Território e Alterações Climáticas

FILIPE DUARTE SANTOS
fdsantos@fc.ul.pt

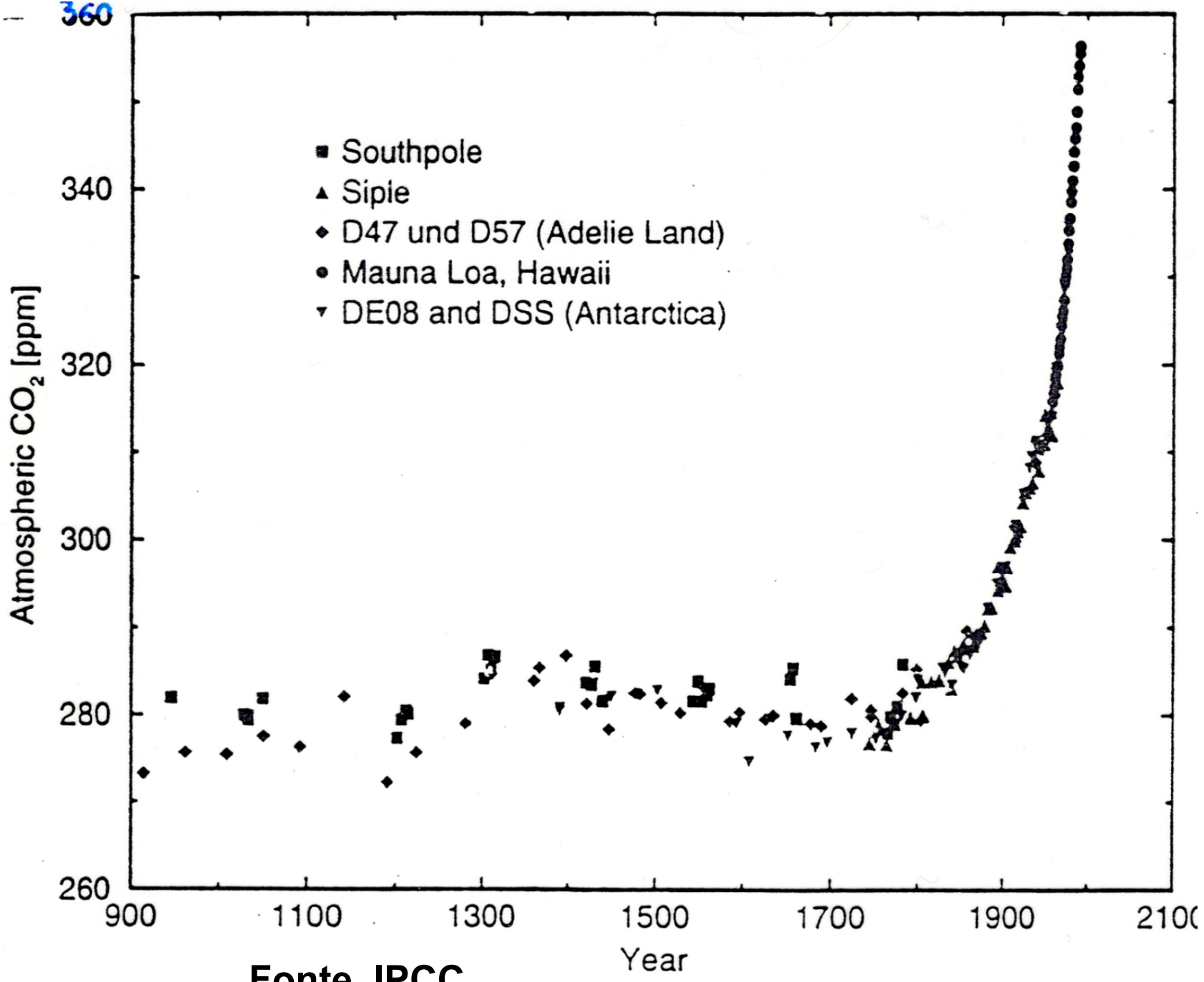
CCIAM – CE3C Centre for Climate Change Impacts, Adaptation and Modelling
Faculdade de Ciências da Universidade de Lisboa
http://www.sim.ul.pt/cciam/

Seminário Território e Alterações Climáticas

A Desertificação. As periferias Urbanas

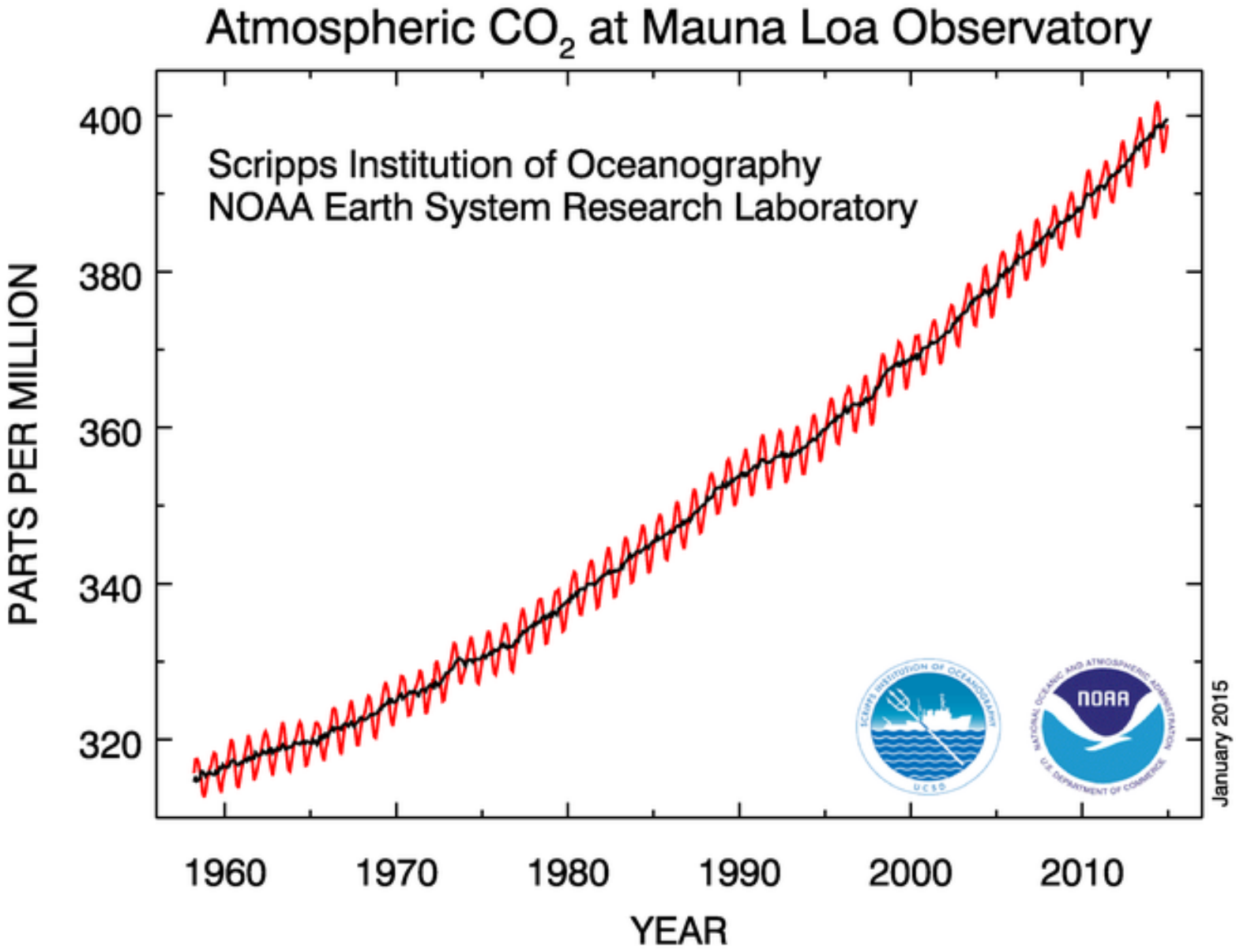
CCDR Norte e D. G. Território

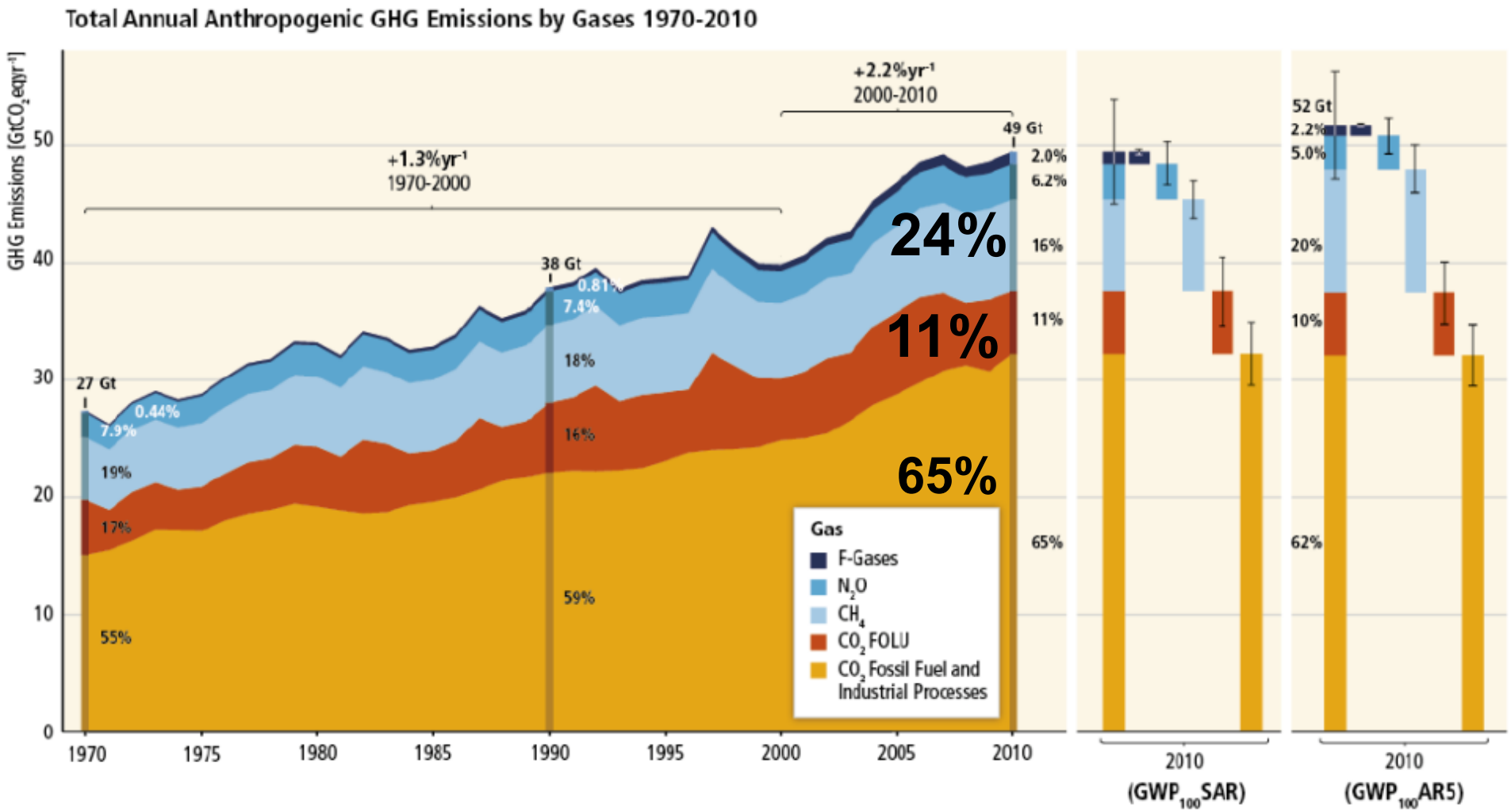
Porto, 7 de dezembro de 2016


Southpole
Sipie
D47 und D57 (Adelie Land)
Mauna Loa, Hawaii
DE08 and DSS (Antarctica)
Atmospheric CO_2 [ppm]
360
340
320
300
280
260
900
1100
1300
1500
1700
1900
2100
Year

Fonte, IPCC

Concentração do dióxido de carbono aumentou de 42% desde o século XVIII





IPCC, AR5, 2014, Synthesis Report

Sources of emissions

Energy production remains the primary driver of GHG emissions

2010 GHG emissions

AR5 WGIII SPM

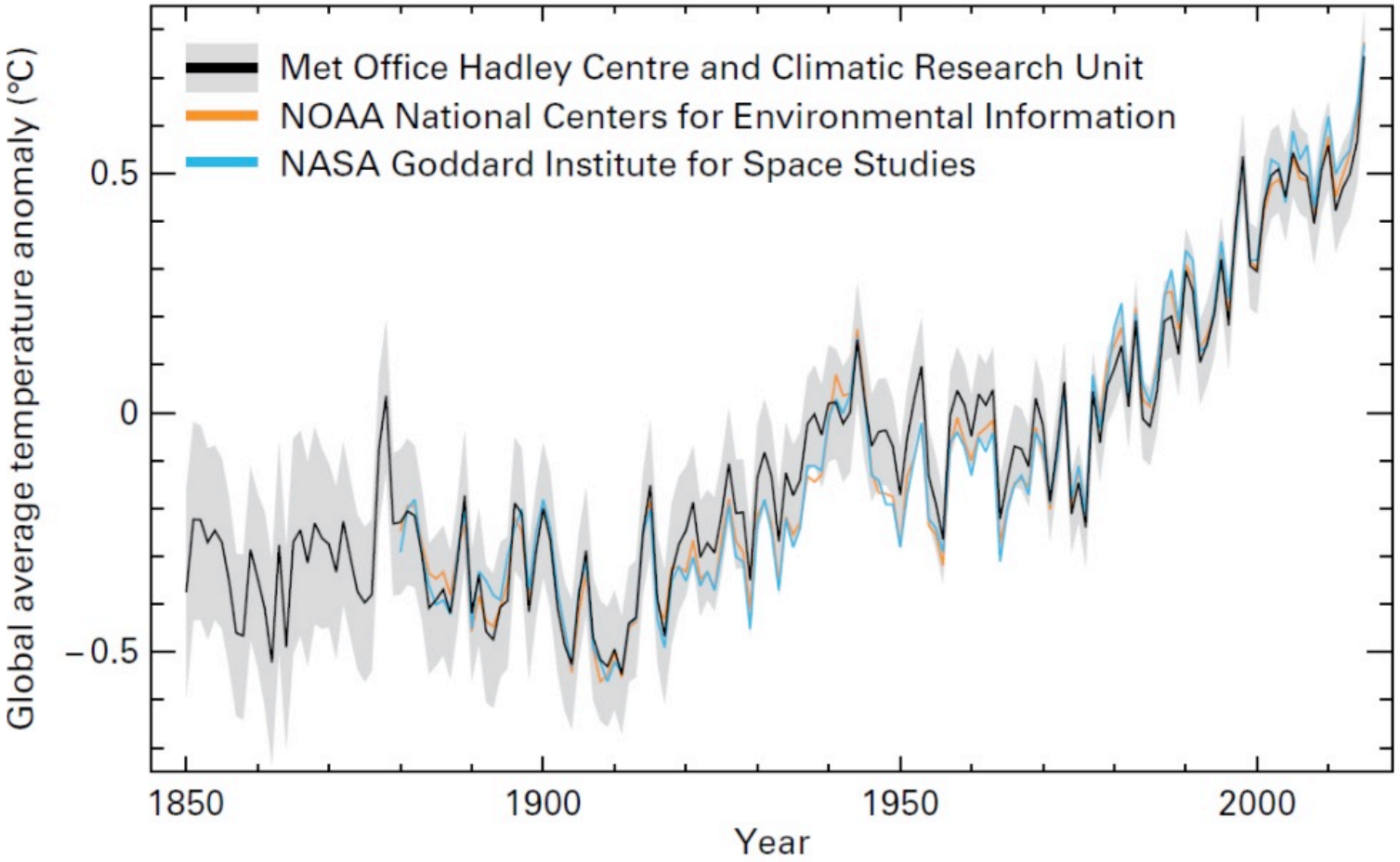
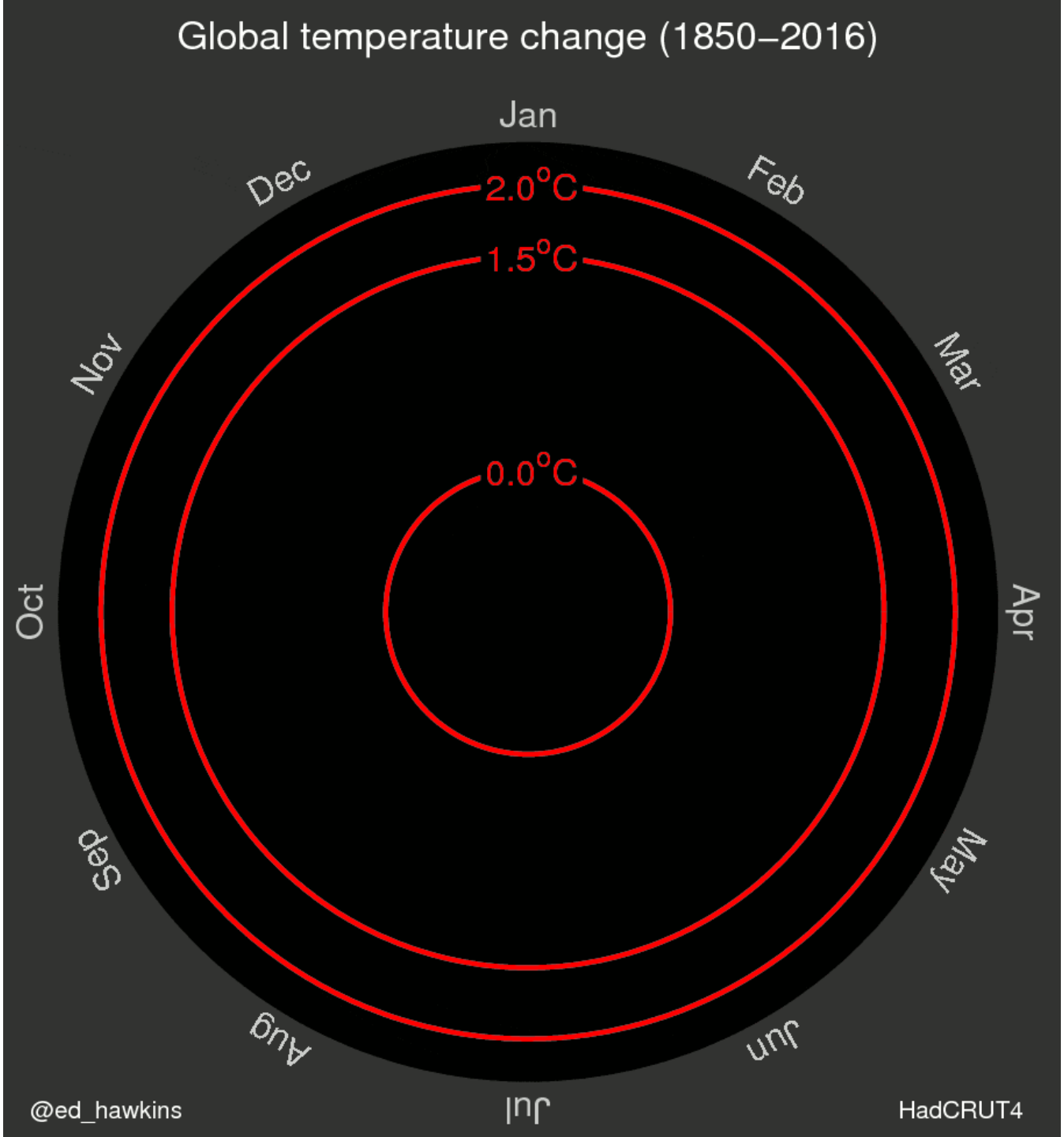
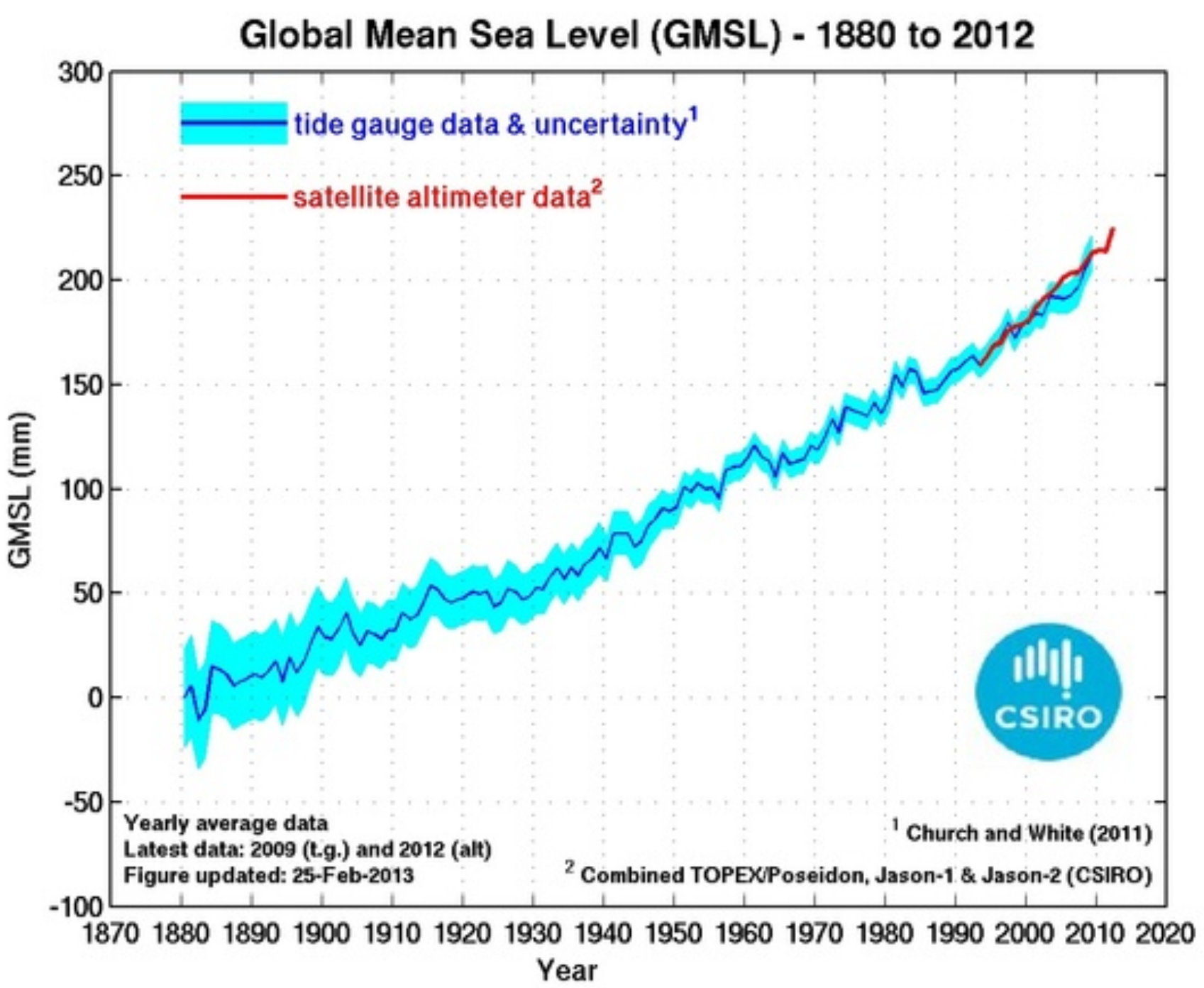


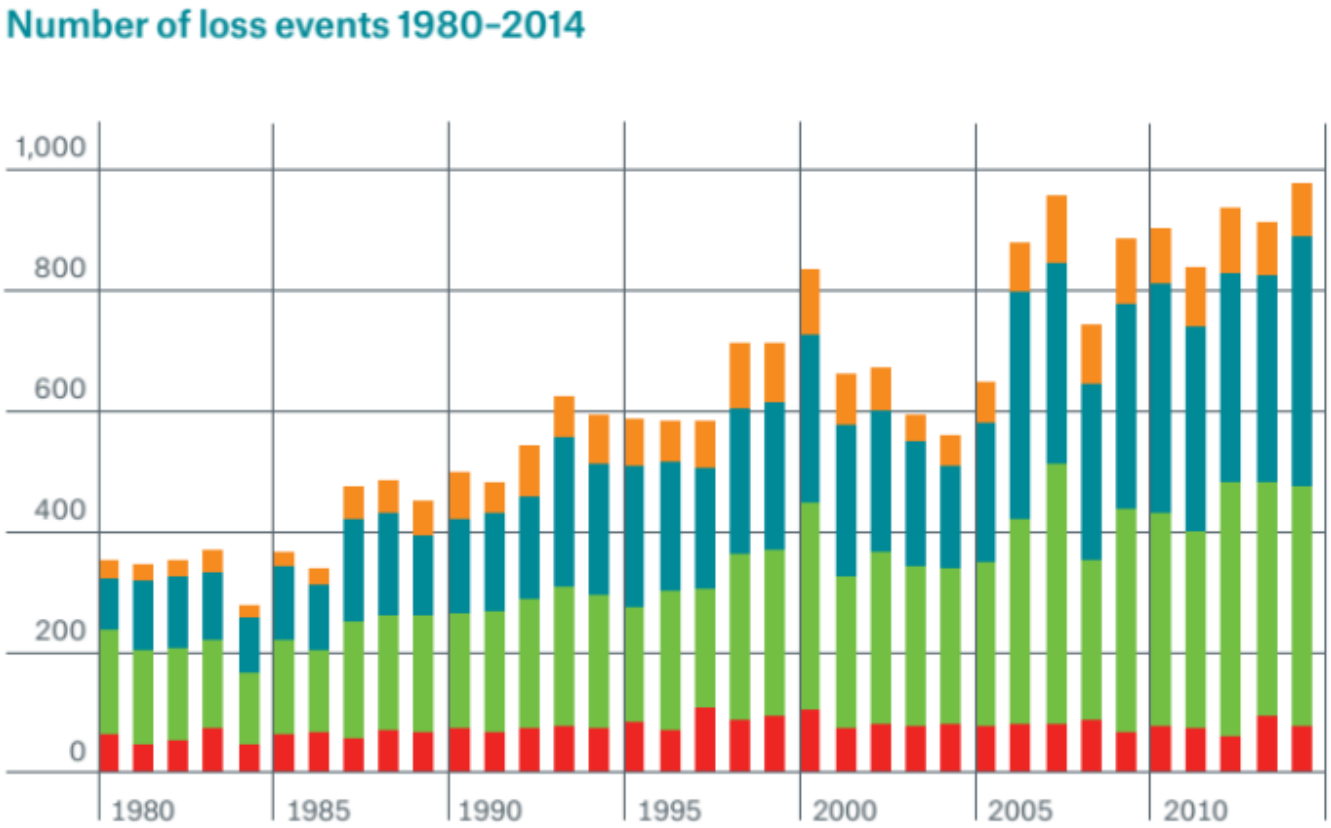
Figure 1. Global annual average temperature anomalies (relative to 1961–1990) for 1850–2015. The black line and grey shading are from the HadCRUT4 analysis produced by the Met Office Hadley Centre in collaboration with the Climatic Research Unit at the University of East Anglia. The grey shading indicates the 95% confidence interval of the estimates. The orange line is the NOAAGlobalTemp dataset produced by the National Oceanic and Atmospheric Administration National Centers for Environmental Information (NOAA NCEI). The blue line is the GISTEMP dataset produced by the National Aeronautics and Space Administration, Goddard Institute for Space Studies (NASA GISS). *(Source: Met Office Hadley Centre, United Kingdom, and Climatic Research Unit, University of East Anglia, United Kingdom)*


Global temperature change (1850–2016)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2.0°C
1.5°C
0.0°C
@ed_hawkins
HadCRUT4


Global Mean Sea Level (GMSL) - 1880 to 2012
tide gauge data & uncertainty[1]
satellite altimeter data[2]
GMSL (mm)
300
250
200
150
100
50
0
-50
-100
1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
Year
CSIRO
Yearly average data
Latest data: 2009 (t.g.) and 2012 (alt)
Figure updated: 25-Feb-2013
[1] Church and White (2011)
[2] Combined TOPEX/Poseidon, Jason-1 & Jason-2 (CSIRO)

Número de eventos extremos

Munich RE



Eventos relacionados com o clima

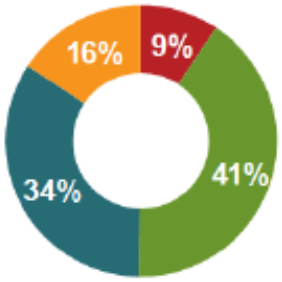
NatCatSERVICE

Natural catastrophes in Europe 1980 – 2010

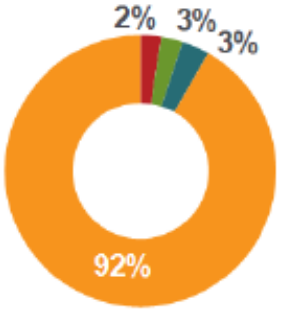
Percentage distribution

Munich RE

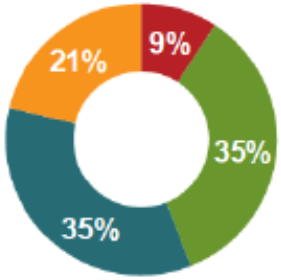
4,100 Loss events



150,000 Fatalities

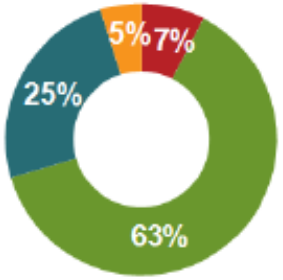


Overall losses* EUR 415bn



*in 2010 values

Insured losses* EUR 130bn



*in 2010 values

- **Geophysical events** (Earthquake, tsunami, volcanic eruption)
- **Meteorological events** (Storm)
- **Hydrological events** (Flood, mass movement)
- **Climatological events** (Extreme temperature, drought, forest fire)

© 2011 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE – As at January 2011

NatCatSERVICE

Natural Catastrophes in Europe 1980 - 2010

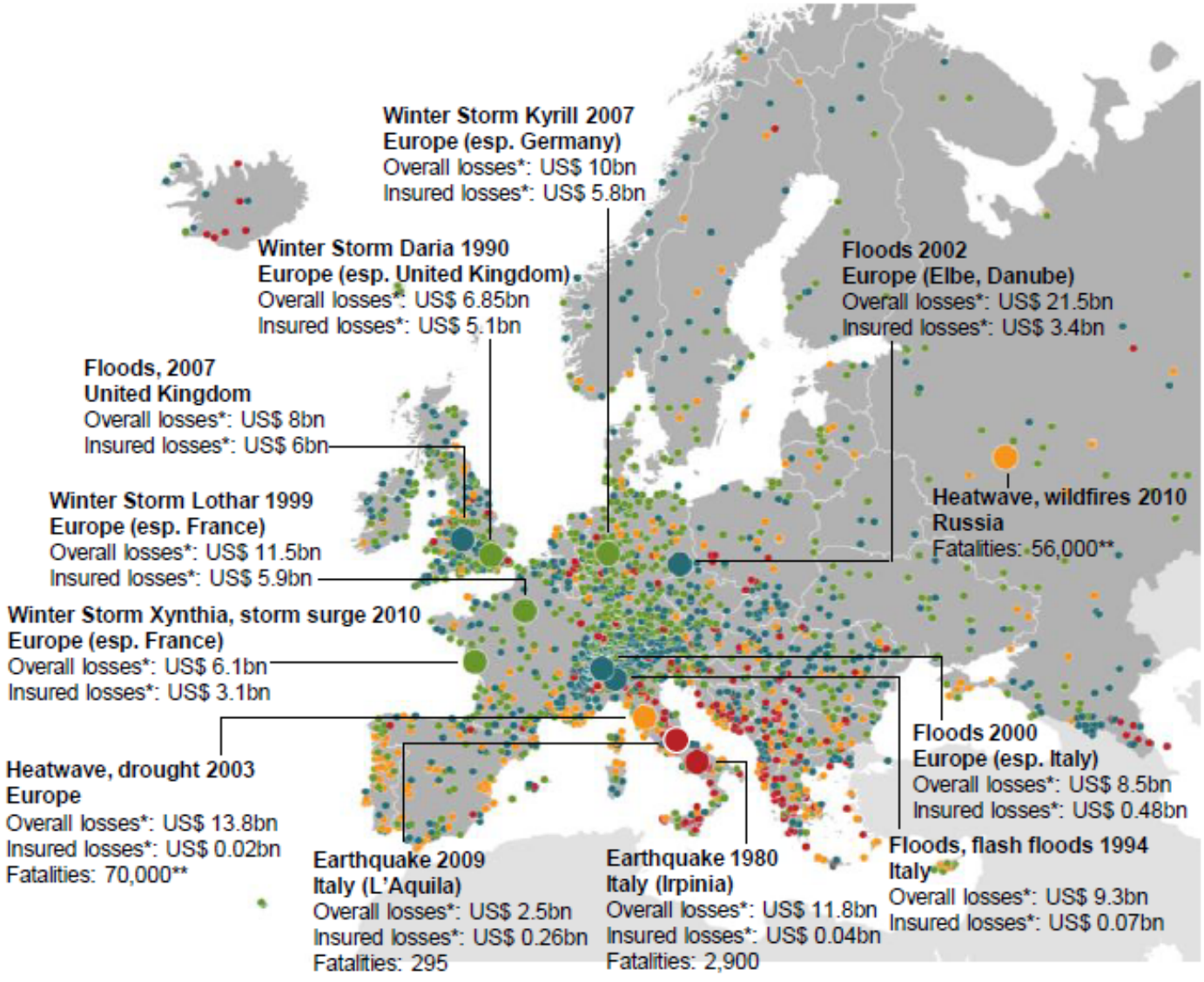
Map

Munich RE

- **Geophysical events** (Earthquake, tsunami, volcanic eruption)
- **Meteorological events** (Storm)
- **Hydrological events** (Flood, mass movement)
- **Climatological events** (Extreme temperature, drought, wildfire)

- **Natural disasters**
- **Deadliest and costliest events***

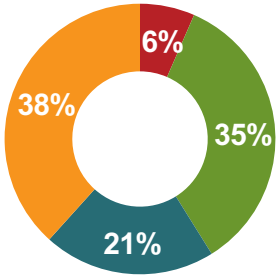
* Losses in original values
** Excess mortality rate



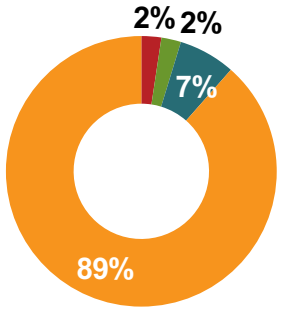
Natural catastrophes in Portugal 1980 – 2011

Percentage distribution

107 loss events

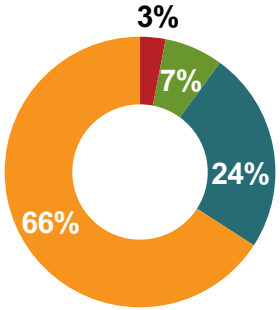


3,000 fatalities*



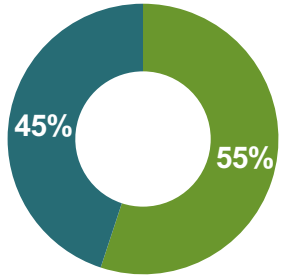
*Heat wave 2003: 2,500 fatalities

Overall losses** US$ 6,900m



**in 2011 values

Insured losses** US$ 160m



**in 2011 values
Storm and flood only

Geophysical events (Earthquake, tsunami, volcanic eruption)

Meteorological events (Storm)

Hydrological events (Flood, mass movement)

Climatological events (Extreme temperature, drought, wildfire)

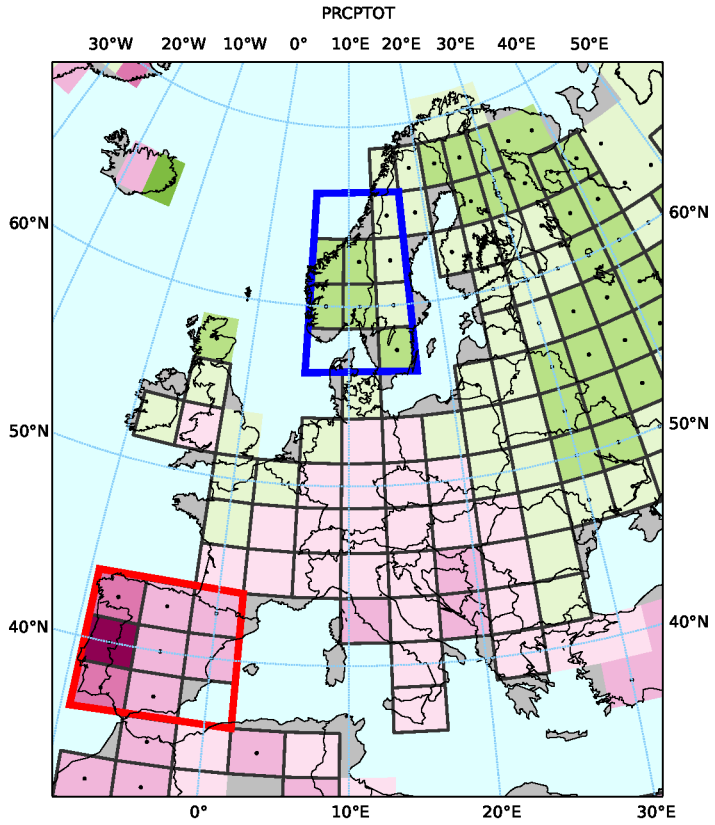
© 2012 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE – As at April 2012

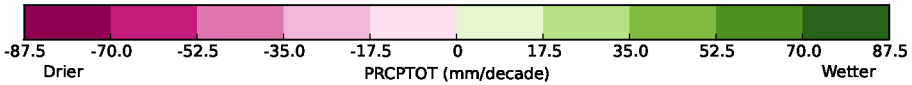
Precipitação observada na Europa 1960 - 2014

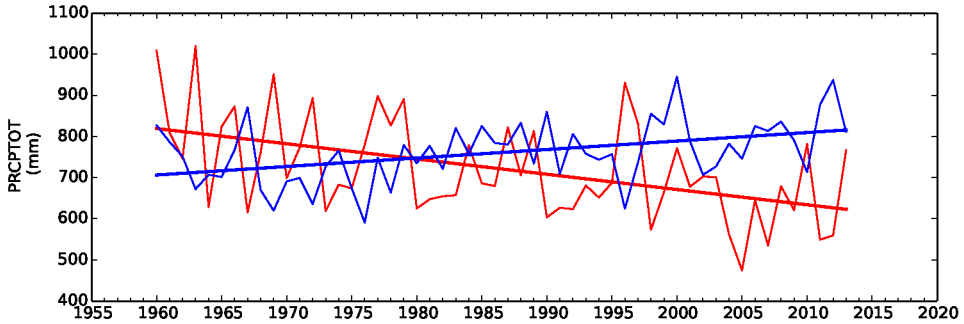
Aumento da precipitação anual na Escandinávia: 20.64mm por década

Diminuição da Precipitação anual na Península Ibérica: -37.07mm por década

EEA Report, 2012







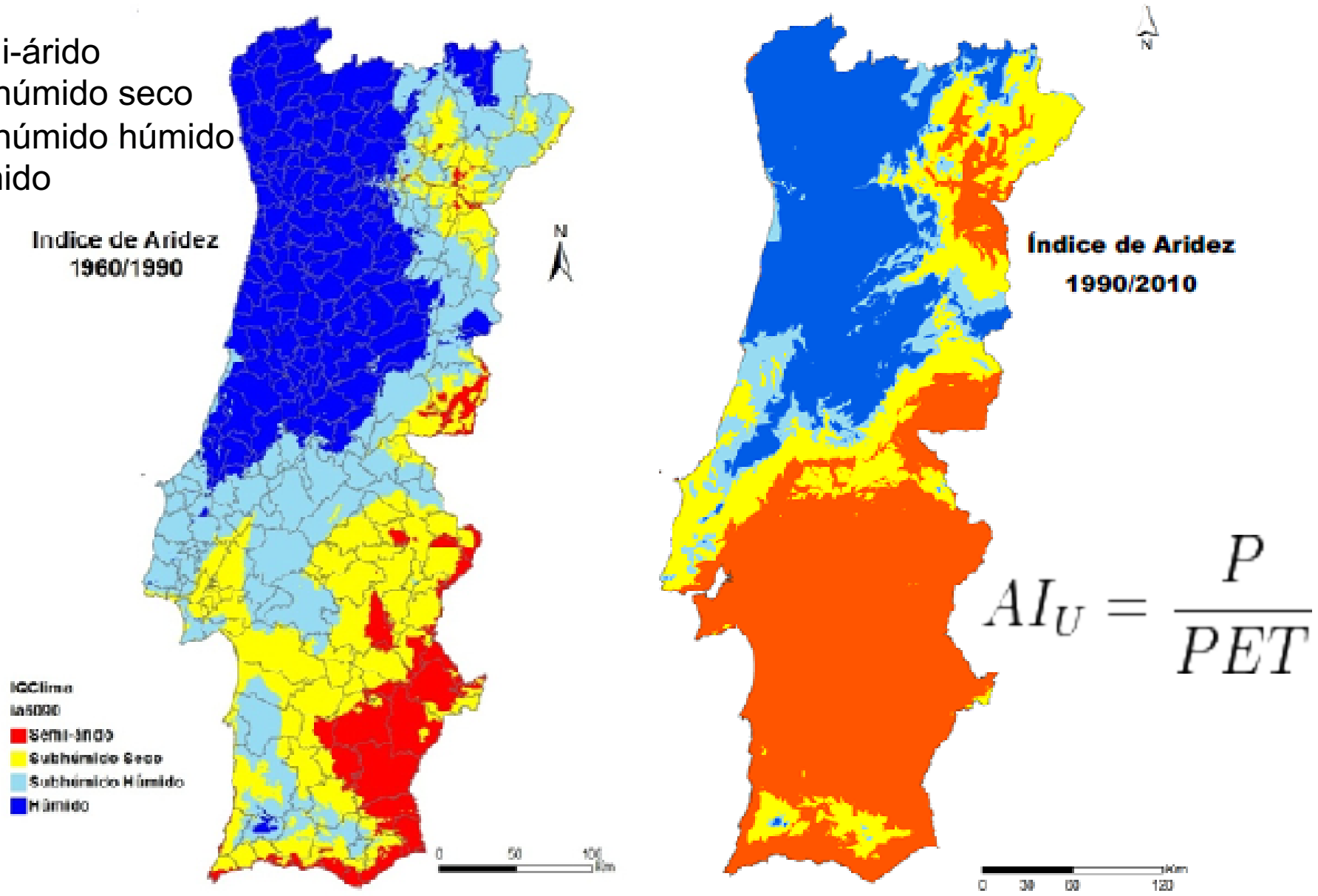
Annual Change of 20.64mm per decade (8.32 to 33.37)
Total Change of 109.37mm from 1960 to 2014 (44.11mm to 176.86mm)

Annual Change of -37.07mm per decade (-55.43 to -15.53)
Total Change of -196.45mm from 1960 to 2014 (-293.79mm to -82.31mm)

HadEX2/code/trunk/plot_eea_average.py 27-Feb-2014 17:47

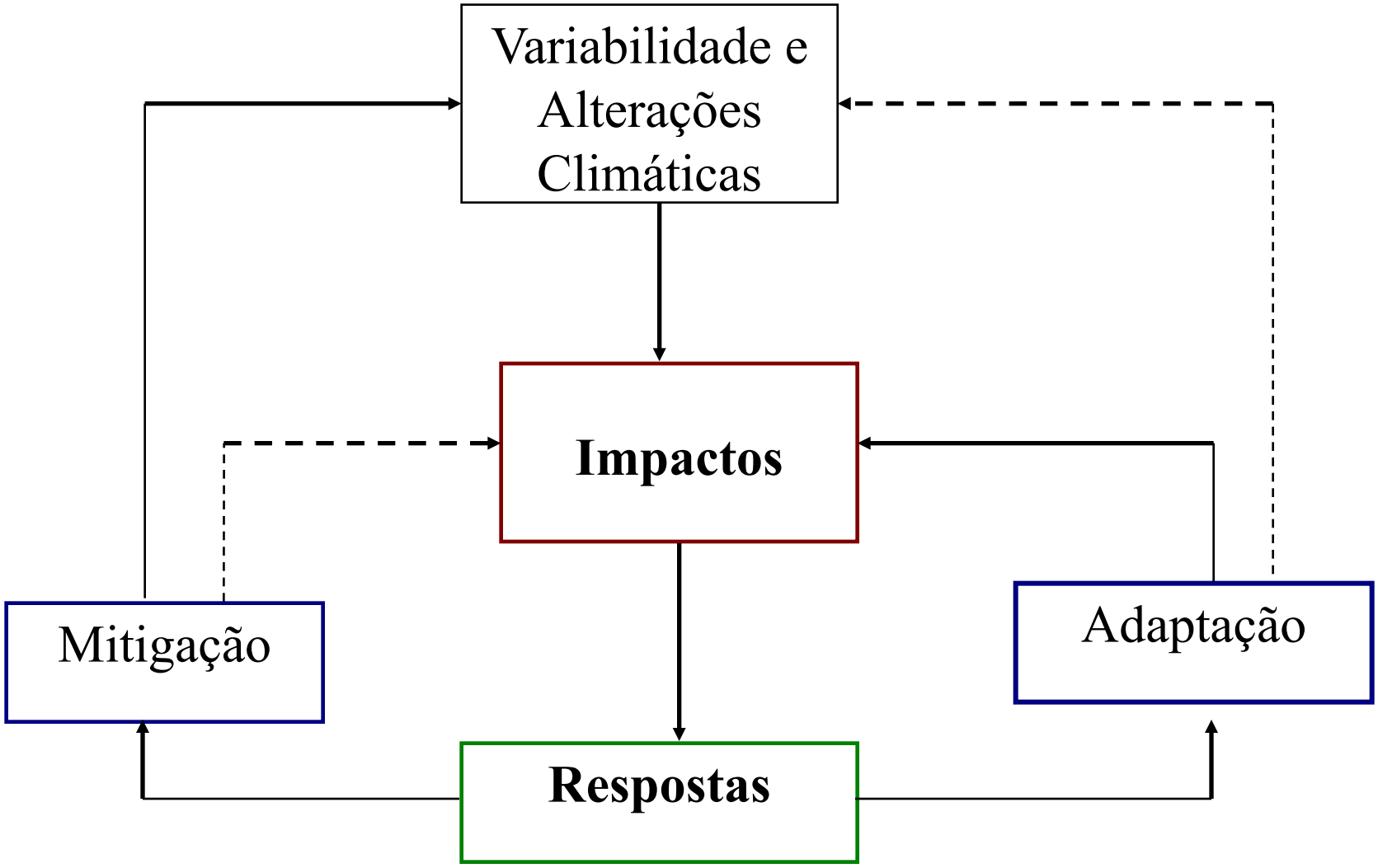
Evolução do Índice de Aridez em Portugal continental nos últimos 50 anos

Semi-árido
Subhúmido seco
Subhúmido húmido
Húmido



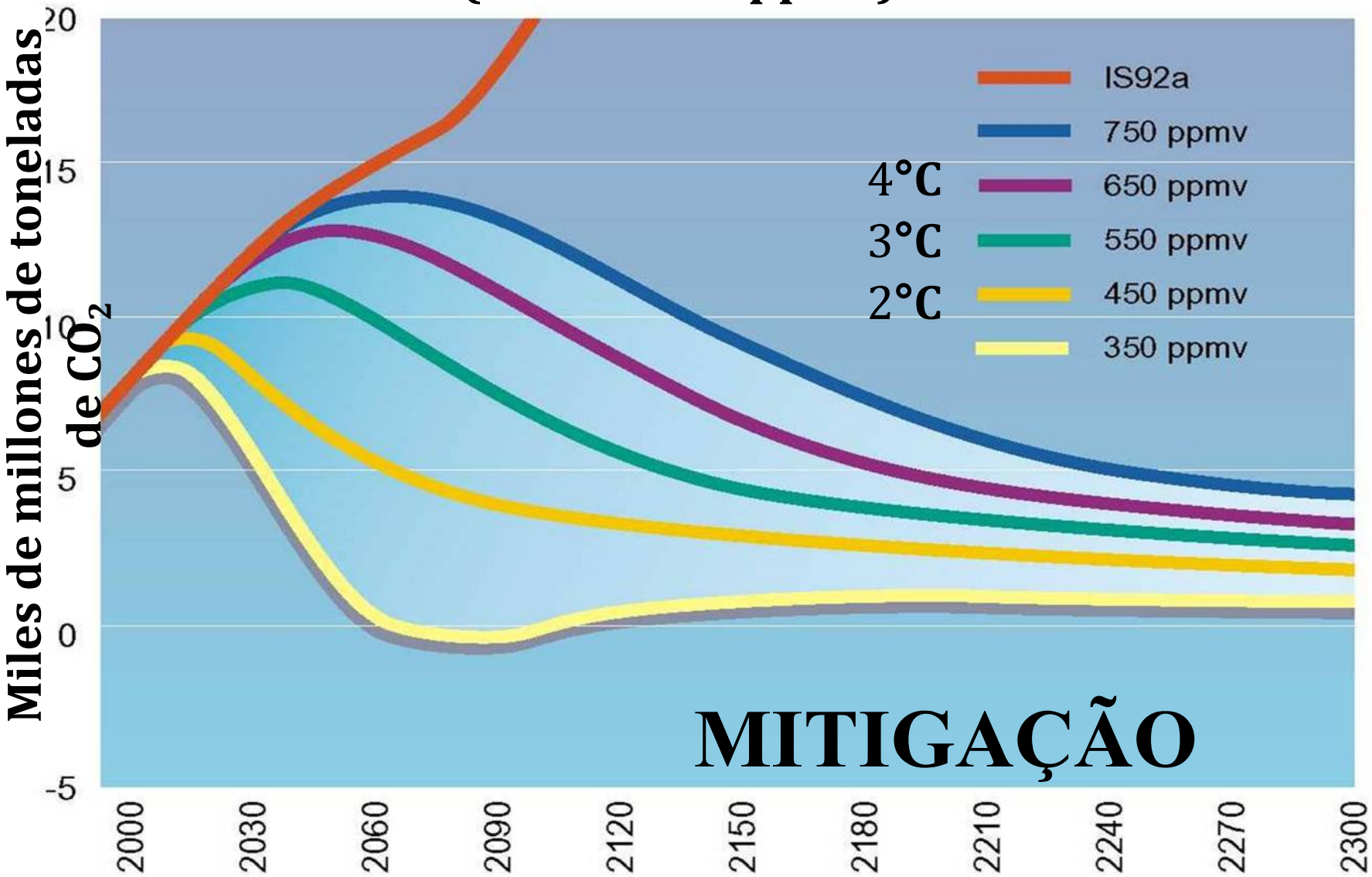
$$AI_U = \frac{P}{PET}$$

Fonte: CNCCD 2004; Del Barrio *et al*, 2010; Sanjuan *et al*, 2011

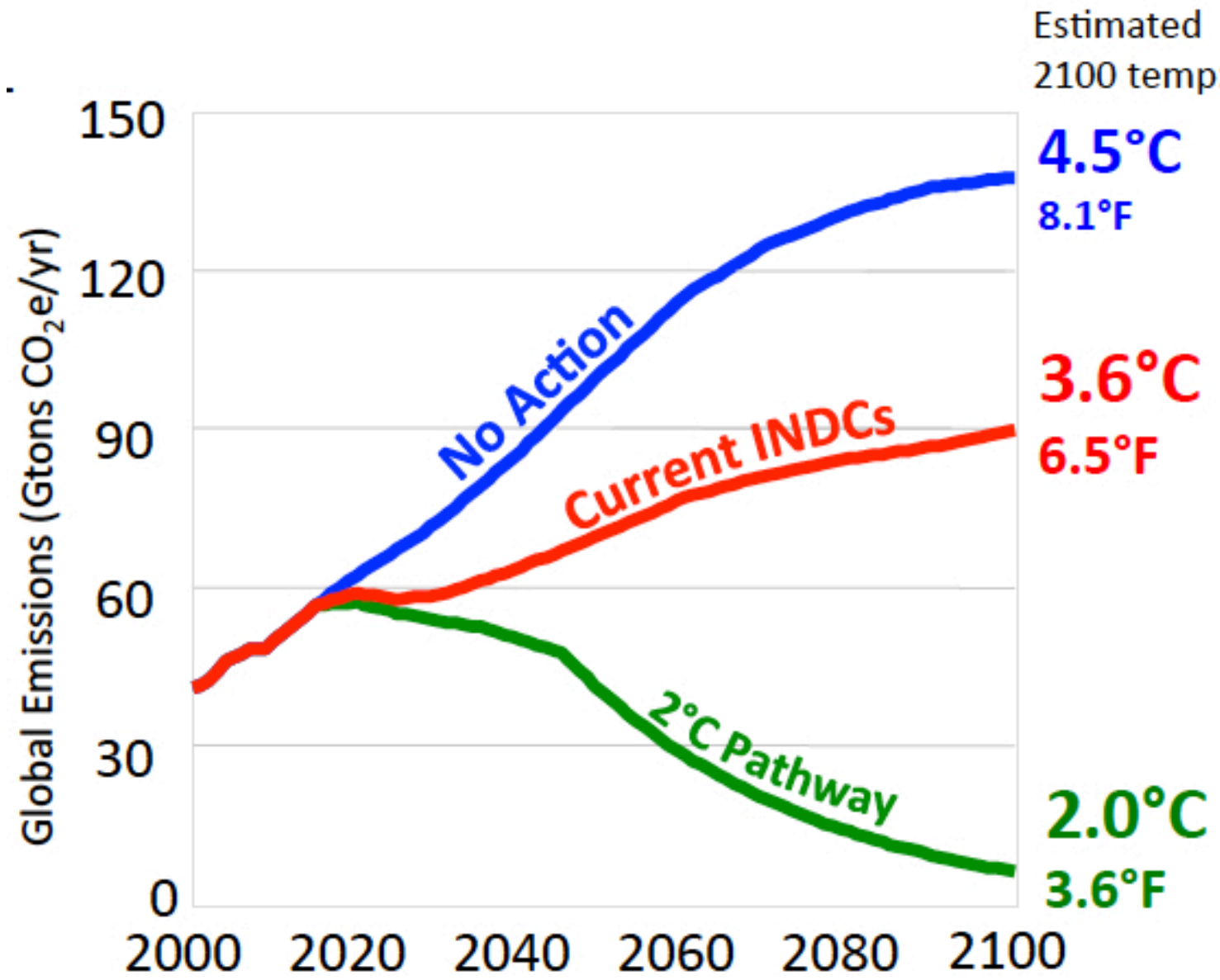

Variabilidade e Alterações Climáticas
Impactos
Mitigação
Adaptação
Respostas
Efeitos directos ou retroacção
Efeitos indirectos

Trajectórias das emissões de CO_2e

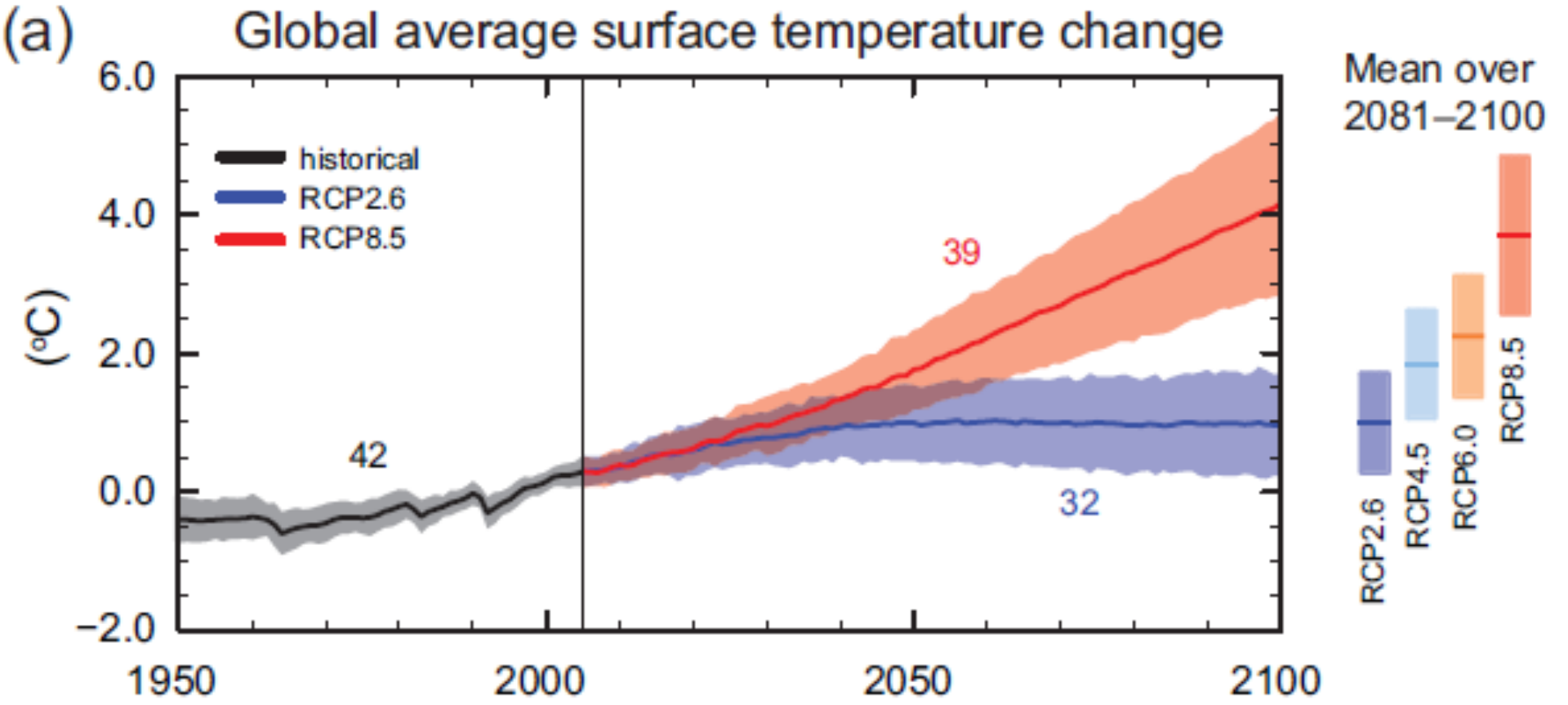
(2005 = 380 ppmv)



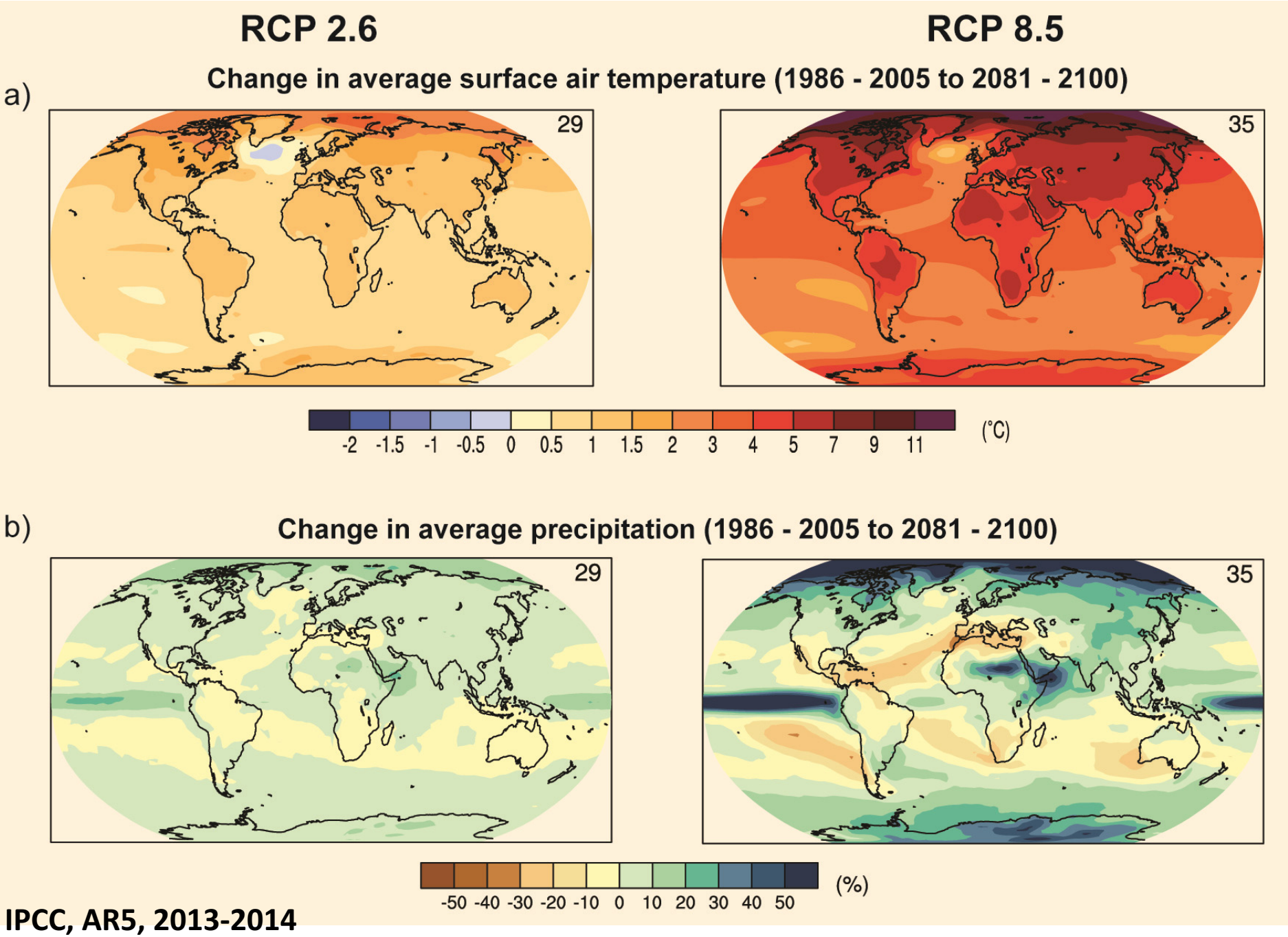
Fuente: Stern Review; World Resources Institute



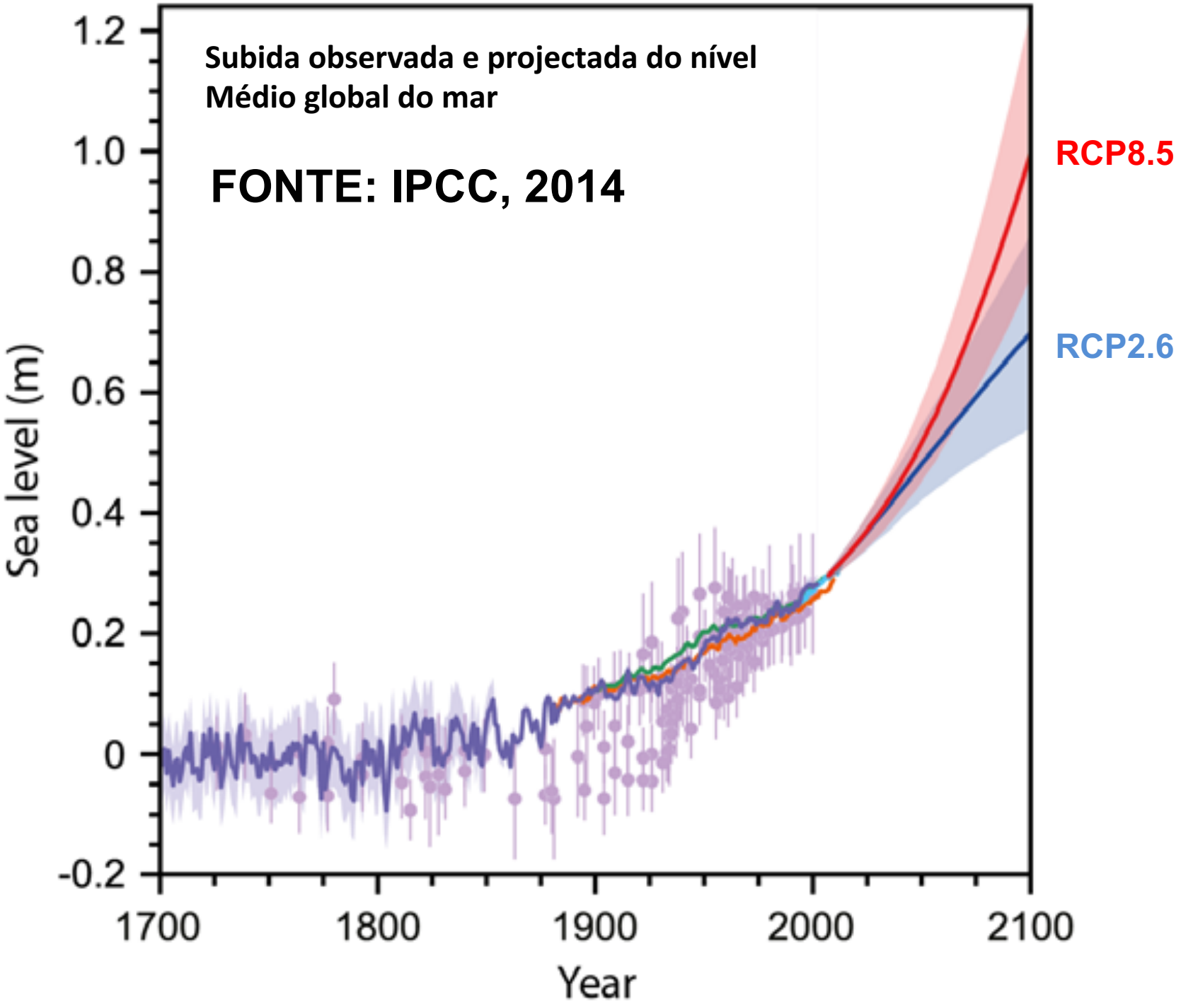
Impact of national climate pledges (aka INDCs) on world's greenhouse gas emissions measured in CO2 equivalents (CO2e).


(a)
Global average surface temperature change
6.0
4.0
2.0
0.0
−2.0
(°C)
1950
2000
2050
2100
historical
RCP2.6
RCP8.5
42
39
32
Mean over
2081–2100
RCP2.6
RCP4.5
RCP6.0
RCP8.5

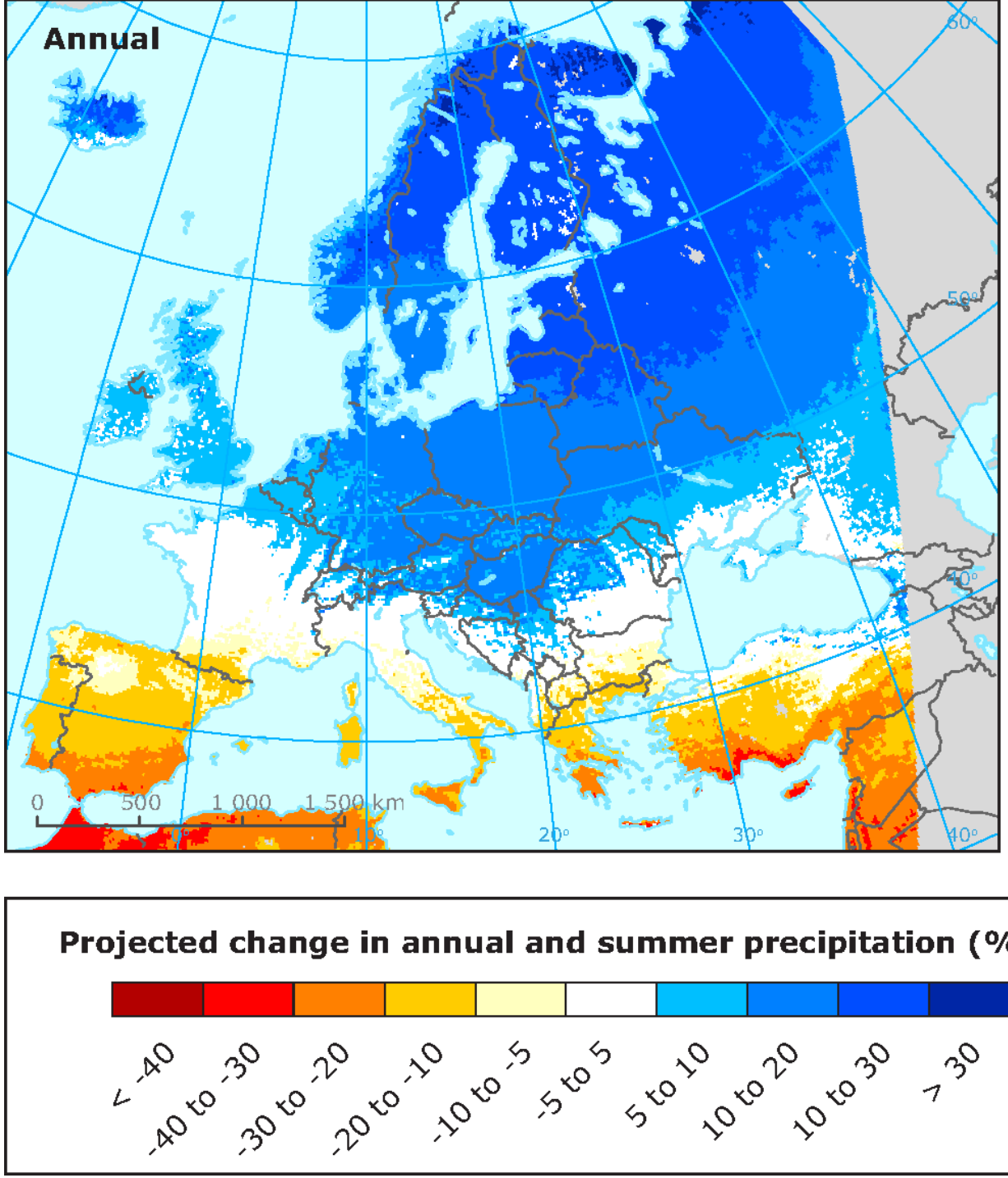
IPCC, 2014

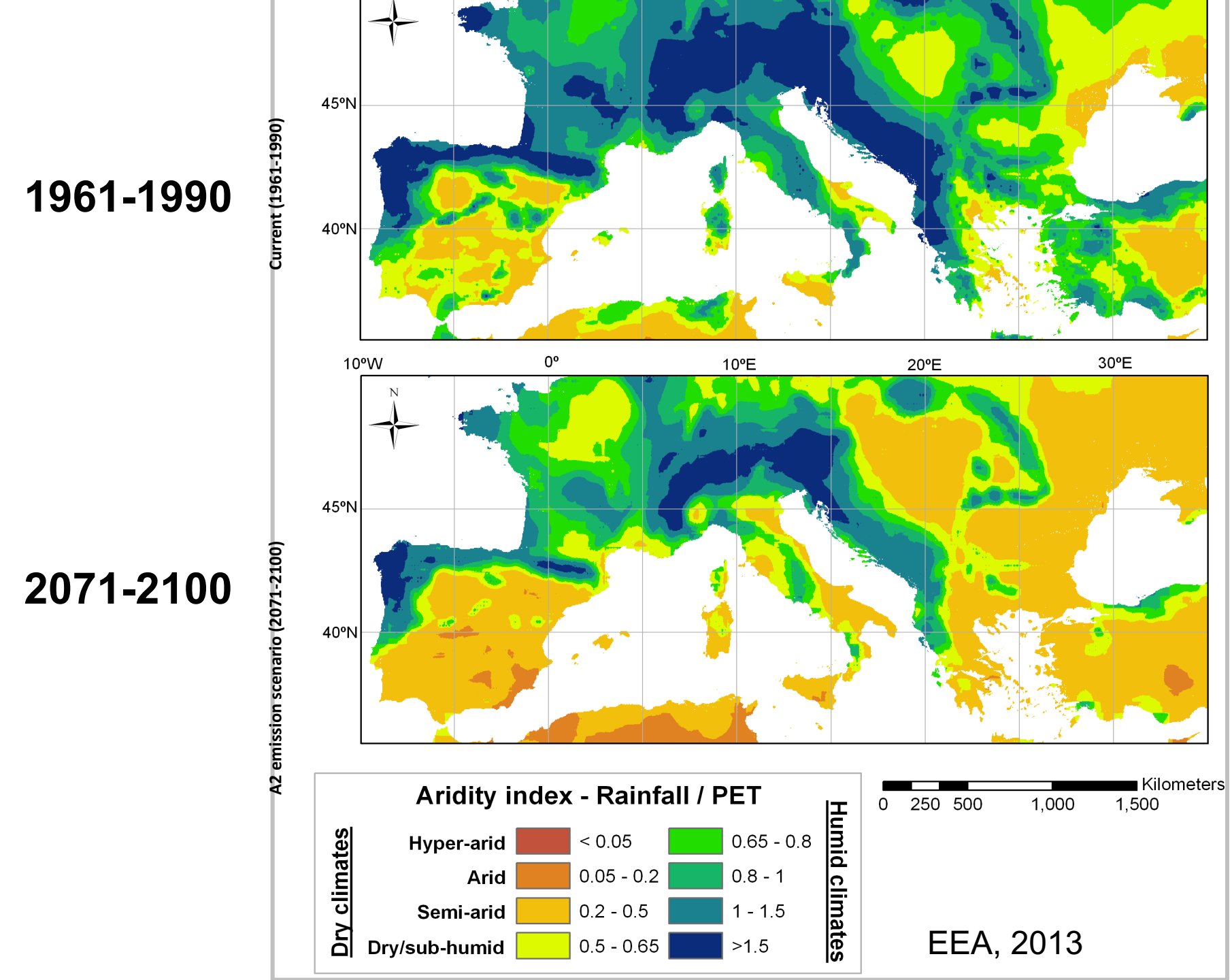


IPCC, AR5, 2013-2014


Subida observada e projectada do nível
Médio global do mar
FONTE: IPCC, 2014
RCP8.5
RCP2.6
Sea level (m)
1.2
1.0
0.8
0.6
0.4
0.2
0
-0.2
1700
1800
1900
2000
2100
Year

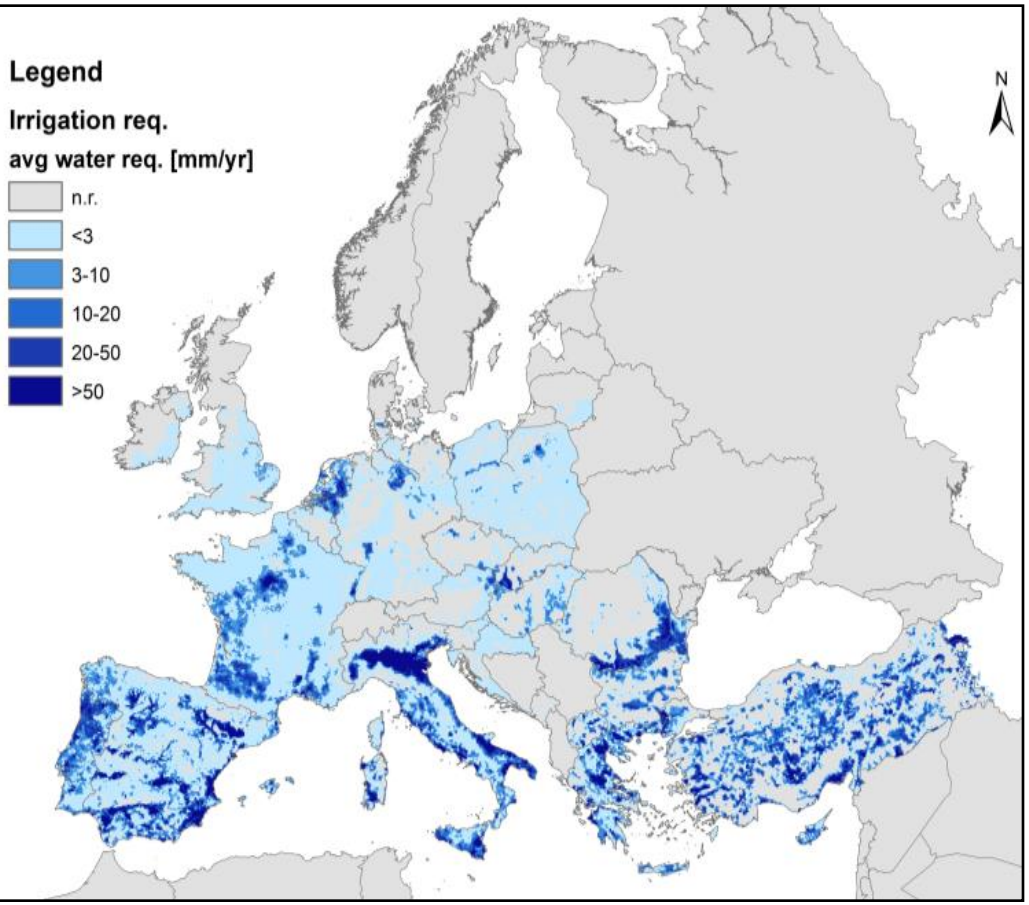
Projected changes in annual precipitation (%) in the period 2071-2100 compared to the baseline period 1971-2000 for the forcing scenario RCP 8.5. Model simulations are based on the multi-model ensemble average of RCM simulations from the EURO-CORDEX initiative.



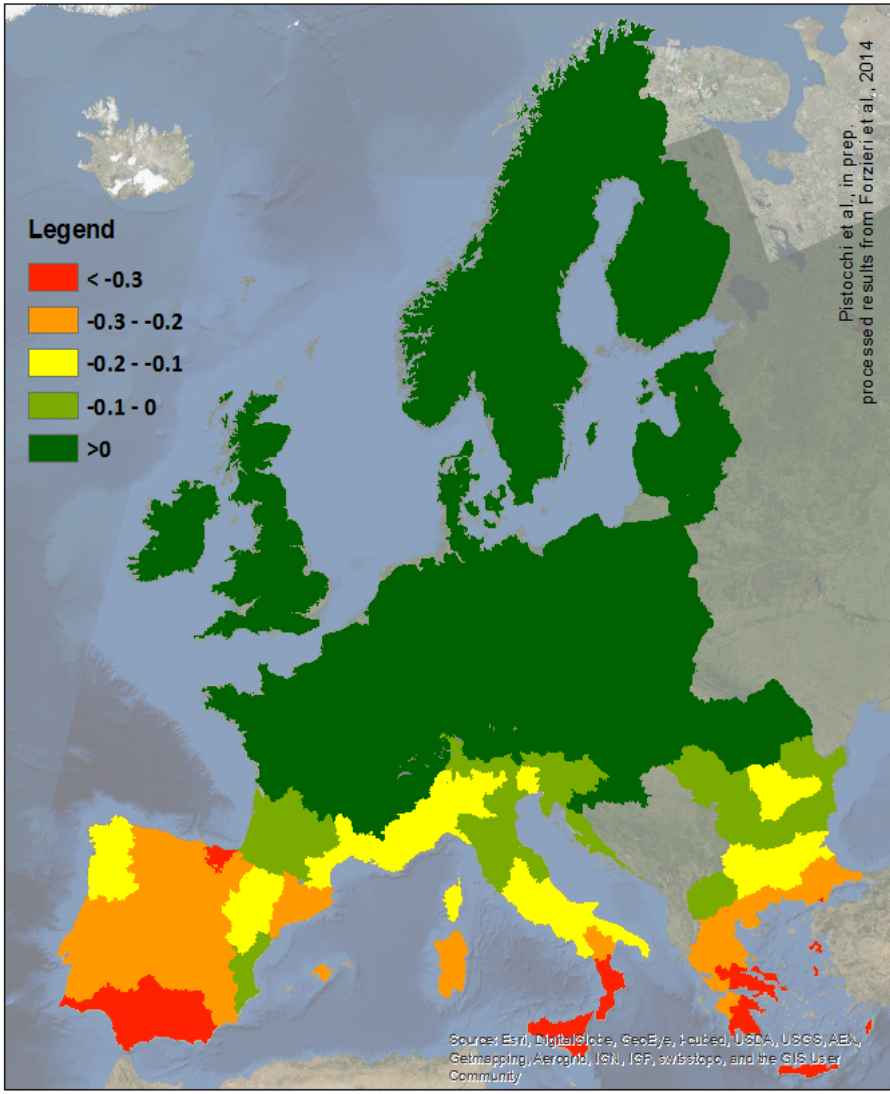

1961-1990
2071-2100
Current (1961-1990)
A2 emission scenario (2071-2100)
45ºN
40ºN
10ºW
0º
10ºE
20ºE
30ºE
N
Aridity index - Rainfall / PET
Dry climates
Humid climates
Hyper-arid
< 0.05
Arid
0.05 - 0.2
Semi-arid
0.2 - 0.5
Dry/sub-humid
0.5 - 0.65
0.65 - 0.8
0.8 - 1
1 - 1.5
>1.5
Kilometers
0 250 500 1,000 1,500
EEA, 2013

Sizing future water gaps

Current level of agricultural irrigation in Europe



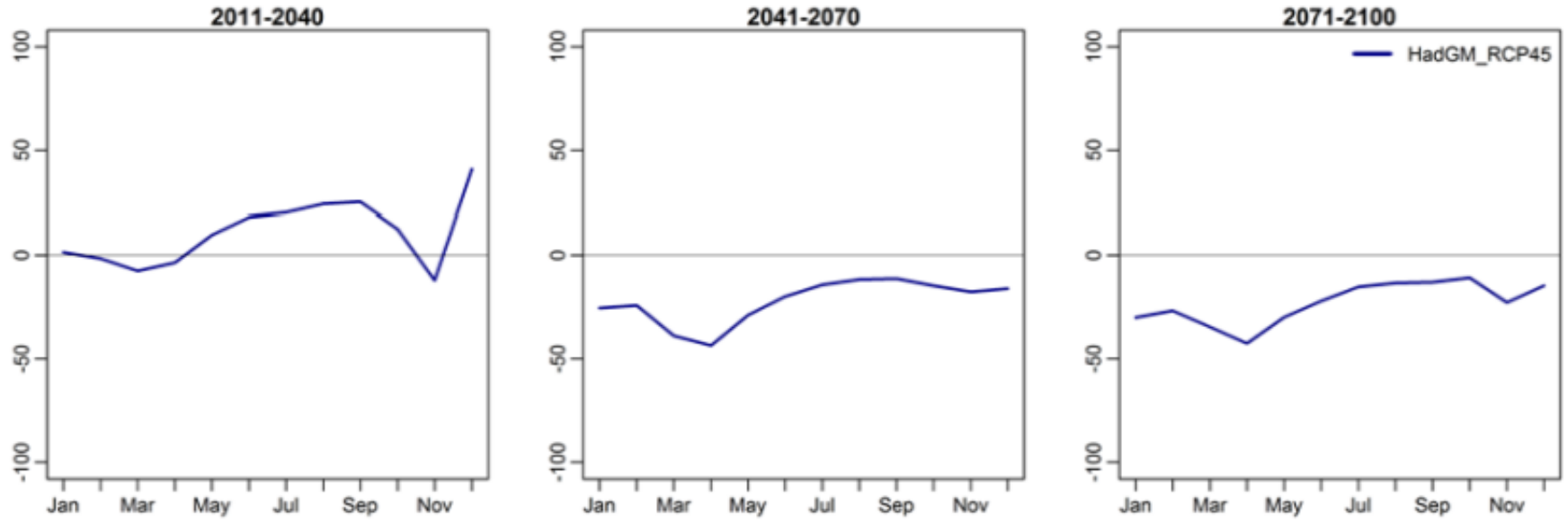
Change in annual water availability by the end of the century



Forzieri et al., 2014

SSP1 – RCP4.5 Sustainability

Water availability entire Tagus River



- Increase in the water availability during the summer months, up to 20% for the first future time slice
- Decrease in water availability for the second and far future time slices: Up to -50% in winter –early spring months and 10 -18% percent during the summer and autumn

Project IMPRESSIONS, T.Capela, M. J. Cruz, F.D.Santos et al., 2016

sions-project.eu

Project CIRAC

Flood Risk and Vulnerability In Climate Change Scenarios

http://siam.fc.ul.pt/cirac/

Pedro Garrett et al.

FACULDADE · DE · CIÊNCIAS UNIVERSIDADE · DE · LISBOA

fundação Faculdade Ciências Universidade Lisboa

CCIAM
www.sim.ul.pt/cciam

associação portuguesa de seguradores aps

ACTION Modulers
Consultores de Segurança

Nat. Hazards Earth Syst. Sci., 15, 1907–1919, 2015
www.nat-hazards-earth-syst-sci.net/15/1907/2015/
doi:10.5194/nhess-15-1907-2015
© Author(s) 2015. CC Attribution 3.0 License.

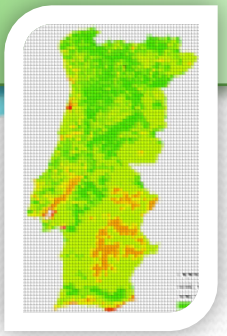
Natural Hazards and Earth System Sciences
Open Access

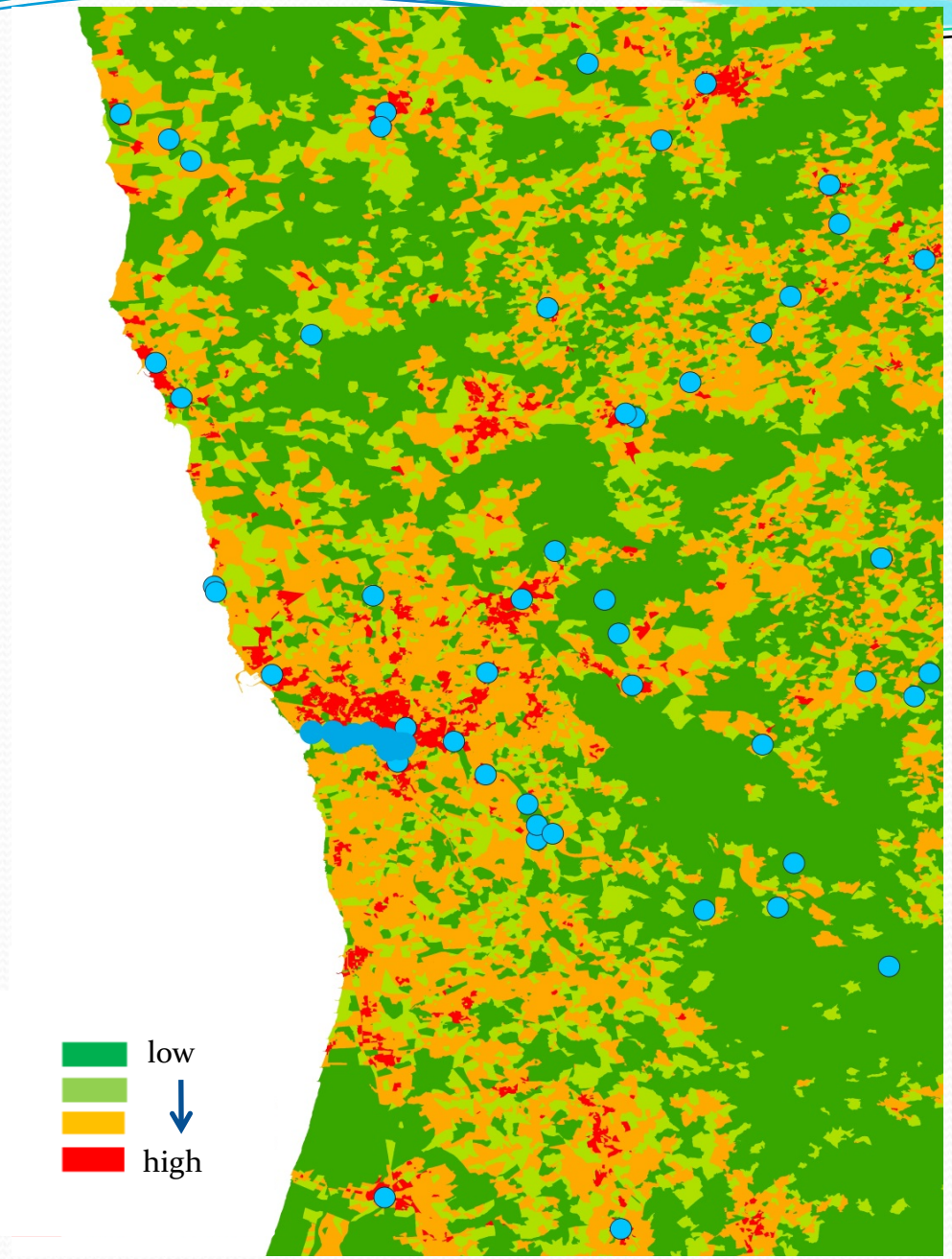
Continental Portuguese Territory Flood Susceptibility Index – contribution to a vulnerability index

R. Jacinto[1,*], N. Grosso[2,*], E. Reis[1], L. Dias[2], F. D. Santos[2], and P. Garrett[2]

[1]Centre for Geographical Studies, IGOT, Edificio da Faculdade de Letras da Universidade de Lisboa, University of Lisbon, Alameda da Universidade, 1600-214 Lisbon, Portugal
[2]CE3C – Centre for Ecology, Evolution and Environmental Changes, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisbon, Portugal

Flood Vulnerability Index in the north of Portugal

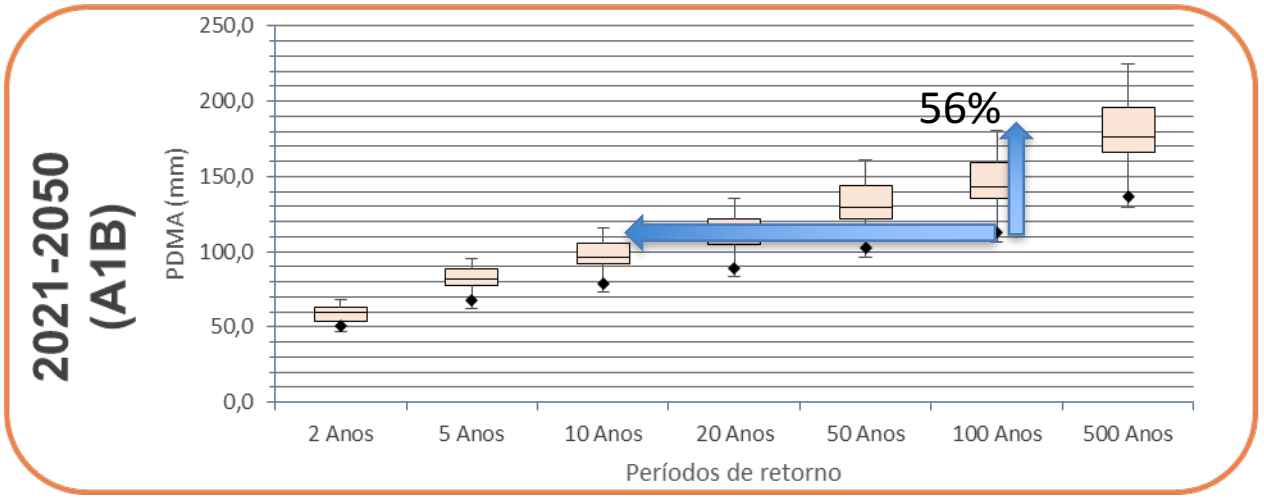


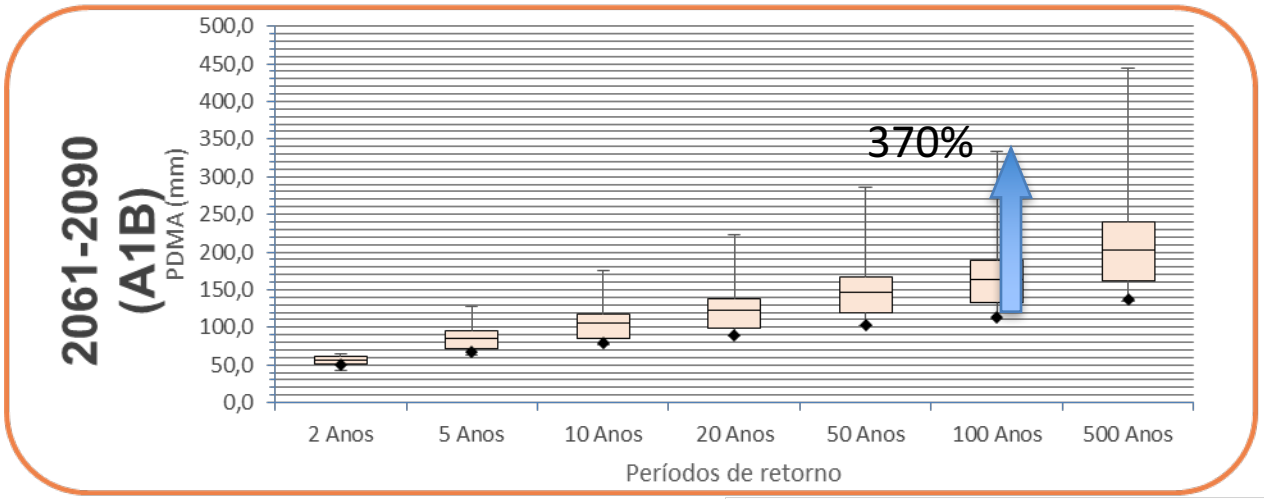


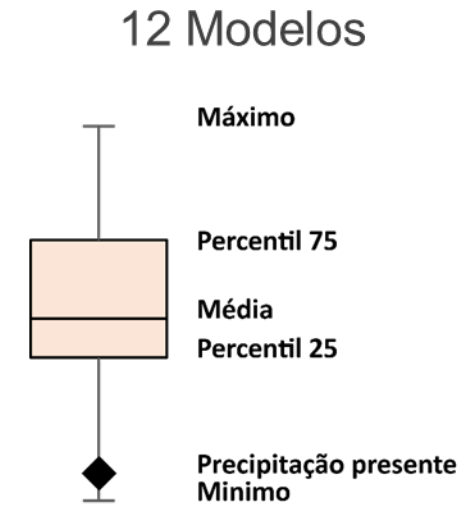
Flood events database from the National Authority of Civil Protection and from Quaresma, 2009

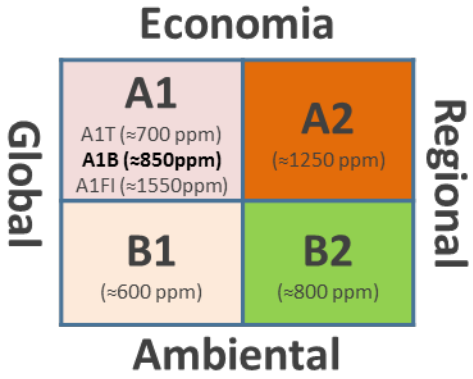
As Alterações Climáticas as Inundações e a Cidade

Contributos para o estudo da resiliência urbana em situações de chuva torrencial num período de 24h. Precipitação no dia do ano com maior precipitação







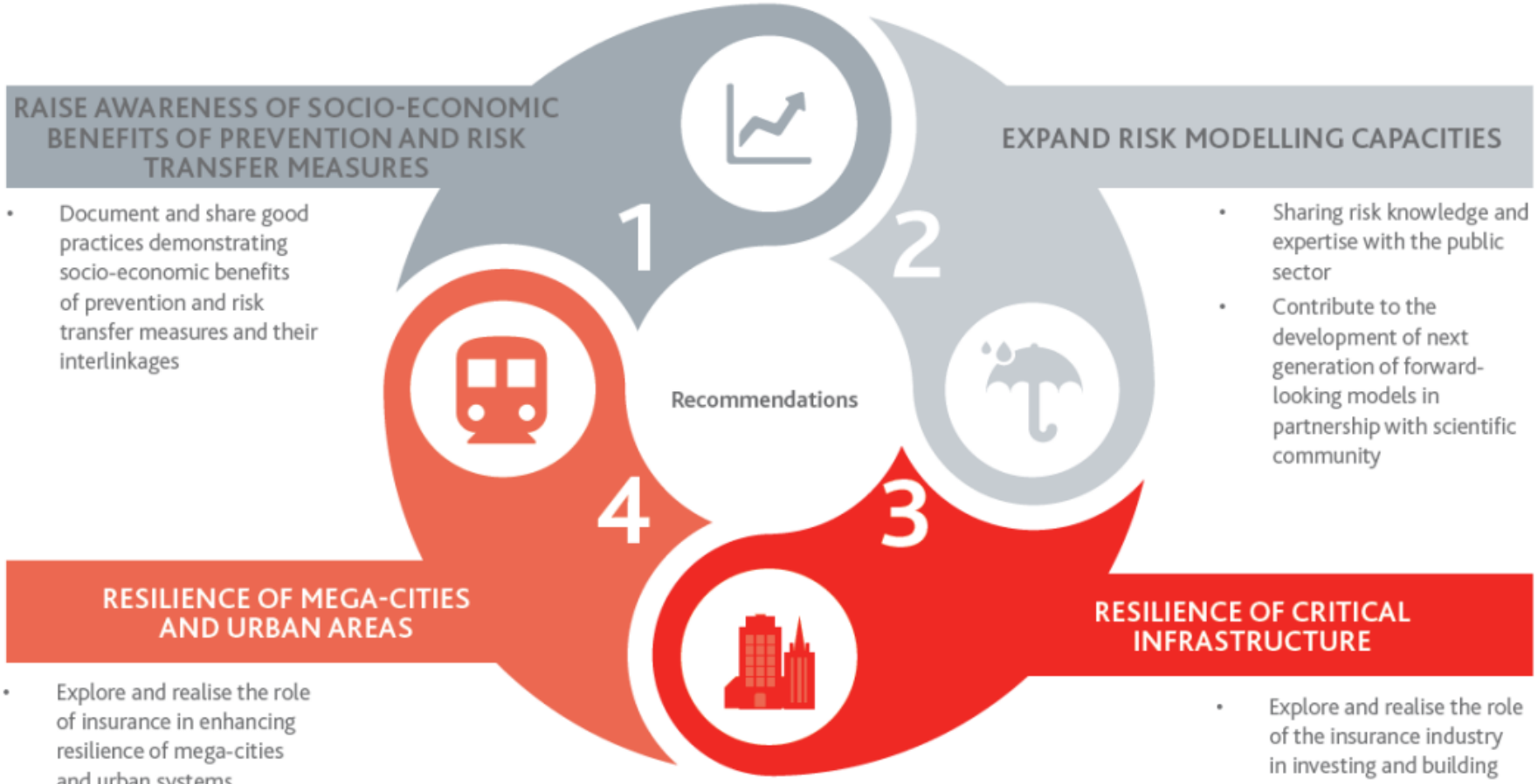


Fonte Luís Dias CCIAM – CE3C

Luís Dias (2015) SFRH/BD/70435/2010

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Building on strong public-private partnerships



1 RAISE AWARENESS OF SOCIO-ECONOMIC BENEFITS OF PREVENTION AND RISK TRANSFER MEASURES

- Document and share good practices demonstrating socio-economic benefits of prevention and risk transfer measures and their interlinkages

2 EXPAND RISK MODELLING CAPACITIES

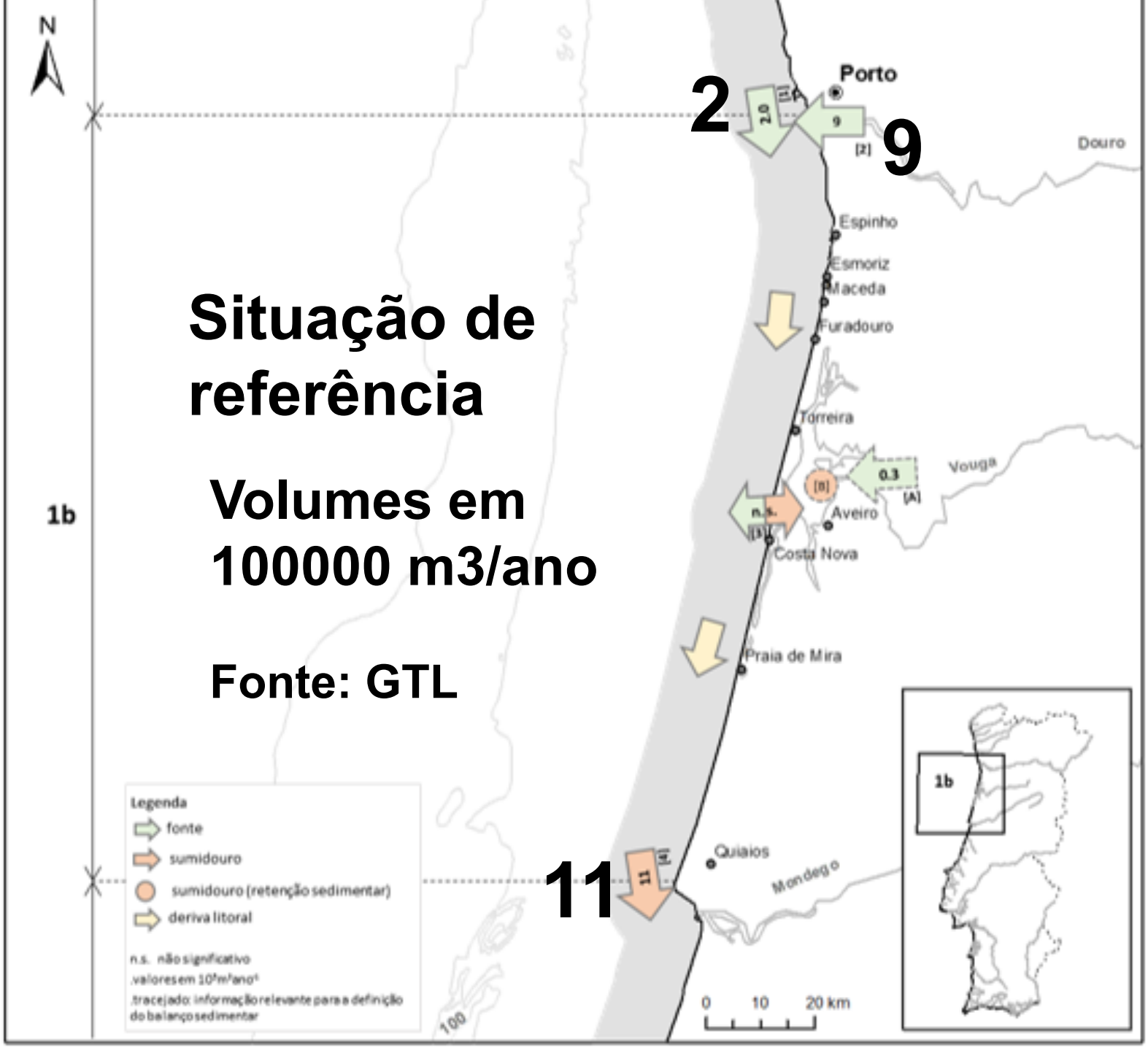
- Sharing risk knowledge and expertise with the public sector
- Contribute to the development of next generation of forward-looking models in partnership with scientific community

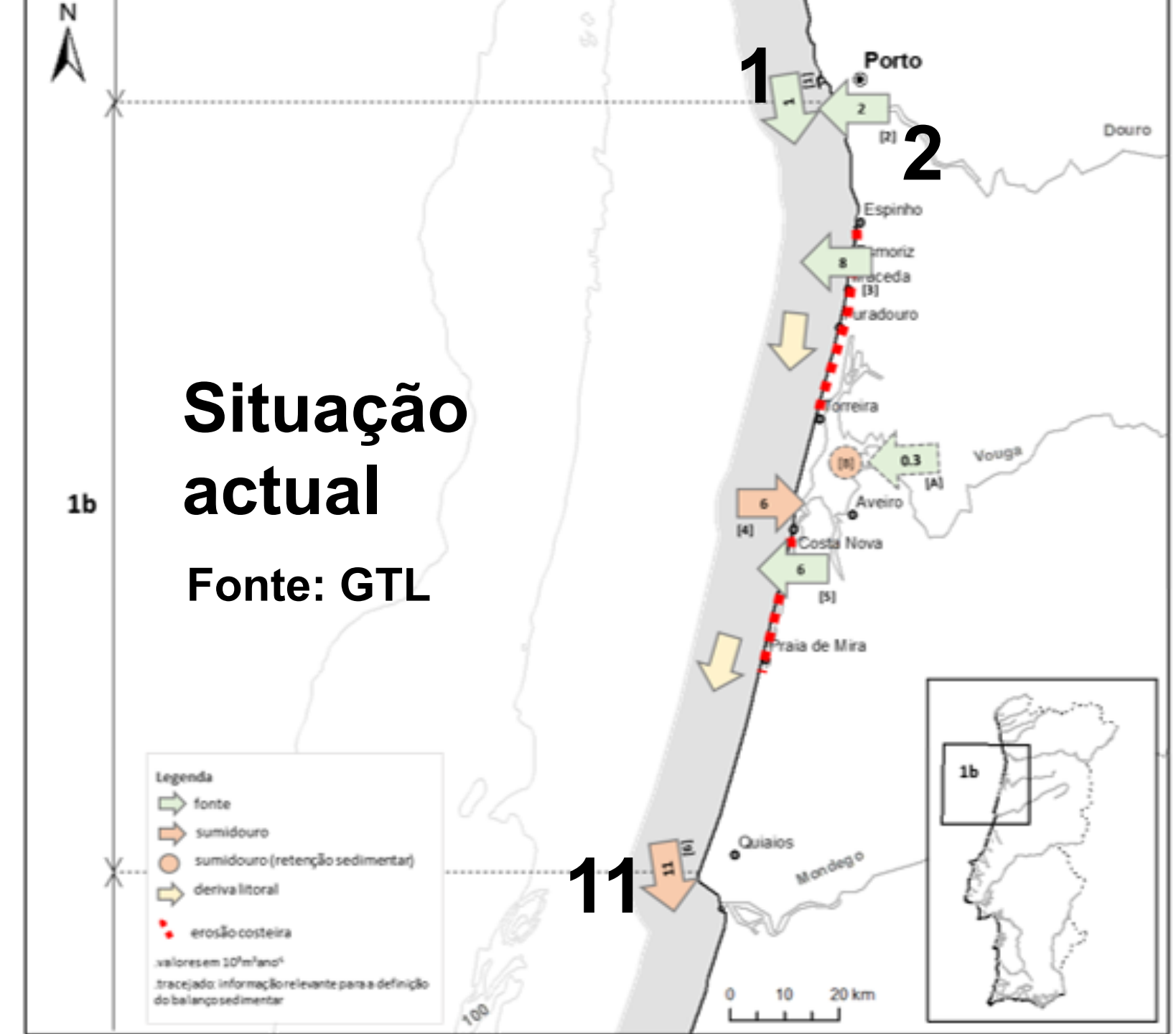
3 RESILIENCE OF CRITICAL INFRASTRUCTURE

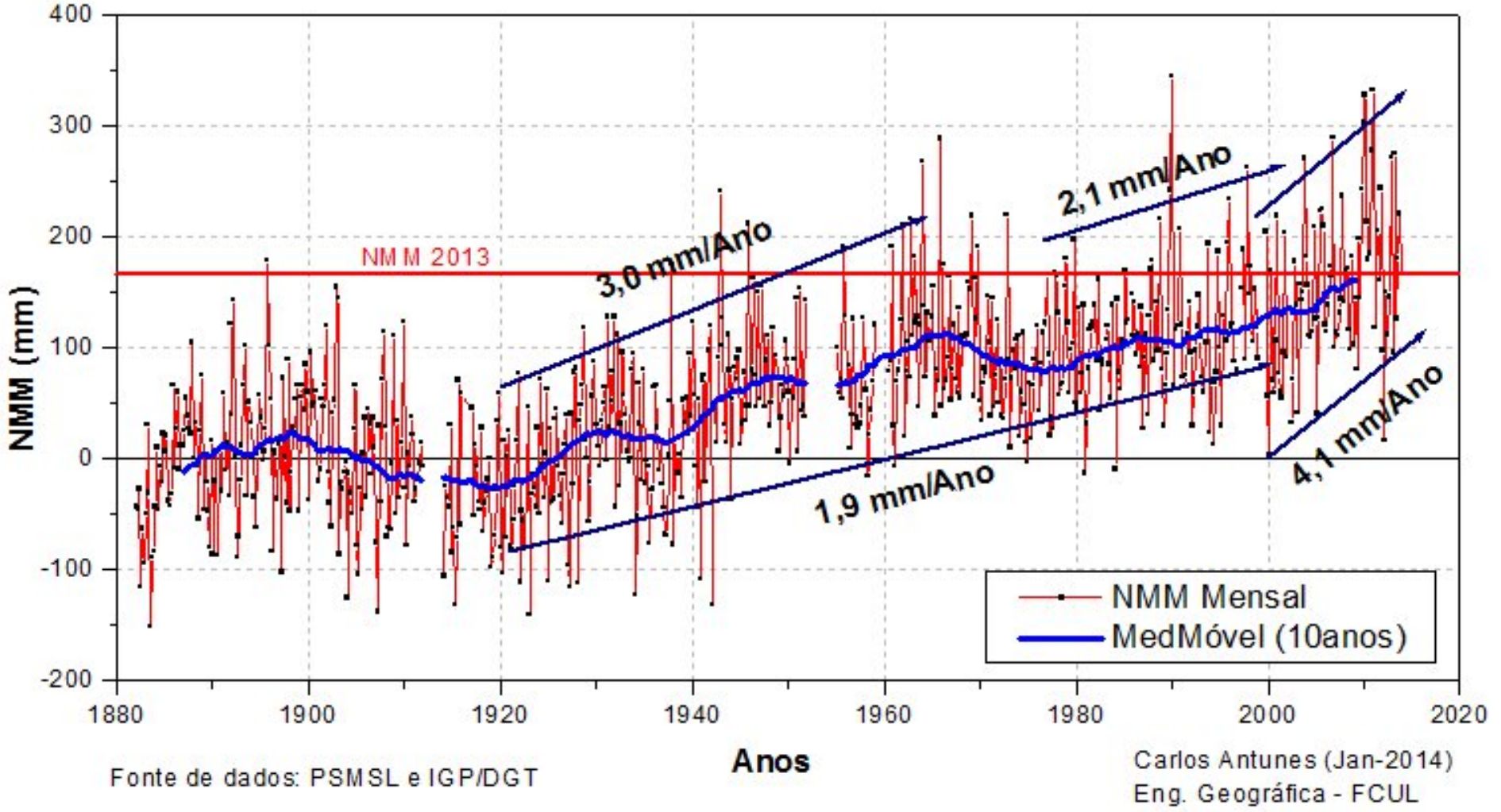
- Explore and realise the role of the insurance industry in investing and building critical infrastructure

4 RESILIENCE OF MEGA-CITIES AND URBAN AREAS

- Explore and realise the role of insurance in enhancing resilience of mega-cities and urban systems

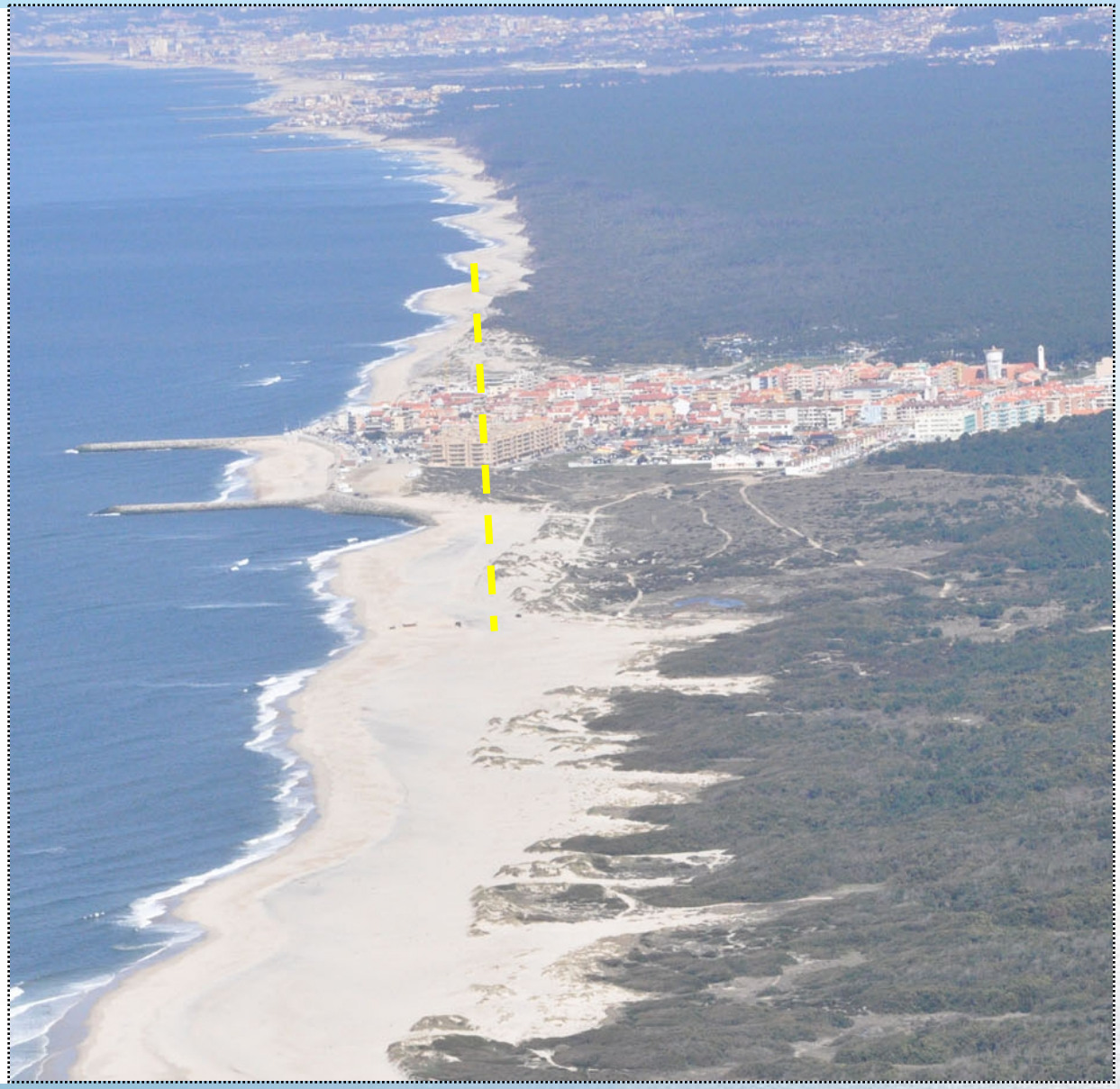

Situação de referência
Volumes em 100000 m3/ano
Fonte: GTL
1b
N
Porto
2
9
11
Douro
Espinho
Esmoriz
Maceda
Furadouro
Torreira
Vouga
Aveiro
Costa Nova
Praia de Mira
Quiaios
Mondego
0.3
n.s.
20
9
11
0 10 20 km
Legenda
fonte
sumidouro
sumidouro (retenção sedimentar)
deriva litoral
n.s. não significativo
valores em 10³m³/ano⁻¹
tracejado: informação relevante para a definição do balanço sedimentar

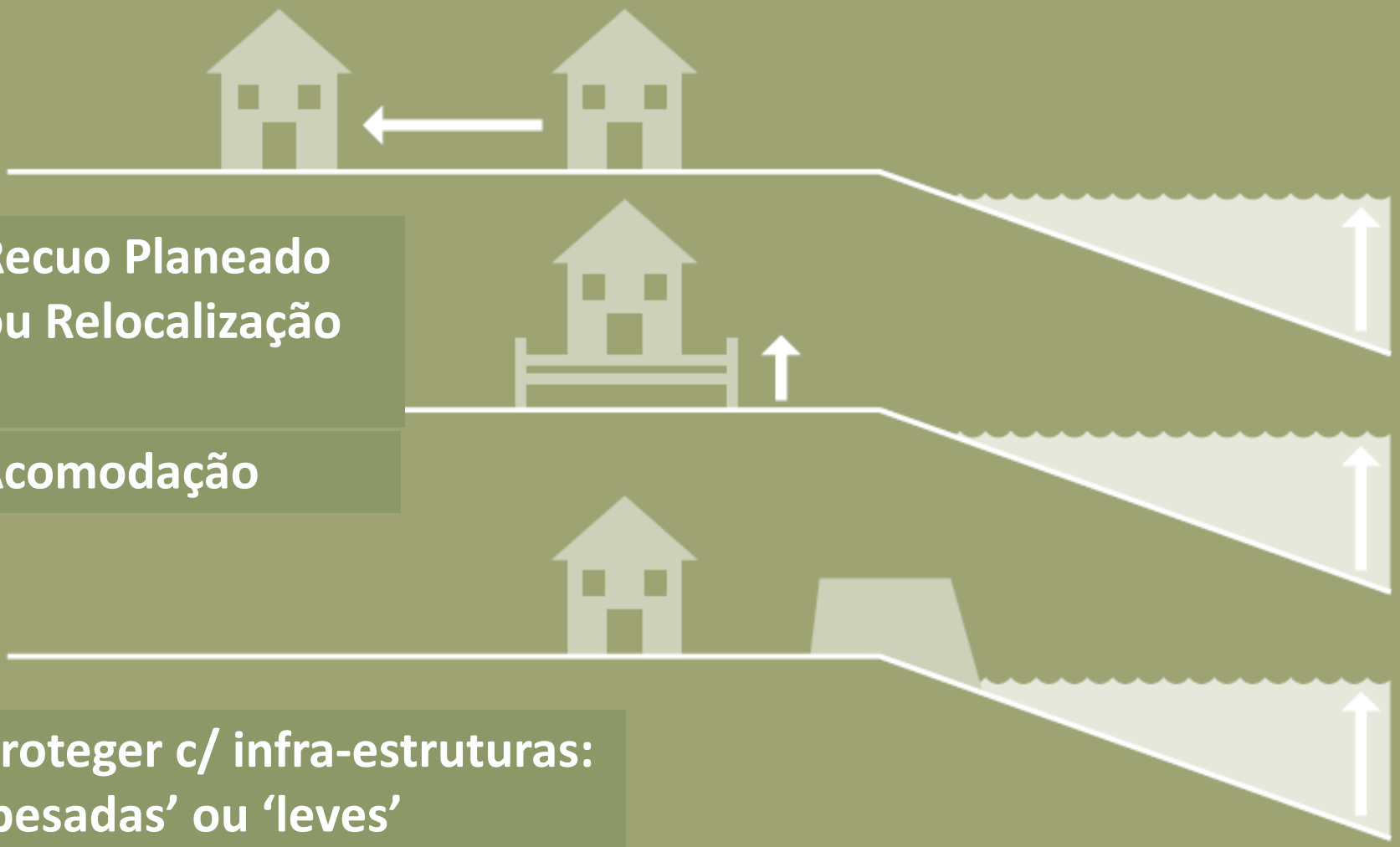

N
1
2
11
1b
Porto
Douro
Espinho
Furadouro
Torreira
Aveiro
Vouga
Costa Nova
Praia de Mira
Quiaios
Mondego
Situação actual
Fonte: GTL
Legenda
fonte
sumidouro
sumidouro (retenção sedimentar)
deriva litoral
erosão costeira
valores em 10³m³/ano¹
tracejado: informação relevante para a definição do balanço sedimentar
0 10 20 km
100


CASCAIS - VARIAÇÃO DO NÍVEL MÉDIO DO MAR
NMM (mm)
400
300
200
100
0
-100
-200
NMM 2013
3,0 mm/Ano
2,1 mm/Ano
1,9 mm/Ano
4,1 mm/Ano
NMM Mensal
MedMóvel (10anos)
1880
1900
1920
1940
1960
1980
2000
2020
Anos
Fonte de dados: PSMSL e IGP/DGT
Carlos Antunes (Jan-2014)
Eng. Geográfica - FCUL

Furadouro


Praia de Esmoriz
Cortegaça
Praia de Cortegaça
1 Km
Furadouro
Charegal
Marinha




Recuo Planeado
ou Relocalização
Acomodação
Proteger c/ infra-estruturas:
‘pesadas’ ou ‘leves’

Fonte:

PLANNING THEORY & PRACTICE, 2016
http://dx.doi.org/10.1080/14649357.2016.1215511

Participation, scenarios and pathways in long-term planning for climate change adaptation

Inês Campos[a], André Vizinho[a], Carlos Coelho[b], Fátima Alves[c], Mónica Truninger[d], Carla Pereira[b], Filipe Duarte Santos[a] and Gil Penha Lopes[a]

[a]Centre for Ecology, Evolution and Environmental Changes (CE3C) Faculty of Sciences, Universidade de Lisboa, Lisbon, Portugal; [b]Risco and Department of Civil Engineering, Universidade de Aveiro, University Campus of Santiago, Aveiro, Portugal; [c]Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning, Universidade de Aveiro, University Campus of Santiago, Aveiro, Portugal; [d]Instituto de Ciências Sociais (ICS), Universidade de Lisboa, Lisbon, Portugal

ABSTRACT

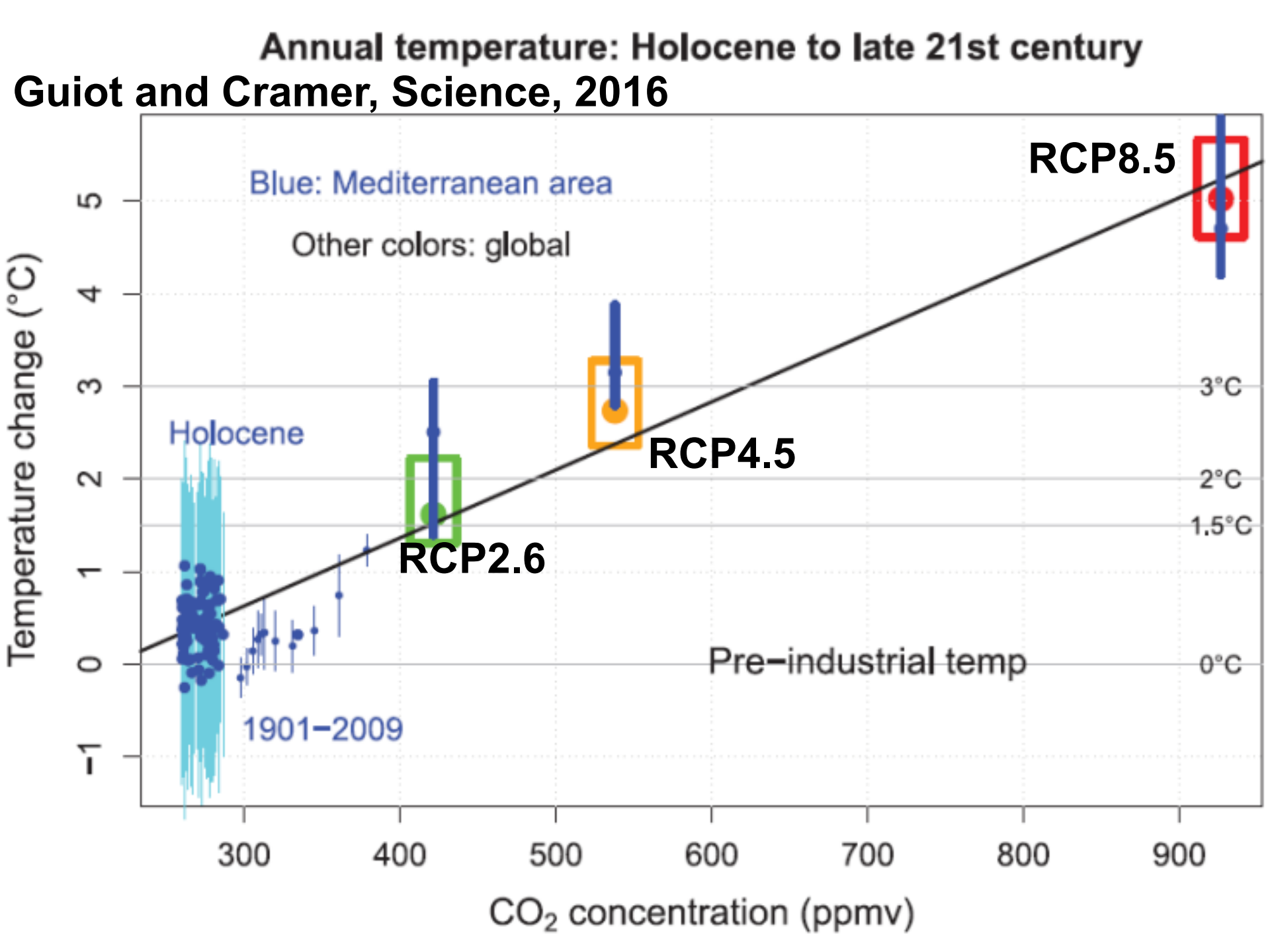
This article describes a climate change adaptation planning process triggered by a group of researchers and stakeholders in a context where no collective responses or long-term plans for protecting a vulnerable coastal system had been initiated, despite local perceptions of vulnerability and risk. The case study shows the application of two methods: scenario workshops and adaptation pathways in the context of a participatory action research methodological design. Participatory action research and qualitative scenario methods are highlighted as accelerators of climate change adaptation processes by calling to action, facilitating and connecting diverse social groups with a stake in a long-term plan towards a more adapted society. The experience leads to the conclusion that planning climate change adaptation has to go far beyond the technical dimension and take into account those affected (in the present and the future) by decisions made. A holistic approach to climate change adaptation planning will depend on the interrelations of managerial and top-down approaches with localized initiatives driven through an inclusive and collective action research process.

ARTICLE HISTORY
Received 27 May 2015
Accepted 18 July 2016

KEYWORDS
Climate change adaptation; long-term; scenario workshop; adaptation pathways; participation

Desertificação no Alentejo Foto: M.J.Roxo

É urgente monitorizar o Montado


Annual temperature: Holocene to late 21st century
Guiot and Cramer, Science, 2016
Blue: Mediterranean area
Other colors: global
Holocene
1901−2009
RCP2.6
RCP4.5
RCP8.5
Pre−industrial temp
3°C
2°C
1.5°C
0°C
Temperature change (°C)
−1
0
1
2
3
4
5
300
400
500
600
700
800
900
CO2 concentration (ppmv)

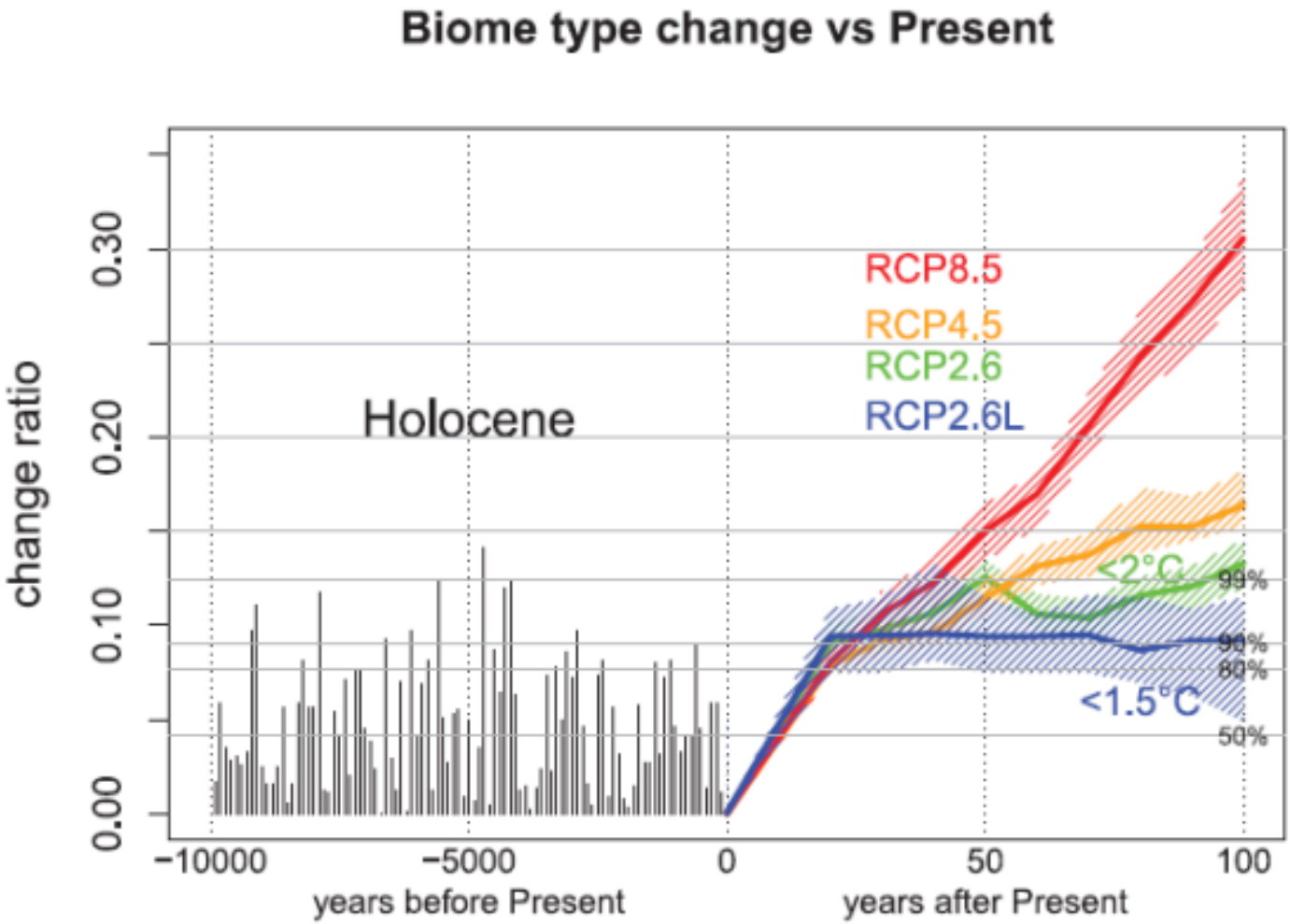
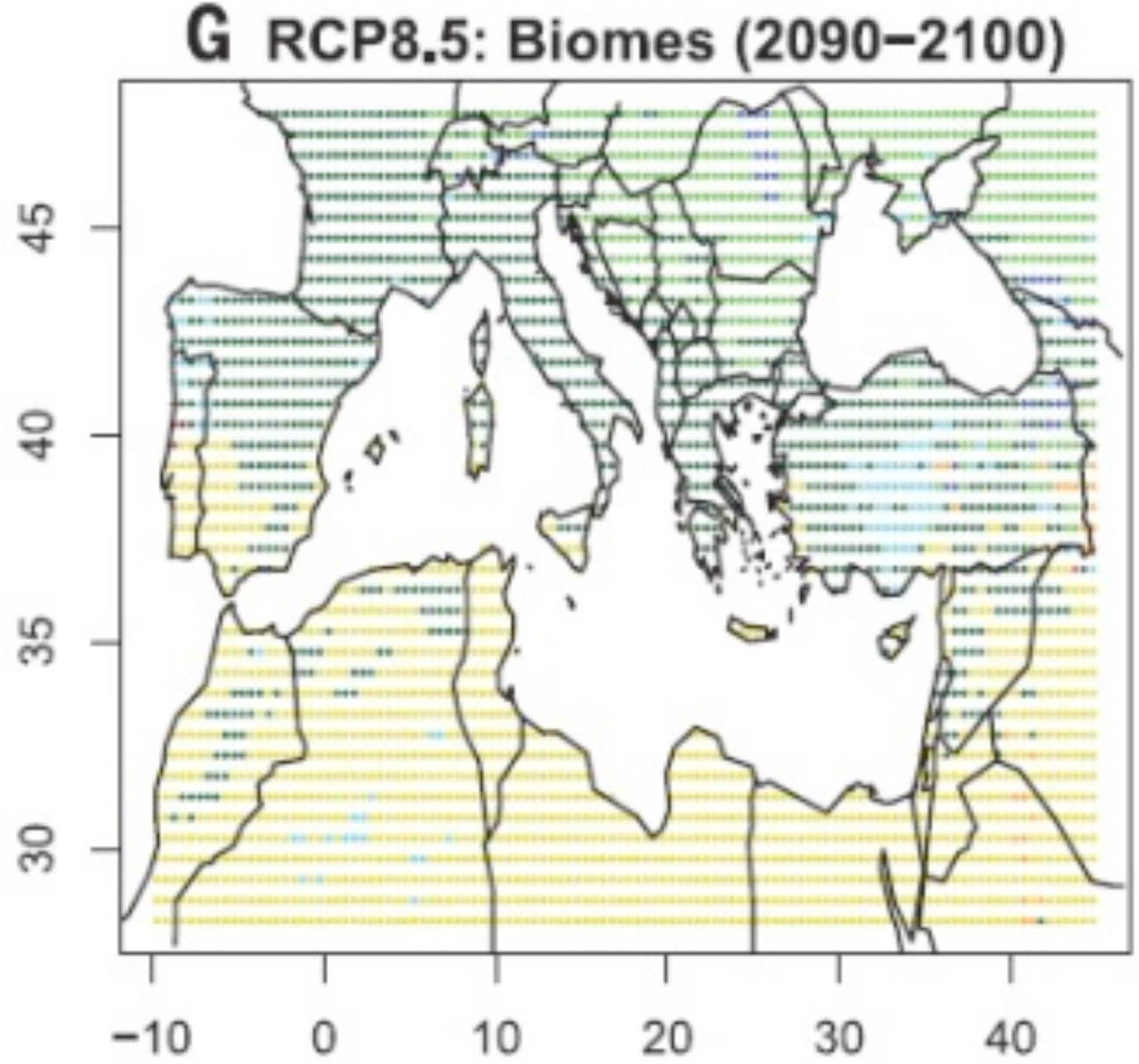


Fig. 2. Proportion of grid cells with a biome change relative to the preindustrial period for the Mediterranean area (10°W to 45°E, 28°N to 48°N). The horizontal axis represents the time scale, in years before the present (20th century) for the past (negative numbers) and in years after the present (CE 2000–2010) for the future (positive numbers). Holocene biomes (in black) are based on reconstructions from pollen data (*4*). Colored lines are given by the BIOME4 model as applied to the RCP projections (see text). Horizontal lines represent the 50th, 80th, 90th, and 99th percentiles of the Holocene values. The colored areas illustrate the interquartile interval provided by the intermodel variability.


G RCP8.5: Biomes (2090−2100)
45
40
35
30
−10
0
10
20
30
40

AdaptForChange

Cenários Climáticos para Mértola (RCP8.5)

RCP 8.5 Mértola	2010	2040	2070	2100
Precip. média anual	482mm	404mm	316mm	288mm
Temp. Mín	3.89 ºC	4.73 ºC	5.15 ºC	6.43 ºC
Temp. média anual	16.9 ºC	17.5 ºC	18.9 ºC	20.9 ºC
Temp. Máx (Agosto)	33.1 ºC	36.26 ºC	37.56 ºC	39.5 ºC

Fonte: Projeto ClimAdapt.Local, Calheiros et 2015

1º Actuar sobre a Exposição / Causas (D + P):

- ••Redução
- ••Sumidouro

1.Mitigação 

- ••Utilizar microclimas para localizar culturas
- ••Criar microclimas

2.Microclimas 

2º Actuar sobre a Sensibilidade / Consequências (S + I):

- ••Barragens
- ••Lagos permanentes
- ••Charcas

3. Capturar Água Chuva 

- ••Diversidade de culturas, espécies, variedades
- ••Preservar património genético
- ••Montado

3.Diversidade 

- ••Utilizar Espécies Adequadas ao clima esperado
- ••Seleccionar e melhorar espécies

3. Espécies 

- ••Regenerar solo
- ••Eficiência no uso da água
- ••Gestão das pastagens

3. Boas práticas 

- ••Seguros agrícolas
- ••Reforçar estruturas
- ••Guardar alimento
- ••Proteger culturas e gado das pragas, calor e frio

4. Protecção 

3º Actuar sobre a Capacidade de Adaptação

PROMOÇÃO E FORMAÇÃO

GOVERNANÇA

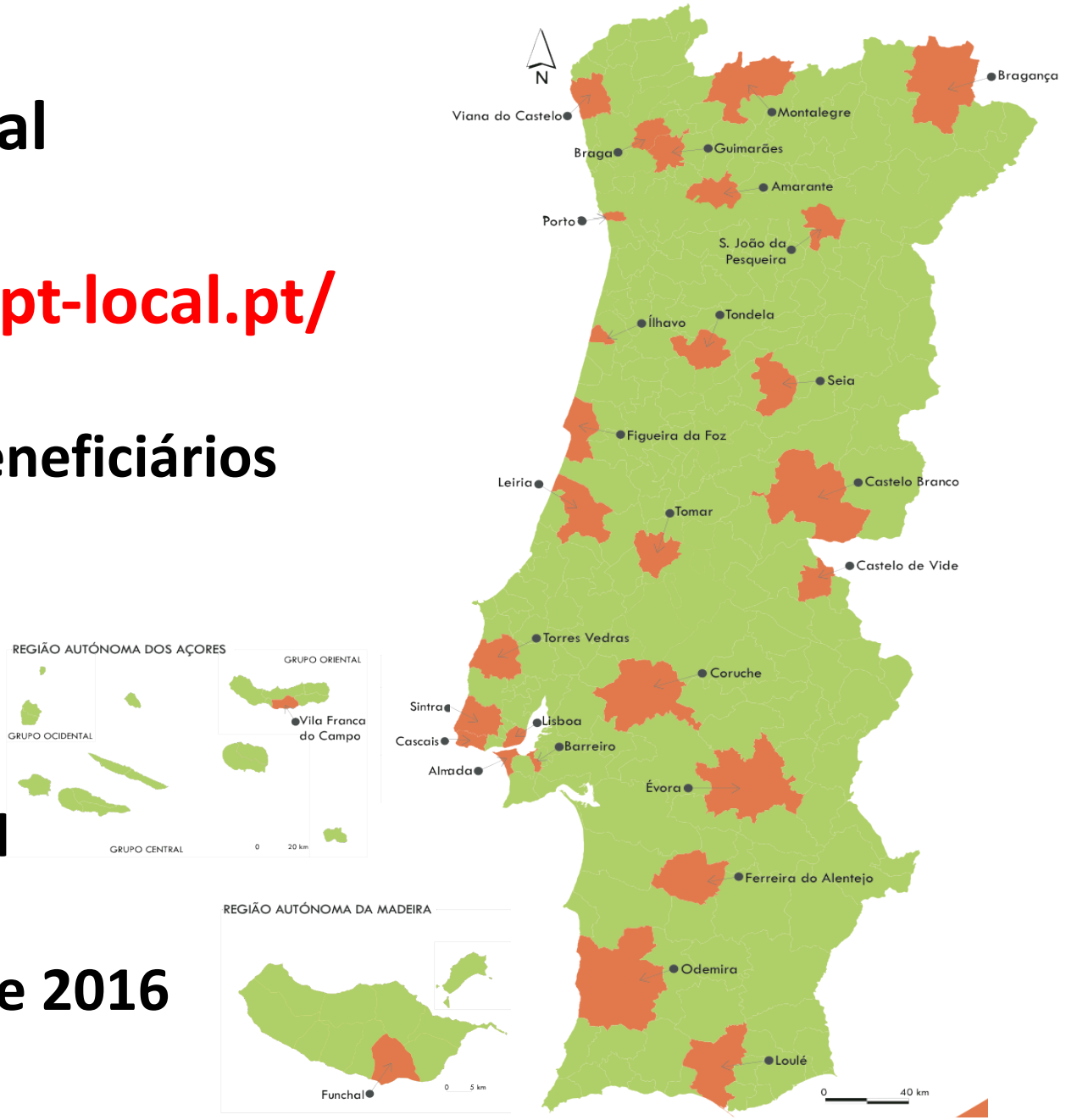
FINANCIAMENTO

MONITORIZAÇÃO

Projeto ClimAdaPT.Local

http://climadapt-local.pt/

26 Municípios beneficiários



Conferência Final
Coimbra
9 de dezembro de 2016

05

MANUAL

INTEGRAÇÃO DAS OPÇÕES DE ADAPTAÇÃO NOS INSTRUMENTOS DE GESTÃO TERRITORIAL DE ÂMBITO MUNICIPAL

ELABORAÇÃO DE ESTRATÉGIAS MUNICIPAIS
DE ADAPTAÇÃO ÀS ALTERAÇÕES CLIMÁTICAS

Obrigado pela vossa atenção