O Desafio da Alterações Climáticas no Setor dos Recursos Hídricos em Portugal

Filipe Duarte Santos
fdsantos@fc.ul.pt

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

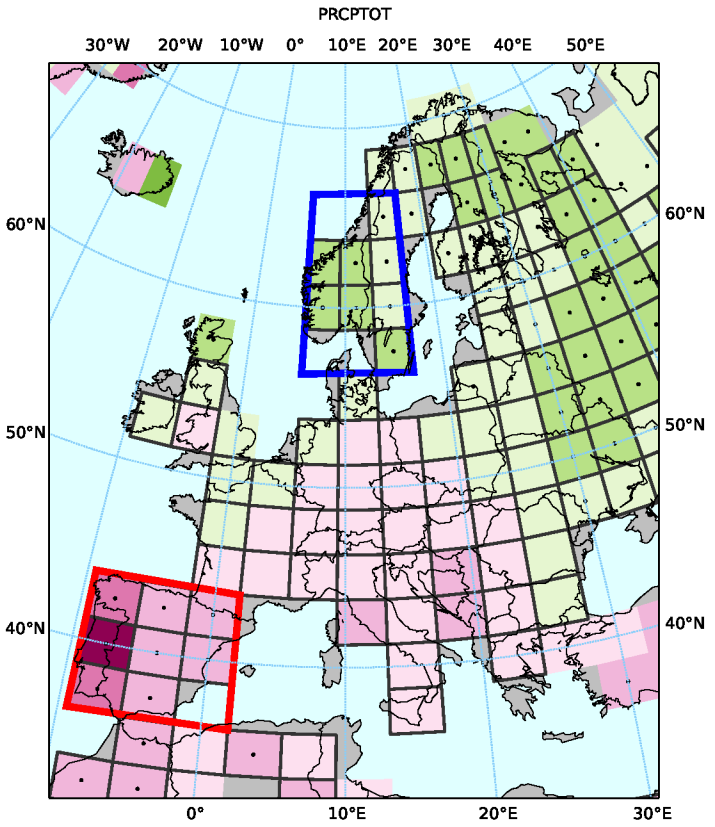
Planeamento dos recursos hídricos no âmbito da DQA - desafios para 2016-2021
Associação Portuguesa de Recursos Hídricos

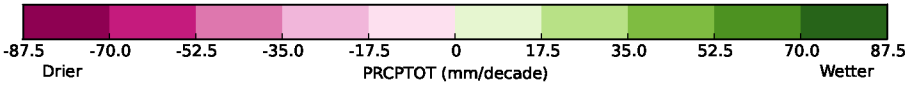
Lisboa, 10 de Março, 2015

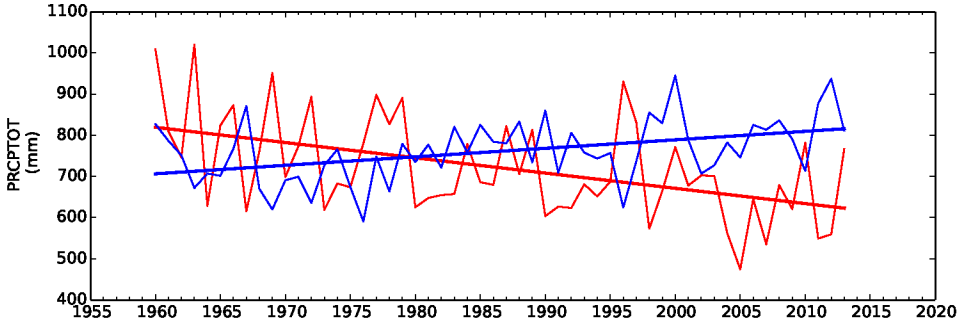
Precipitação observada na Europa 1960 - 2014

Aumento da precipitação anual na Escandinávia: 20.64mm por década

Diminuição da Precipitação anual na Península Ibérica:
-37.07mm por década
-196.45mm (-293.79 mm a -82.31mm)
EEA Report, 2012





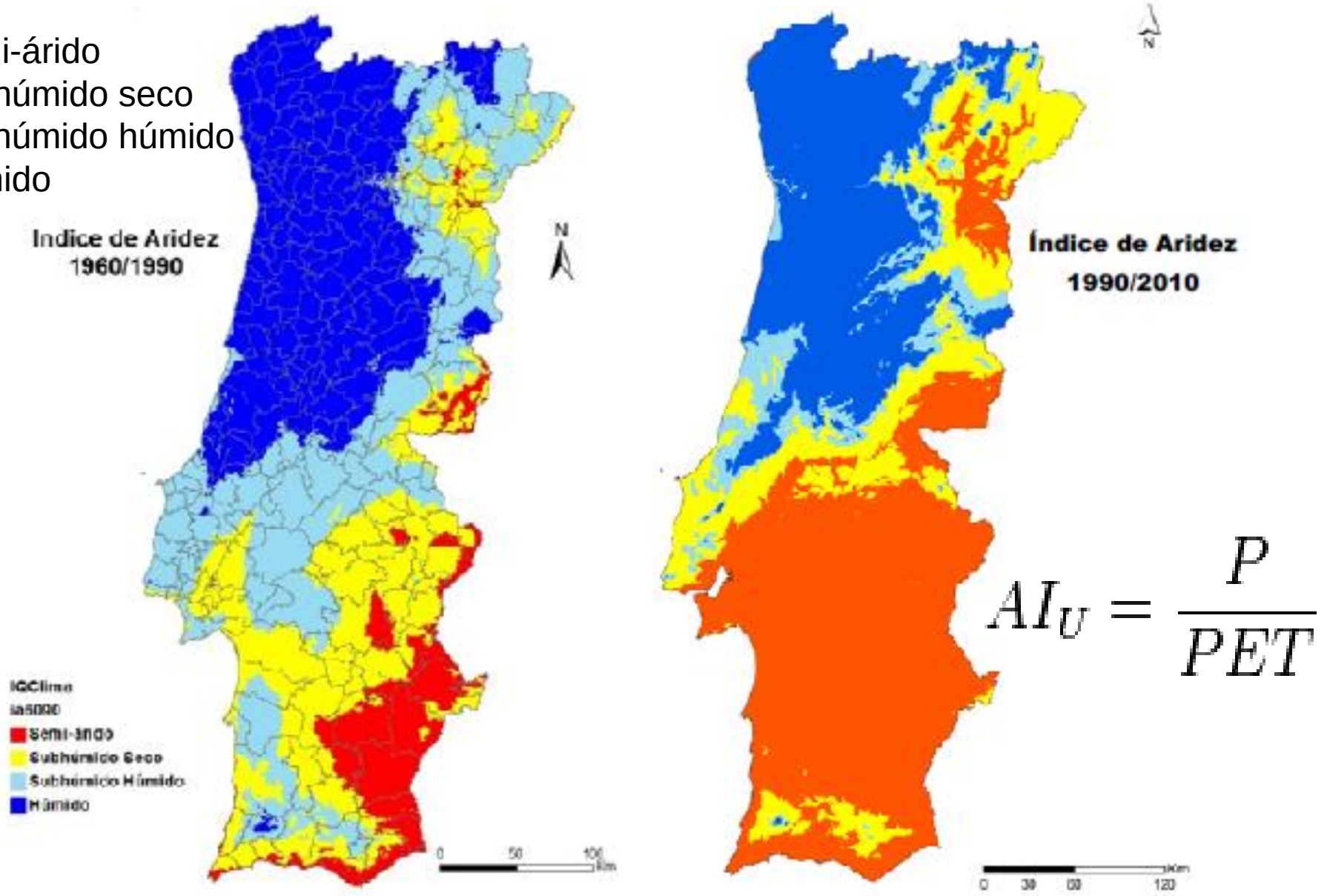


Fonte, IPMA

Variação decadal da precipitação em Portugal Continental

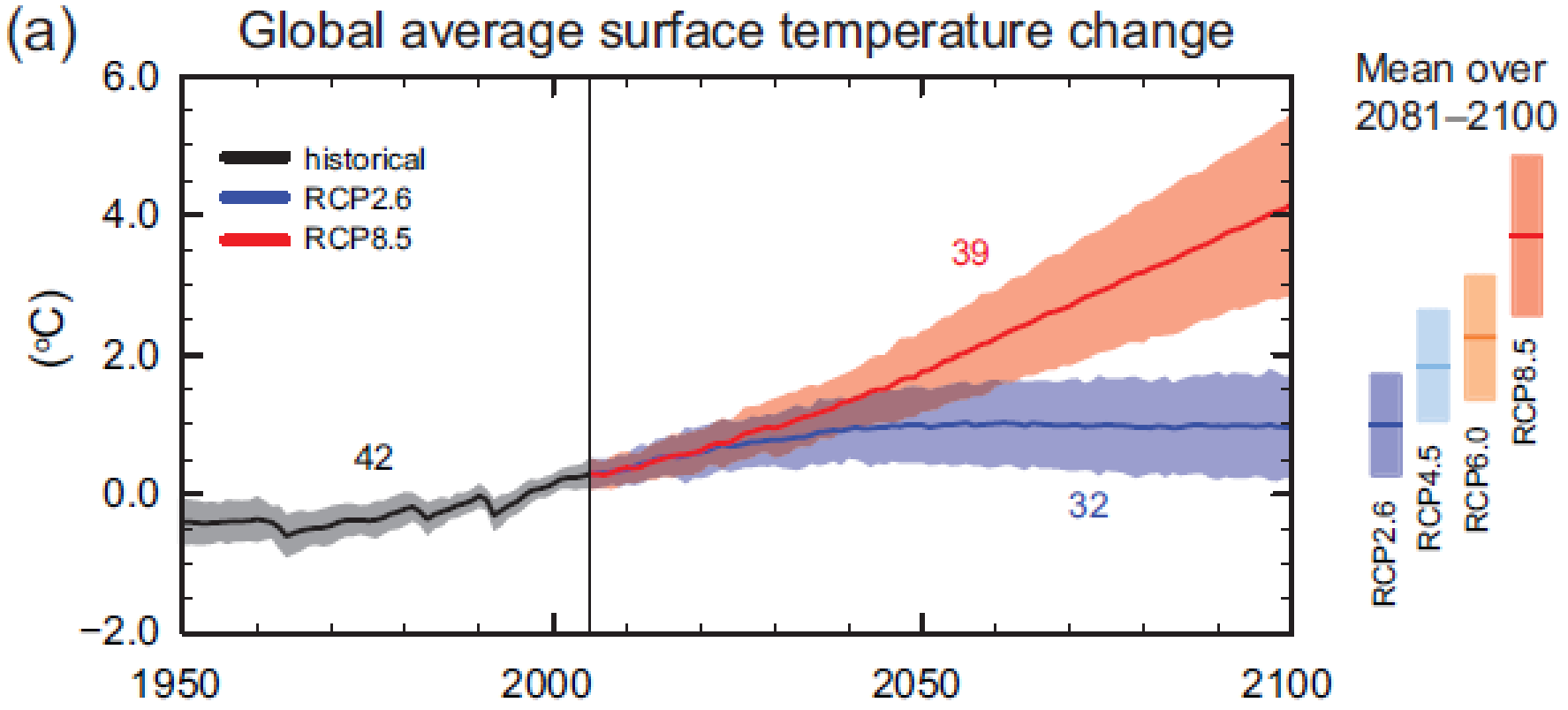
Evolução do Índice de Aridez em Portugal continental nos últimos 50 anos

Semi-árido
Subhúmido seco
Subhúmido húmido
Húmido

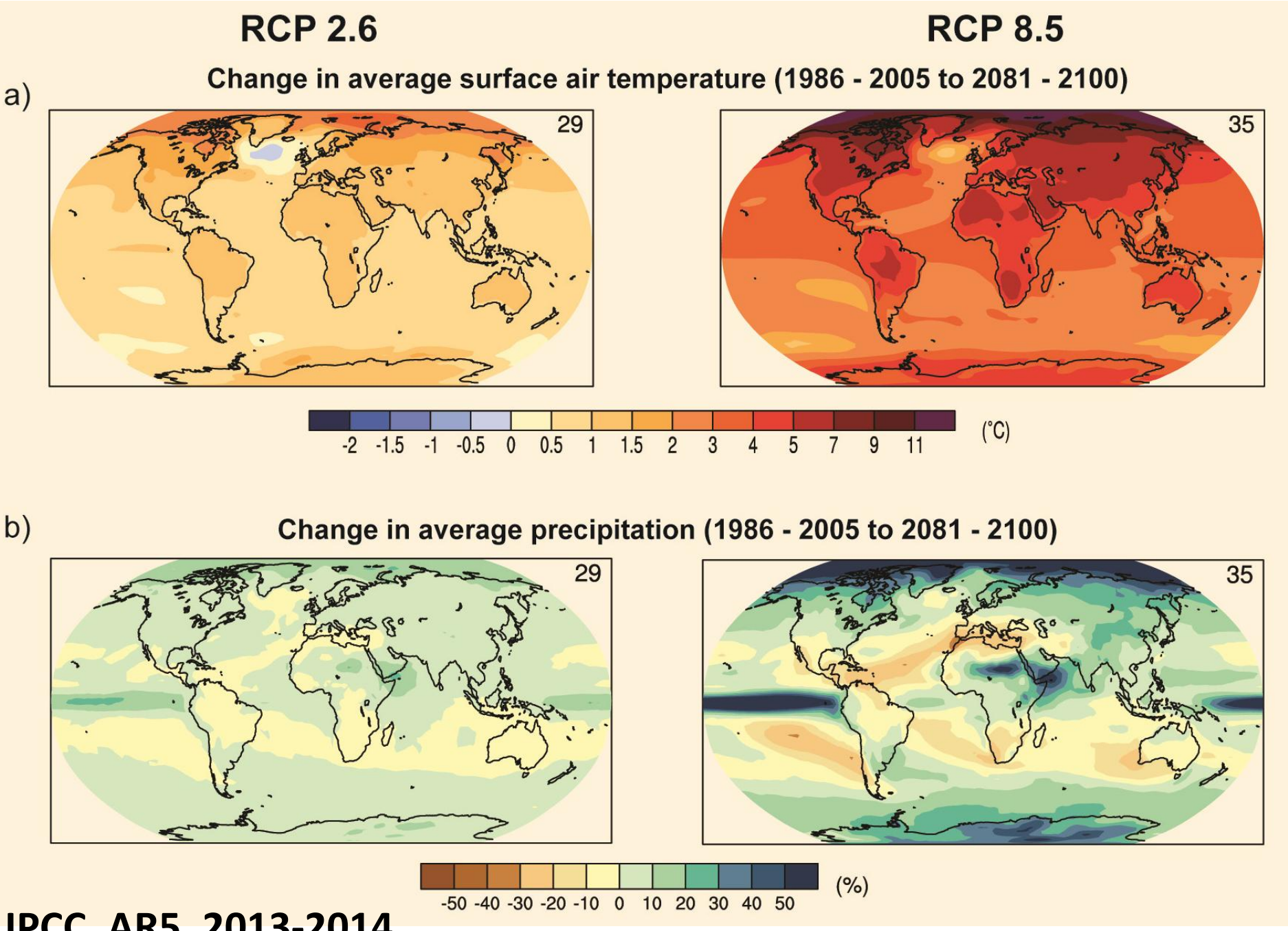


$$AI_U = \frac{P}{PET}$$

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


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

IPCC, 2014



IPCC, AR5, 2013-2014

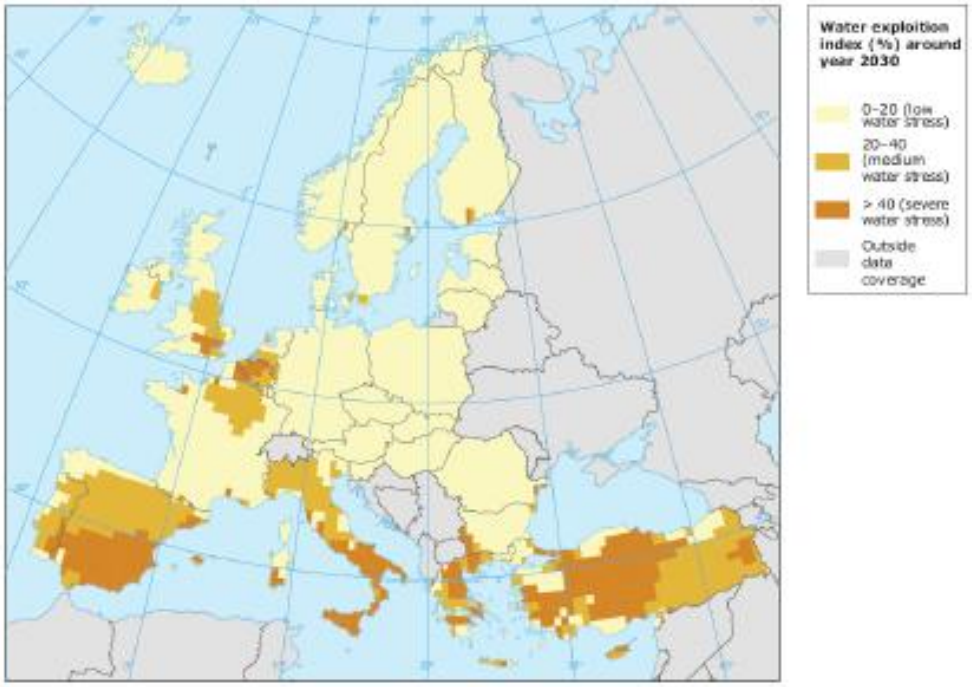
A tale of two Europes

Source: EEA

One threatened by drought

One threatened by floods

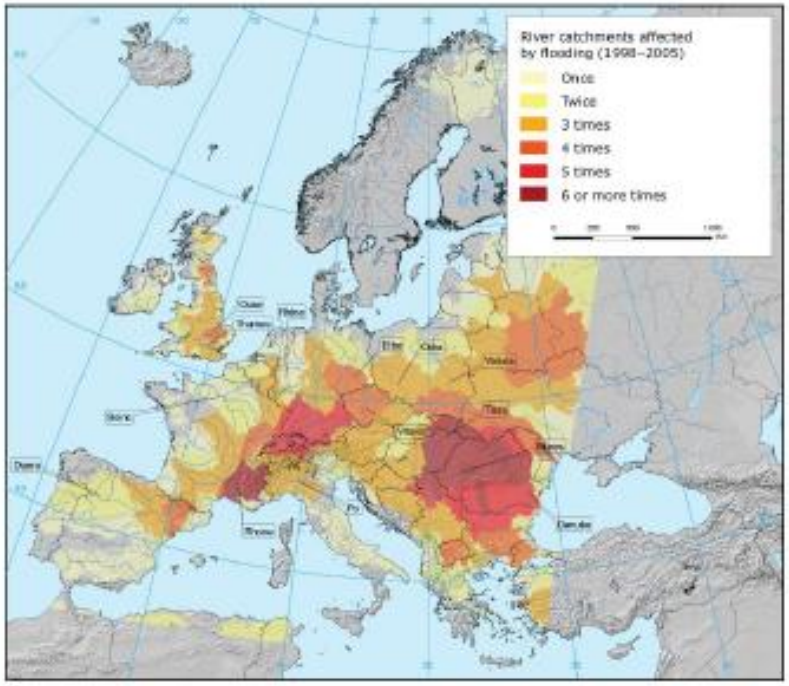
Figure 1.4 Water stress in European river basins under a base-line scenario by 2030



Note: The water exploitation index is the percentage of available water resource abstracted each year.
Source: EEA, 2005b.

Water exploitation index (%) aroud 2030

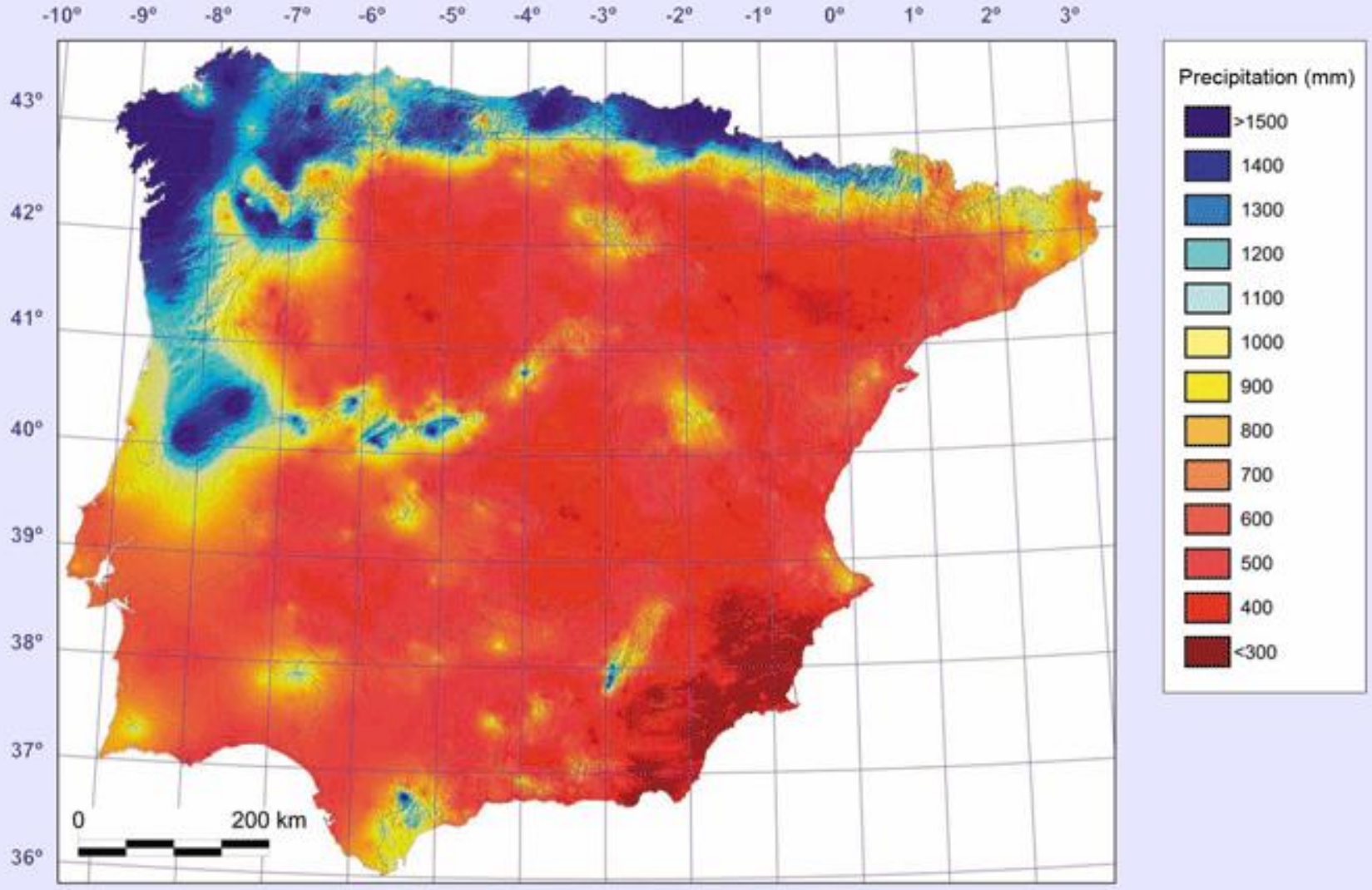
Figure 1.3 Recurrence of flood events in Europe between 1998 and 2005



Source: EEA, based on data from Dartmouth Flood Observatory.

River catchments affected by floods 1998-2005

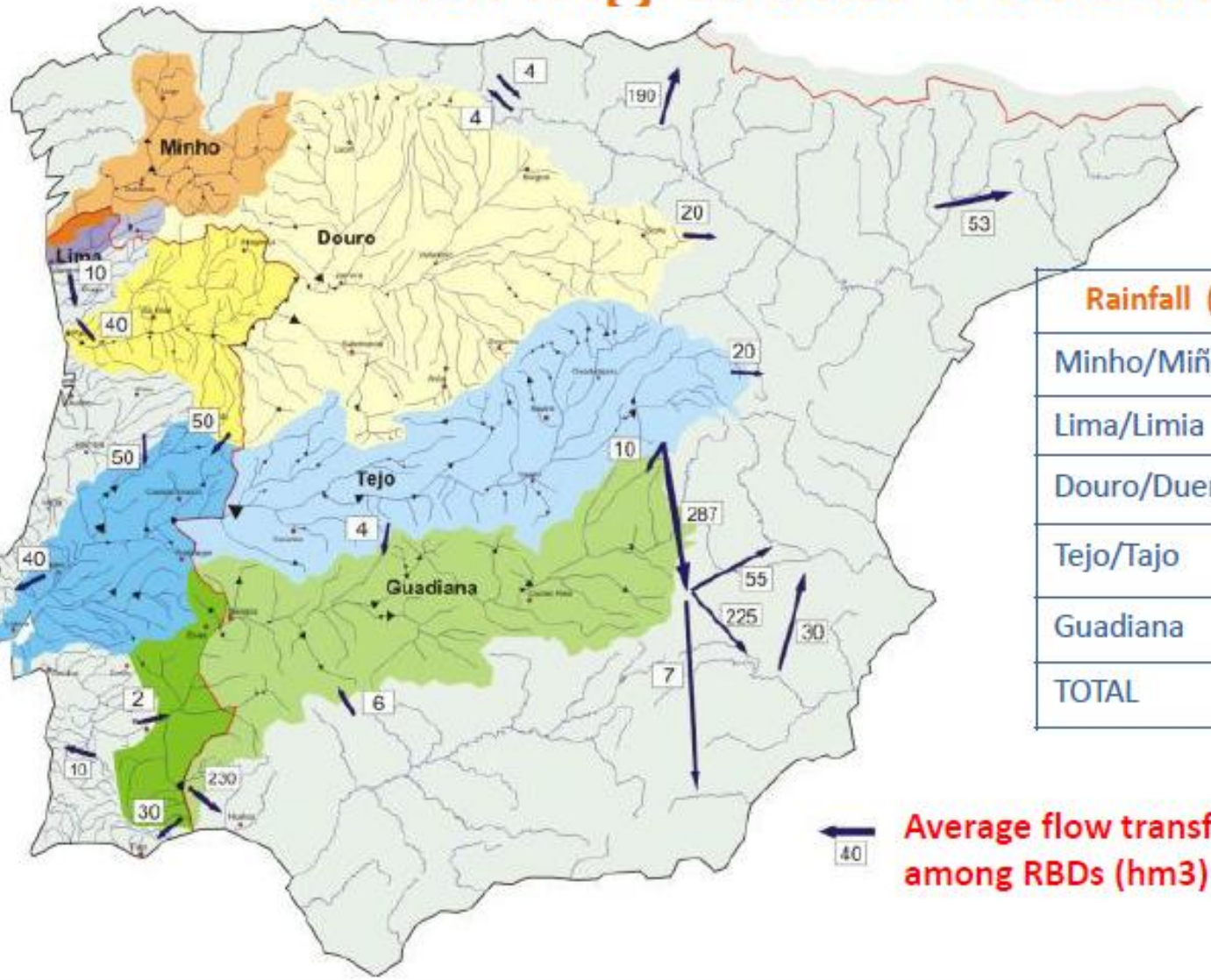
Iberian Peninsula: Annual Precipitation



Source: Ninyerola, Pons and Roure (2005)

Water Transfer Between River Basins

Sharing water resources



Rainfall (mm)	Portugal	Spain
Minho/Miño	2040	1228
Lima/Limia	2280	1440
Douro/Duero	1030	611
Tejo/Tajo	830	633
Guadiana	580	521
TOTAL	6760	4433

The Tagus-Segura water transfer

The water transfer in figures:

- In 1978 the first water runs through the transfer.
- From the Iberian System in Central Spain:
  - 600 hm^3 of water goes to the Mediterranean Southeast region.
  - 50 hm^3 of water goes to the protected area Tablas de Daimiel.
- Length: 286 km

More water, but not for irrigation

Since 1999 the whole 600 hm^3 of water per year is being transferred. The main reason for the increase in transferred water is the improvement of the availability of infrastructures to make use of the water. In spite of this increase, not all planned irrigations are working. It can be concluded that the transferred water goes more and more to urban and tourist water supply instead of irrigation.

ICPDR
Contracting Parties

icpdr iksd
International Commission for the Protection of the Danube River
Internationale Kommission zum Schutz der Donau

- Germany
- Austria
- Czech Republic
- Slovakia
- Hungary
- Slovenia
- Croatia

- Bosnia & Herzegovina
- Serbia
- Montenegro
- Romania
- Bulgaria
- Rep. of Moldova
- Ukraine
- European Union

– EU Member States (9)
– Non-EU Member States (5)

Stakeholder Involvement
22 Observer Organisations

icpdr iksd
International Commission for the Protection of the Danube River
Internationale Kommission zum Schutz der Donau

Danube Ministerial Meeting 2010

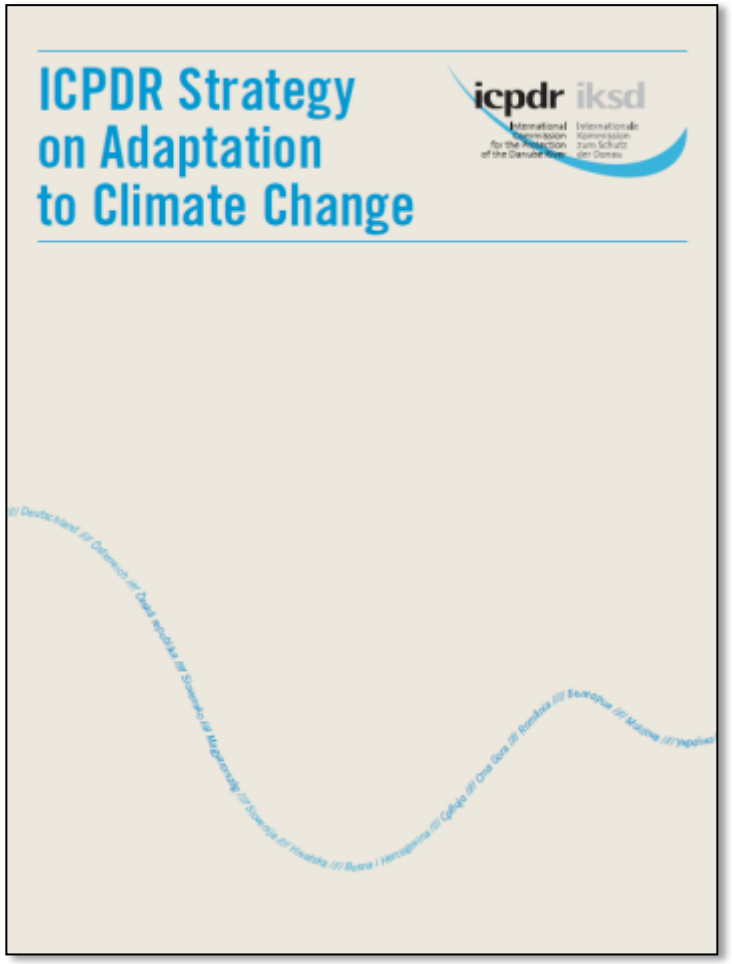
icpdr iksd
International Commission for the Protection of the Danube River
Internationale Kommission zum Schutz der Donau

ICPDR was asked to develop until 2012 a **Climate Adaptation Strategy** for the Danube River Basin

Danube Climate Adaptation Strategy

Main elements

http://www.icpdr.org/main/activities-projects/climate-change-adaptation



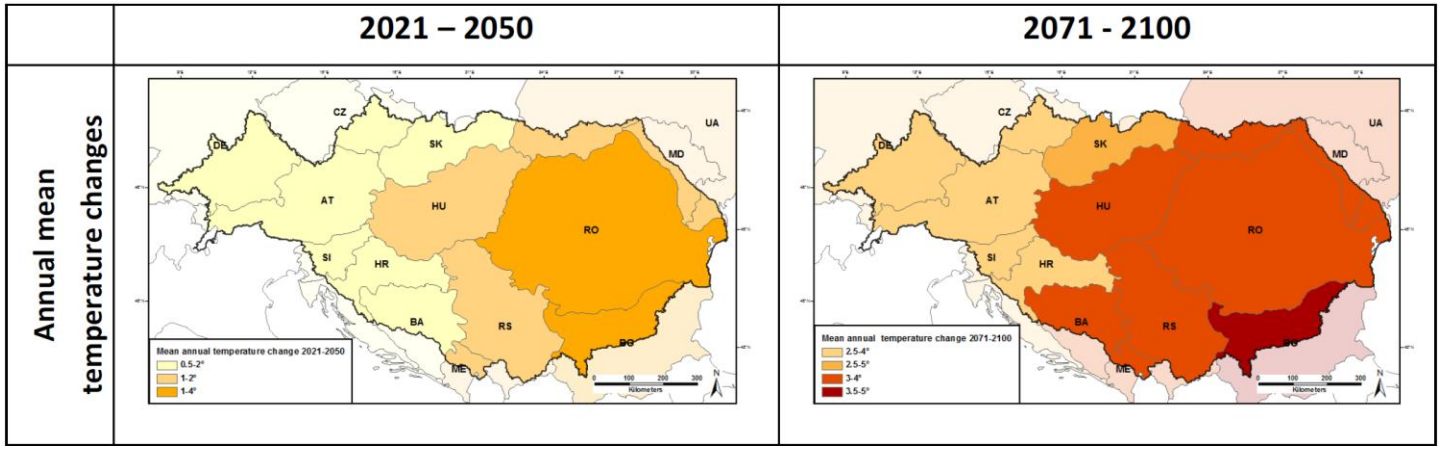
Contents:

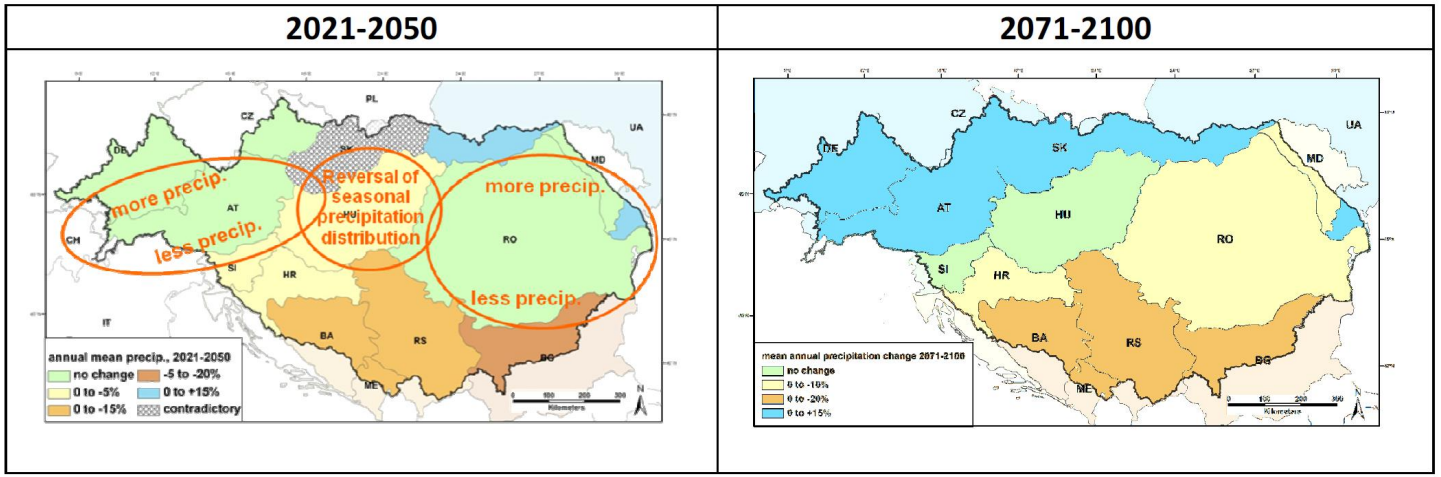
1. Introduction
2. Framework conditions
3. Climate change scenarios
4. Water-related impacts
5. Vulnerability
6. Overview of possible adaptation measures
7. Guiding principles on adaptation and integration into ICPDR activities
8. Next steps

Danube Climate Adapation Strategy

Climate change scenarios

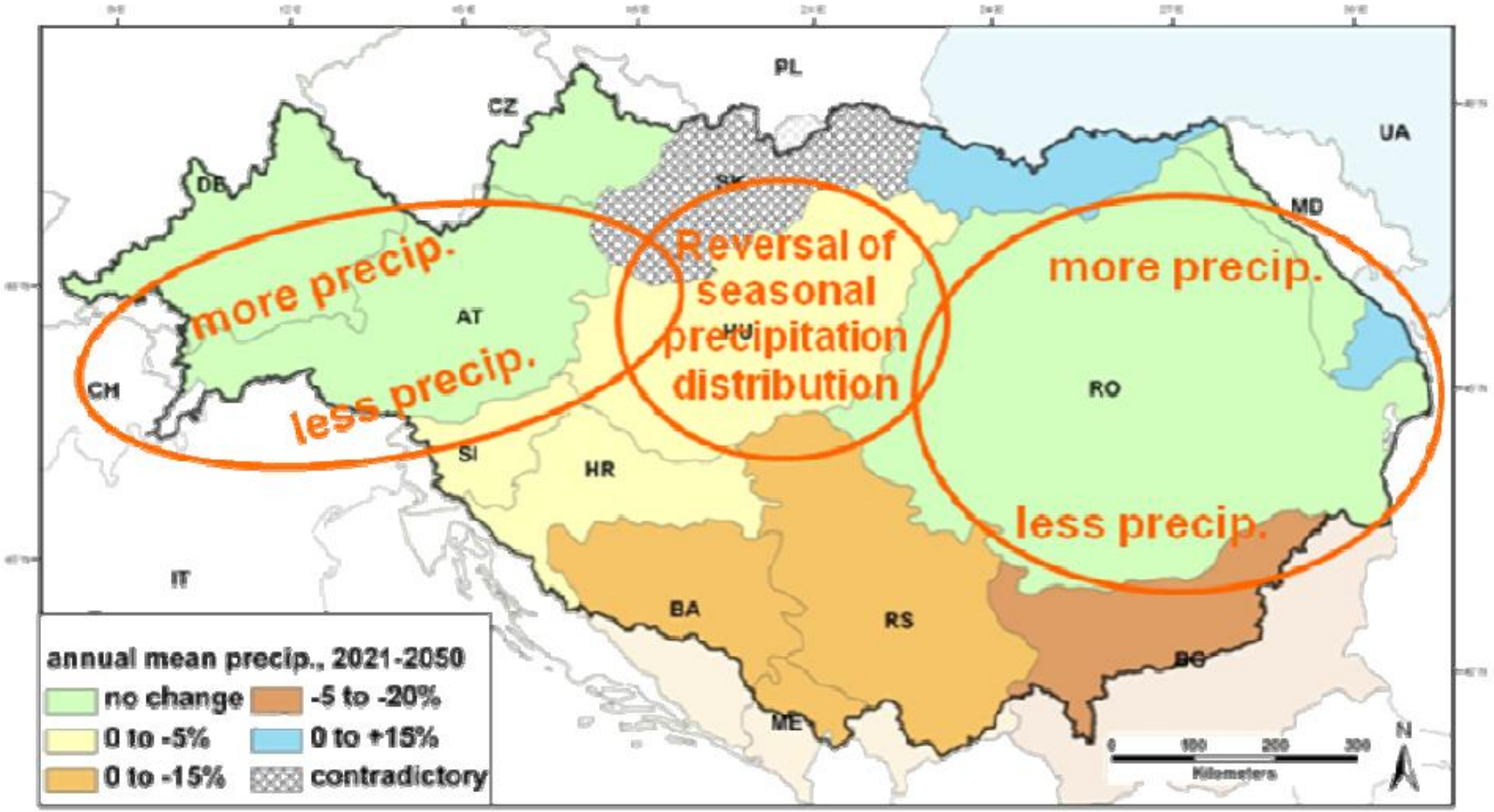
Annual mean temperature changes



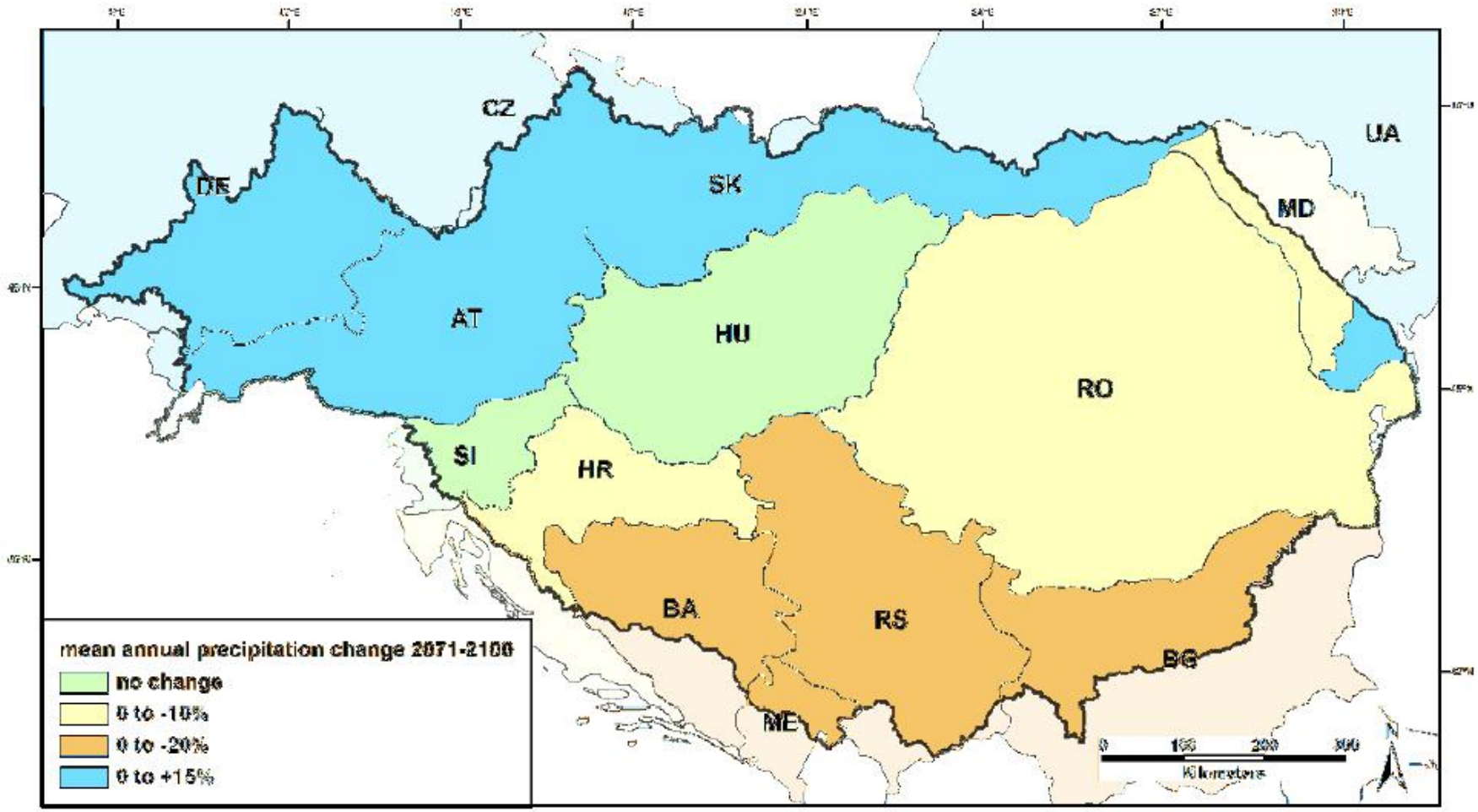


Changes in mean annual precipitation

2021-2050


PL
CZ
UA
DE
SK
MD
more precip.
AT
HU
Reversal of seasonal precipitation distribution
more precip.
CH
less precip.
RO
SI
HR
less precip.
IT
BA
RS
BG
ME
annual mean precip., 2021-2050
no change
-5 to -20%
0 to -5%
0 to +15%
0 to -15%
contradictory
0
100
200
300
Kilometers
N

2071-2100


CZ
DE
SK
UA
MD
AT
HU
RO
SI
HR
BA
RS
BG
ME
mean annual precipitation change 2071-2100
no change
0 to -10%
0 to -20%
0 to +15%
Kilometers

Water-related impacts

- **Changes** in seasonal **runoff patterns**
- **Droughts**, low flow situations and **water scarcity** likely to become **more intense**, longer and more frequent
- Local and regional **increased heavy rainfall**, however, **no clear picture for changes in flood** magnitude and frequency
- **Changes for ecosystems** and biodiversity predicted with shifts of aquatic and terrestrial flora and fauna
- **Sectors** as agriculture, forestry, navigation and water related energy production **likely to suffer**

Second Mekong Climate Change Forum promotes 'trans-boundary' adaptation

The Second Mekong Climate Change Forum was held in Siem Reap, Cambodia on 6-8 October 2014, five years after the first Forum in Bangkok, Thailand. The three-day event brought together 175 participants, including academics, development agency officials, and representatives of the Mekong River Committee (MRC) and National Mekong Committees, to share their knowledge and experience on the topic of climate change adaptation in the river basin, particularly in the trans-boundary context.

2nd Mekong Climate Change Forum

Adaptation to Climate Change in the Transboundary Context

6 - 8 October 2014

Siem Reap, Cambodia

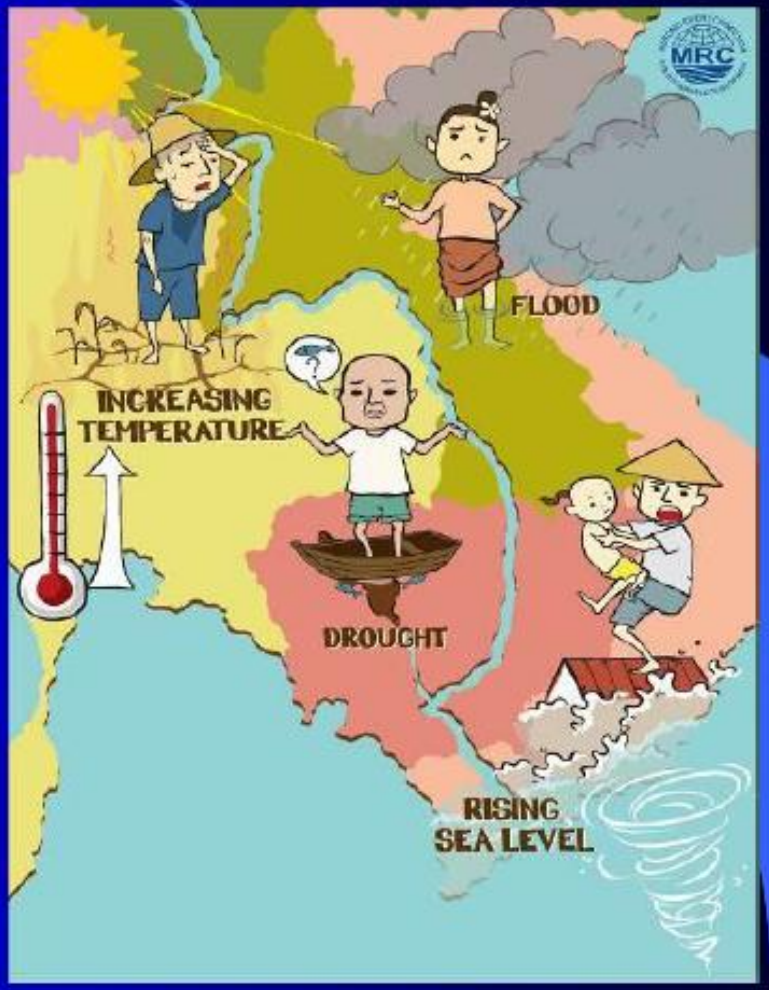
National and transboundary adaptation strategies and action plans in the Lower Mekong Basin, Cambodia

By KOL Vathana

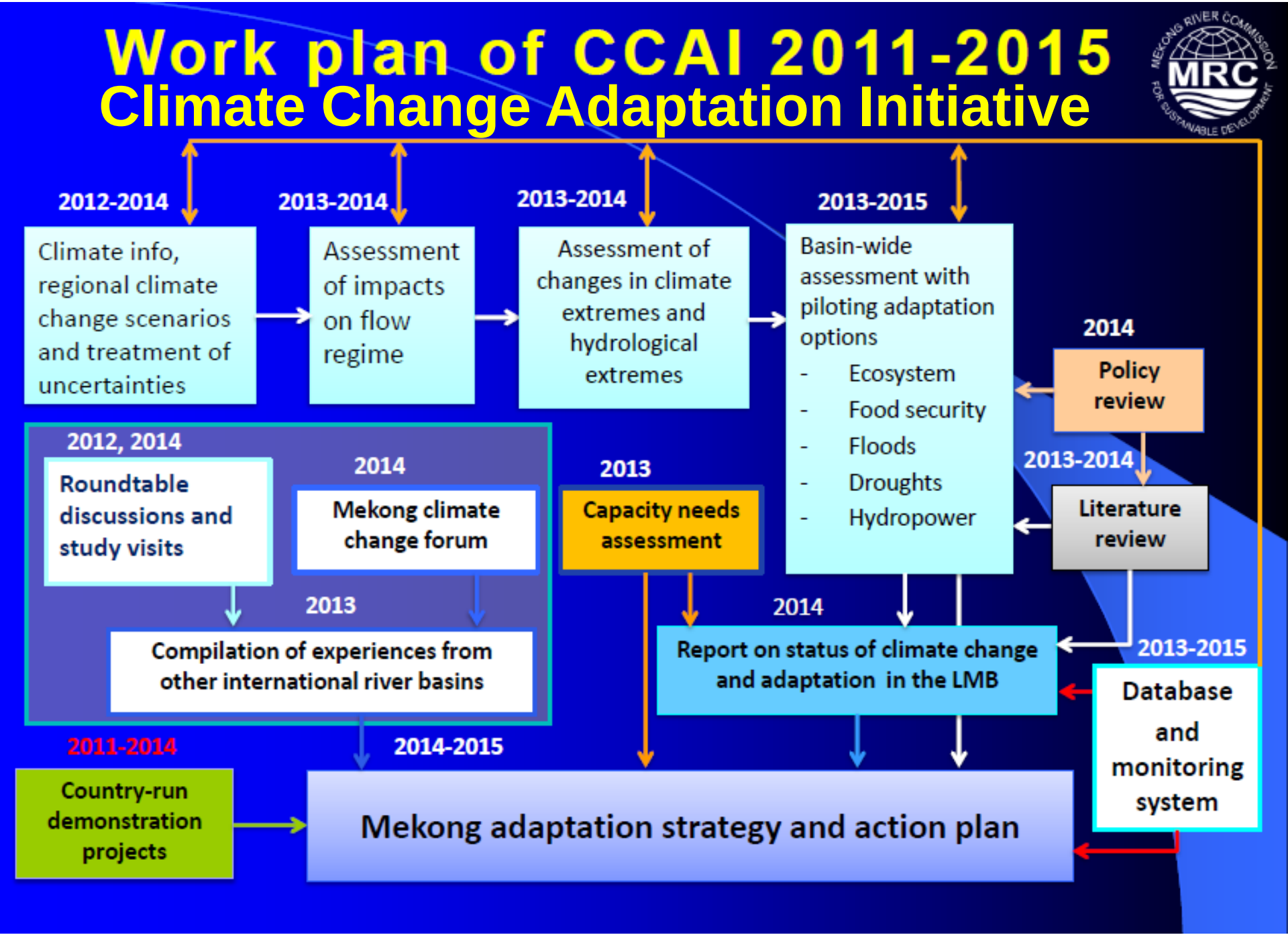
Deputy Secretary General and

CCAI National Coordinator, CNMC

Climate change in the LMB



Work plan of CCAI 2011-2015
Climate Change Adaptation Initiative



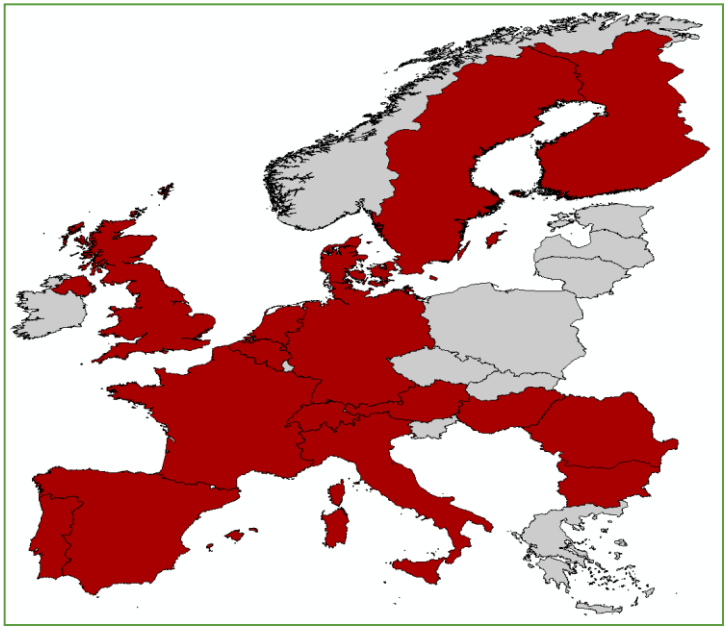
Impacts and Risks from High-End Scenarios: Strategies for Innovative Solutions

Funded by the 7th Framework Programme of the European Union
Contract Number: 603416

SEVENTH FRAMEWORK PROGRAMME

What is IMPRESSIONS?

- **Imp**acts and **R**isks from High-**E**nd **S**cenarios: **S**trategies for **I**nnovative Soluti**ons**
- EU FP7 Project which started 1 November 2013
- EU contribution: ~ 9m €
- Duration: 5 years
- Coordinated by University of Oxford, UK
- Transdisciplinary consortium of 24 partners from 16 European countries



Multi-scale: 6 case studies

Global and central Asia case studies

European case study

- 3 regional/local case studies (Scotland, 2 Iberian catchments, 2 Hungarian municipalities)

The Iberian case study

EC Seventh Framework Programme
Contract Number: 603416

Overall aim

- To improve scientific understanding of the **implications of scenarios involving high levels of climate and socio-economic change in South-west Iberia**
- **Work jointly with decision-makers** to explore the development of systemic **transformative solutions** to problems related to the integrated resource management of the **Tagus and Guadiana** transboundary river basins under these 'high-end' scenarios.

IMPRESSIONS

Approach

- Provide illustrative **examples of existing integrated solutions** and initiatives relevant to improve capacities to cope with HES in the two selected river basins.

- Initial focus: role of **Integrated River Basin Management (IRBM) and Ecosystem-based Adaptation** in the face of HES.

- Exploring the **effects of current and alternative policies under HES** and sustainable development pathways, including the role of transformative institutional innovation and cooperation;

Models

- Application of a detailed, process-based ecohydrological model **(SWIM)** to understand the impacts of extreme events (especially droughts) and the potential of Integrated River Basin Management for the **Tagus** river basin under high-end scenarios;

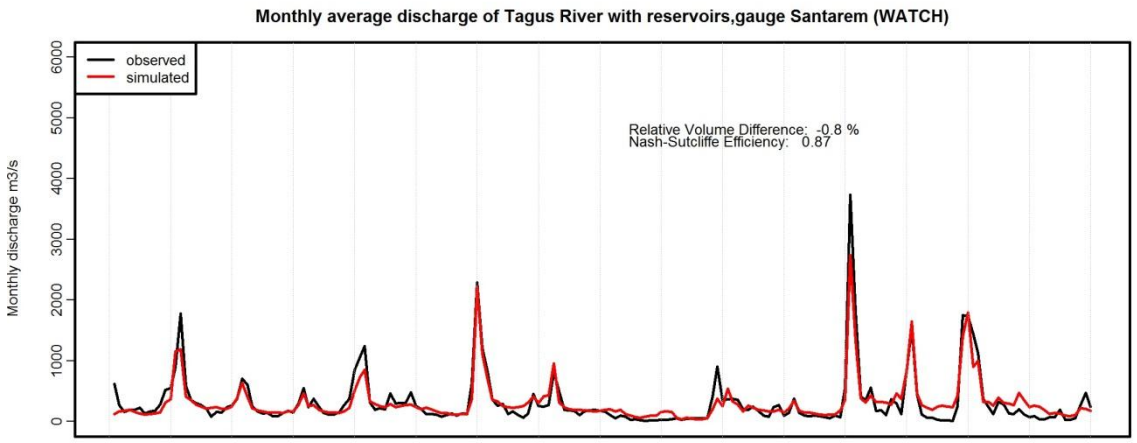
- Application of a detailed, process-based model of agroforestry resources **(LandClim)** to assess conditions for improving the resilience and productivity of the **Dehesa /Montado (oak-grassland) systems** and other forestry ecosystems under high-end scenarios.

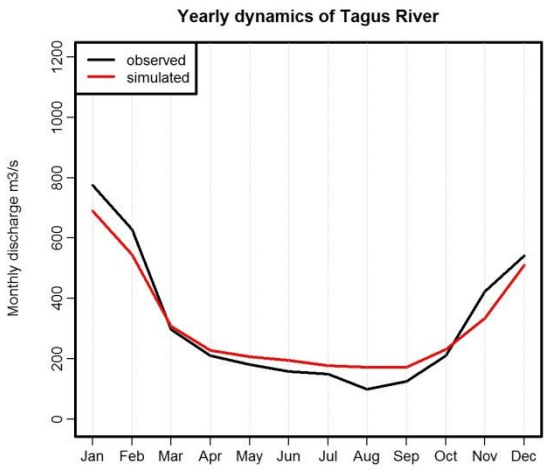
REGIONAL CASE STUDY
SWIM, Soil and Water Integrated Model

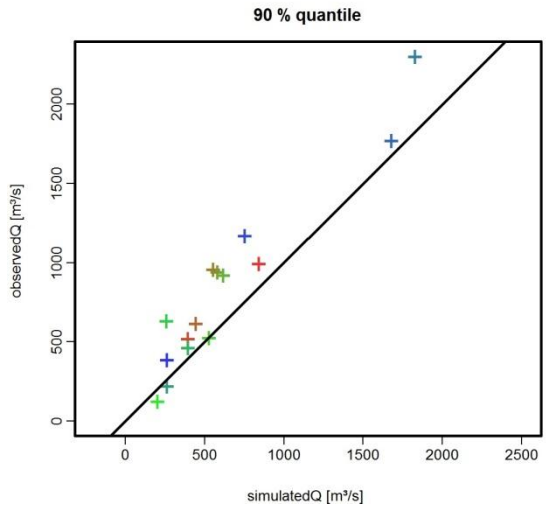
Modelling progress (PIK- Germany)

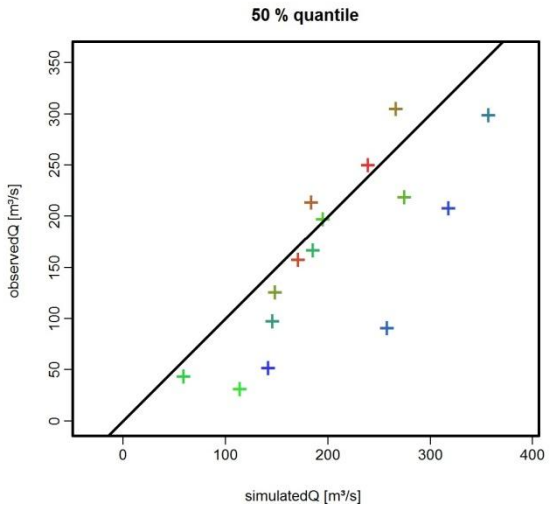
River	Case Study	State of model	Additonal data/information needed
Tagus	Iberian	Set up, calibrated and validated. Reservoir management included - 15 reservoirs in total. First impact assessments for ISI-MIP. RCP 4.5	Crop management, crop types, hydropower production rates (Spanish side)

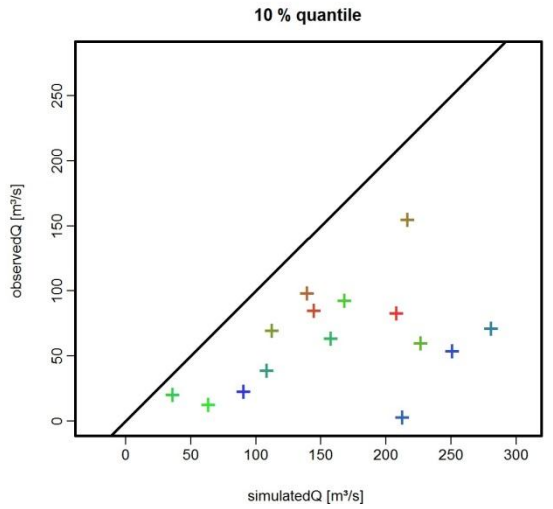
IBERIAN CASE STUDY
SWIM, Soil and Water Integrated Model
Calibration results Tagus river



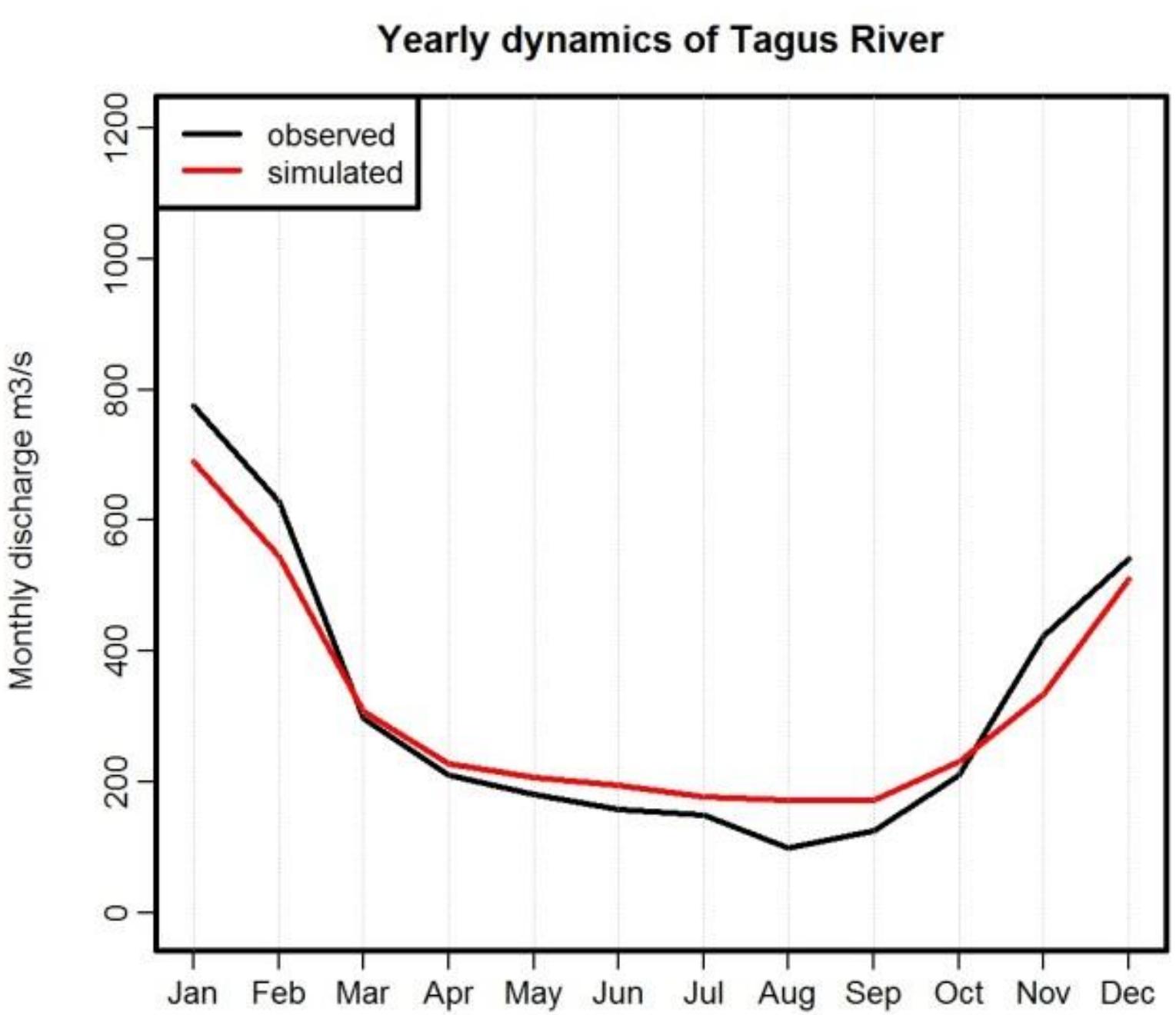




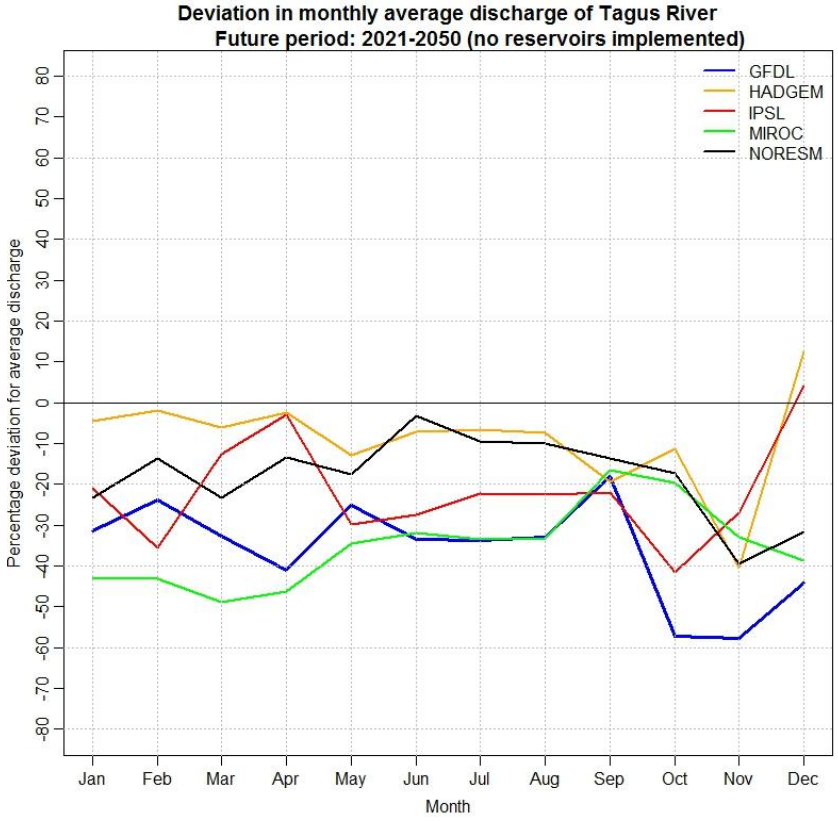


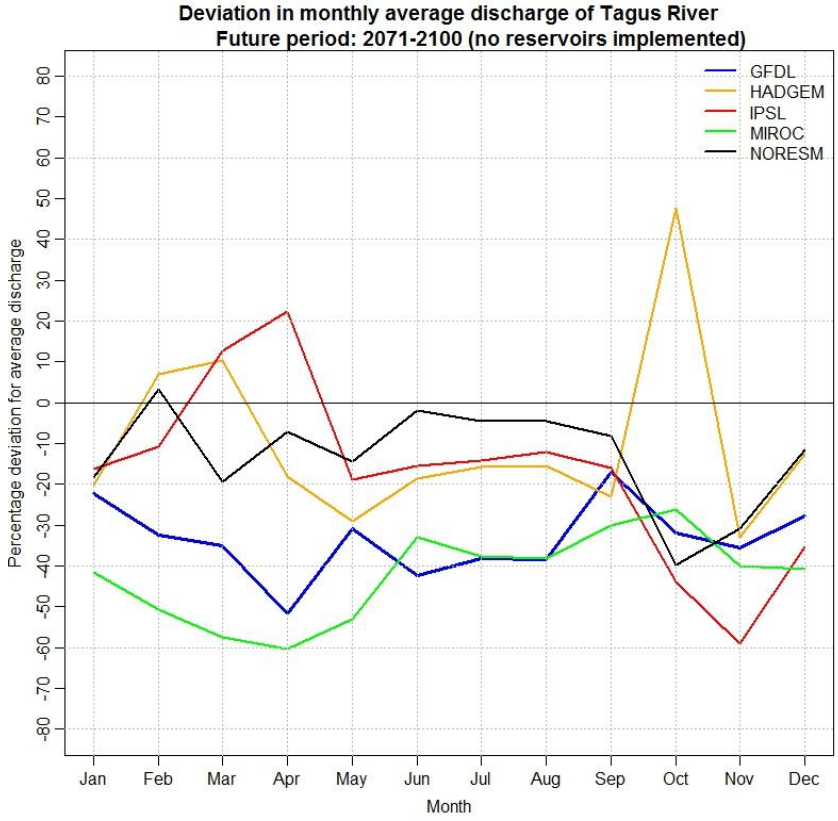


Modelling progress (PIK- Germany)


Yearly dynamics of Tagus River
observed
simulated
Monthly discharge m3/s
0
200
400
600
800
1000
1200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

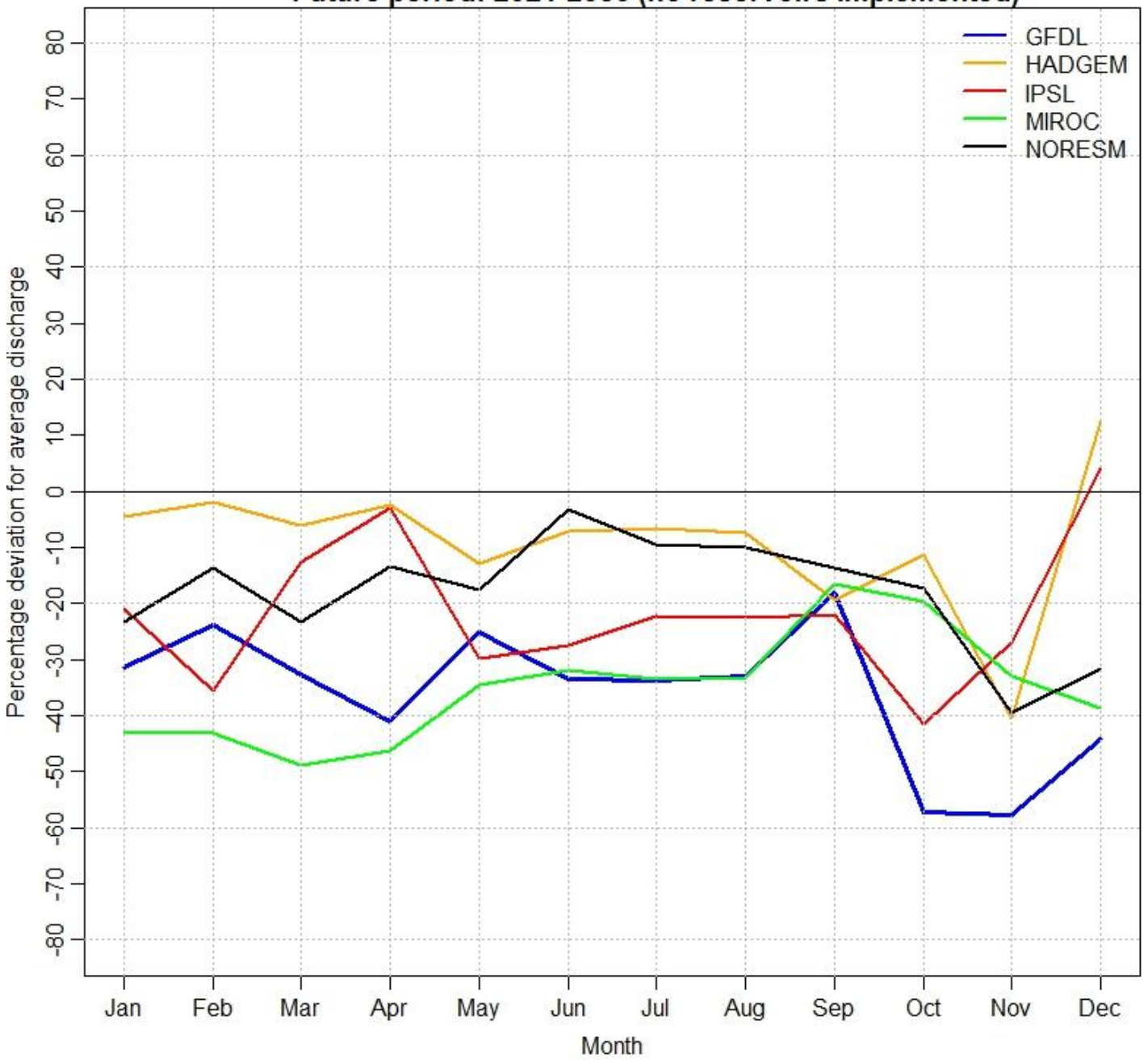
IBERIAN CASE STUDY
Impact of RCP 4.5 Scenario at the Outlet of Tagus River

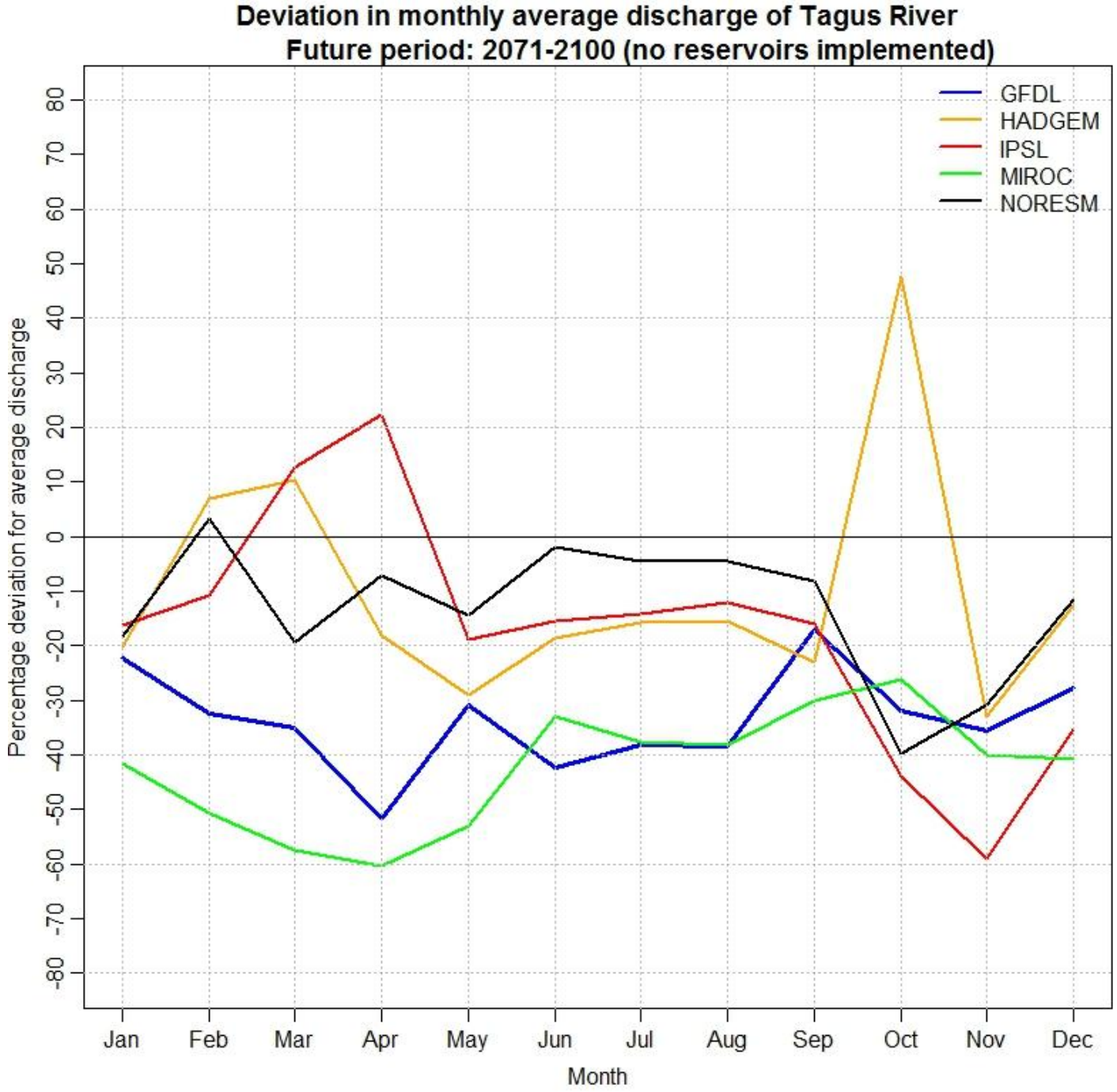




- ISI-MIP Scenarios: 5 GCM outputs, bias corrected for Iberian Peninsula

Modelling progress (PIK- Germany)


Deviation in monthly average discharge of Tagus River
Future period: 2021-2050 (no reservoirs implemented)
GFDL
HADGEM
IPSL
MIROC
NORESM
Percentage deviation for average discharge
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Deviation in monthly average discharge of Tagus River
Future period: 2071-2100 (no reservoirs implemented)
GFDL
HADGEM
IPSL
MIROC
NORESM
Percentage deviation for average discharge
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Jan
Feb
Mar
Apr
May
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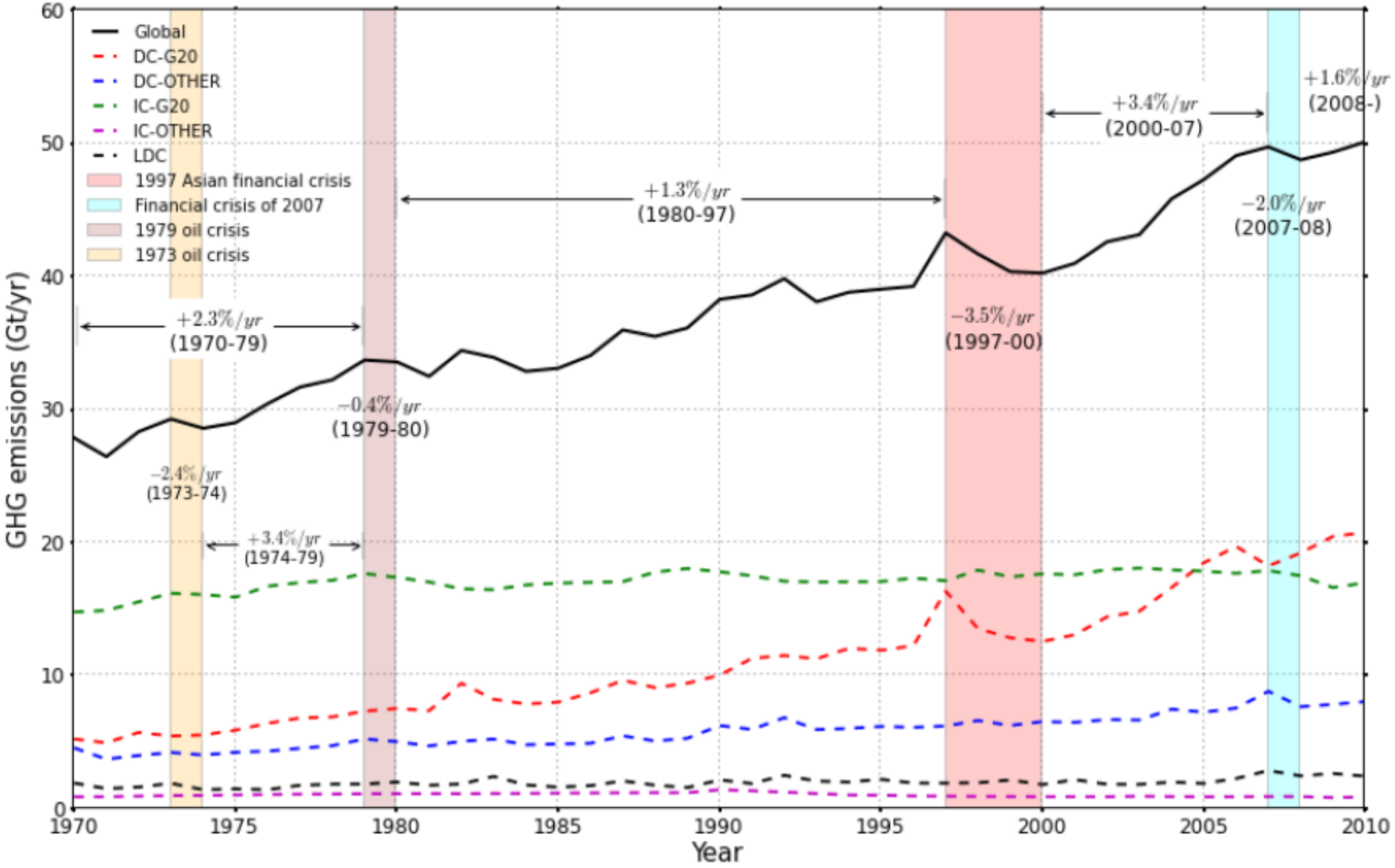
Oct
Nov
Dec
Month

More information on the website

http://www.impressions-project.eu/

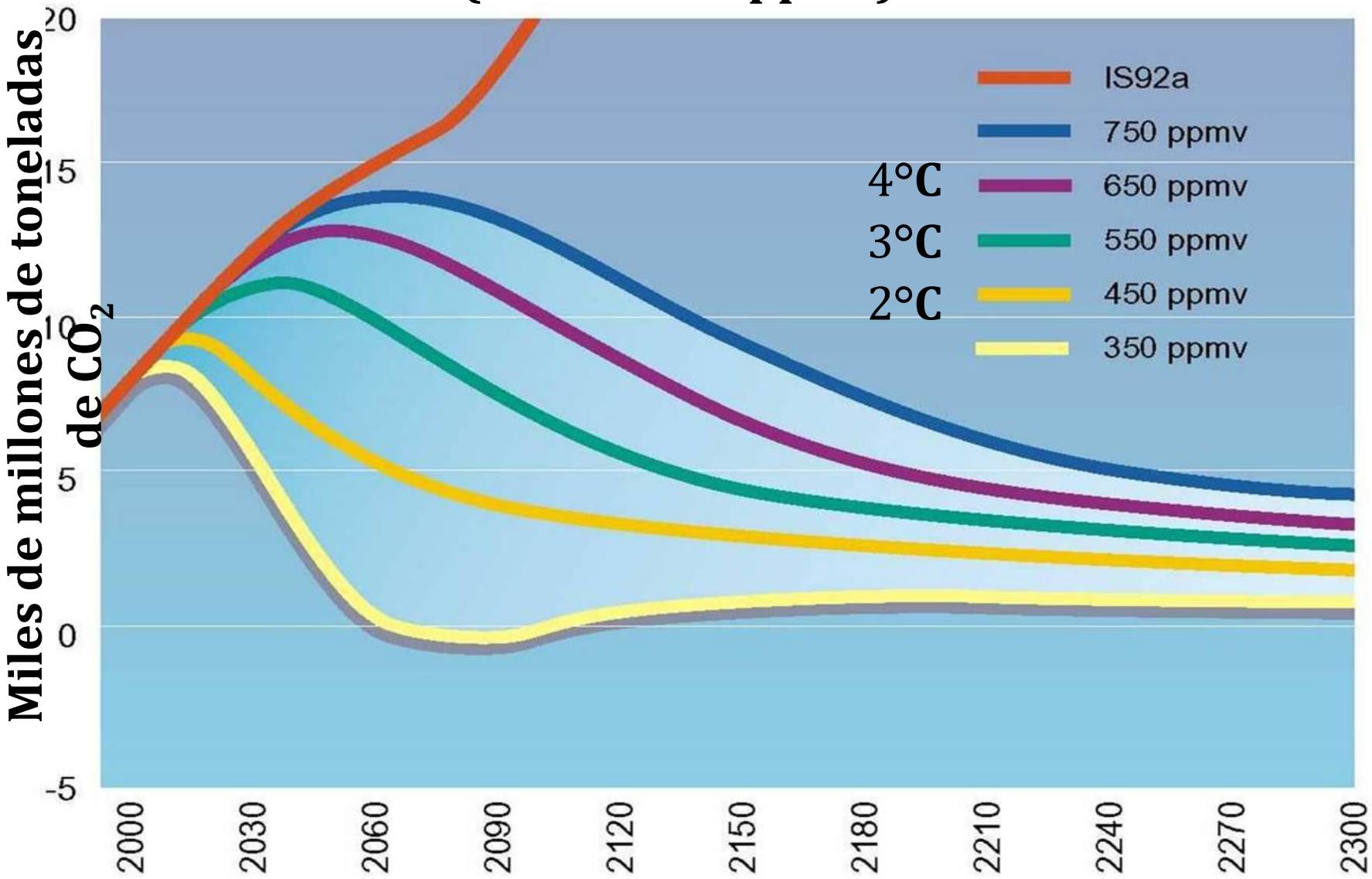
Global Greenhouse Gases emissions since 1970



IPCC, 2014

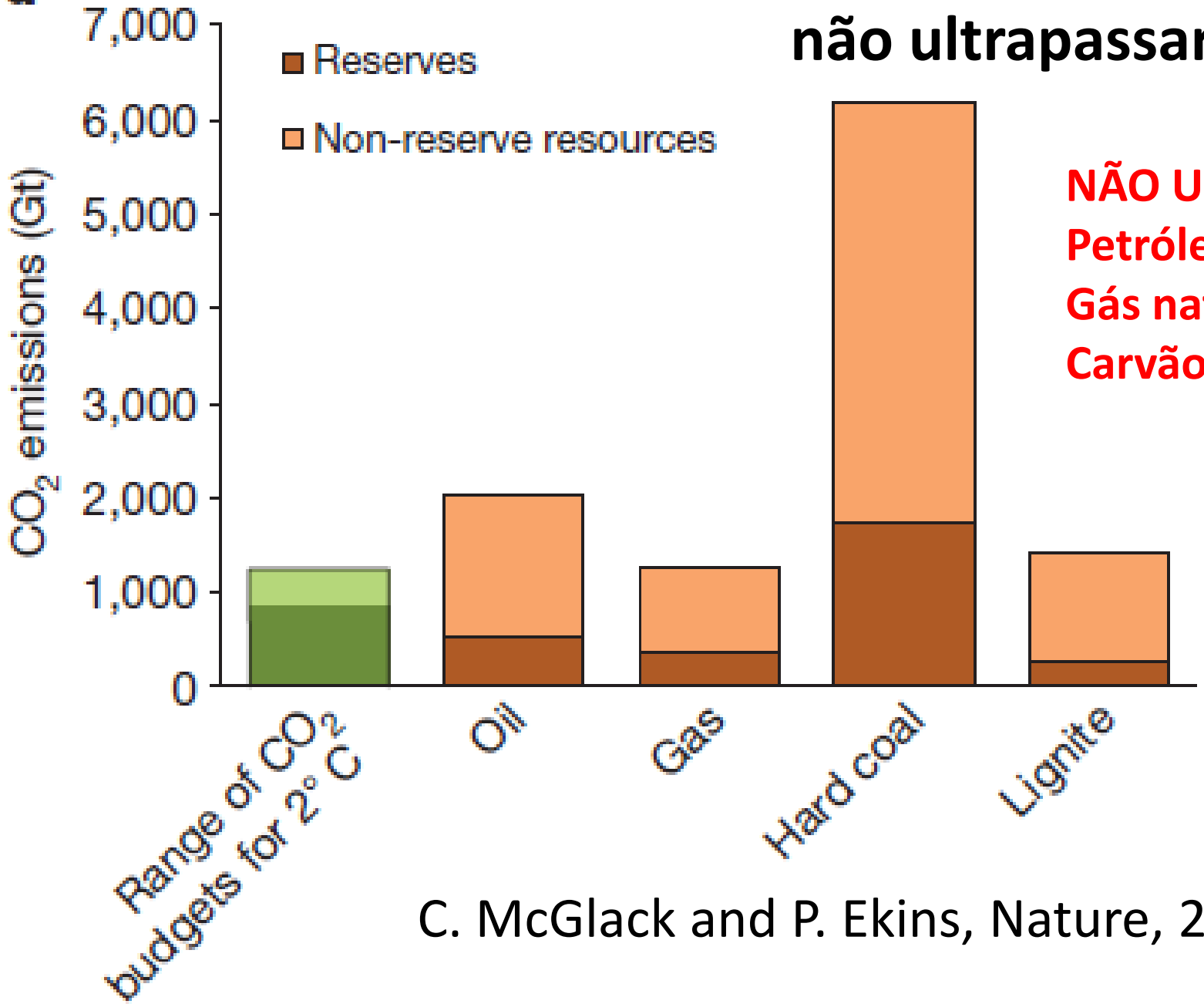
Trajectórias das emissões de CO_2e

(2005 = 380 ppmv)



Fuente: Stern Review; World Resources Institute

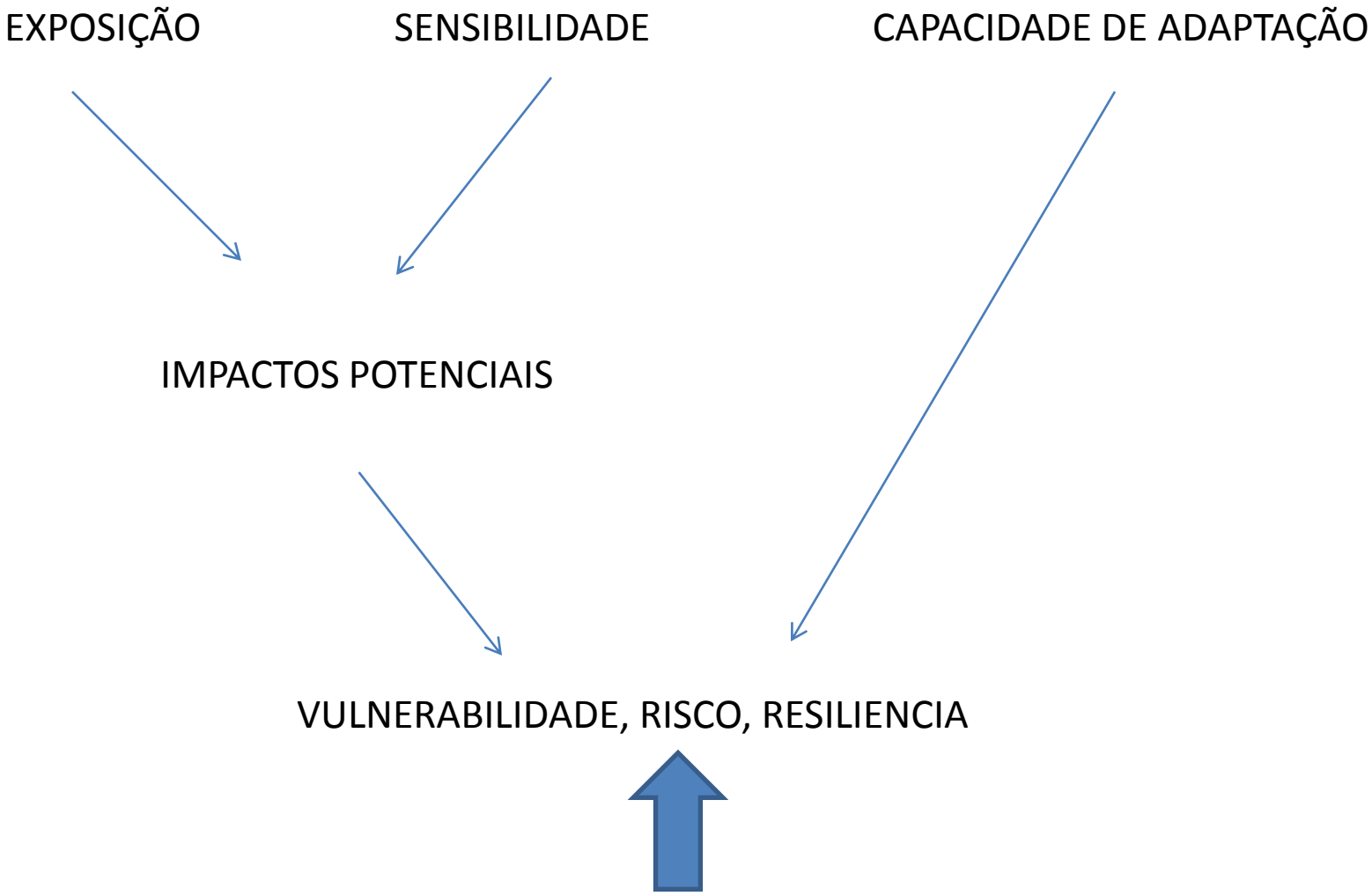
Orçamento de carbono que permite não ultrapassar 2ºC



NÃO USAR!
Petróleo 35%
Gás natural 50%
Carvão 80%

C. McGlack and P. Ekins, Nature, 2015

VULNERABILIDADE ÀS MUDANÇAS CLIMÁTICAS



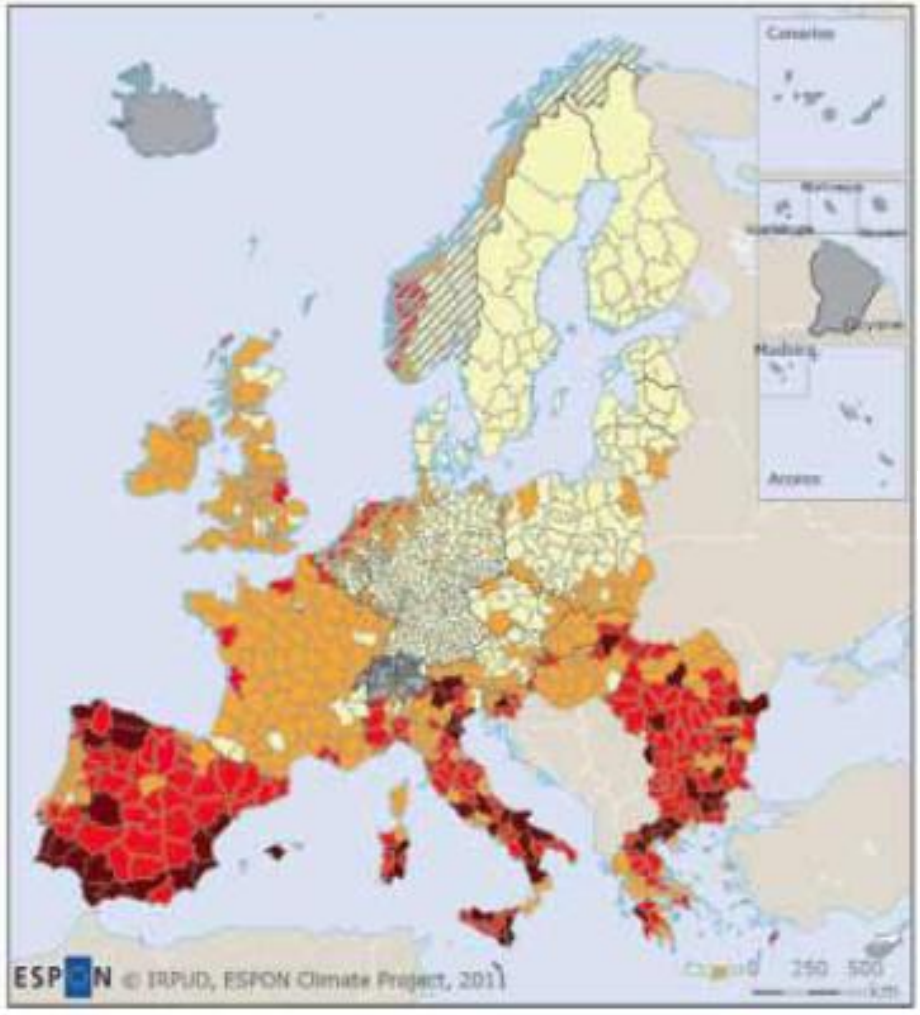
ClimAdaPT.Local
Estratégias Municipais de Adaptação às Alterações Climáticas

eea grants

AGÊNCIA PORTUGUESA DO AMBIENTE

Fundo português de Carbono

Impactos, Capacidade Adaptativa e Vulnerabilidades



ESPON Climate (2011) Climate Change and Territorial Effects on Regions and Local Economies (Scientific Report). Institute of Spatial Planning (IRPUD), TU Dortmund University. http://www.espon.eu/main/Menu_Projects/Menu_AppliedResearch/climate.html.

Vulnerabilidade Potencial às Alterações Climáticas

- Vulnerabilidade Elevada
- Vulnerabilidade Média
- Vulnerabilidade Baixa
- Sem Vulnerabilidade
- Sem informação
- Informação Reduzida

Obrigado pela vossa atenção

O principal fundamento e motivação para prosseguir e fortalecer a política de adaptação na UE têm sido os avanços feitos na qualidade e abrangência das estimativas dos custos dos impactos gravosos das mudanças climáticas para a UE num cenário de não-adaptação.

Estima-se que o custo mínimo da não-adaptação às alterações climáticas varie entre **100 mil milhões de euros por ano em 2020 e 250 mil milhões de euros em 2050**, para o conjunto da UE.

Entre 1980 e 2011, as perdas económicas directas na UE devidas a inundações ultrapassaram 90 mil milhões de euros. Prevê-se que este montante se agrave, porquanto o custo anual dos danos causados por cheias fluviais está estimado em 20 mil milhões de euros na década de 2020 e em 46 mil milhões de euros na década de 2050.

O custo social das alterações climáticas pode também ser considerável. Ao longo do período 1980-2011, as inundações causaram mais de 2500 mortes e afectaram mais de 5,5 milhões de pessoas na UE

Essas medidas podem ser bastante eficazes, pois, “por cada euro gasto na protecção contra inundações, poderemos evitar seis euros de custos de danos”.

Estima-se que as medidas adicionais de protecção contra inundações se cifrem em 1,7 mil milhões de euros por ano na década de 2020, valor que aumentará para 3,4 mil milhões na década de 2050.

Se não se tomarem mais medidas de adaptação, o número de mortes causadas pelo excesso de temperatura nas ondas de calor poderá sofrer um acréscimo anual de 26 000 na década de 2020, ascendendo a 89 000 na década de 20509.

O projeto ClimateCost avalia em 11 mil milhões de euros o valor médio anual dos estragos provocados pela erosão e inundação nas zonas costeiras da UE no período de 2040-2070 num cenário de não adaptação conjugado com um cenário intermédio de emissões de gases com efeito de estufa.

O mesmo estudo projeta para os custos médios anuais do investimento em adaptação no mesmo intervalo de tempo valores compreendidos entre 1 e 1,5 milhares de milhões de euros (a preços de 2005).

Com essa adaptação os custos dos prejuízos provocados pelos impactos seriam reduzidos, relativamente aos custos da não adaptação, por um fator de 6 (Relatório do Grupo de Trabalho do Litoral, Dezembro de 2014).

Estratégia Nacional de Adaptação às Alterações Climáticas (ENAAC)

Concluída a 1ª fase dos trabalhos da ENAAC, estabelecida pela Resolução do Conselho de Ministros n.º 24/2010, de 1 de abril, foi elaborado pelo grupo de coordenação da ENAAC o Relatório de Progresso que resulta das contribuições dos grupos sectoriais. Este relatório desenvolve os objetivos da estratégia, apresenta os resultados dos trabalhos dos diversos grupos setoriais e identifica linhas de força para o desenvolvimento da fase seguinte. Os setores abordados foram os seguintes:

Agricultura, Florestas e Pescas (GPP)
Florestas (ICNF)
Biodiversidade (ICNF)
Energia (DGEG)
Ordenamento do Território e Cidades (DGT)
Recursos Hídricos e Zonas Costeiras (APA)
Saúde (DGS)
Saúde - Fichas (DGS)
Segurança de Pessoas e Bens (ANPC)

O Relatório de Progresso pode ser consultado em:

http://www.apambiente.pt/_zdata/Politicas/AlteracoesClimaticas/Adaptacao/ENAAC/RelatProgresso/Relat_Progresso.pdf

Vai ser brevemente colocada para discussão pública a Fase 2 da ENAAC (2014-2020)

CIRAC

Flood Risk and Vulnerability In Climate Change Scenarios

27th February 2014

www.siam.fc.ul.pt/cirac

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associação portuguesa de seguradores aps

ACTION Modulers Consultores de Segurança

Impacts and Risks from High-End Scenarios: Strategies for Innovative Solutions

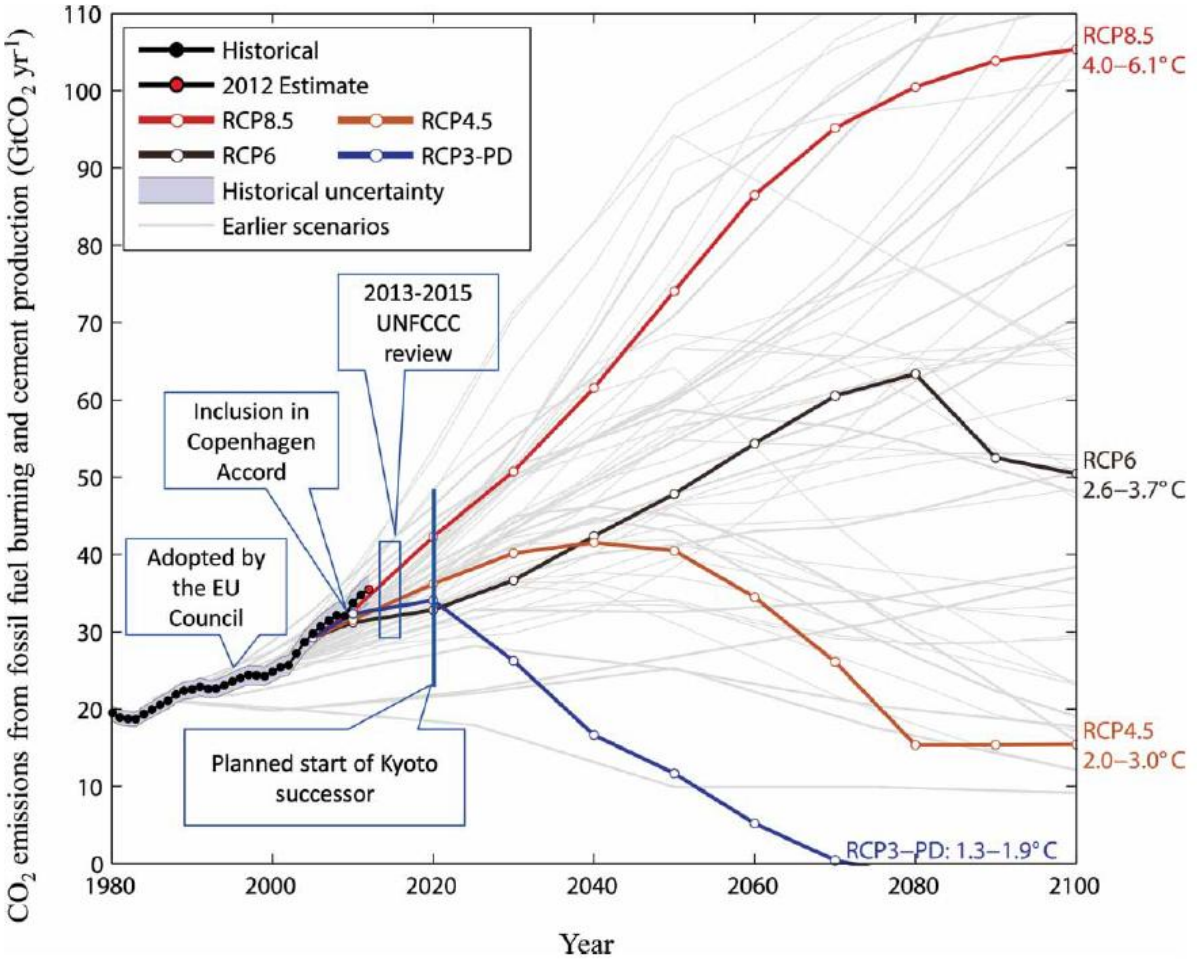
Overview

Funded by the 7th Framework Programme of the European Union
Contract Number: 603416

SEVENTH FRAMEWORK PROGRAMME

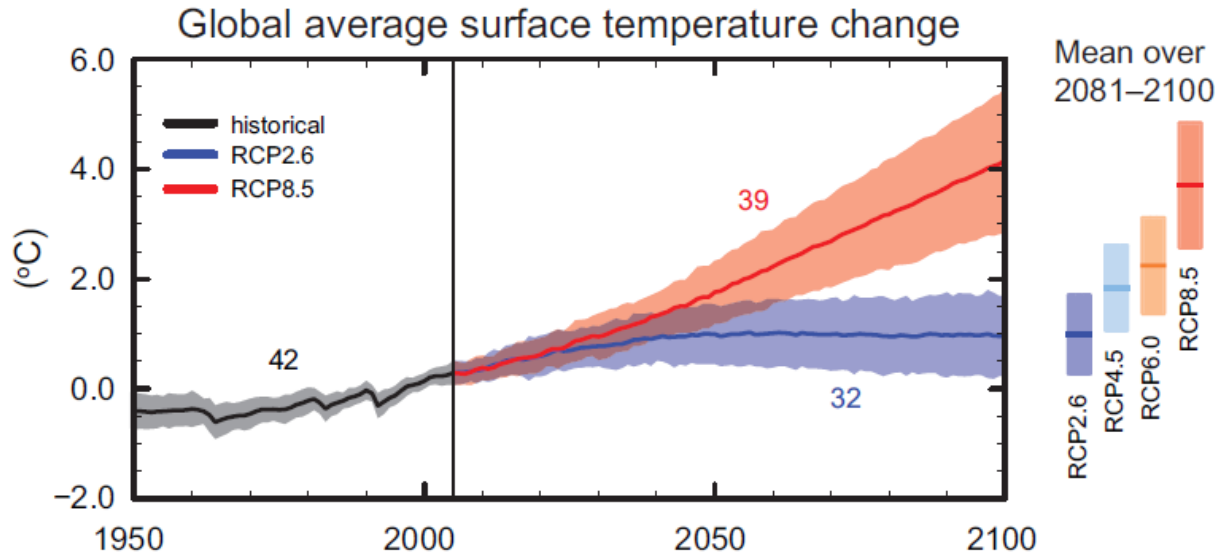
Background

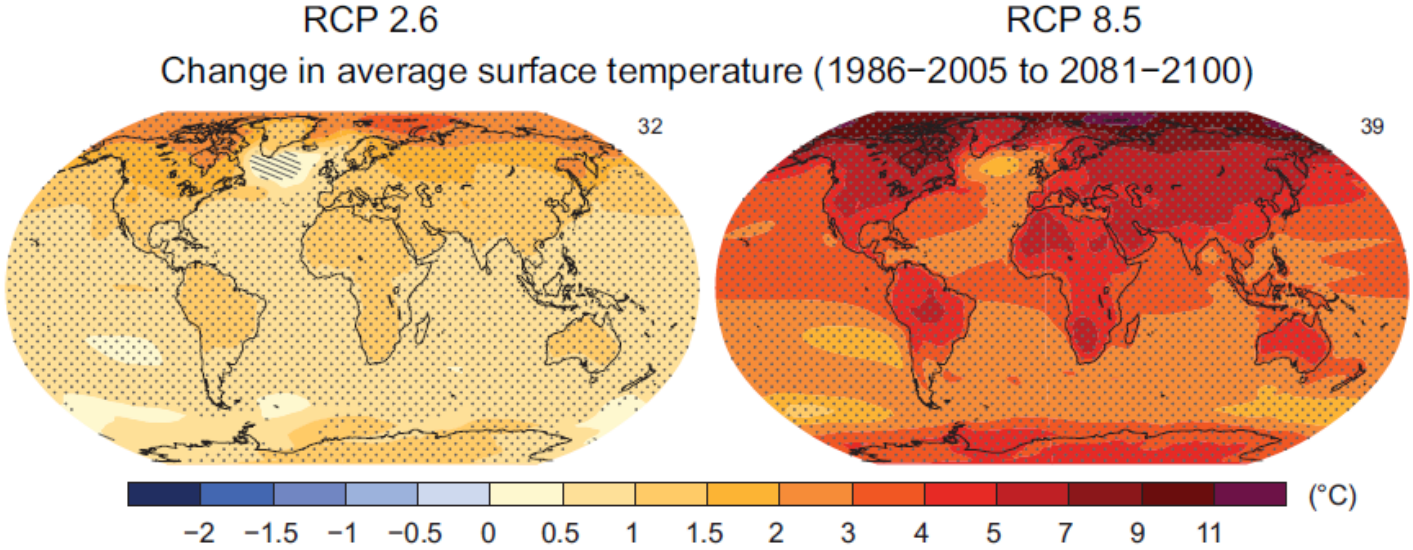
- Recent research on mitigation indicates that the increasing growth in CO_2 emissions that has occurred since 2000 has significantly reduced the probability of limiting warming to 2°C.



Jordan et al. (2013). Going beyond two degrees? The risks and opportunities of alternative options. Climate Policy, 13: 751-769.

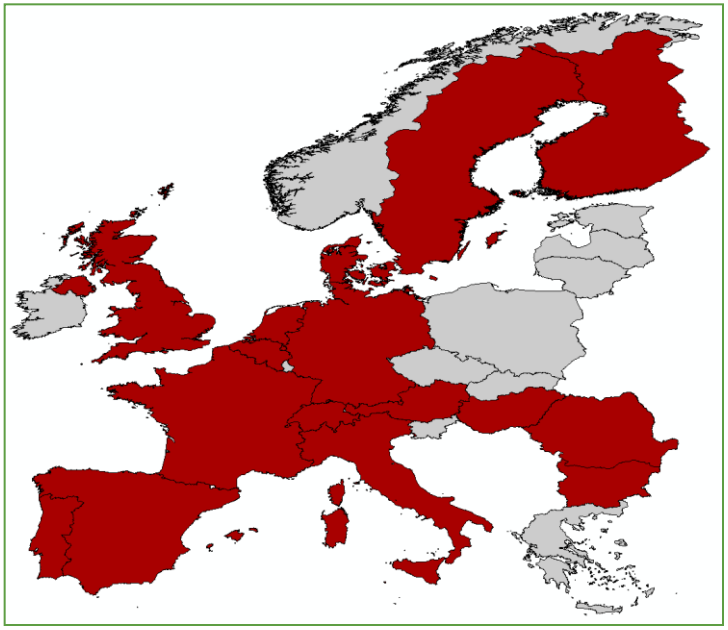
Background


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

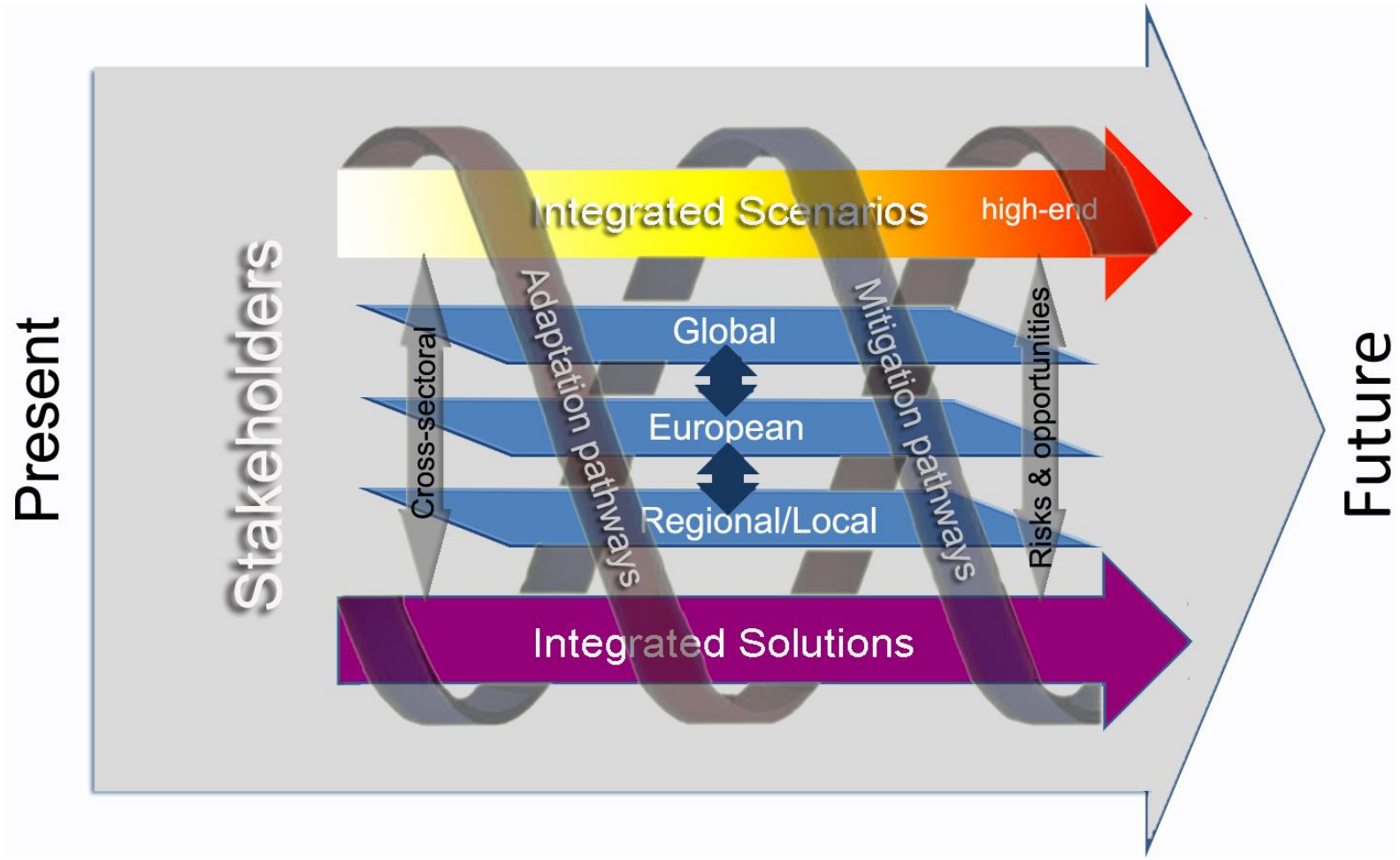

RCP 2.6
RCP 8.5
Change in average surface temperature (1986–2005 to 2081–2100)
32
39
(°C)
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
3
4
5
7
9
11

What is IMPRESSIONS?

- **Imp**acts and **R**isks from High-**E**nd **S**cenarios: **S**trategies for **I**nnovative Soluti**ons**
- EU FP7 Project which started 1 November 2013
- EU contribution: ~ 9m €
- Duration: 5 years
- Coordinated by University of Oxford, UK
- Transdisciplinary consortium of 24 partners from 16 European countries



IMPRESSIONS Concept



Multi-scale: 6 case studies

Global and central Asia case studies

European case study

- 3 regional/local case studies (Scotland, 2 Iberian catchments, 2 Hungarian municipalities)

The Iberian case study

EC Seventh Framework Programme
Contract Number: 603416

Overall aim

- To improve scientific understanding of the **implications of scenarios involving high levels of climate and socio-economic change in South-west Iberia**
- **Work jointly with decision-makers** to explore the development of systemic **transformative solutions** to problems related to the integrated resource management of the **Tagus and Guadiana** transboundary river basins under these 'high-end' scenarios.

IMPRESSIONS

Approach

- Provide illustrative **examples of existing integrated solutions** and initiatives relevant to improve capacities to cope with HES in the two selected river basins.

- Initial focus: role of **Integrated River Basin Management (IRBM) and Ecosystem-based Adaptation** in the face of HES.

- Exploring the **effects of current and alternative policies under HES** and sustainable development pathways, including the role of transformative institutional innovation and cooperation;

Models

- Application of a detailed, process-based ecohydrological model **(SWIM)** to understand the impacts of extreme events (especially droughts) and the potential of Integrated River Basin Management for the **Tagus** river basin under high-end scenarios;

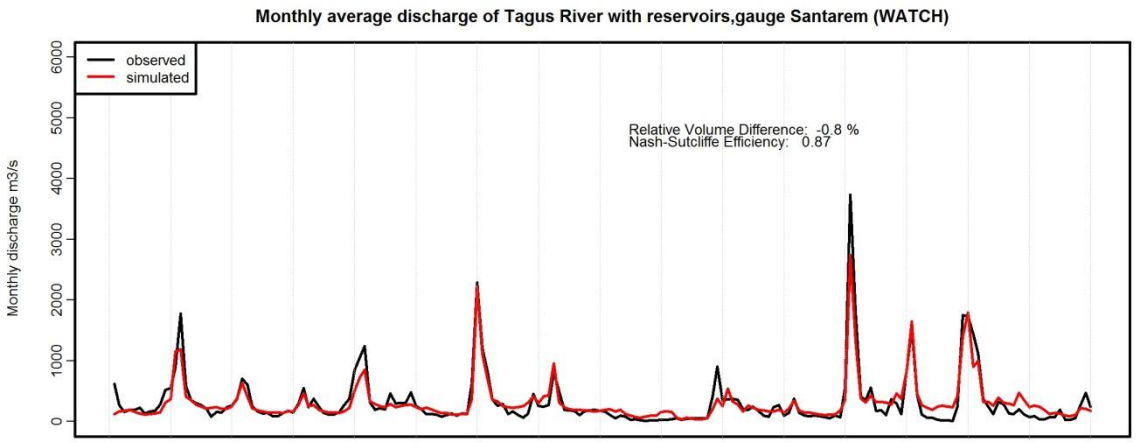
- Application of a detailed, process-based model of agroforestry resources **(LandClim)** to assess conditions for improving the resilience and productivity of the **Dehesa /Montado (oak-grassland) systems** and other forestry ecosystems under high-end scenarios.

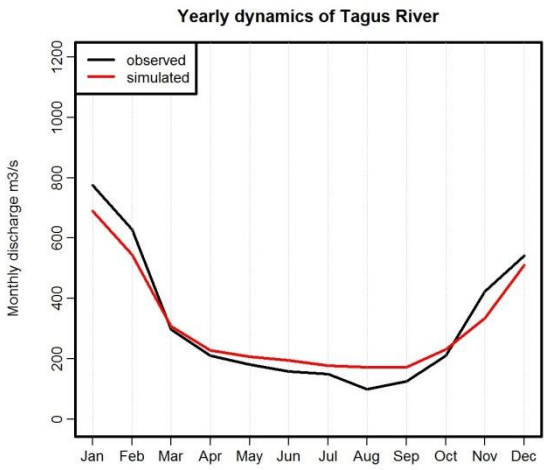
REGIONAL CASE STUDY
SWIM, Soil and Water Integrated Model

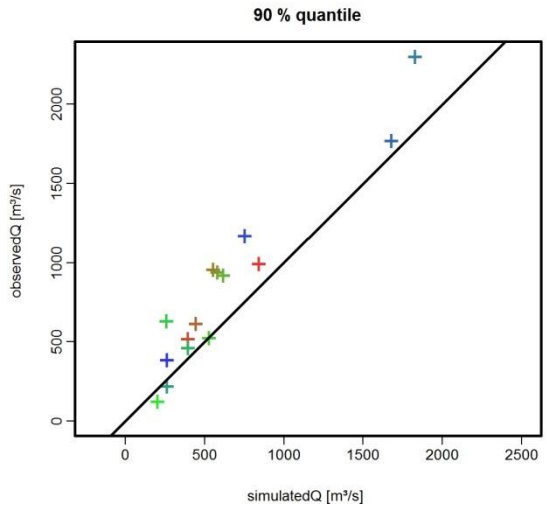
Modelling progress (PIK- Germany)

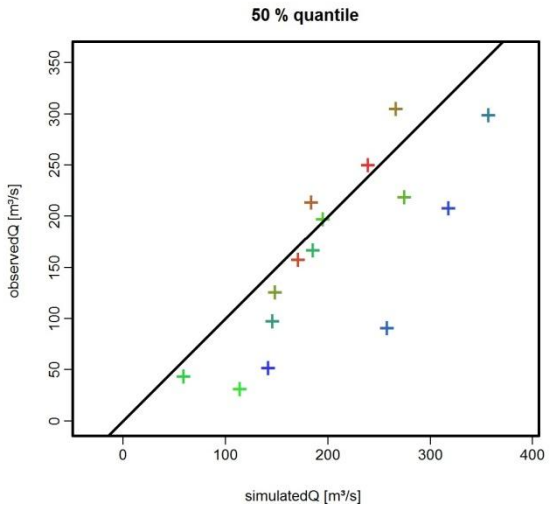
River	Case Study	State of model	Additonal data/information needed
Tagus	Iberian	Set up, calibrated and validated. Reservoir management included - 15 reservoirs in total. First impact assessments for ISI-MIP. RCP 4.5	Crop management, crop types, hydropower production rates (Spanish side)

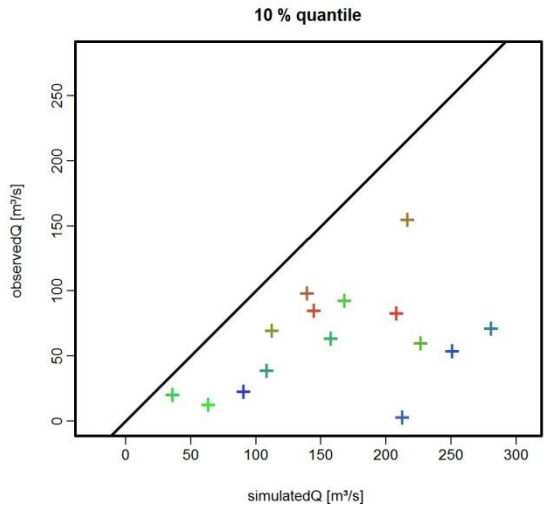
IBERIAN CASE STUDY
SWIM, Soil and Water Integrated Model
Calibration results Tagus river





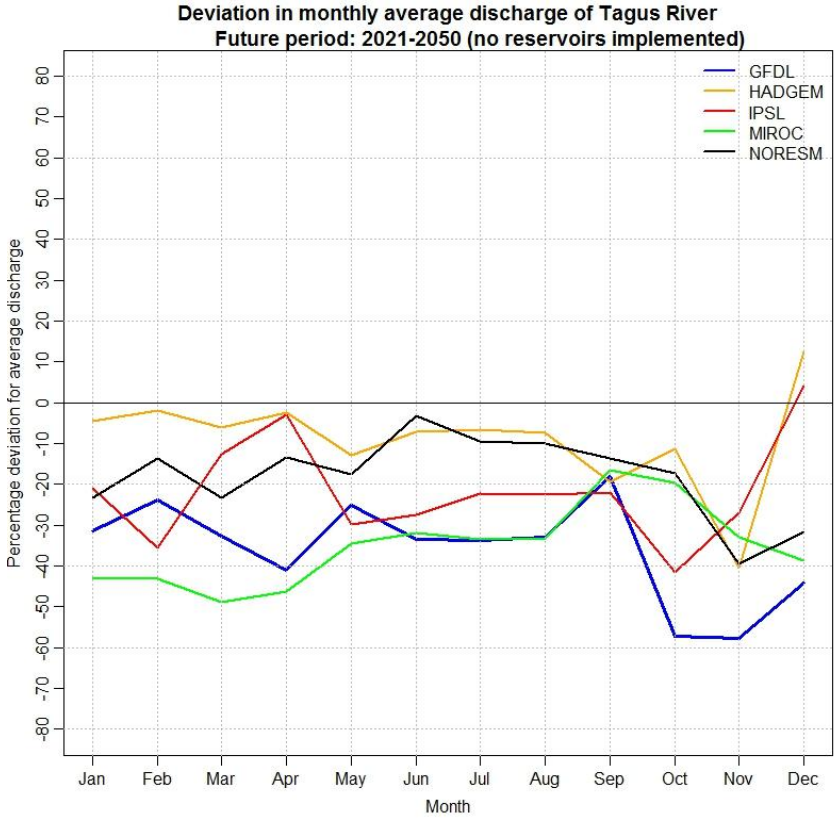


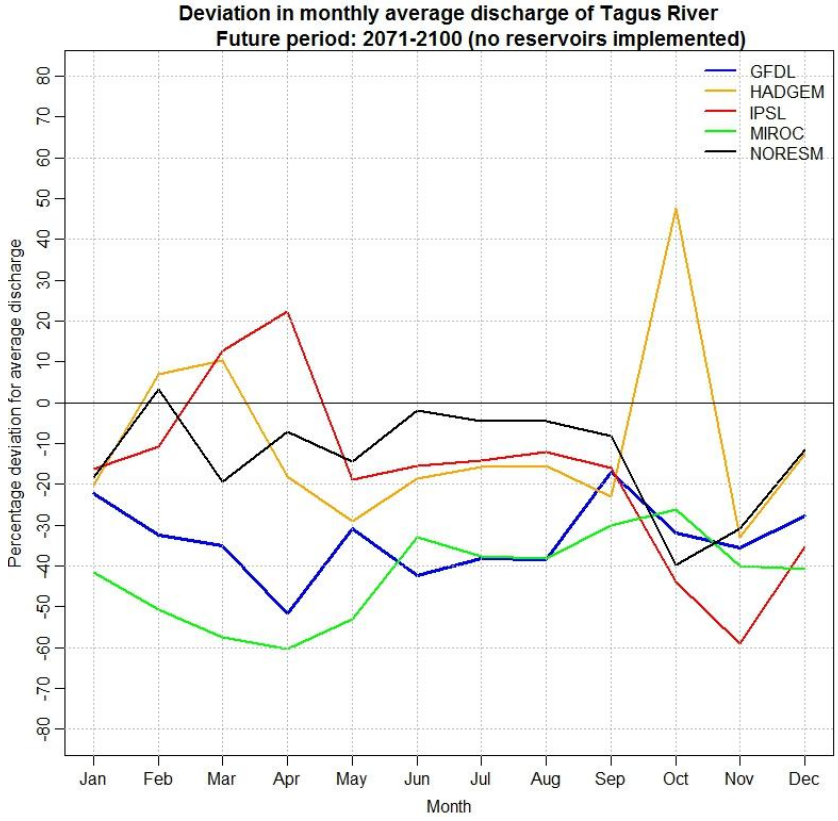




Modelling progress (PIK- Germany)

IBERIAN CASE STUDY
Impact of RCP 4.5 Scenario at the Outlet of Tagus River





- ISI-MIP Scenarios: 5 GCM outputs, bias corrected for Iberian Peninsula

Modelling progress (PIK- Germany)

More information on the website

http://www.impressions-project.eu/