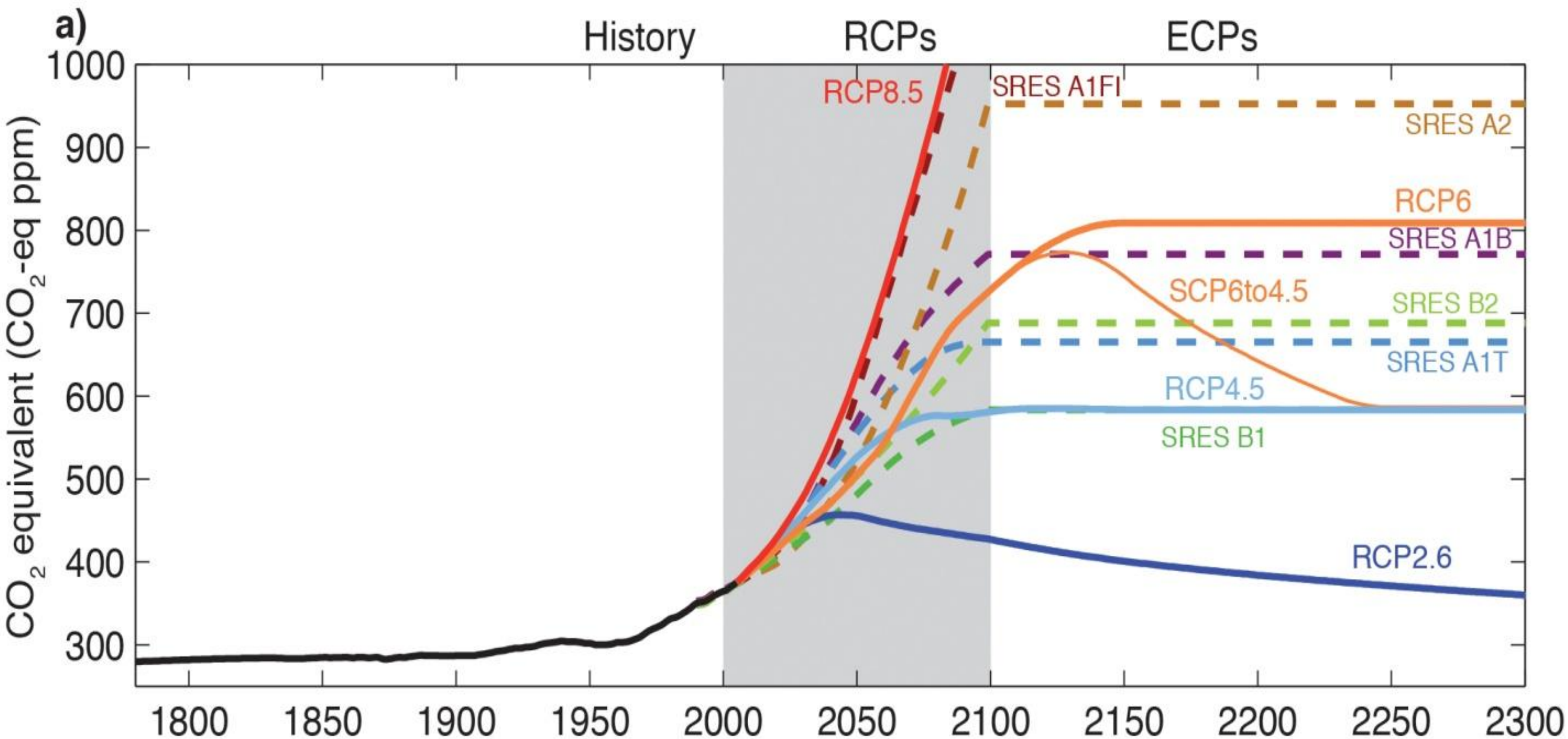
ECONOMICS OF CLIMATE CHANGE IN LATIN AMERICA AND THE CARIBBEAN



Escenarios del IPCC: Reportes pasados y presentes



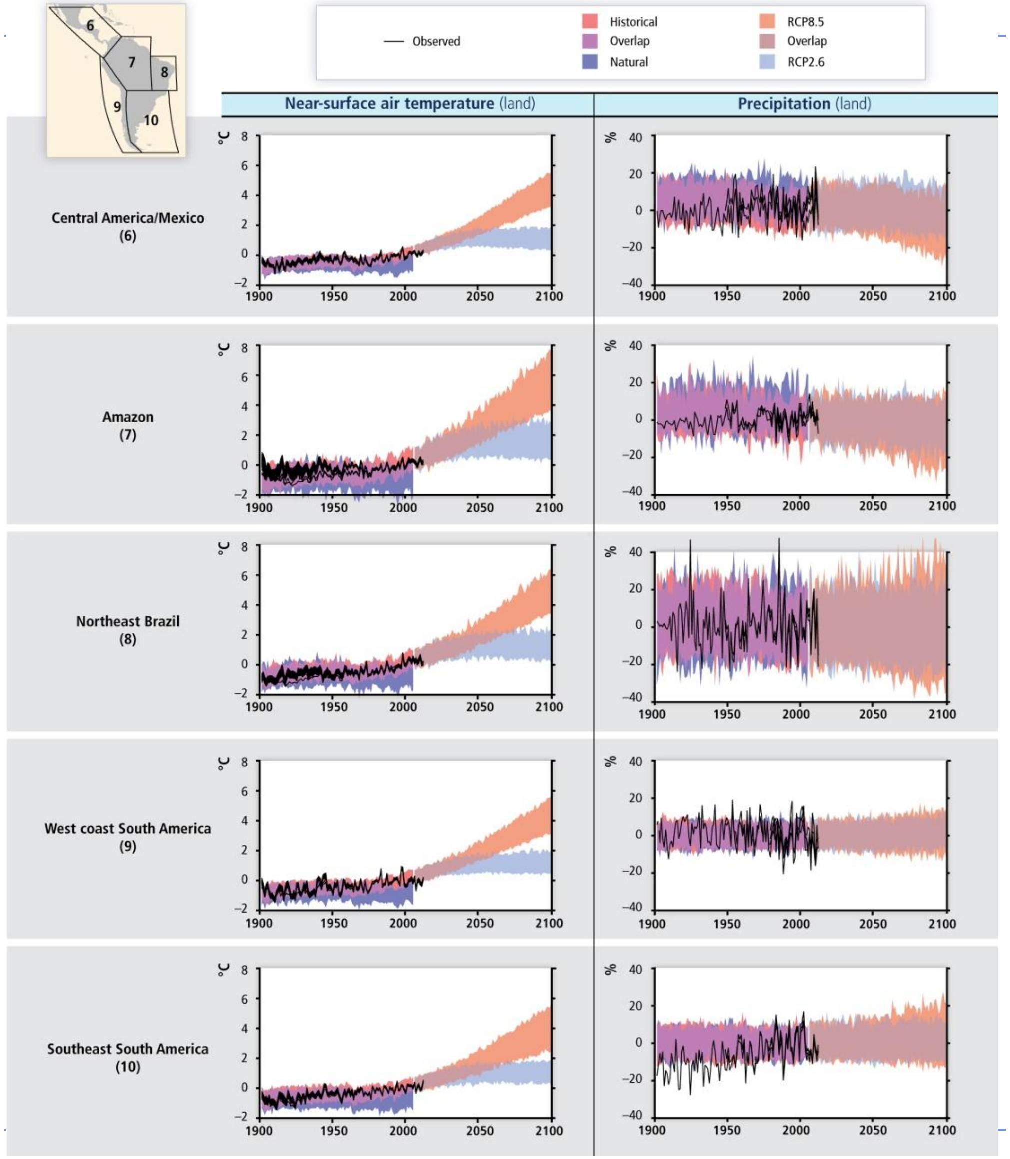
Fuente: IPCC (2014), *Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

Latin America: observations and projections of temperature and precipitation, IPCC (2014)

Black lines are observations.

Shadows are percentile 5-95.

Average data from 1986-2006



Fuente: Magrin, G.O., et al, 2014: Central and South America. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

SIDS: Observations and projections of temperature and precipitation, IPCC (2014)

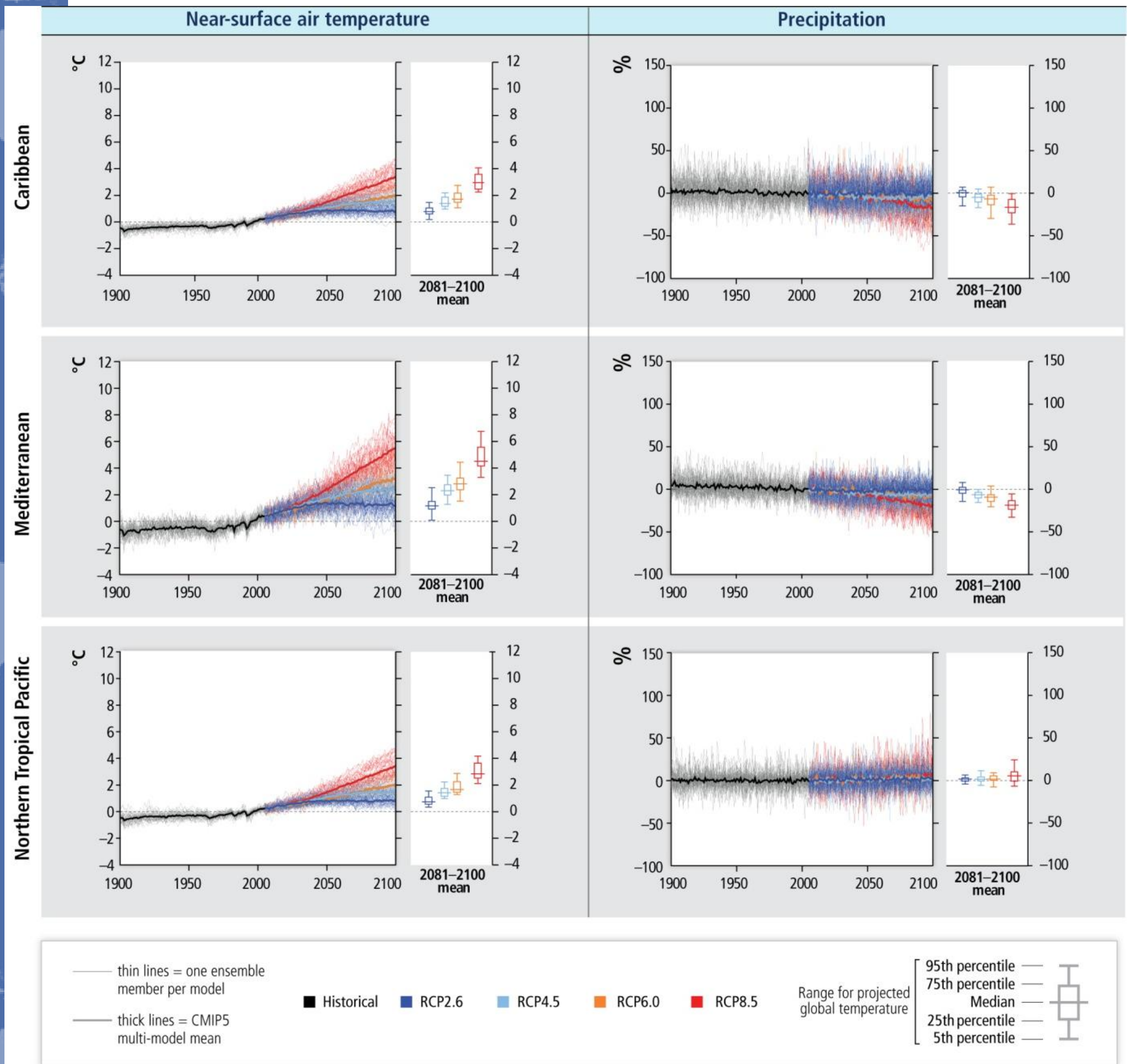


Table 29-1 | Climate change projections for the intermediate low (500–700 ppm CO_2e) Representative Concentration Pathway 4.5 (RCP4.5) scenario for the main small island regions. The table shows the 25th, 50th (median), and 75th percentiles for surface temperature and precipitation based on averages from 42 Coupled Model Intercomparison Project Phase 5 (CMIP5) global models (adapted from WGI AR5 Table 14.1). Mean net regional sea level change is evaluated from 21 CMIP5 models and includes regional non-scenario components (adapted from WGI AR5 Figure 13-20).

Small island region	RCP4.5 annual projected change for 2081–2100 compared to 1986–2005						
	Temperature (°C)			Precipitation (%)			Sea level (m)
	25%	50%	75%	25%	50%	75%	Range
Caribbean	1.2	1.4	1.9	−10	−5	−1	0.5–0.6
Mediterranean	2.0	2.3	2.7	−10	−6	−3	0.4–0.5
Northern tropical Pacific	1.2	1.4	1.7	0	1	4	0.5–0.6
Southern Pacific	1.1	1.2	1.5	0	2	4	0.5–0.6
North Indian Ocean	1.3	1.5	2.0	5	9	20	0.4–0.5
West Indian Ocean	1.2	1.4	1.8	0	2	5	0.5–0.6

Main objective

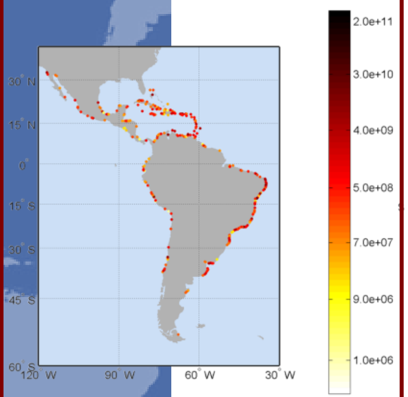
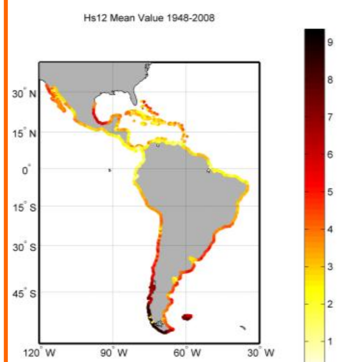
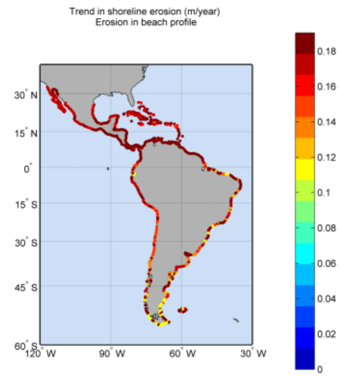
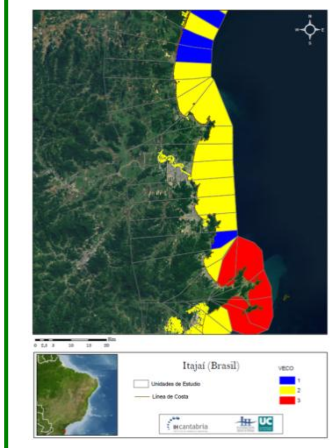
Compile the information required to analyze the modifications and impacts of climate change in the coastal areas of Latin America and the Caribbean

PROJECT STRUCTURE AND DOCUMENTS

Climate change in Latin American and Caribbean coastal areas			
Document 1: **Coastal agents** (soon available in English) • Dynamics • Trends • Climate variability in coastal areas	Document 2: **Vulnerability**	Document 3: **Impacts** (Available in English)	Document 4: **Risks**

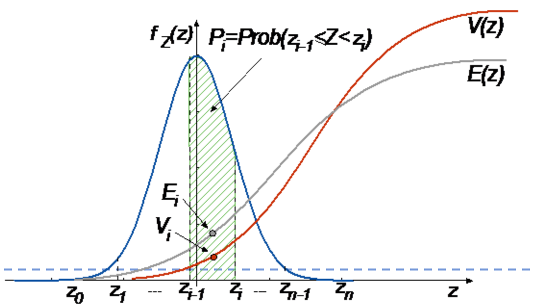
Supplementary documents		
Theoretically derived effects of climate change in coastal areas	Methodological handbook	Project findings web viewer

Framework of the project

Risk	=	Probable danger	x	Exposure	x	Vulnerability
		Dynamics / Impacts  				
Scenarios		**Uncertainty** **Climate change trends**		**Coast types**		**Functions of the coast**

Extrapolation of trends

Scenarios



Beaches, ports, coral reefs, urban areas, etc.

Physical Vuln.

Ecological

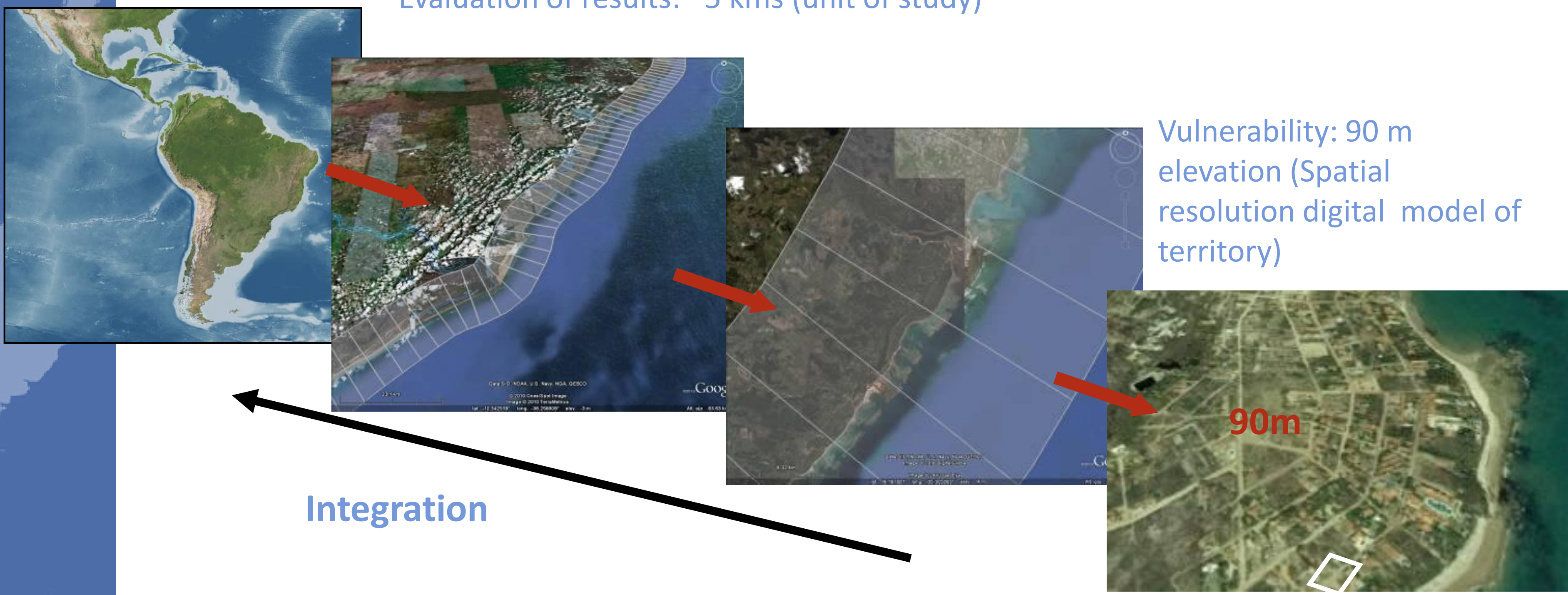
Socioeconomic

Framework of the project (cont.)

Spatial scales:

Presentation of results: ~50 kms

Evaluation of results: ~5 kms (unit of study)



Existing databases and generated

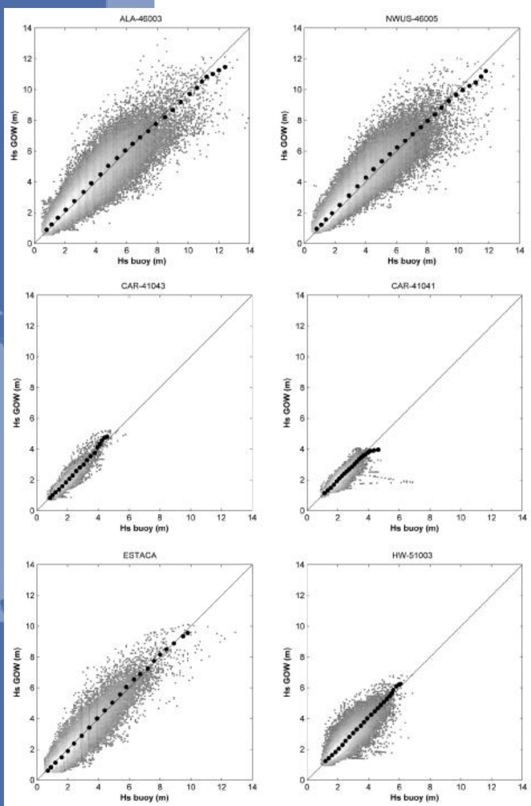
Type of information	Time period covered	Spatial resolution	Source
Mean sea level (MSL)	1950-2009 / monthly	Global, 1º	CSIRO—Commonwealth Scientific and Industrial Research Organisation.
	Variable	Global, dispersed	Tide gauges UHSLC—University of Hawaii Sea Level Center.
Subsidence	-	Variable	DIVA—Dynamic Interactive Vulnerability Assessment. (Peltier et al. 2000)
Tides	Harmonic constants	Global, 0.25º	TPXO—Global model of ocean tides based on altimetric data from the TOPEX/POSEIDON mission.
Salinity (SAL)	1980-2009 / monthly	Global, 1ºx0.333º	NCEP - GODAS—National Centers for Environmental Prediction (USA), Global Ocean Data Assimilation System.
	1948-2011 / monthly	Global, 2.5º (Gaussian grid)	NCEP - NCAR—National Centers for Environmental Prediction (USA), National Center for Atmospheric Research.
Sea surface temperature (SST)	1950-2009 / monthly	Global, 2º	ERSSTv3 - NOAA—Extended Reconstructed Sea Surface Temperature, National Oceanic and Atmospheric Administration (USA).
Air temperature anomaly	1950-2005 / monthly	Global, 2º	GISS - NASA—Goddard Institute for Space Studies, National Aeronautics and Space Administration (USA).
Air temperature	1948-2009 / monthly	Global, 2.5º (Gaussiana grid)	NCEP - NCAR
Atmospheric pressure	1948-2009 / 6h	Global, 2.5º (Gaussian grid)	NCEP - NCAR
Wind	1948-2009 / 6h	Global, 2.5º (Gaussian grid)	NCEP - NCAR
Hurricanes	1950-2010	Global, dispersed	National Hurricane Center, NOAA
Swells	Variable	Global, dispersed	CSIRO satellite data
	Variable	Global, dispersed	NOAA buoys
	Variable	Global, dispersed	State port buoys
Bathymetry	-	Global, 2´	ETOPO—Earth Topography Digital Dataset. A global relief model of the Earth's surface that integrates land topography and ocean bathymetry.
	-	Global, 0.5´	GEBCO—General Bathymetric Chart of the Oceans.

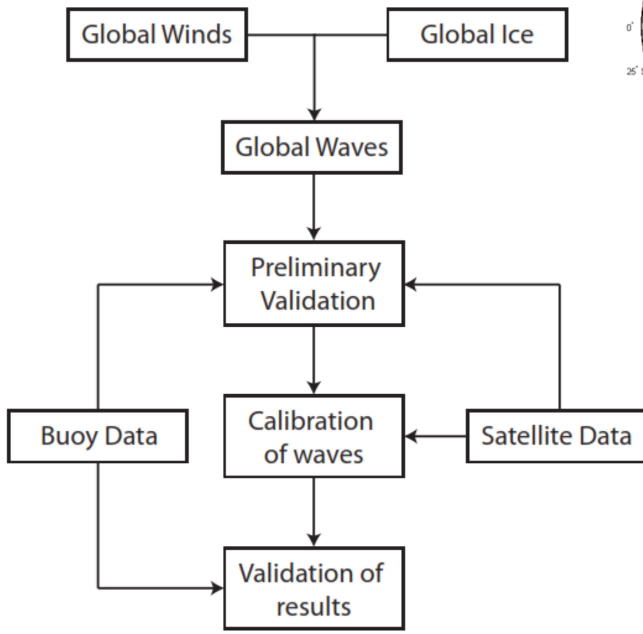
Type of information generated by IHC	Period of time covered	Spatial resolution	Source
Swells	1948-2010	Global, Latin America and the Caribbean 0.25º (Caribbean) and 0.5º	GOW-IHC
Storm surges	1948-2010	Global, Latin America and the Caribbean 0.25º	GOS-IHC
Tides	1948-2010	Global, Latin America and the Caribbean 0.25º	GOT-IHC

Databases generated: swells, storm surges and tides

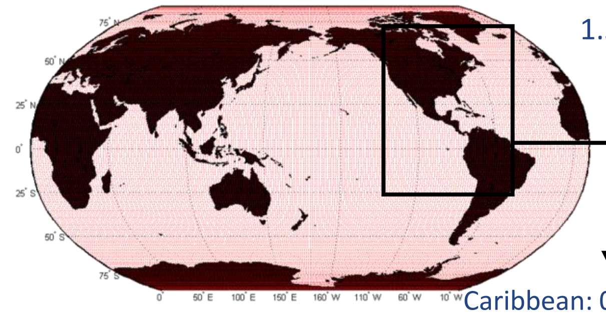
Reanalysis of GOW
(*Global Ocean Waves)*

Preliminary validation in buoys





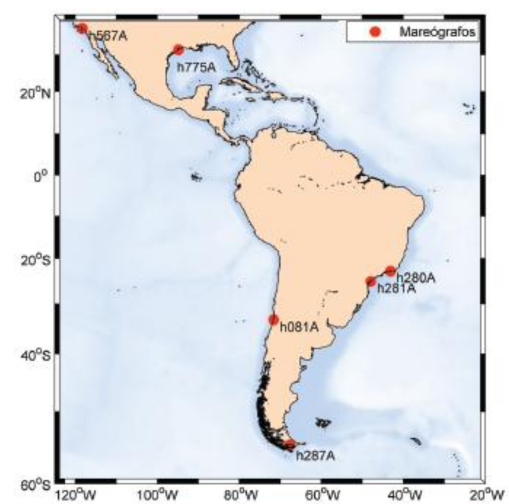
Global Ocean Surge (GOS)
Satellite numeric database since 1948



1.5ºx1º

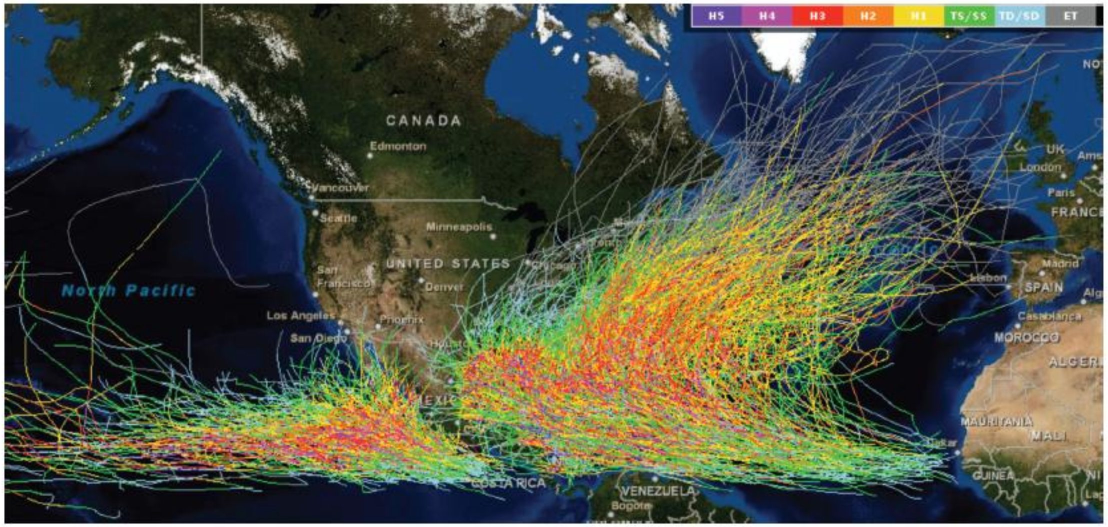
Caribbean: 0.25x0.25
Atlantic and Pacific: 0.5x0.5

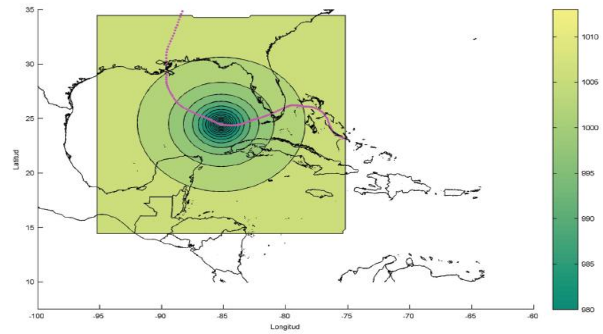
Locations and names of tide gauges



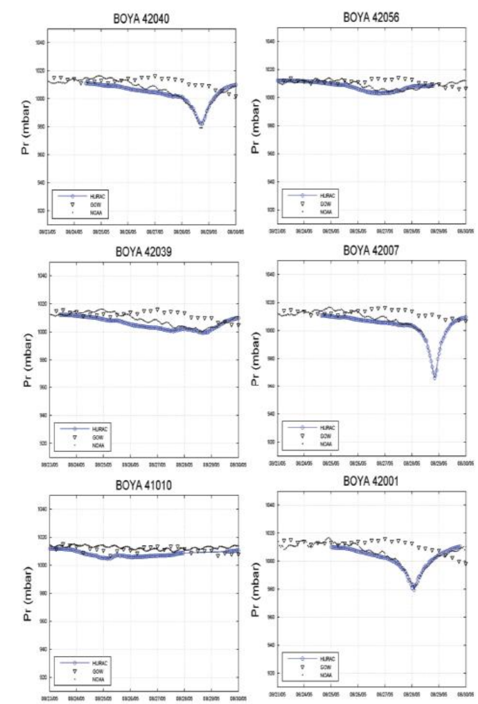
Map the historical data on pressure, waves, winds and sea levels during hurricanes using analytical and parametric models

POSITIONS AND INTENSITIES OF HURRICANES OVER A 54-YEAR PERIOD

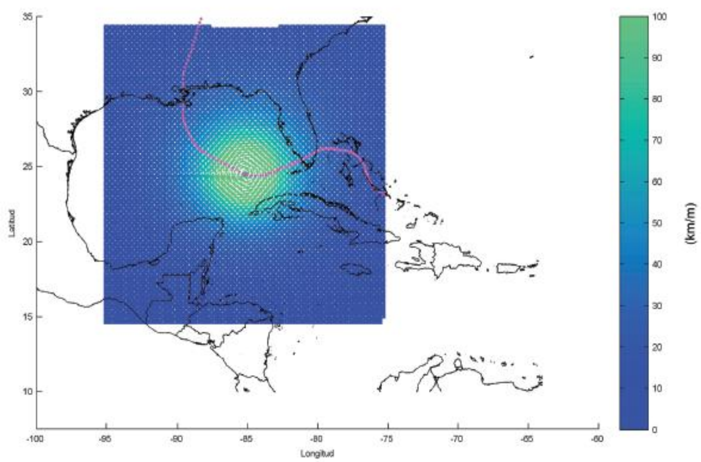




ATMOSPHERIC PRESSURE MAP FOR HURRICANE KATRINA (*Mbar*)



COMPARISON OF PRESSURE SERIES FOR THE HURAC-HYDROMET-RANKIN VORTEX MODEL (1980), BUOY DATA AND NCEP/NCAR REANALYSIS FOR HURRICANE KATRINA (2005)

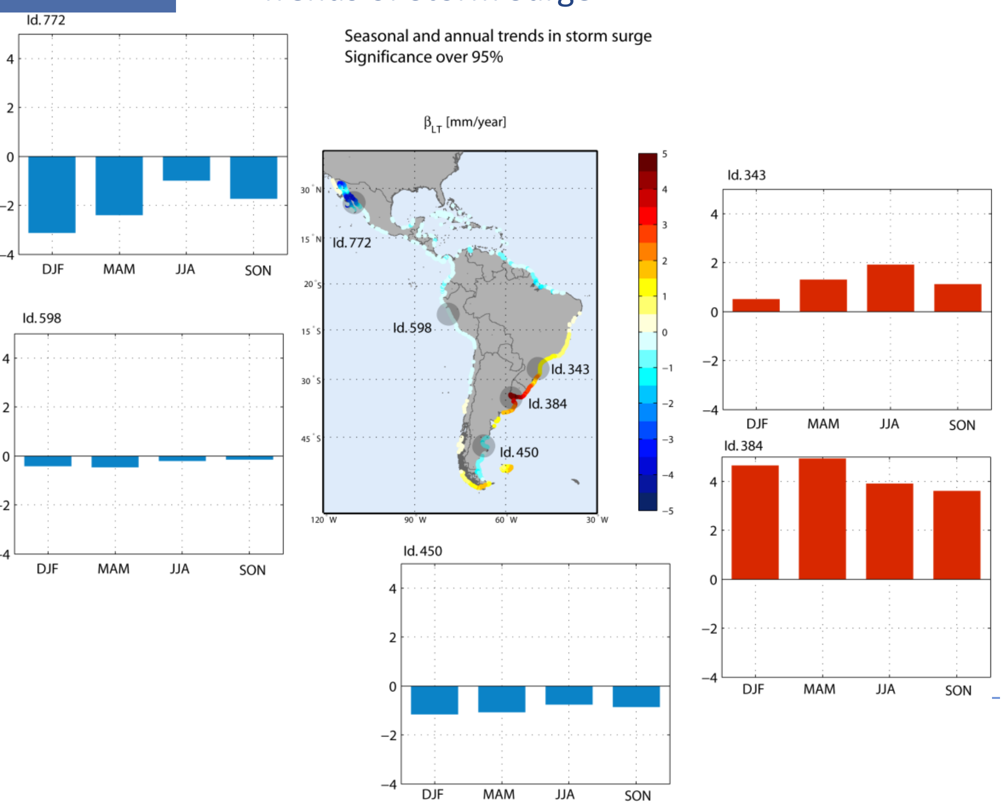


MAP OF WIND VARIATIONS: HURRICANE KATRINA (*Km/metres*)

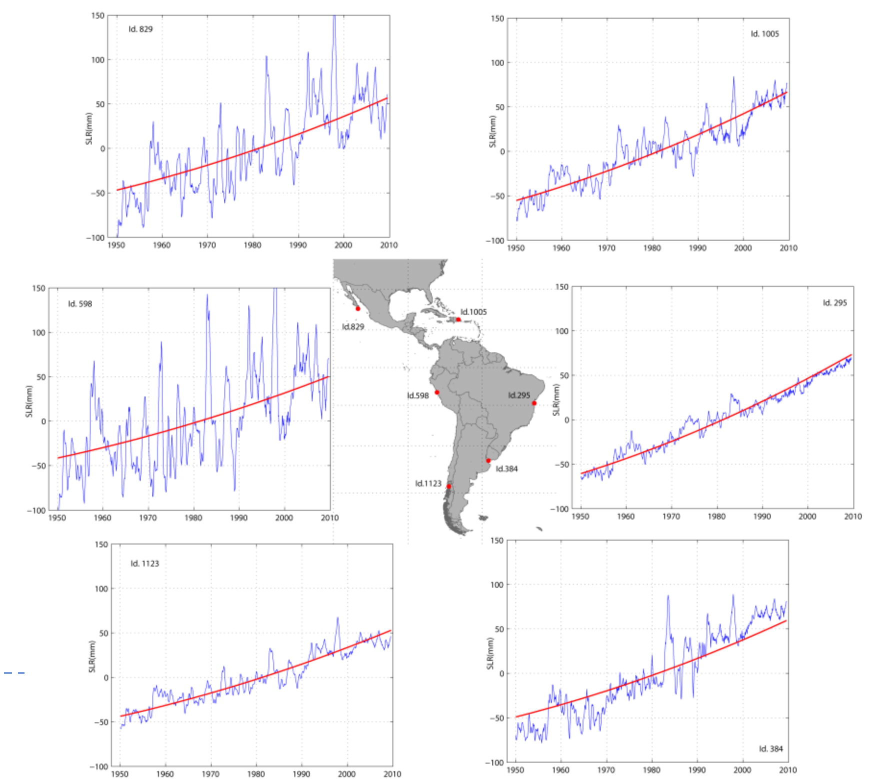
Overview of coastal variables in this study

Meteo-oceanographic variables	Coastal dynamics (IHC)	Extreme events	Hurricane events
• Mean sea level (MSL) • Sea surface temperature (SST) • Salinity (SAL) • Air surface temperature (AST) • Wind (W)	• Waves (monthly mean, monthly peak, height exceeded 12 hours per year and mean wave direction) • Storm surge • Tide	• Waves • Storm surges	• Winds • Waves • Storm surges

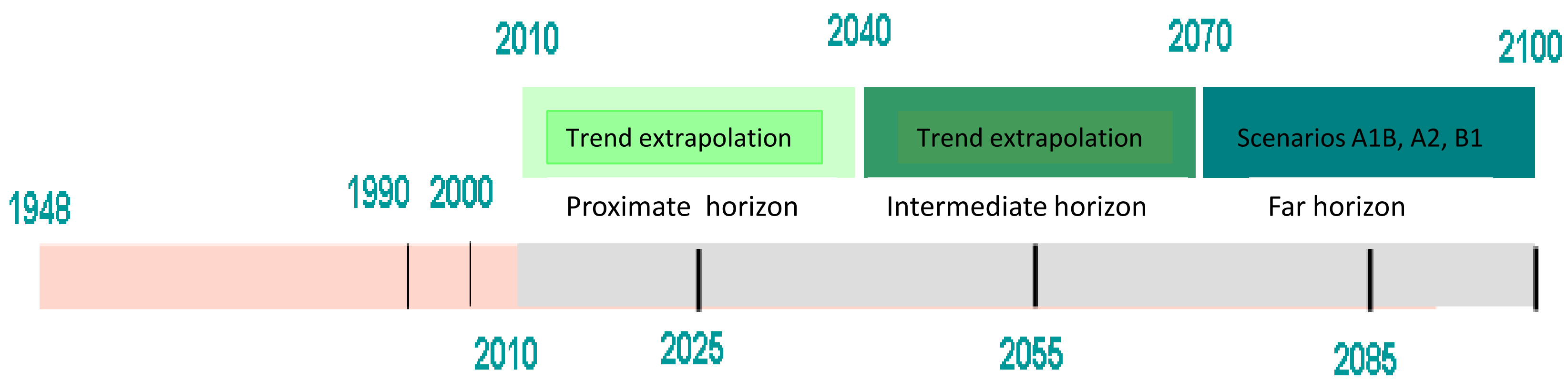
Trends of Storm Surge



Trends of sea level rise

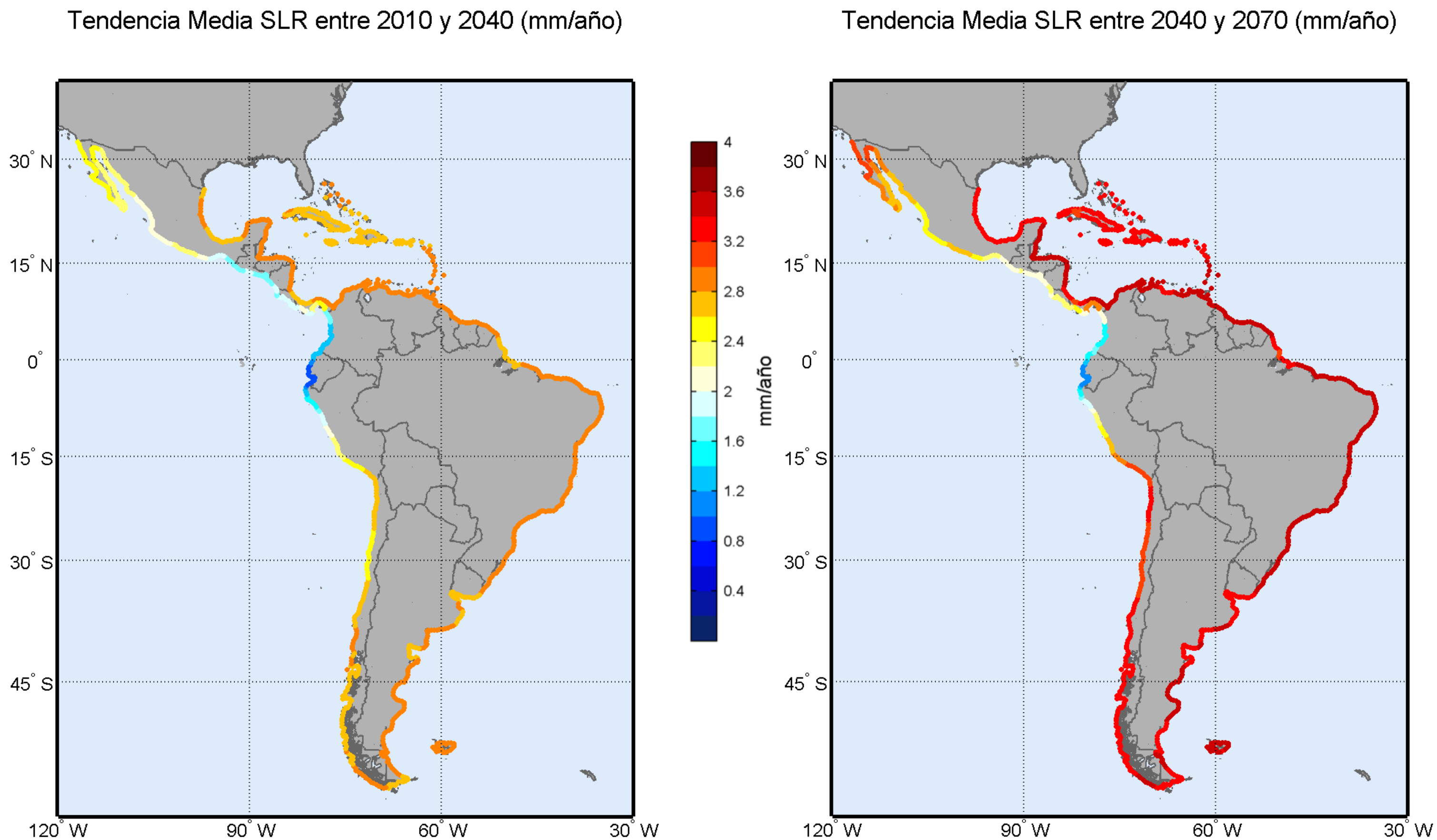


Temporal dimension and methodologies for each time horizon

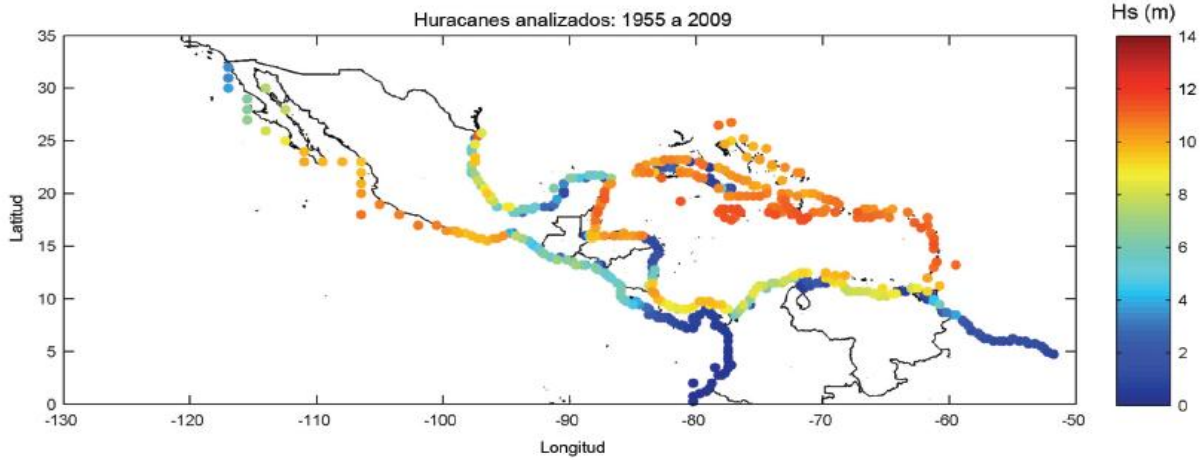


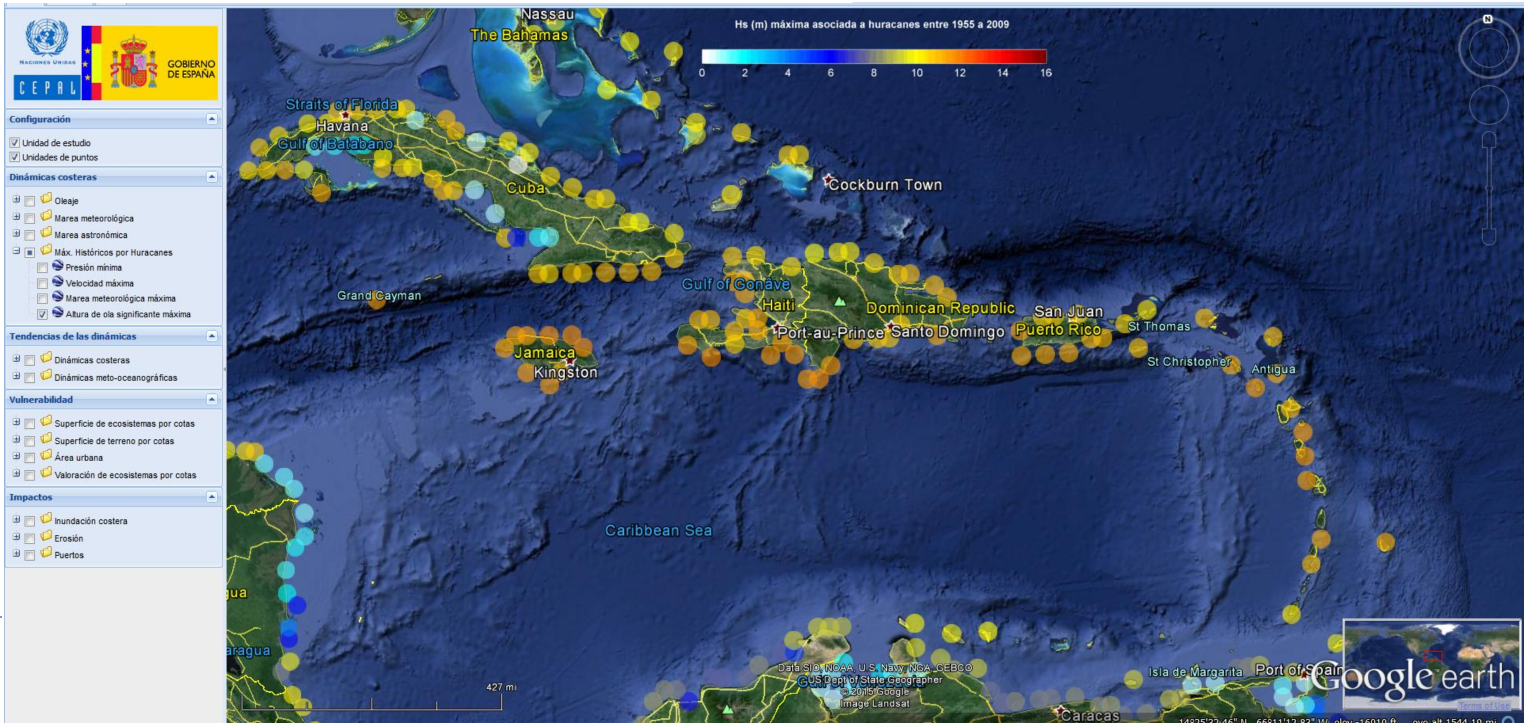
Long-term trends of the coastal dynamics

Mean trend in sea level for 2010-2040 and 2040-2070



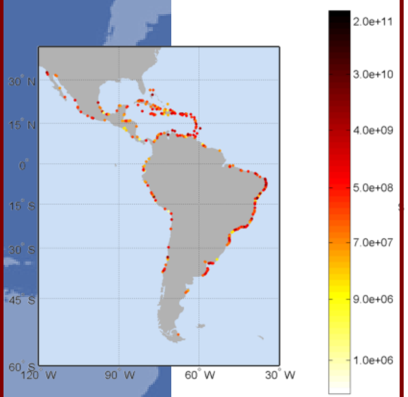
Map of historical maximums (54 years) for significant wave heights at specified control points

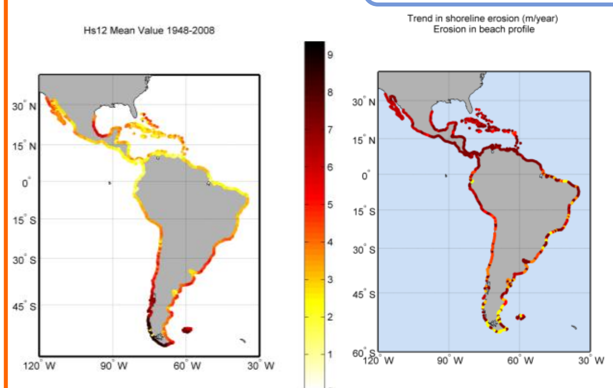


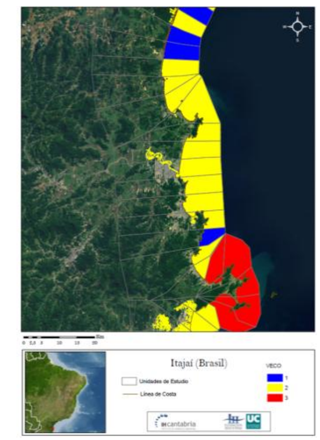


Framework of the project

Risk = **Probable danger** (Dynamics | Impacts) x **Exposure** x **Vulnerability**







Scenarios

Uncertainty

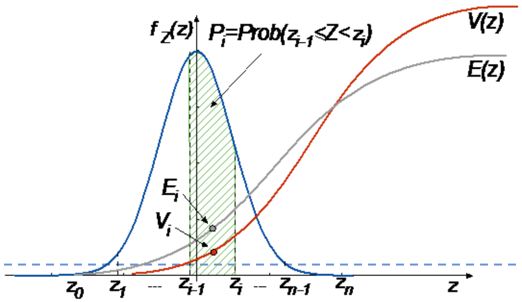
Climate change trends

Coast types

Functions of the coast

Extrapolation of trends

Scenarios



Beaches, ports, coral reefs, urban areas, etc.

Physical Vuln.

Ecological

Socioeconomic

Scenarios used for impact assessments

Scenario		Time horizon	Method	Dynamics assessed	Variants-observations
A		2040	Statistical trends	Statistical trends. All	-
B		2050	Statistical trends	Statistical trends. All	-
C		2070	Statistical trends	Statistical trends. All	-
D		2100	Justification - IPCC SLR scenario	Sea level rise of 0.5 m	Statistical trends – other dynamics as of 2070
E		2100	Justification - IPCC SLR scenario	Sea level rise of 1 m	Statistical trends – other dynamics as of 2070
F	F1	2010	El Niño 98	Sea level	El Niño of 1998 at present
	F2	2100	El Niño 98 + IPCC SLR scenario	Sea level rise of 1 m	El Niño of 1998 with CC scenario
G	G1	2010	La Niña 89	Sea level	La Niña of 1989 at present
	G2	2100	La Niña 89 + IPCC SLR scenario	Sea level rise of 1 m	La Niña of 1989 with CC scenario
H	H1	2010	Hurricanes	Sea level and flood level	Hurricanes at present
	H2	2100	Hurricanes + IPCC SLR scenario	Sea level rise of 1 m	Hurricanes with CC scenario

IMPACTS COVERED IN THE STUDY, DYNAMICS AND THE TECHNIQUES USED TO COMPUTE THE SCALE OF LONG-TERM CHANGES

Impact	Variables	Analytical techniques used
Permanent flooding	Sea level rise (SLR)	Long-term statistical trends
Temporary flooding	Storm surge, sea level rise, tides, wave setup and seasonality of sea levels	Long-term statistical trends
Beach erosion	H_{S12}, sea level rise, wave direction	Long-term statistical trends
Port activity	Overtopping and wave-related navigation conditions	Long-term statistical trends
Reliability of maritime structures	Extreme wave heights (modification of heights used in calculations)	Models of non-stationary extremes
Coral bleaching	Sea surface temperature	Long-term statistical trends
Potential sediment transport	Waves and winds	Disturbance-based trends and long-term statistical trends

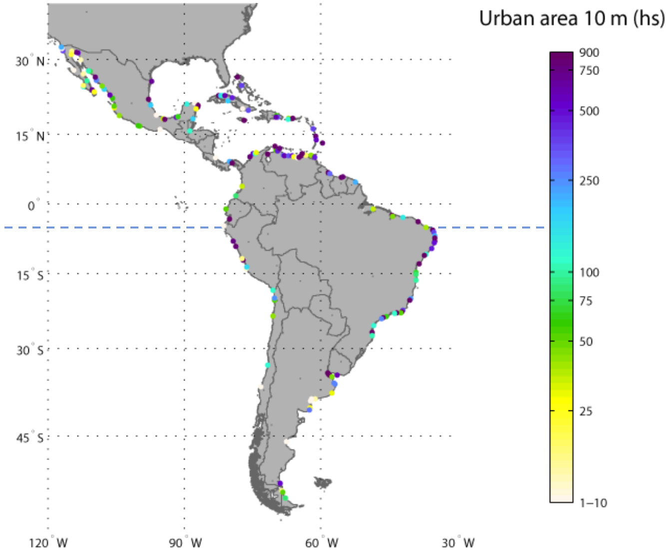
Examples of impacts on the coast: flooding

Coastal flooding by sea level rise

The distribution of the population and the territory is the main factor of impact caused by floods in the coastal strip

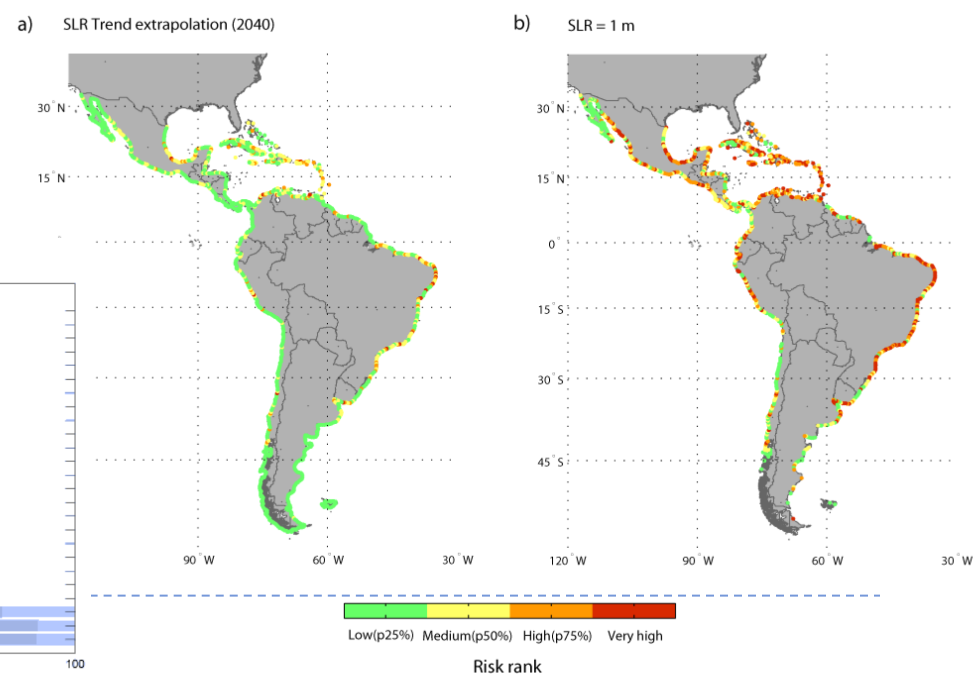
Particular concern is on the **Caribbean islands and the Atlantic** coast regarding to the mean sea level

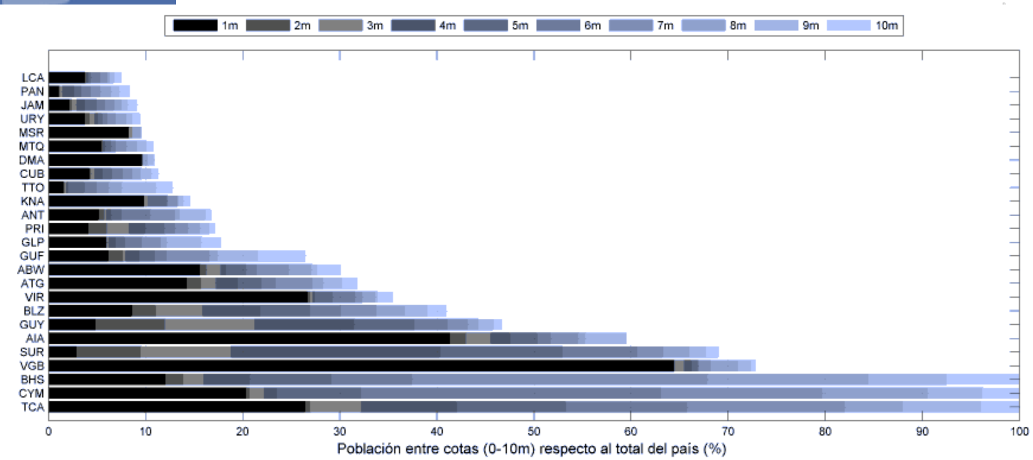
In the tropical **Pacific coast**, the influence of ENSO on sea level change is greater than the magnitude of the long-term trend of sea level rise.



The impact of hurricanes due to a rise of 1 m would change significantly (p.e. **Venezuela, Honduras, Panama or Costa Rica**)

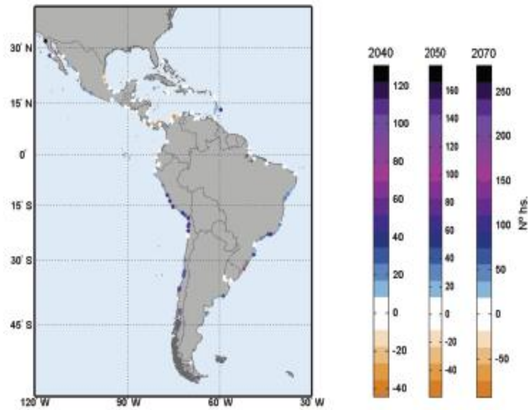
In other countries the variation in the impact is not as significant compared to the current level impact (p.e. Dominican Republic).





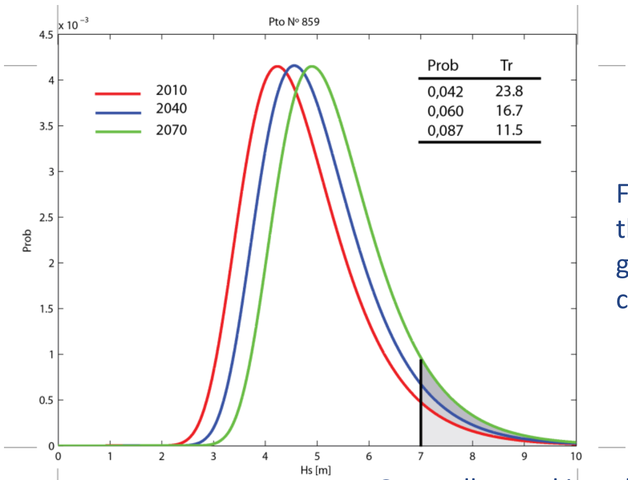
Examples of impacts on the coast: ports

Port activity and infrastructure protection



Under mean conditions, the probability of the occurrence of a significant wave height of over 3 m will increase, navigation conditions for ships wishing to enter ports in the region will worsen.

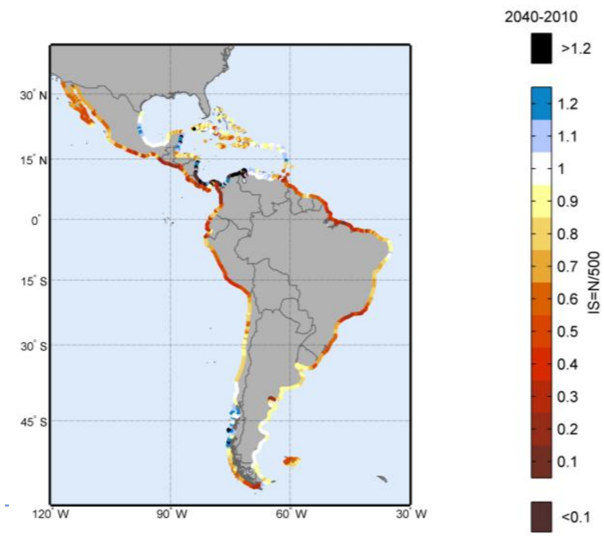
The **reliability of existing maritime structures** and of those designed in the near future without factoring in the effects of long-term changes **will be reduced by around 60%** (in mean terms as of 2070) in a large part of the region (other than the inner portion of the Caribbean Sea, where tropical storms are the main design actions taken into account).



Baja California

For the most part, except in some areas of the Caribbean, any maritime structure is going to need to be shielded with heavier components in the future.

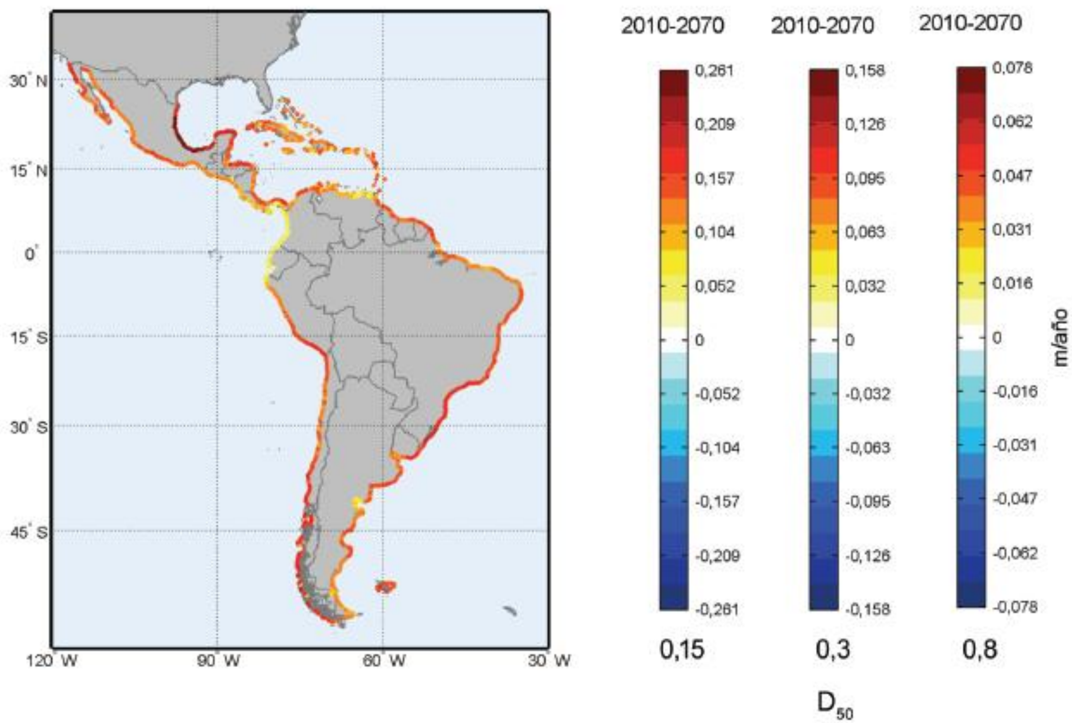
Generally speaking, the ability of maritime structures to withstand the effects of climate change is expected to decline. However, in the southern Caribbean, there will be gains in the reliability of maritime structures due to the foreseen reduction in the design wave height.



MARITIME STRUCTURAL SAFETY INDEX FOR A MEAN RECURRENCE INTERVAL OF 500 YEARS: 2040 TIME HORIZON (SCENARIO A)

Examples of impacts on the coast: beach erosion

MEAN TREND IN BEACH EROSION FROM CHANGES IN EQUILIBRIUM PROFILE BETWEEN 2010 AND 2070
(Metres/year)

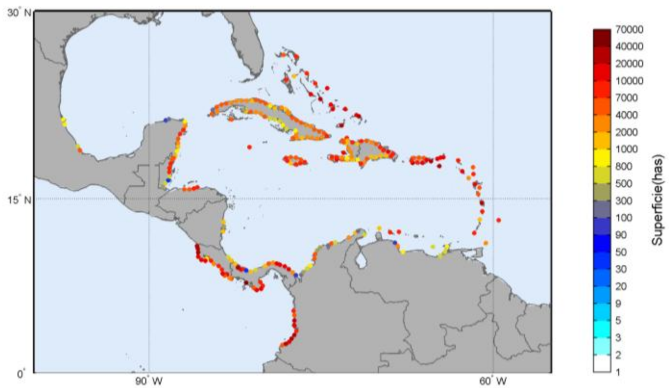


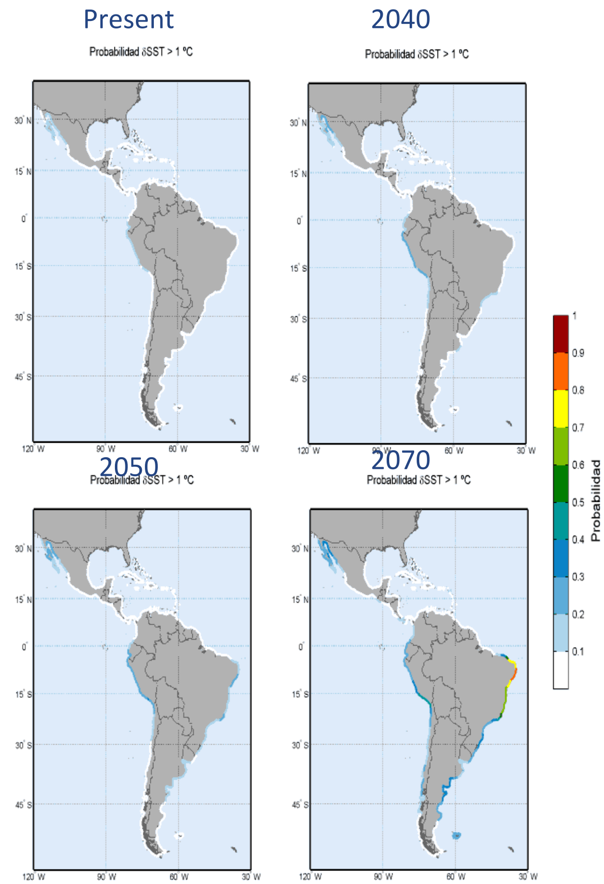
The worst affected areas will be the **northern Caribbean** and the coastlines to the south of Brazil down to the Río de la Plata. Erosion is, in any case, generalized throughout the region, **especially in the event of sea level rise**.

The **largest changes from beach planform** rotation are likely to occur on the southern coasts of Brazil (more than 1 m/year), **the Caribbean coasts** (especially eastern Cuba and the easterly islands), part of the coast of Chile and the north-east coast of Mexico; in the last case again at rates of over 1 m of erosion per year on average.

Examples of impacts on the coast: coral reefs

SURFACE AREA OF CORAL REEFS IN THE CARIBBEAN SEA AND THE CENTRAL PACIFIC
(Hectares)

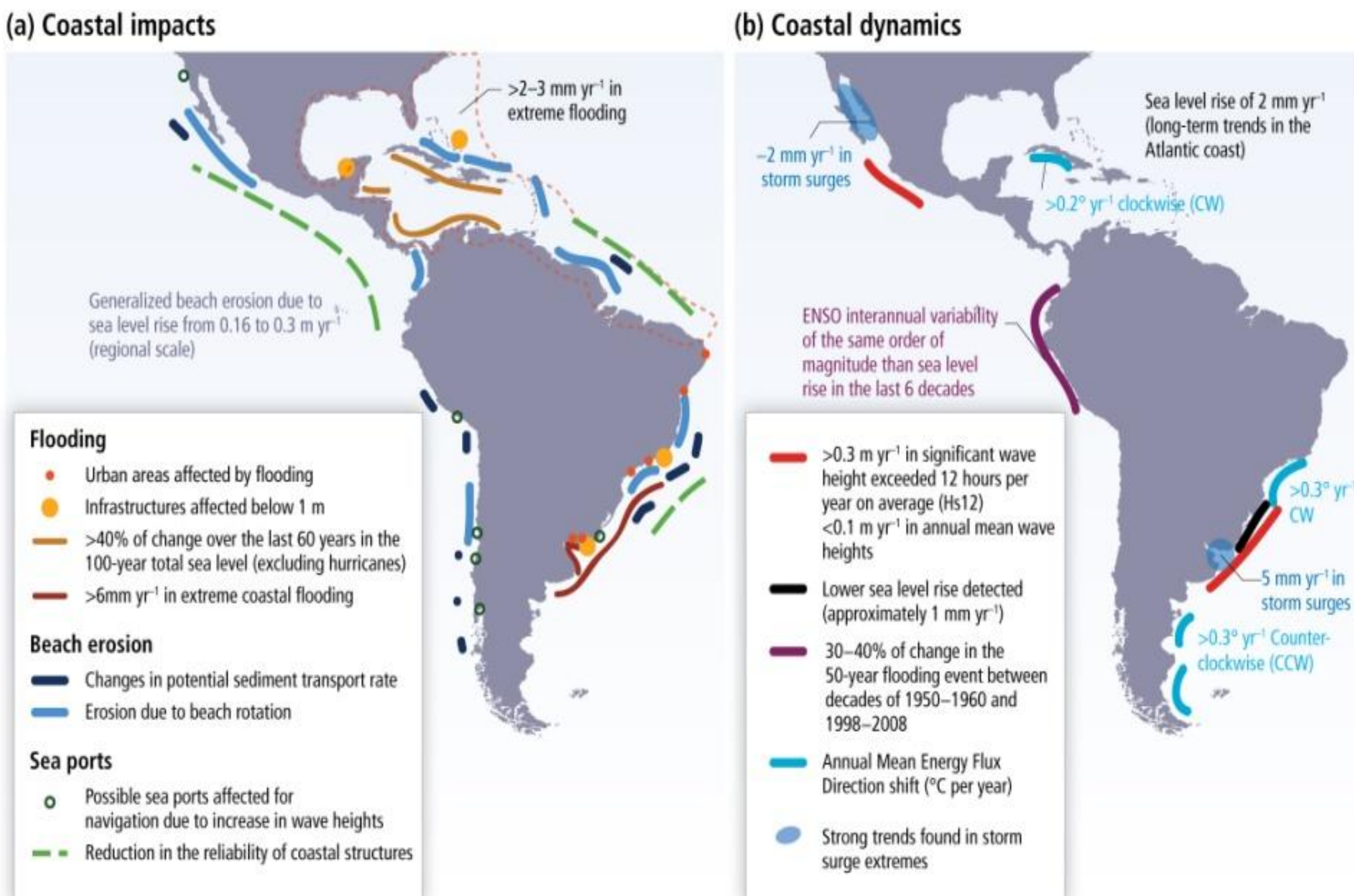




MEAN PROBABILITY OF AN INCREASE IN SEA SURFACE TEMPERATURE IN EXCESS OF 1°C

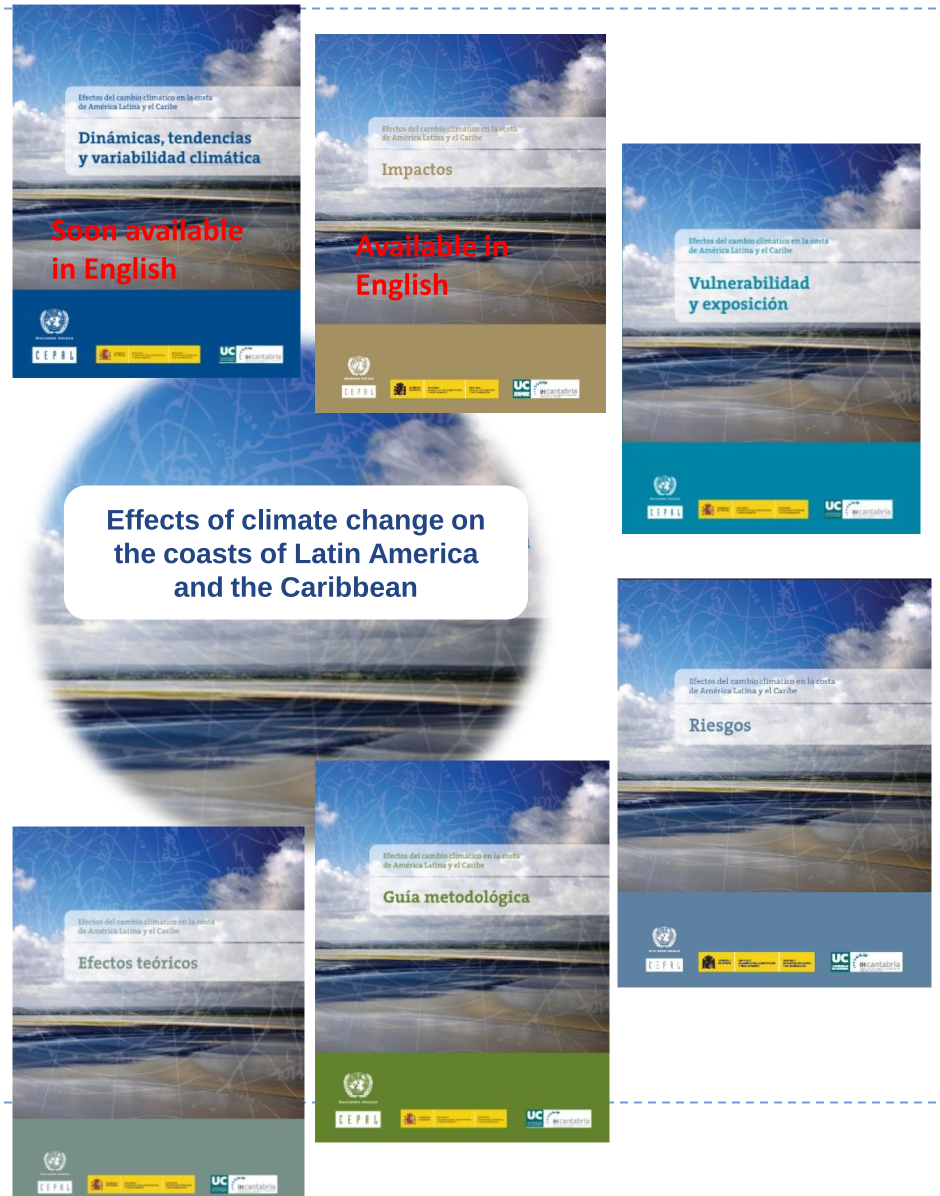
It is probable that the **current impacts being seen in the Caribbean will spread** to islands where there are virtually no such impacts at present. Finally, for the Caribbean islands where the probability of exceeding the threshold value is currently below 0.1, **the probability will rise to 0.2 by 2070.**

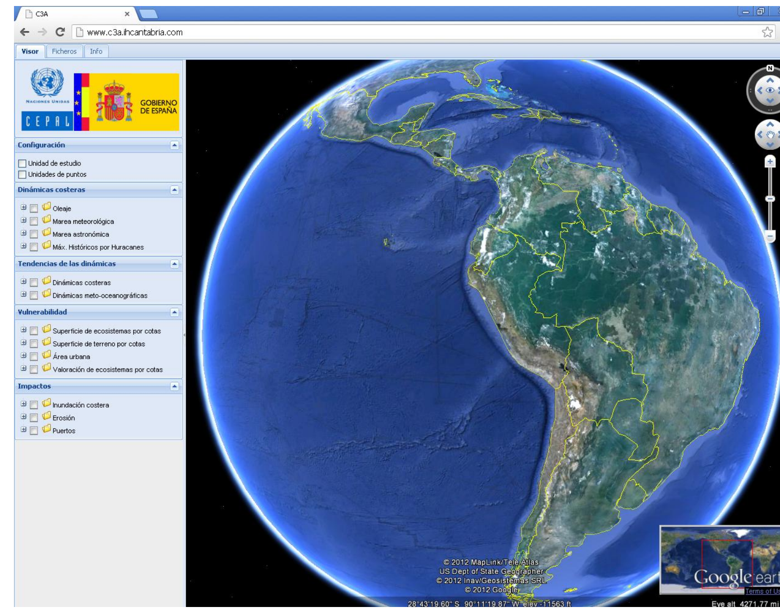
Current and predicted coastal impacts and coastal dynamics in response to climate change



Source: Taken form ECLAC 2011, 2012 in Magrin, G.O., et al, 2014: Central and South America. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

Publications of the project and web





Available at:
http://www.cepal.org/id.asp?id=48025

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Desarrollo sostenible y asentamientos humanos
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Acerca de
Equipo de trabajo
Principio 10
Acuerdo regional sobre el acceso a la información, la participación y la justicia en asuntos ambientales.
Leer más
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CAMBIO CLIMÁTICO
MEDIO AMBIENTE
ASENTAMIENTOS HUMANOS
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NOTA INFORMATIVA
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The effects of climate change in the coastal areas of Latin America and the Caribbean. Impacts
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Efectos del cambio climático en la costa de América Latina y el Caribe

(12 de septiembre, 2013) La CEPAL, la Oficina Española de Cambio Climático -dependiente del Ministerio de Agricultura, Alimentación y Medio Ambiente del Gobierno de España- y el Instituto de Hidráulica Ambiental de la Universidad de Cantabria han desarrollado una metodología específica para la evaluación de impactos del cambio climático en zonas costeras, que ponen a disposición de los países de América Latina y el Caribe.

Esta metodología y las herramientas asociadas al **Estudio regional de los efectos del cambio climático en la costa de América Latina y el Caribe** pueden ser de gran utilidad para evaluar impactos, plantear medidas de adaptación y realizar un análisis económico de las mismas. También permiten complementar los análisis a escala local que entregan los Estudios Regionales sobre Economía del Cambio Climático (ERECC), coordinados técnicamente por la CEPAL, que ayudan a países y regiones a identificar las implicaciones del cambio climático sobre sus economías y ciudadanos.

En concreto, el Estudio regional de los efectos del cambio climático en la costa de América Latina y el Caribe comprende un total de seis publicaciones: cuatro documentos principales y dos auxiliares.

Los primeros abordan el análisis de los agentes, el estudio de la vulnerabilidad de las costas, la evaluación de los impactos derivados y la integración de todos los factores en la evaluación de los riesgos asociados a algunos de los impactos estudiados en las costas de la región. Uno de los documentos auxiliares se centra en los efectos teóricos del cambio climático, constituyéndose en un manual de los conceptos, procesos y fenómenos costeros analizados en el estudio. El otro aborda la metodología desarrollada para el estudio del riesgo de forma integral.

Por último, en el marco del proyecto se ha desarrollado un visor web de los resultados para la máxima difusión de los mismos en los países de la región.

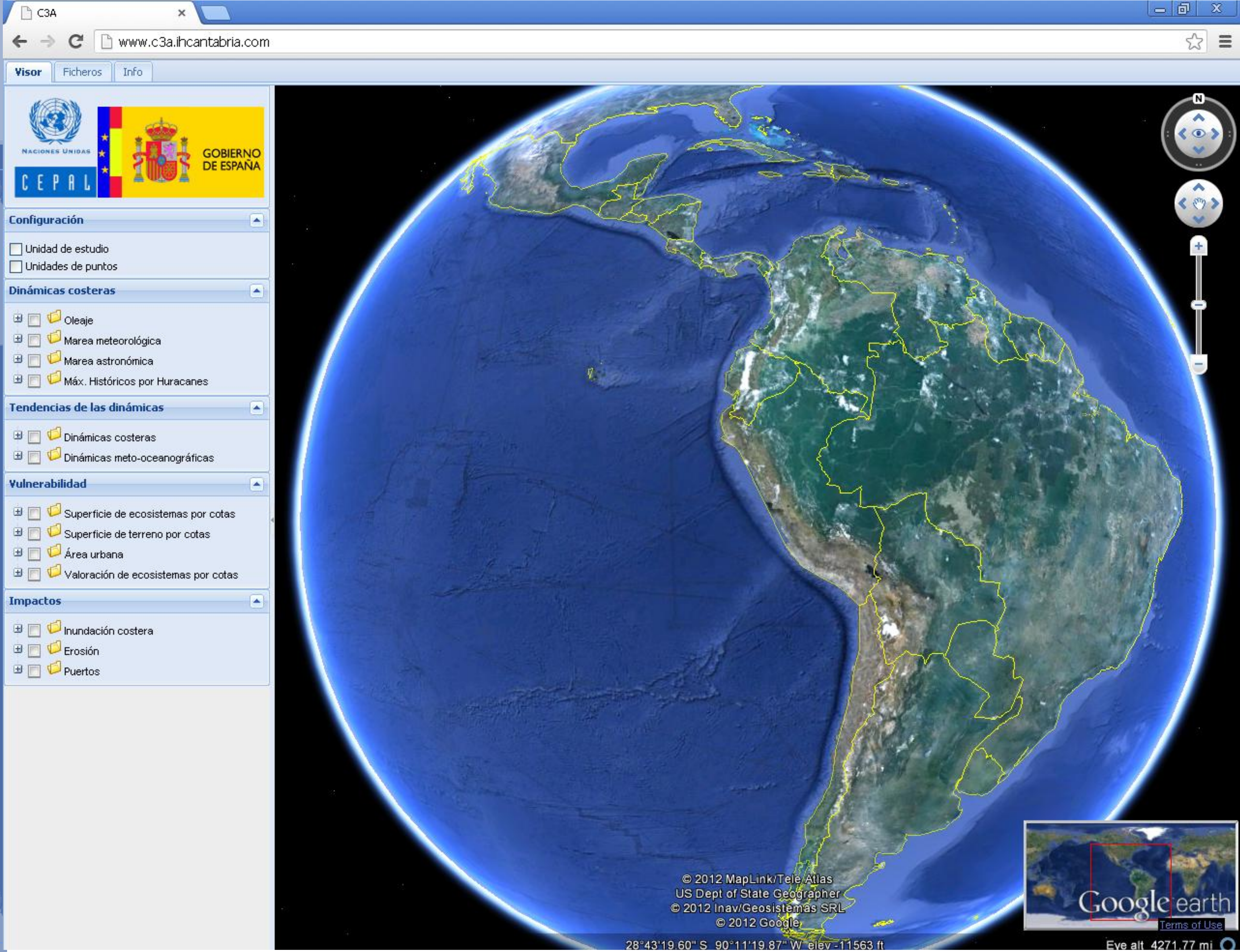
Dinámicas, tendencias y variabilidad climática

Vulnerabilidad y exposición

Visor web

Para usar el visor web se recomienda utilizar como navegador web Mozilla Firefox o Google Chrome. El visor funciona utilizando Google Earth Plugin, el cual debe instalarse en su equipo.

En este enlace podrá visualizar el listado de variables a las que podrá tener acceso.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Dinámicas meto-oceanográficas
Vulnerabilidad
Superficie de ecosistemas por cotas
Superficie de terreno por cotas
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Inundación costera
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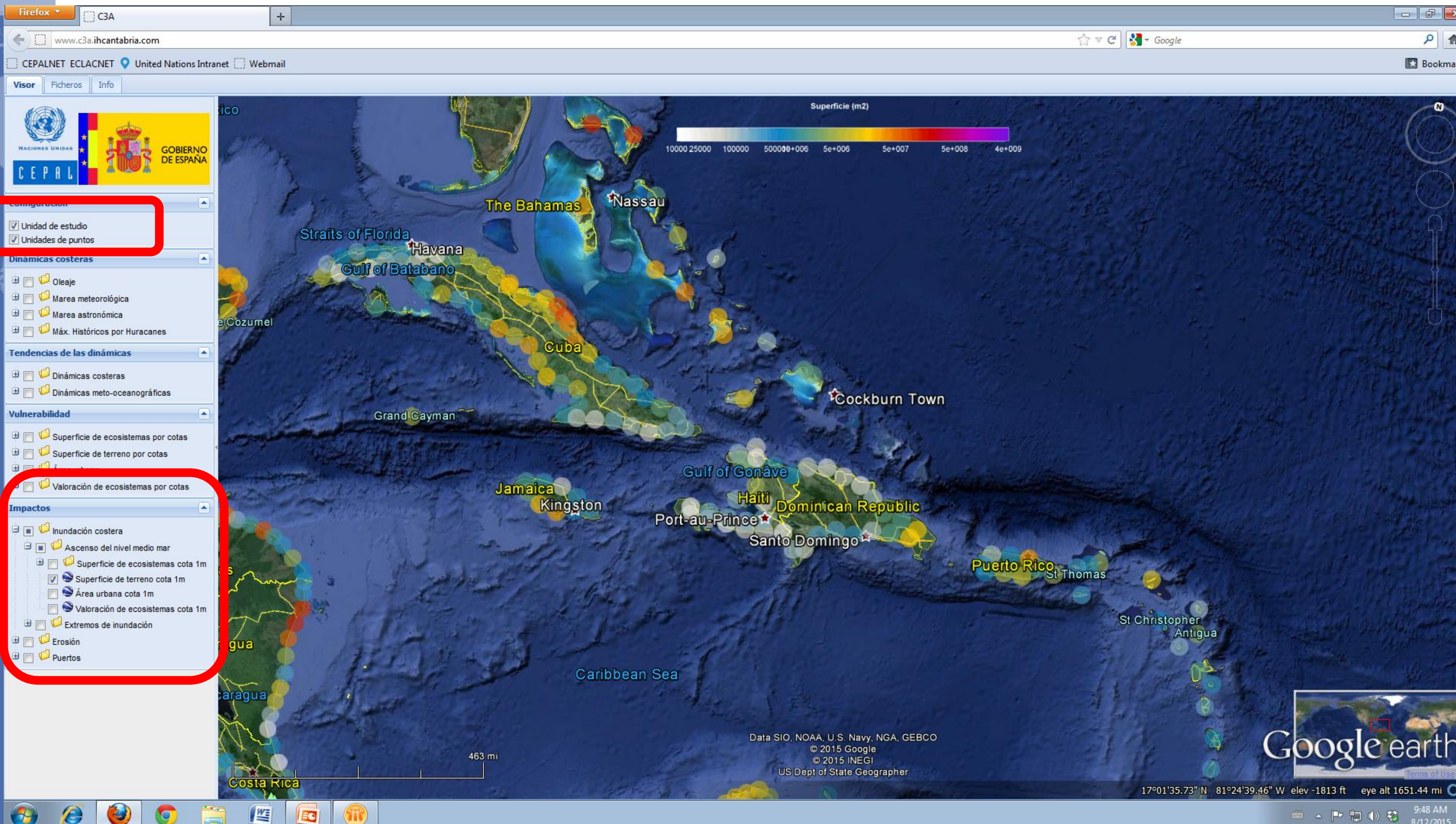
28°43'19.60" S 90°11'19.87" W elev -11563 ft
Eye alt 4271.77 mi



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Vulnerabilidad
Superficie de ecosistemas por cotas
Superficie de terreno por cotas
Valoración de ecosistemas por cotas
Impactos
Inundación costera
Ascenso del nivel medio mar
Superficie de ecosistemas cota 1m
Superficie de terreno cota 1m
Área urbana cota 1m
Valoración de ecosistemas cota 1m
Extremos de inundación
Erosión
Puertos
Superficie (m2)
10000 25000 100000 500000 1e+006 5e+006 5e+007 5e+008 4e+009
The Bahamas
Nassau
Straits of Florida
Havana
Gulf of Batabano
Cuba
Cockburn Town
Grand Cayman
Gulf of Gonâve
Haiti
Dominican Republic
Jamaica
Kingston
Port-au-Prince
Santo Domingo
Puerto Rico
St Thomas
St Christopher
Antigua
Caribbean Sea
Costa Rica
463 mi
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Google earth
17°01'35.73" N 81°24'39.46" W elev -1813 ft eye alt 1651.44 mi
9:48 AM
8/12/2015

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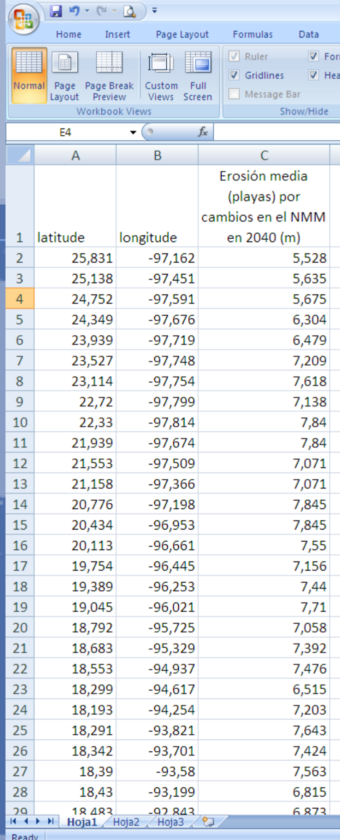


REperfil2040.xlsx - Microsoft Excel

	A	B	C
1	latitude	longitude	Erosión media (playas) por cambios en el NMM en 2040 (m)
2	25,831	-97,162	5,528
3	25,138	-97,451	5,635
4	24,752	-97,591	5,675
5	24,349	-97,676	6,304
6	23,939	-97,719	6,479
7	23,527	-97,748	7,209
8	23,114	-97,754	7,618
9	22,72	-97,799	7,138
10	22,33	-97,814	7,84
11	21,939	-97,674	7,84
12	21,553	-97,509	7,071
13	21,158	-97,366	7,071
14	20,776	-97,198	7,845
15	20,434	-96,953	7,845
16	20,113	-96,661	7,55
17	19,754	-96,445	7,156
18	19,389	-96,253	7,44
19	19,045	-96,021	7,71
20	18,792	-95,725	7,058
21	18,683	-95,329	7,392
22	18,553	-94,937	7,476
23	18,299	-94,617	6,515
24	18,193	-94,254	7,203
25	18,291	-93,821	7,643
26	18,342	-93,701	7,424
27	18,39	-93,58	7,563
28	18,43	-93,199	6,815
29	18,483	-92,843	6,873

Hoja1 Hoja2 Hoja3

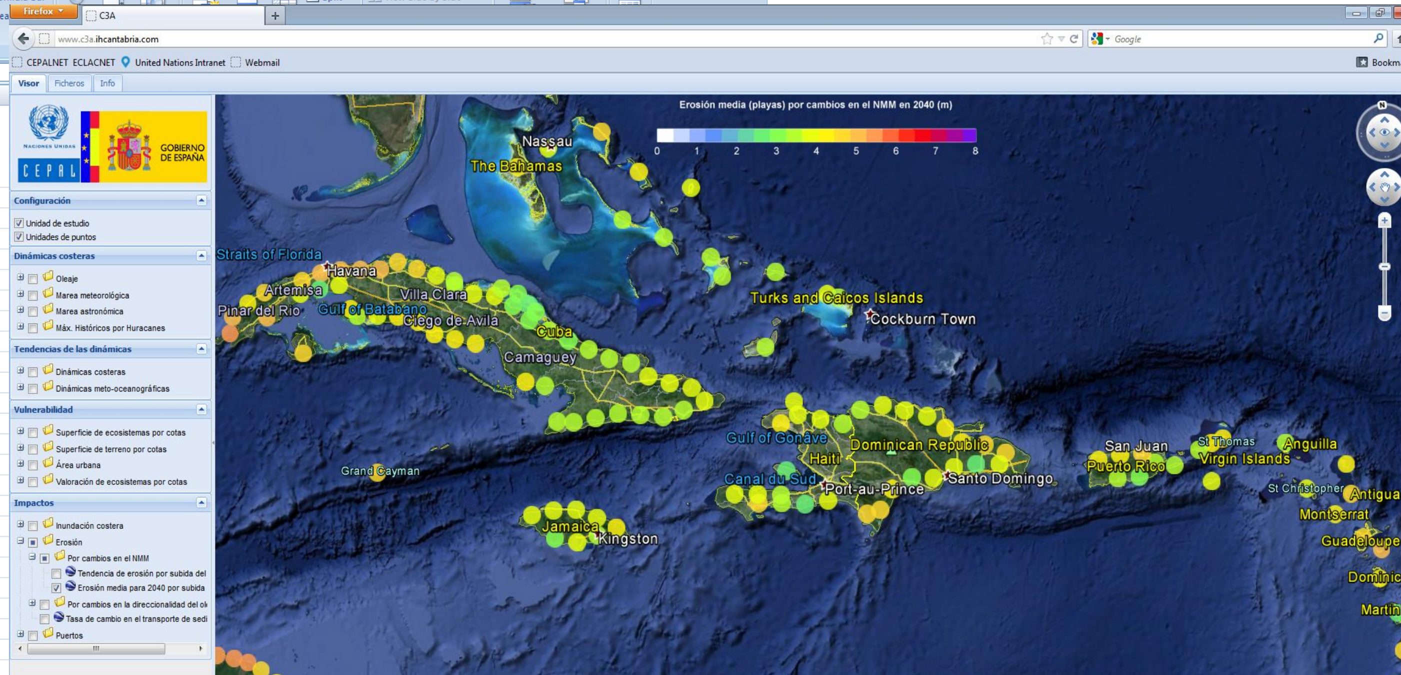
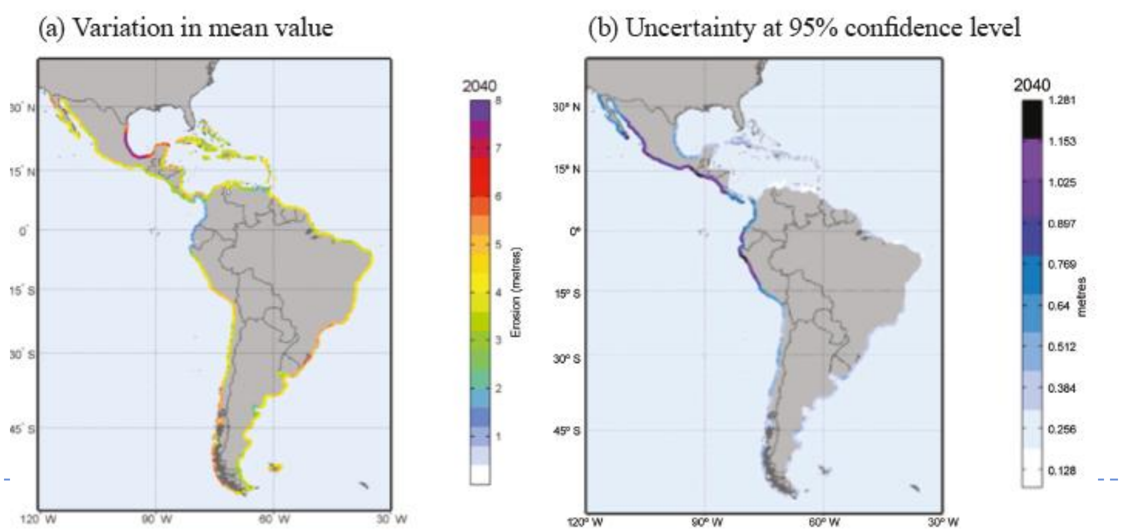


FIGURE 3.41

BEACH EROSION FROM CHANGES IN EQUILIBRIUM PROFILE, IN 2040

(Metres)



Source: Prepared by the authors.

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Effects of climate change on the coasts of Latin America and the Caribbean

http://www.cepal.org/id.asp?id=48025

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