

A Região do Algarve e as 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://cciam.fc.ul.pt/>

**Conselho Nacional do Ambiente e do Desenvolvimento
Sustentável**

9 de maio - Dia da Europa

CCDR do Algarve

Faro, 9 de maio de 2022

6º Relatório do IPCC, Grupos de Trabalho I e II

<https://www.ipcc.ch/report/ar6/wg1/>

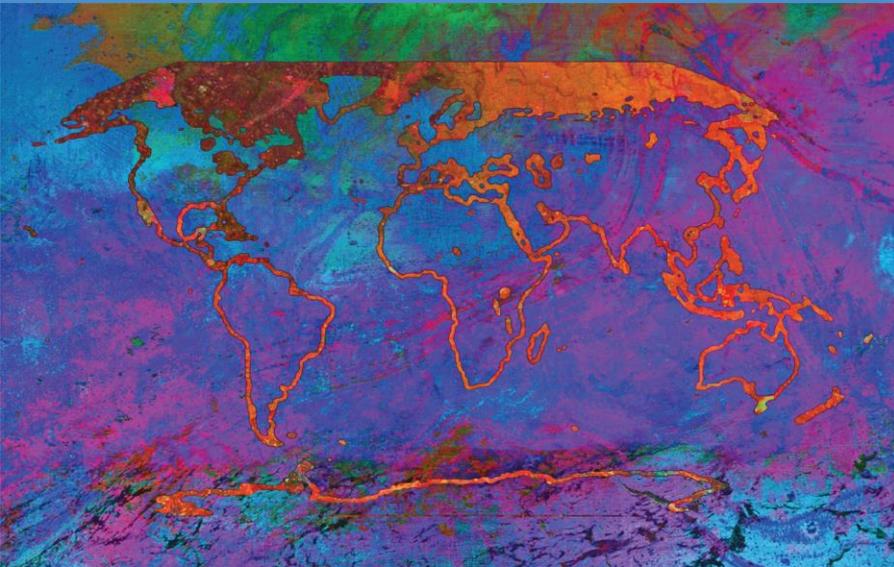
<https://www.ipcc.ch/report/ar6/wg2/>

ipcc

INTERGOVERNMENTAL PANEL ON climate change

Climate Change 2021

The Physical Science Basis



WGI

Working Group I contribution to the
Sixth Assessment Report of the
Intergovernmental Panel on Climate Change



ipcc

INTERGOVERNMENTAL PANEL ON climate change

Climate Change 2022

Impacts, Adaptation and Vulnerability

Summary for Policymakers



WGII

Working Group II contribution to the
Sixth Assessment Report of the
Intergovernmental Panel on Climate Change



ipcc

INTERGOVERNMENTAL PANEL ON climate change

Climate Change 2022

Mitigation of Climate Change

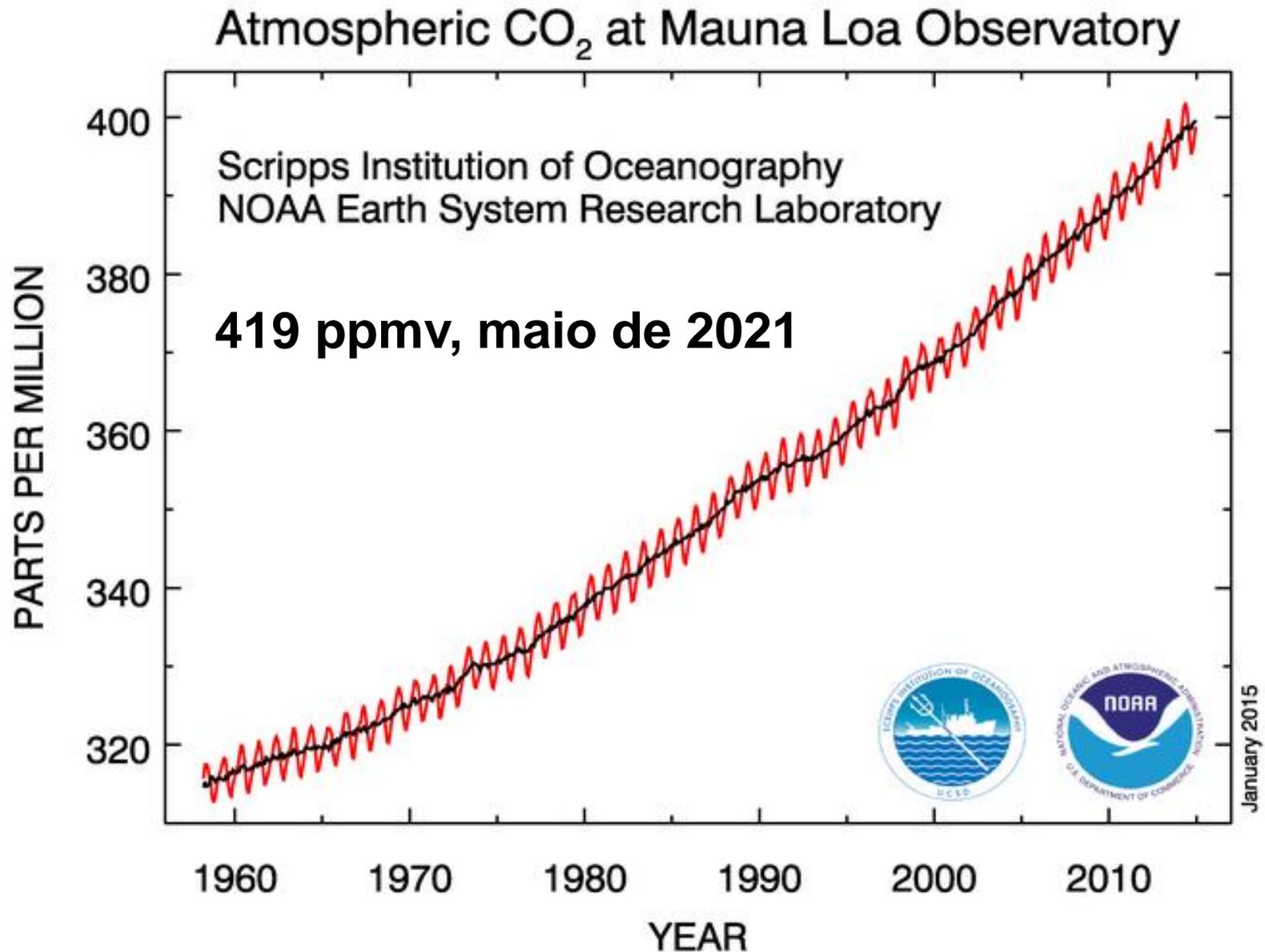


WGIII

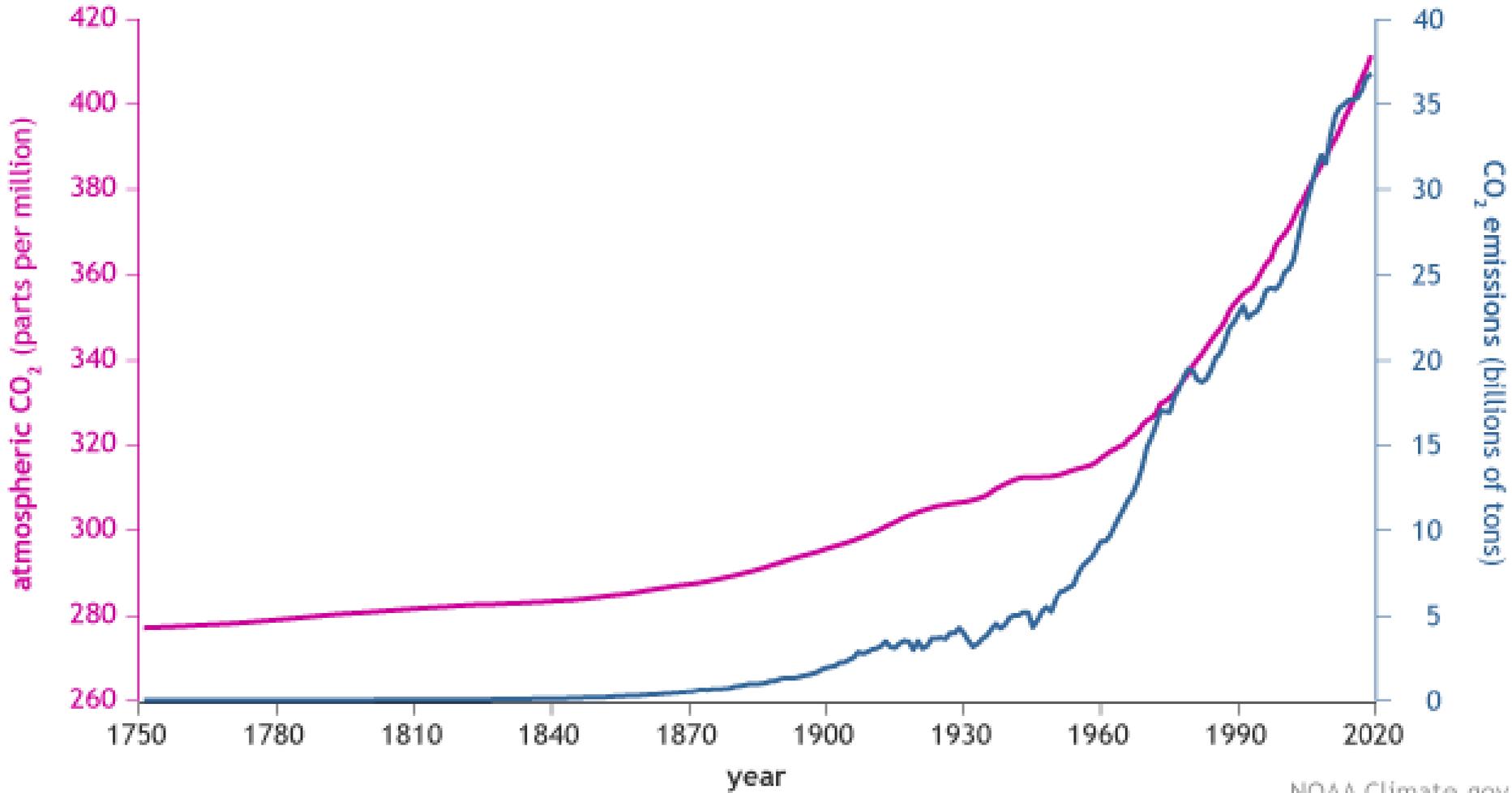
Working Group III contribution to the
Sixth Assessment Report of the
Intergovernmental Panel on Climate Change



A concentração de dióxido de carbono na atmosfera aumentou 49% desde o início da Revolução Industrial

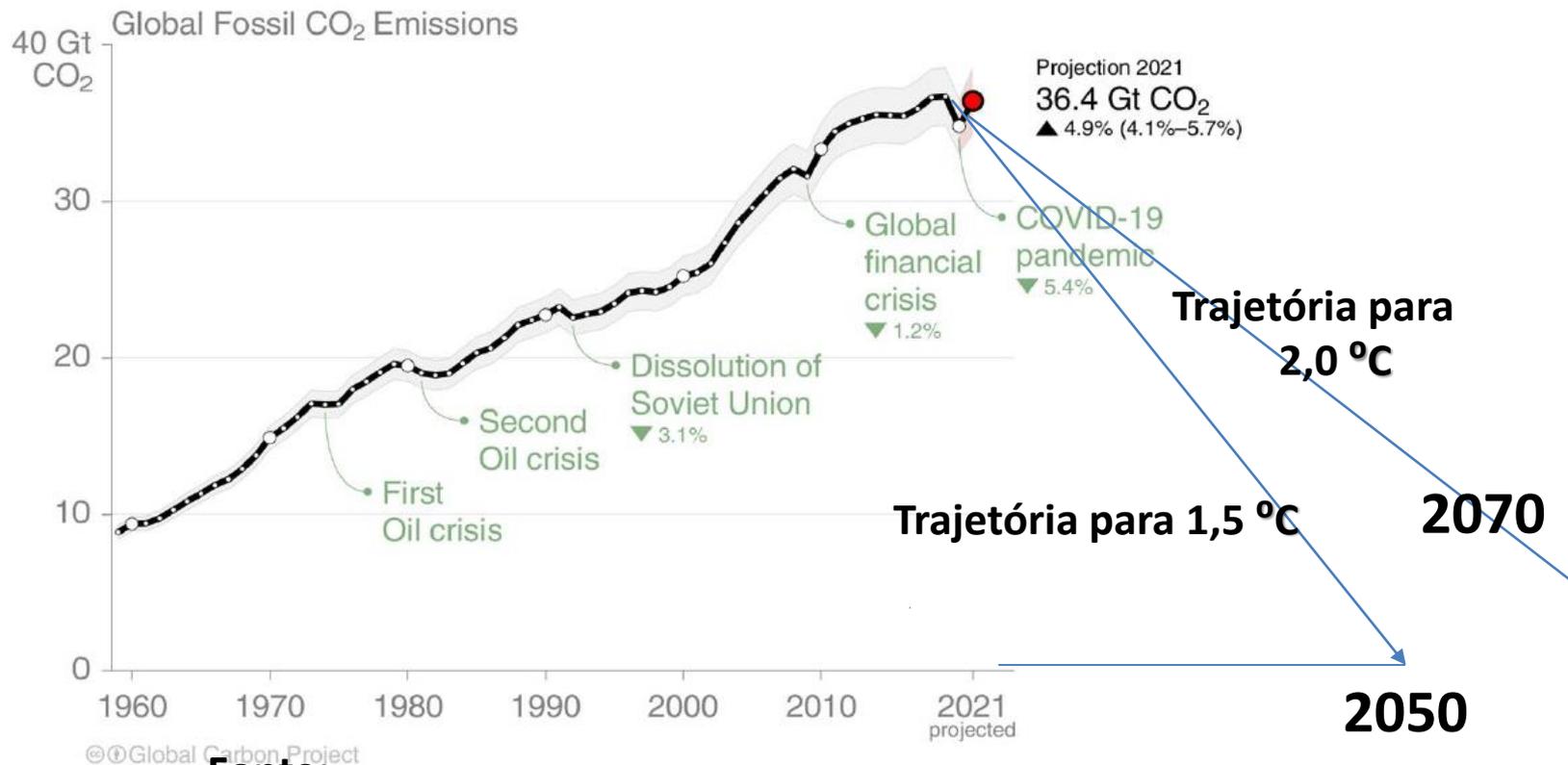


CO₂ in the atmosphere and annual emissions (1750-2019)



NOAA Climate.gov
Data: NOAA, ETHZ, Our World in Data

Global fossil CO₂ emissions have risen steadily over the last decades. Emissions in 2021 are set to rebound towards their pre-COVID-19 levels after an unprecedented drop in 2020.



Fonte:

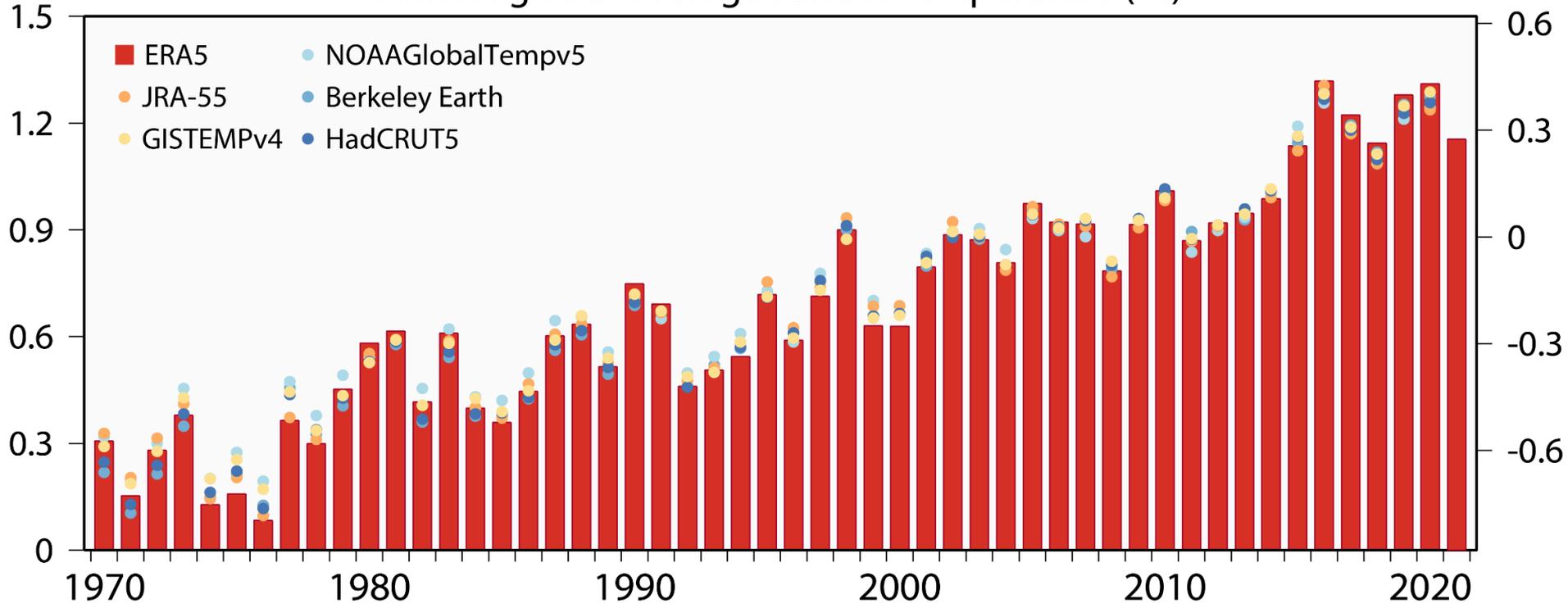
The 2021 projection is based on preliminary data and modelling.

Source: [Friedlingstein et al 2021](#); [Global Carbon Project 2021](#)

Increase above
1850-1900
reference level

Relative to
1991-2020

Annual global-average surface temperature (°C)



Fontes:



Annual averages of global air temperature at a height of two metres estimated change since the pre-industrial period (left-hand axis) and relative to 1991-2020 (right-hand axis) according to different datasets: Red bars: ERA5 (ECMWF Copernicus Climate Change Service, C3S); Dots: GISTEMPv4 (NASA); HadCRUT5 (Met Office Hadley Centre); NOAA GlobalTempv5 (NOAA), JRA-55 (JMA); and Berkeley Earth. Credit: Copernicus Climate Change Service/ECMWF

c) Synthesis of assessment of observed change in agricultural and ecological drought and confidence in human contribution to the observed changes in the world's regions

Type of observed change in agricultural and ecological drought

 Increase (12)

 Decrease (1)

 Low agreement in the type of change (28)

 Limited data and/or literature (4)

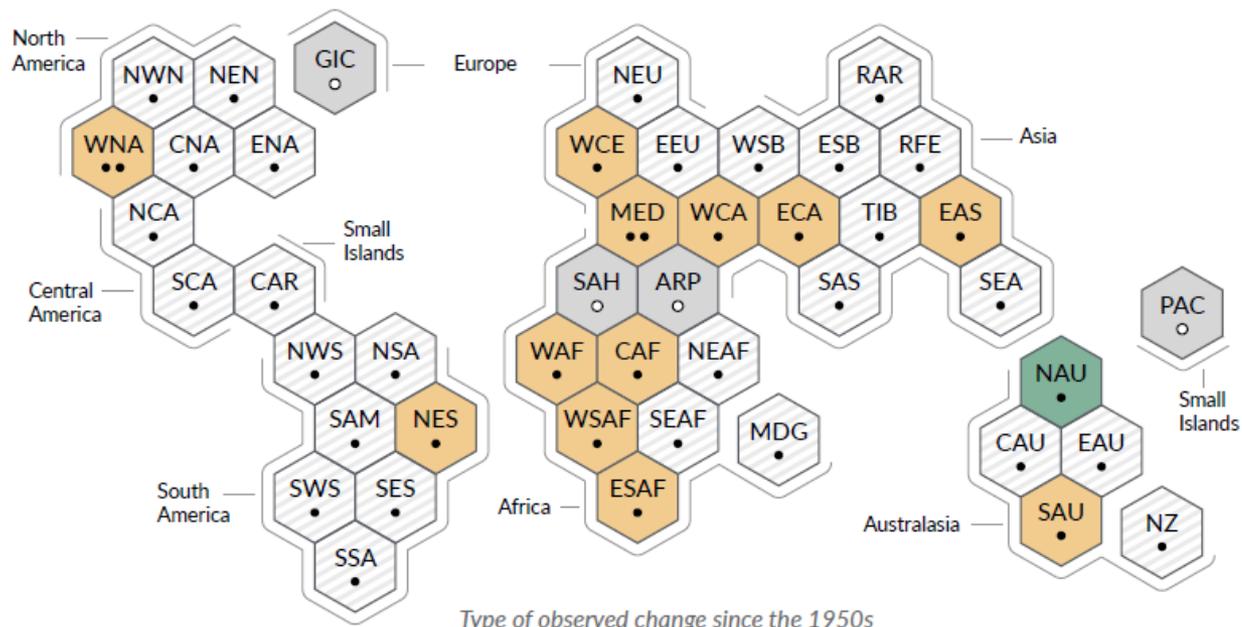
Confidence in human contribution to the observed change

●●● High

●● Medium

● Low due to limited agreement

○ Low due to limited evidence



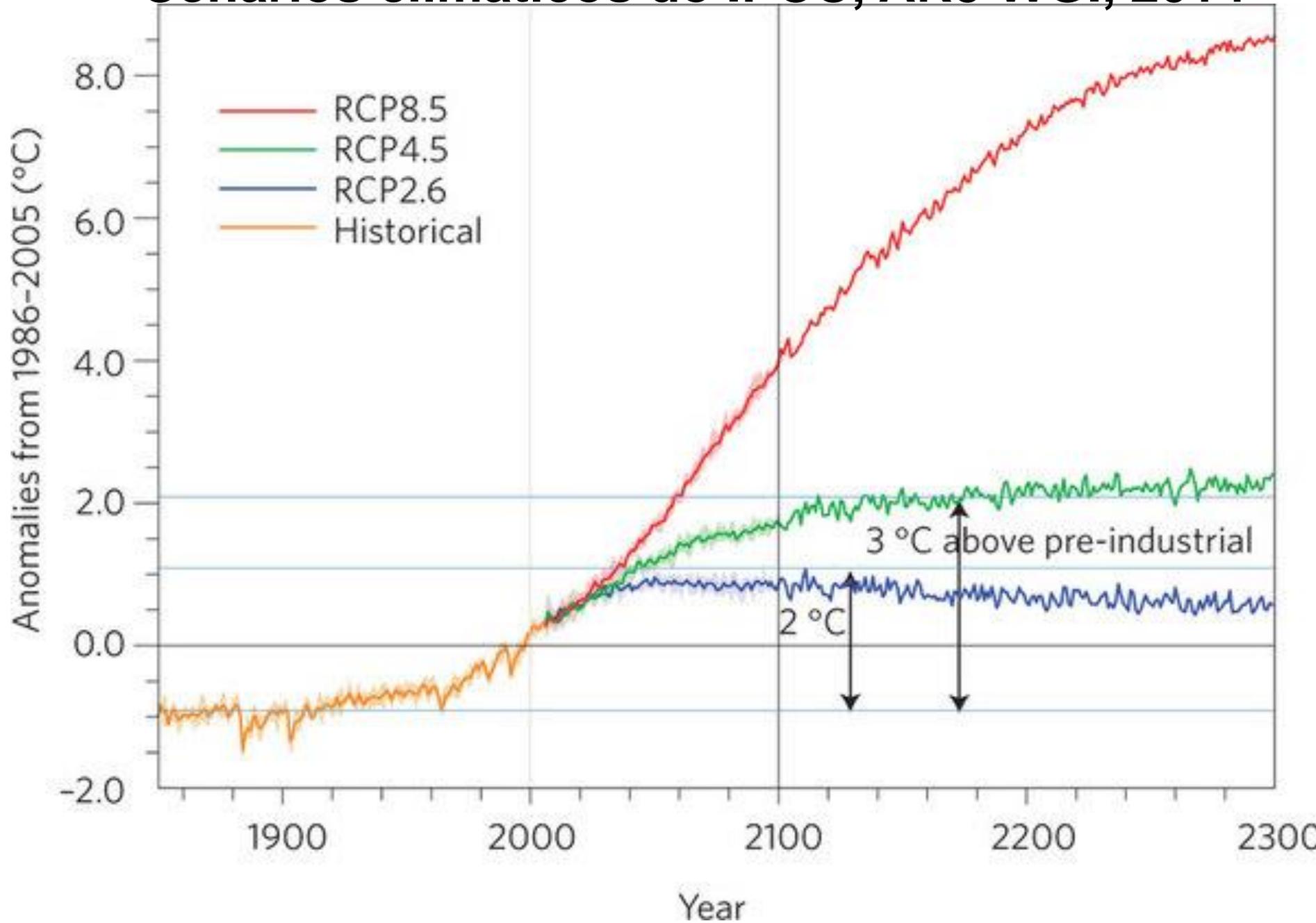
Type of observed change since the 1950s

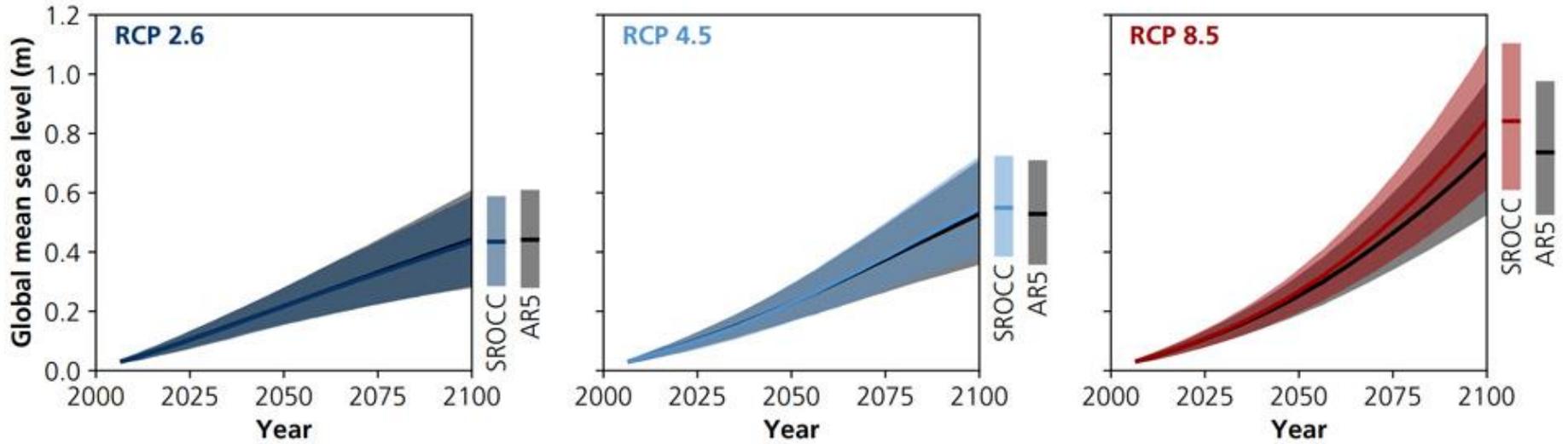
Each hexagon corresponds to one of the IPCC AR6 WGI reference regions

 North-Western North America

IPCC AR6 WGI reference regions: **North America:** *NWN* (North-Western North America), *NEN* (North-Eastern North America), *WNA* (Western North America), *CNA* (Central North America), *ENA* (Eastern North America), **Central America:** *NCA* (Northern Central America), *SCA* (Southern Central America), *CAR* (Caribbean), **South America:** *NWS* (North-Western South America), *NSA* (Northern South America), *NES* (North-Eastern South America), *SAM* (South American Monsoon), *SWS* (South-Western South America), *SES* (South-Eastern South America), *SSA* (Southern South America), **Europe:** *GIC* (Greenland/Iceland), *NEU* (Northern Europe), *WCE* (Western and Central Europe), *EEU* (Eastern Europe), *MED* (Mediterranean), **Africa:** *MED* (Mediterranean), *SAH* (Sahara), *WAF* (Western Africa), *CAF* (Central Africa), *NEAF* (North Eastern Africa), *SEAF* (South Eastern Africa), *WSAF* (West Southern Africa), *ESAF* (East Southern Africa), *MDG* (Madagascar), **Asia:** *RAR* (Russian Arctic), *WSB* (West Siberia), *ESB* (East Siberia), *RFE* (Russian Far East), *WCA* (West Central Asia), *ECA* (East Central Asia), *TIB* (Tibetan Plateau), *EAS* (East Asia), *ARP* (Arabian Peninsula), *SAS* (South Asia), *SEA* (South East Asia), **Australasia:** *NAU* (Northern Australia), *CAU* (Central Australia), *EAU* (Eastern Australia), *SAU* (Southern Australia), *NZ* (New Zealand), **Small Islands:** *CAR* (Caribbean), *PAC* (Pacific Small Islands)

Cenários climáticos do IPCC, AR5 WGI, 2014





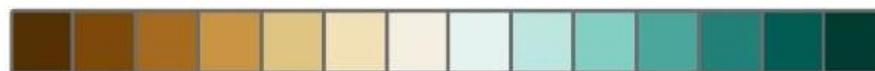
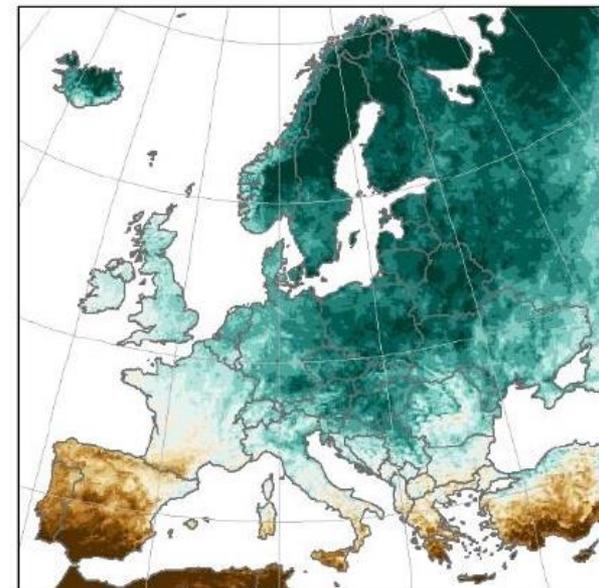
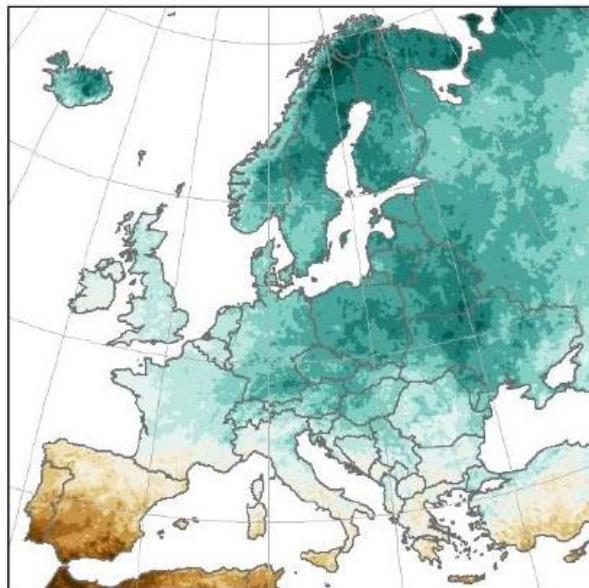
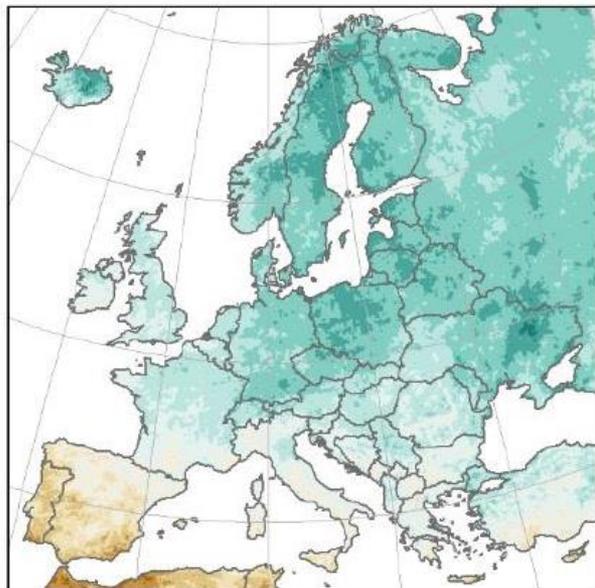
SROCC - Special Report on the Ocean and Cryosphere in a Changing Climate, IPCC, 2019

Variação da precipitação media annual na Europa para aumentos da temperature media global de 1,5°, 2° e 3°

1.5 °C

2 °C

3 °C



-15

-10

-5

0

5

10

15

change in
annual average
precipitation (in %)

Figure 2. Changes from reference (1981-2010) in annual average temperature (top panels) and precipitation (bottom) for the three global warming scenarios used in PESETA IV (1.5°C, 2°C and 3°C warmer than pre-industrial times).

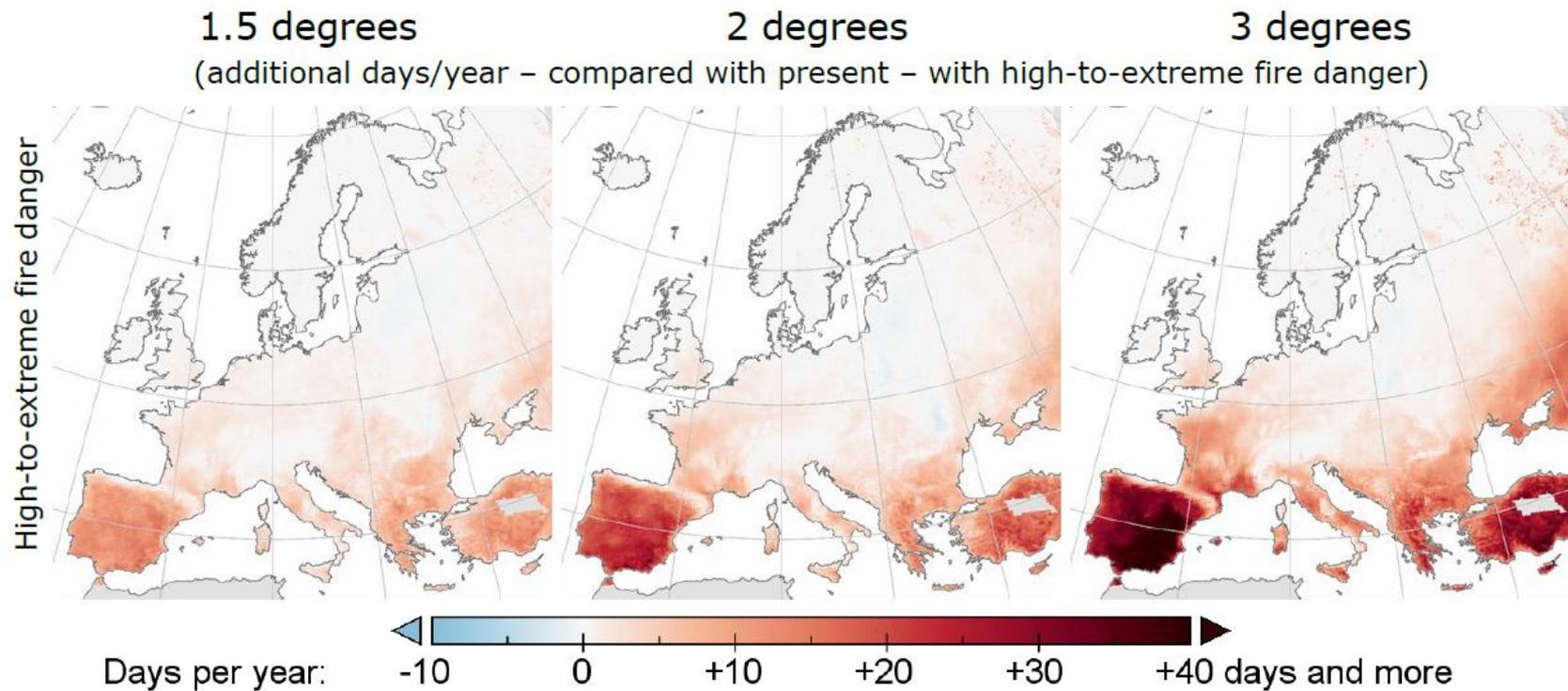
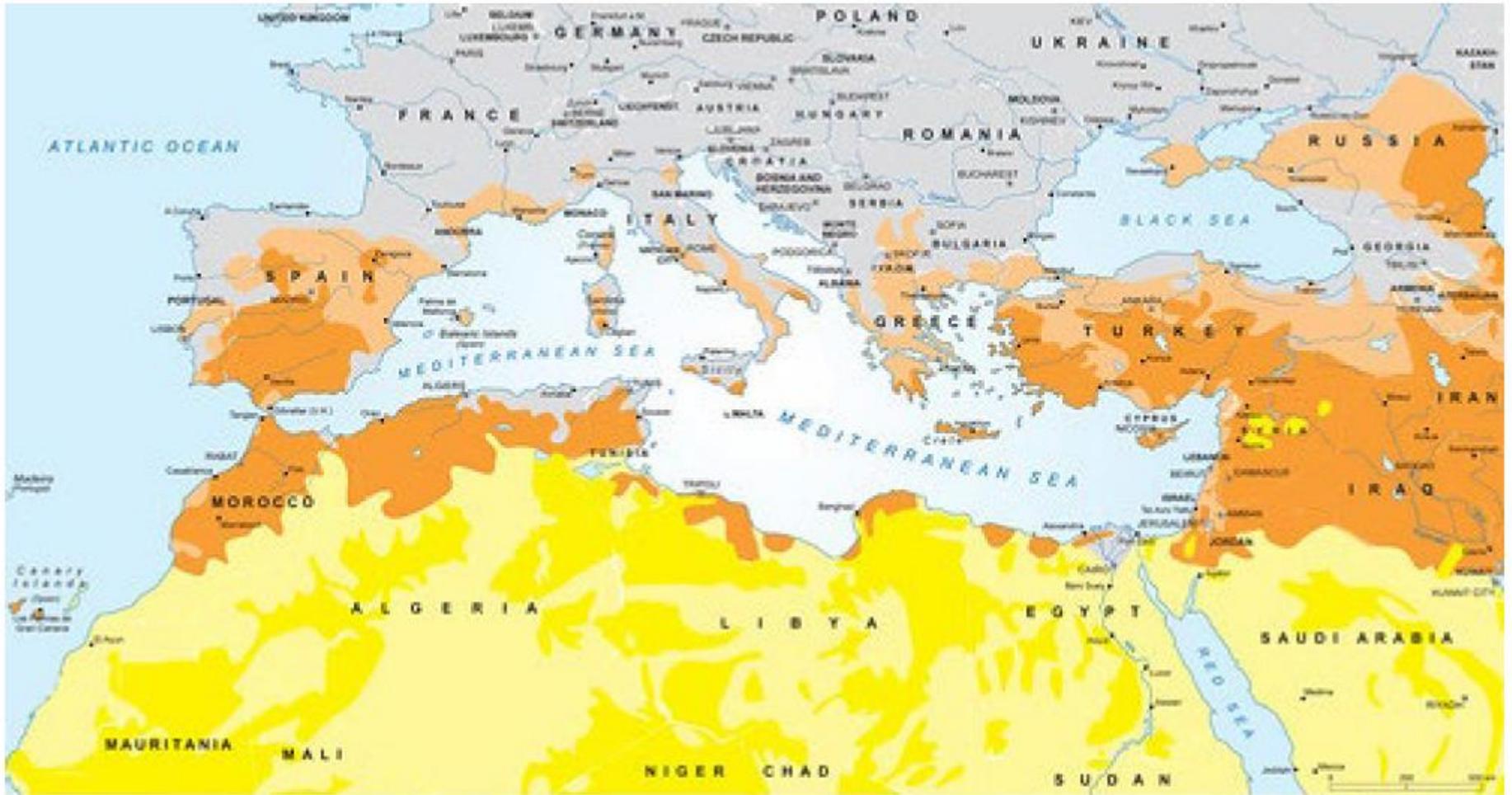


Figure 1: **Number of days per year with high-to-extreme fire danger** (daily FWI ≥ 30). Additional days per year with high-to-extreme fire danger, with reference to the situation in the control period 1981-2010, for different levels of global warming. Red shades denote an increment of days, blue shades a decrement. See Figure 10 and Figure 11 for more details.

**Número de dias por ano com Índice meteorológico de perigo incêndio florestal (FWI) muito elevado ou extremo,
 Fonte, Projeto PESETA IV, JRC**



Environment and Security in the Mediterranean: Desertification

- Desert
- Semi-desert
- Desertification vulnerability, serious
- Desertification vulnerability, moderate

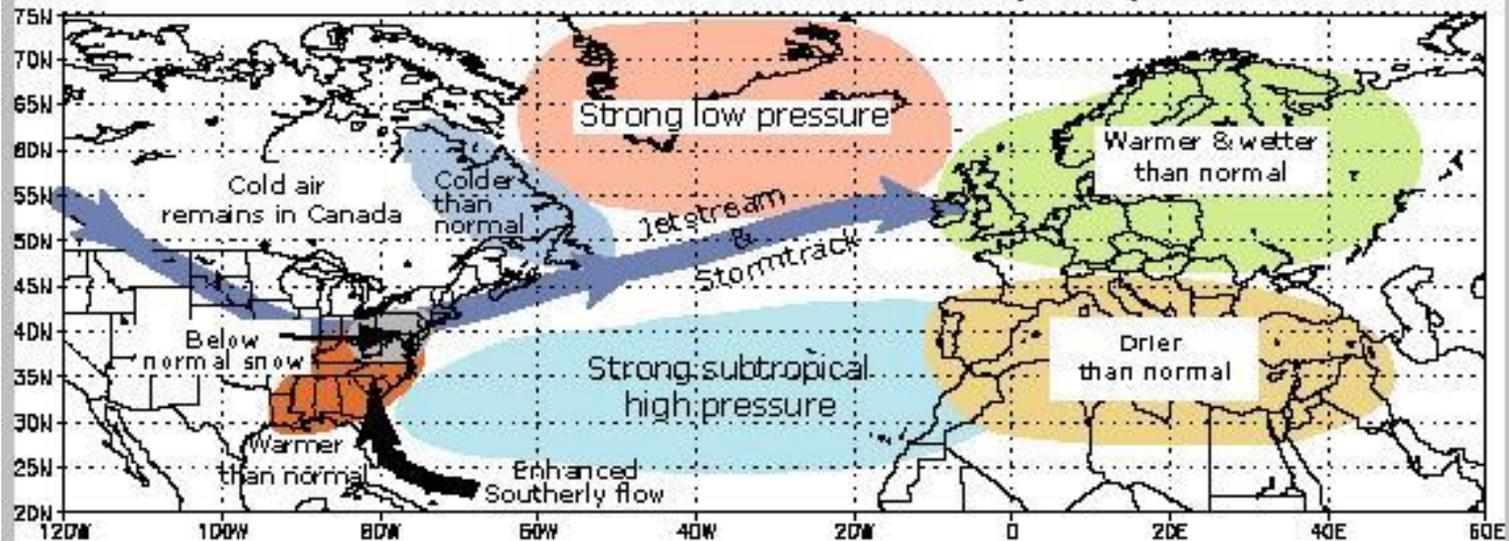
Desertification Vulnerability, serious
Desertification Vulnerability, moderate

Sources: Natural Resources Conservation Service, Plan Bleu, Times Atlas of the World

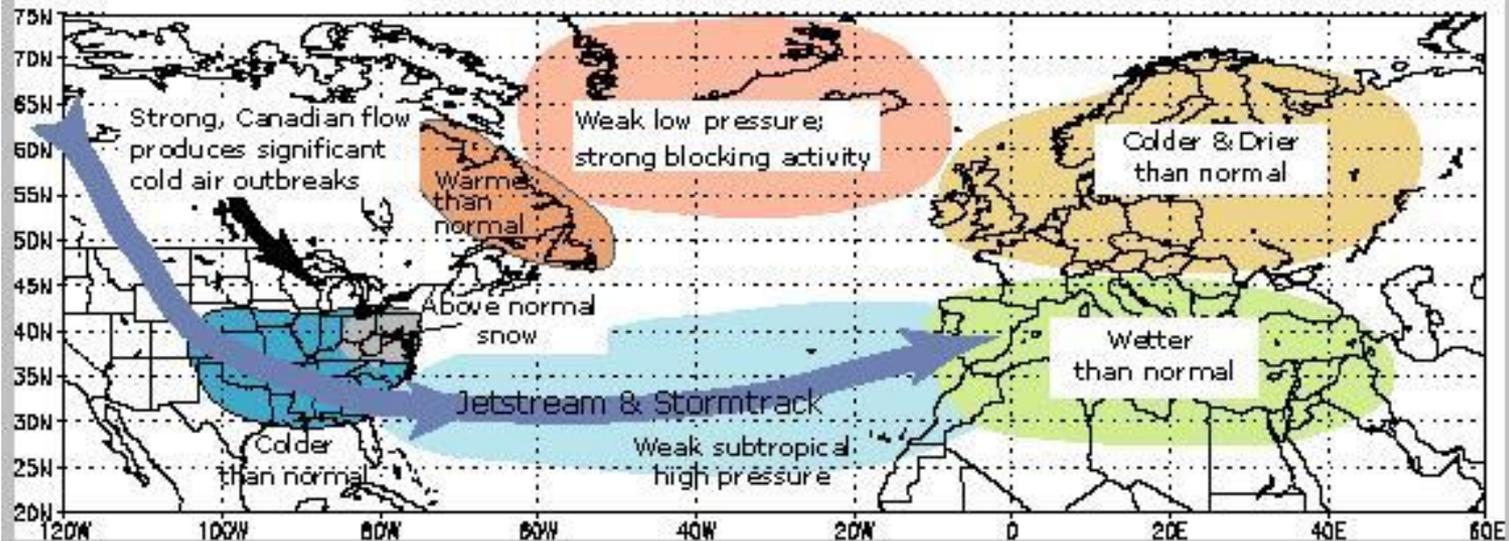


Source

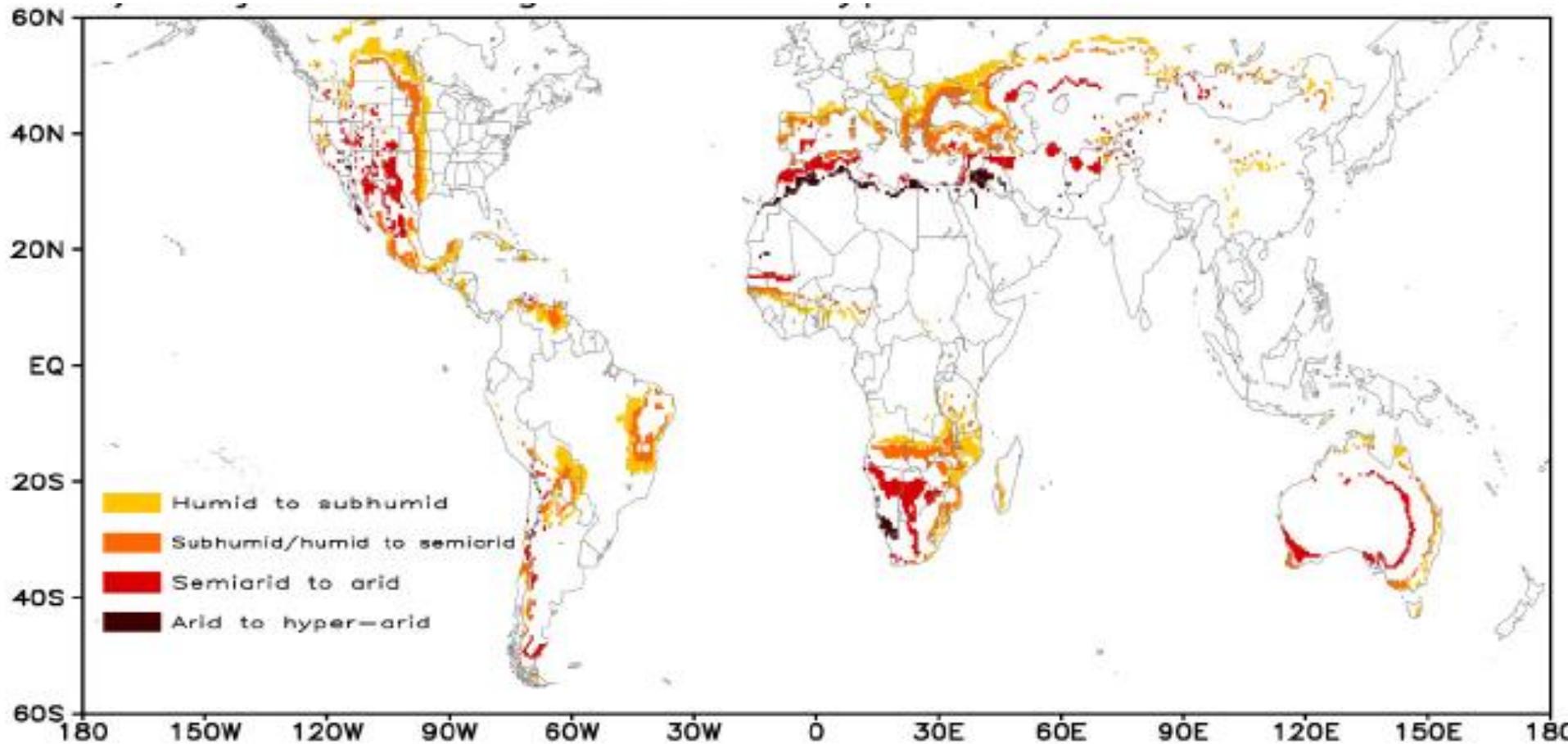
Positive Phase of the Wintertime North Atlantic Oscillation (NAO)



Negative Phase of the Wintertime North Atlantic Oscillation (NAO)



Transformação de climas húmidos em sub-húmidos, sub-húmidos em semiáridos, semiáridos em áridos e áridos em hiper-áridos devido às alterações climáticas





Houseboats float, amid extreme drought, on California's Lake Oroville in October 2021. (David Paul Morris/Bloomberg News)

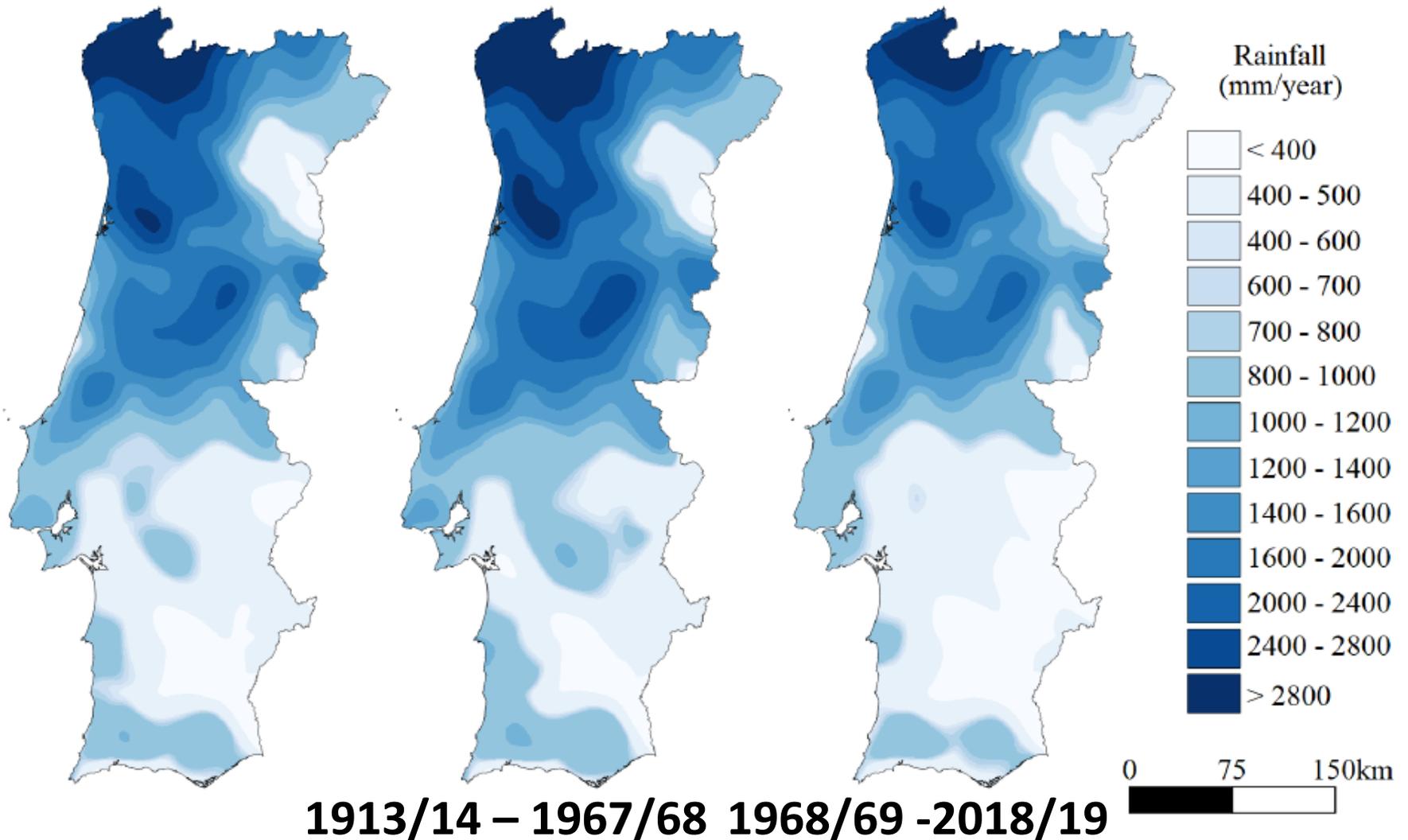


Um amendoal abandonado em Newman, California, EUA, 2021
Foto de Terry Chea/AP

a) Global period - 1913/1914 to 2018/2019 (961 mm)

b) Initial sub period - 1913/1914 to 1967/1968 (1041 mm)

c) Final sub period - 1968/1969 to 2018/2019 (874 mm)



1913/14 – 1967/68 1968/69 -2018/19
Figure 5. Mean annual rainfall maps for the global period (106 hydrological years) and for the initial (55 hydrological years) and final (51 hydrological years) sub-periods based on the 532 rain gauges schematically located in Figure 1 (between brackets, the weighted mean annual rainfall in each period given by the cubic spline interpolation).

Fonte: Portela et al., 2020

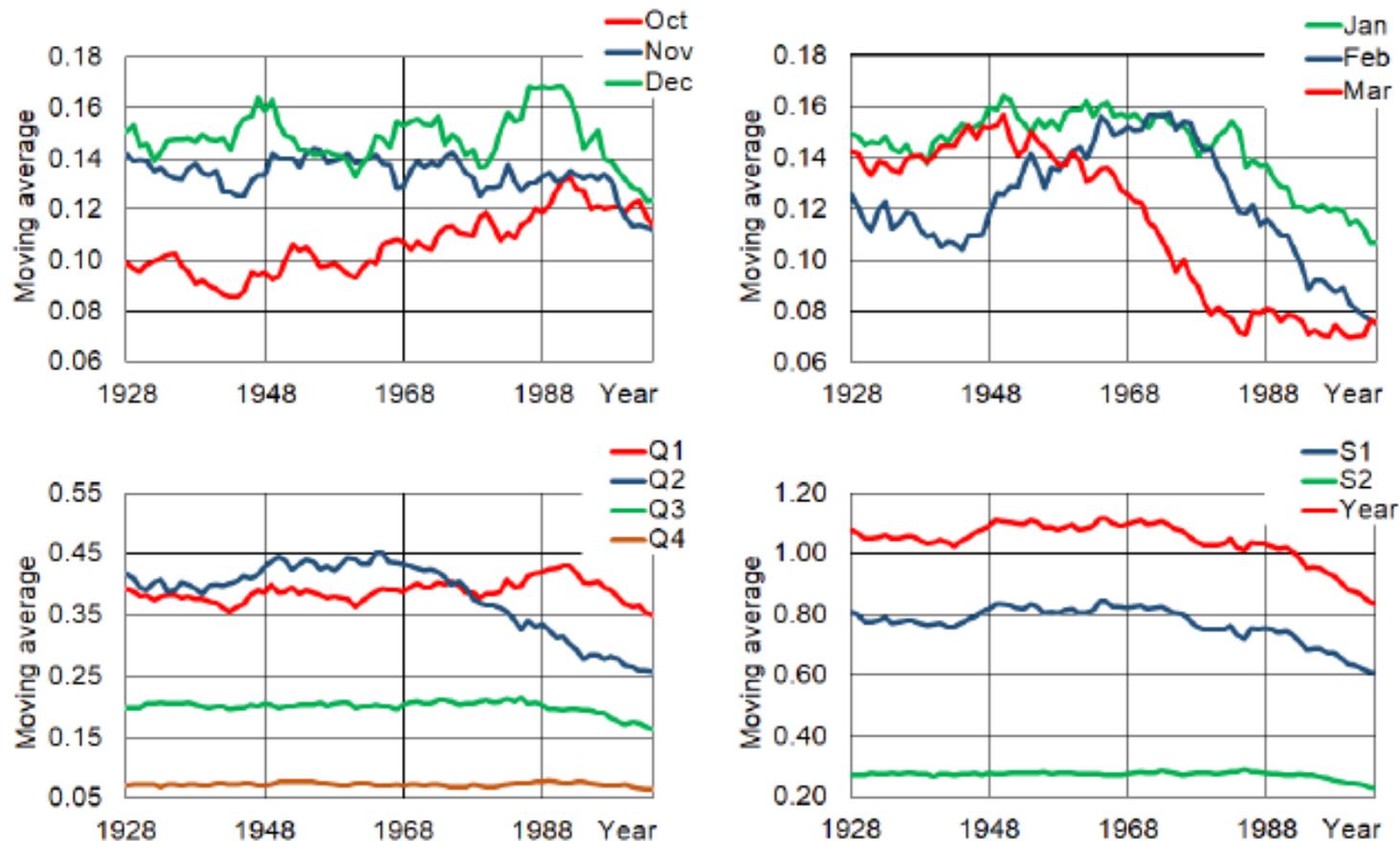
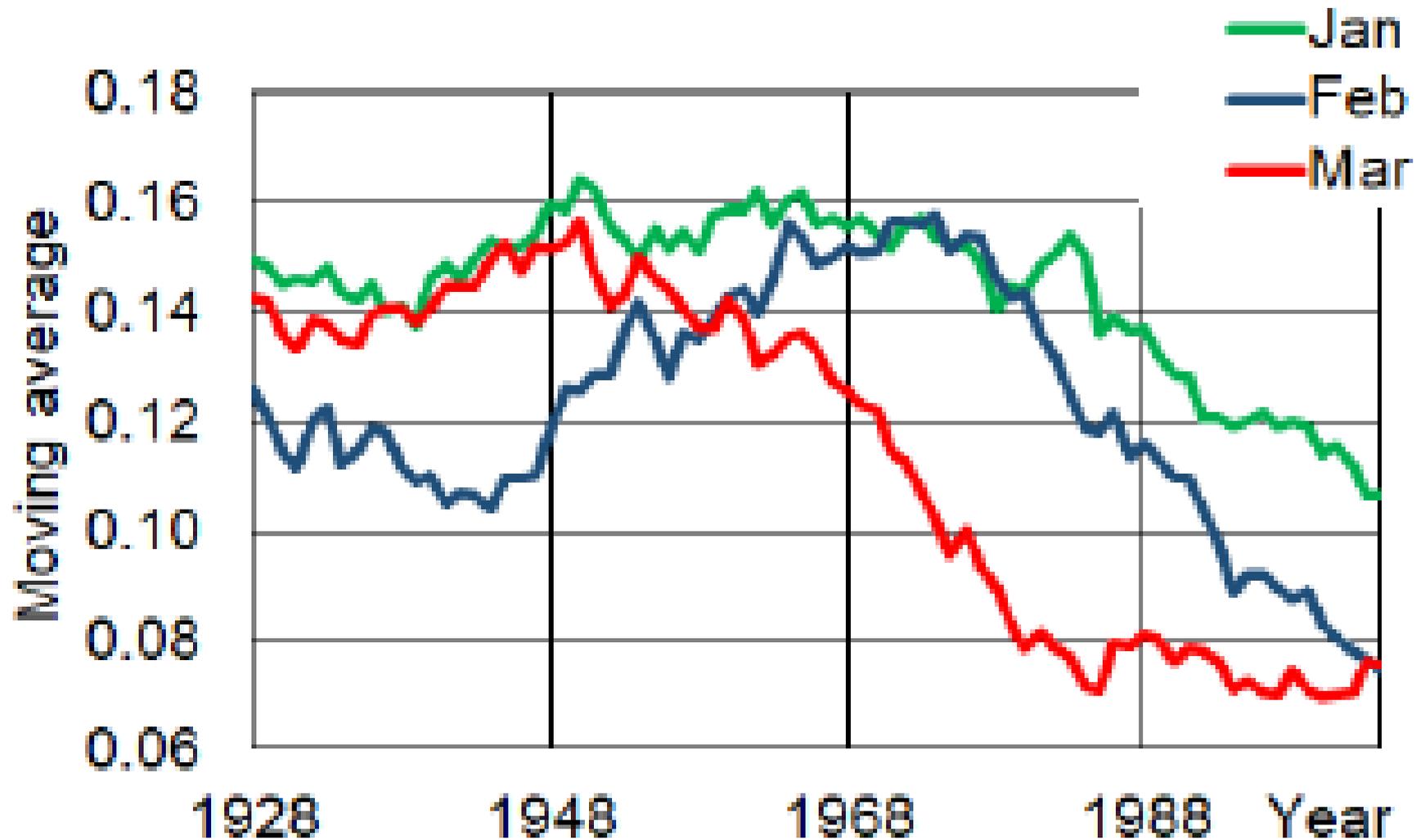


Figure 9. Dimensionless moving average of the rainfall in different periods of the year, from 1913/1914 on, for a running length of 30 years. Each moving was made dimensionless by reference to the mean annual rainfall and assigned to the first civil year of the 16th hydrological year of the corresponding 30-year period.

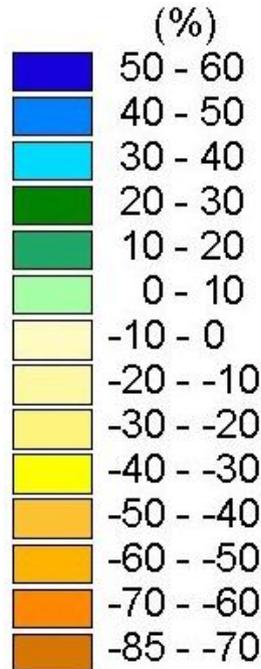
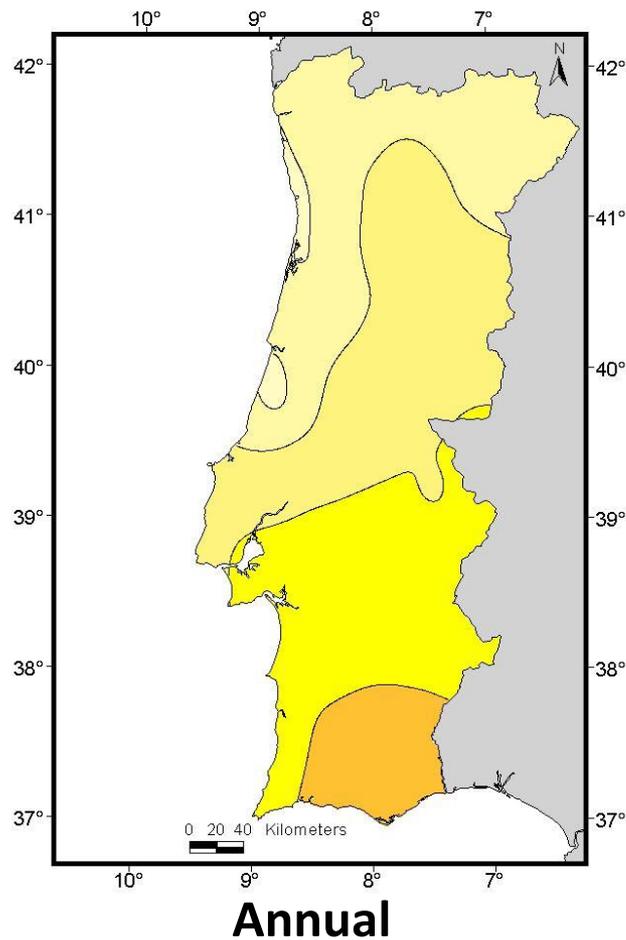
Fonte: Portela et al.,2021Portela, M.M.; Espinosa, L.A.; Zelenakova, M., Long-Term Rainfall Trends and Their Variability in Mainland Portugal in the Last 106 Years. *Climate*, 2020, 8, 146, DOI: 10.3390/cli8120146



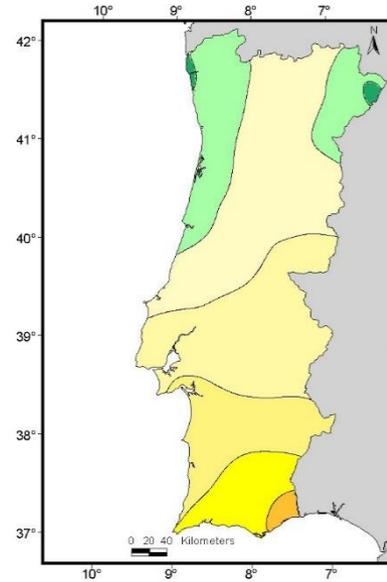
Fonte: Portela et al., 2021

Precipitation Anomaly

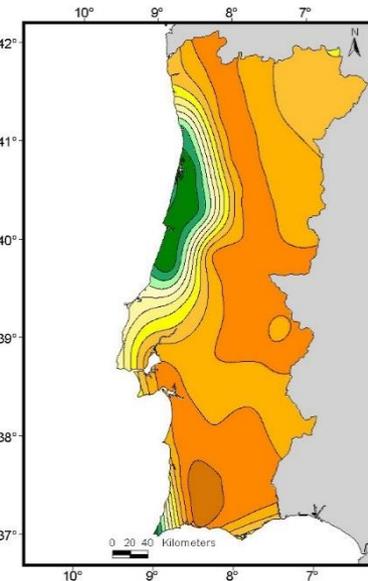
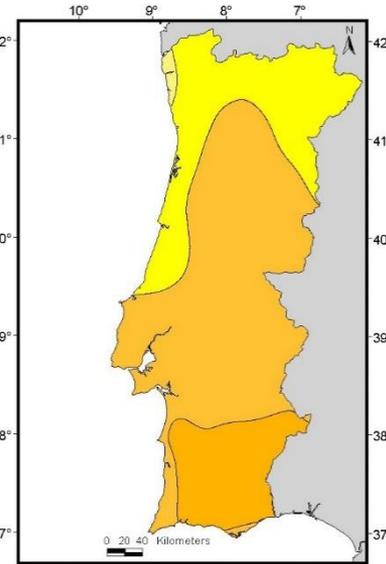
A2 scenario for the period 2071-2100 relative to 1961-1990, SIAM I Project, 2002



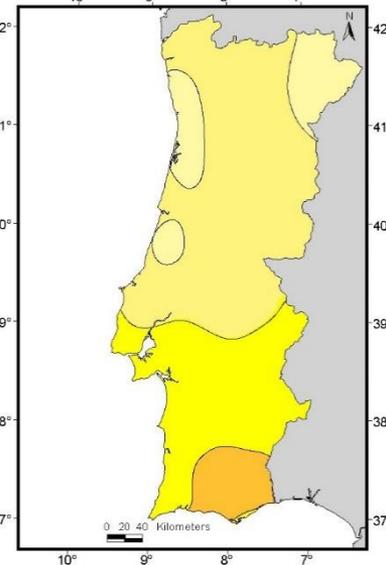
Winter (DJF)



Spring (MAM)



Summer (JJA)



Autumn (SON)

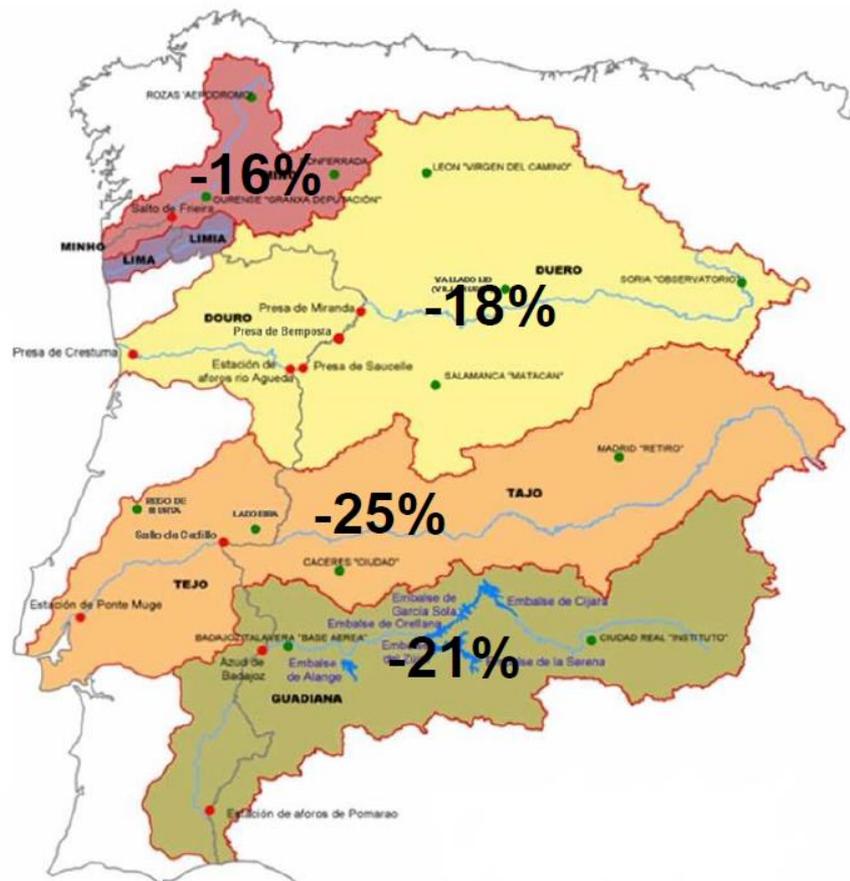
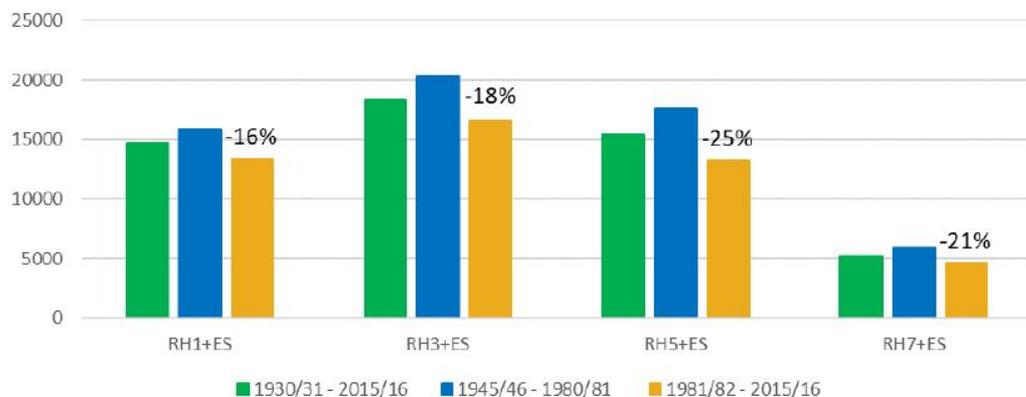
- **Nos últimos 20 anos a precipitação em Portugal e Espanha diminuiu cerca de 15%, prevendo-se que diminua entre 10 a 25% até ao final do século.**
- **Nos últimos 20 anos a disponibilidade de água reduziu-se cerca de 20%.**

Fonte: Avaliação das disponibilidades hídricas atuais e futuras e aplicação do índice de escassez WEI+, APA, Período de consulta pública de 2021-12-11 a 2022-06-30

Disponibilidades de água: Escoamento anual

Percentagens de diminuição ao nível de cada uma das bacias internacionais considerando a parte espanhola e a parte portuguesa

Escoamento anual (hm³)



Comparação entre 1945/46-1980/81 e 1981/82-2015/16

Índice WEI+

$$WEI + = \frac{\text{Uso de água}}{\text{Recursos disponíveis renováveis (RWR)}}$$

RWR: Recursos superficiais e subterrâneos disponíveis, deduzidos dos volumes para fins ecológicos

Usos de água: Volumes captados, deduzidos dos retornos

0 (sem escassez) ↔ **1** (crítico)

WEI+ inferior a 10% - Sem Escassez

WEI+ entre 10% a 20% - Escassez Baixa

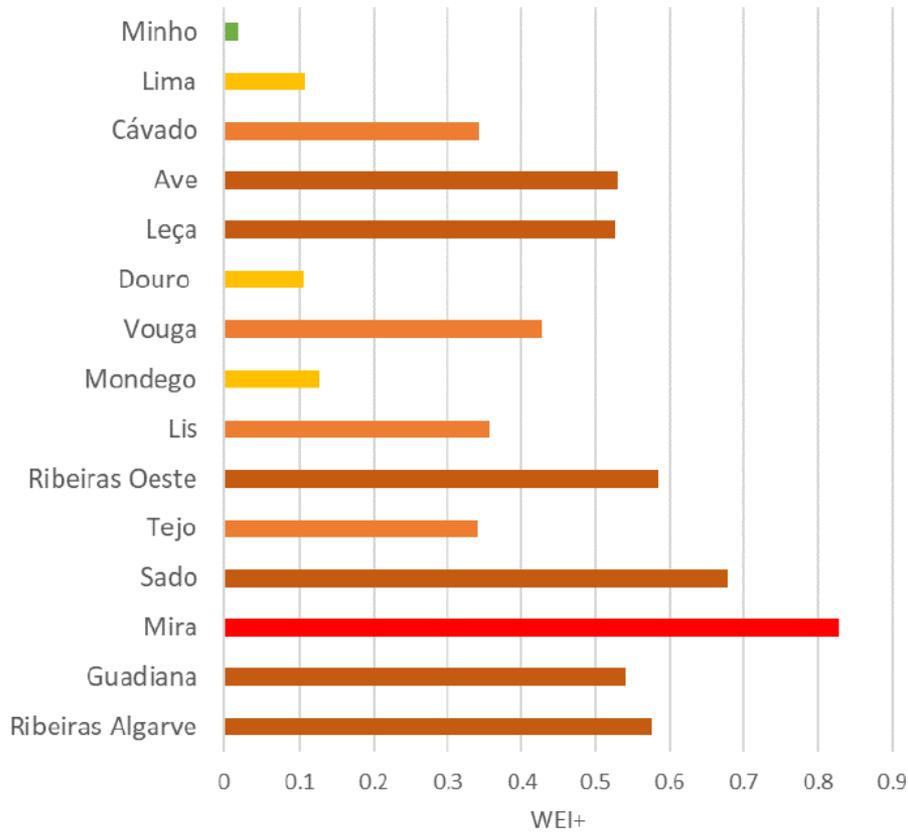
WEI+ entre 20% a 30% - Escassez Moderada

WEI+ entre 30% a 50% - Escassez Elevada

WEI+ entre 50% a 70% - Escassez Severa

WEI+ superior 70% - Escassez Extrema

WEI+ por Região Hidrográfica



- Os valores do WEI+ são genericamente elevados.
- As bacias hidrográficas do Sado e do Mira são aquelas que merecem mais preocupação.
- Localmente, certas sub-bacias apresentam valores mais elevados.

Comparando com outros países da UE, Portugal tem:

1 - Uma excelente qualidade de água para consumo humano

2 - Uma percentagem muito elevada de tratamento das águas residuais urbanas

3 - Uma das mais baixas percentagens de re-utilização das águas residuais tratadas

Reutilizar as águas residuais urbanas

	Wastewater Generated	Wastewater Treated	Wastewater Treated and Used
	km3/ano	km3/ano	km3/ano
Alemanha	6,172	5,123 (83,0%)	0,042 (0,82%)
Espanha	5,204	4,570 (87,8%)	0,487 (10,66%)
Itália	3,926	3,902 (99,4%)	0,233 (5,97%)
França	7,910	6,654 (84,1%)	0,411 (6,17%)
Portugal	0,577	0,561 (97,2%)	0,006 (1,07%)

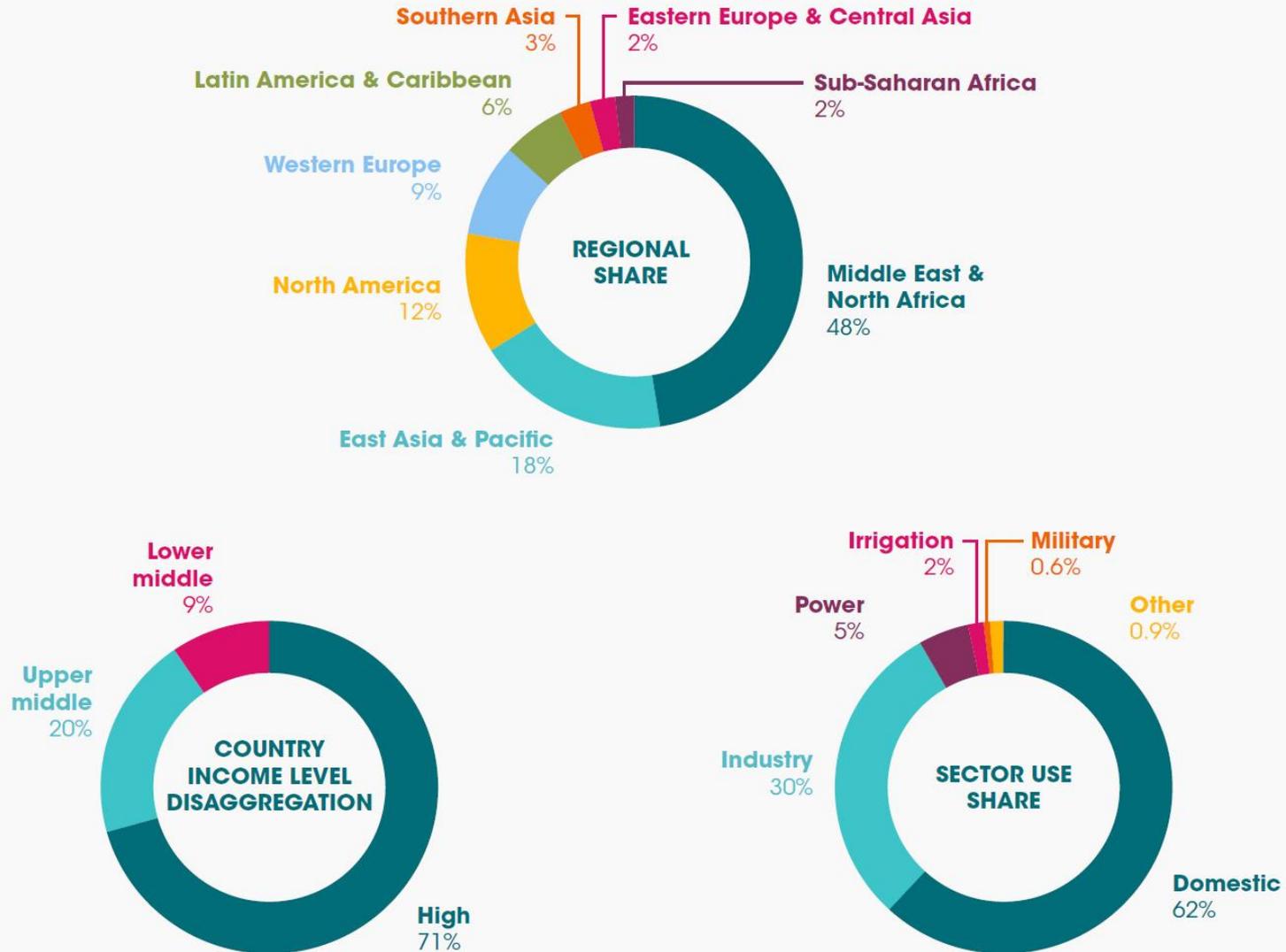
Fonte: Global, regional, and country level need for data on wastewater generation, treatment, and use, Agricultural Water Management 130(2013):1–13

DOI: 10.1016/j.agwat.2013.08.007

Toshio Sato, Manzoor Qadir, Sadahiro Yamamoto et al., 2013

Figure 17
**Global share of operational desalination plants by region,
 country income level and sector use**

Dessalinização da água do mar por meio de energias renováveis



No sector da agricultura e da silvicultura, as medidas de adaptação podem concentrar-se:

- (i) na cultura (a adaptação pode consistir em mudar ou melhorar a cultura/espécie/variedade)**

- (ii) no sistema de cultivo (inclui as práticas e técnicas de gestão como bem como a rotação de culturas e os tempos);**

- (iii) no sistema de agricultura (inclui o agricultor e, portanto, a capacidade de adaptação, o mercado, a regulamentação, os incentivos económicos, mecanismos de proteção e informação).**

Assim, a adaptação no sector da agricultura requer conhecimentos sobre a sensibilidade climática de cada **cultura, espécie e variedade mais adequada conforme as diferentes condições de solo (por exemplo, retenção de água, nutrientes, matéria orgânica e estrutura, entre outros), exposição às variáveis climáticas ao longo do ano (por exemplo, radiação solar, humidade, precipitação, temperatura), interações com outras espécies (por exemplo, culturas, biodiversidade, pragas), usos do solo e a interdependência com as técnicas agrícolas utilizadas.**

Requer também o uso sistemático de avisos meteorológicos sobre temperatura e precipitação, sobre a ocorrência futura de eventos extremos e projeções sobre as anomalias na temperatura e precipitação semanais (6 semanas) e mensais (6 meses).

<https://effis.jrc.ec.europa.eu/apps/effis.longterm.forecasts/>

Basta procurar: [effis.longterm.forecast](#)

Monthly Temperature (T2m) Anomalies valid for week: from 23 to 29 May 2022

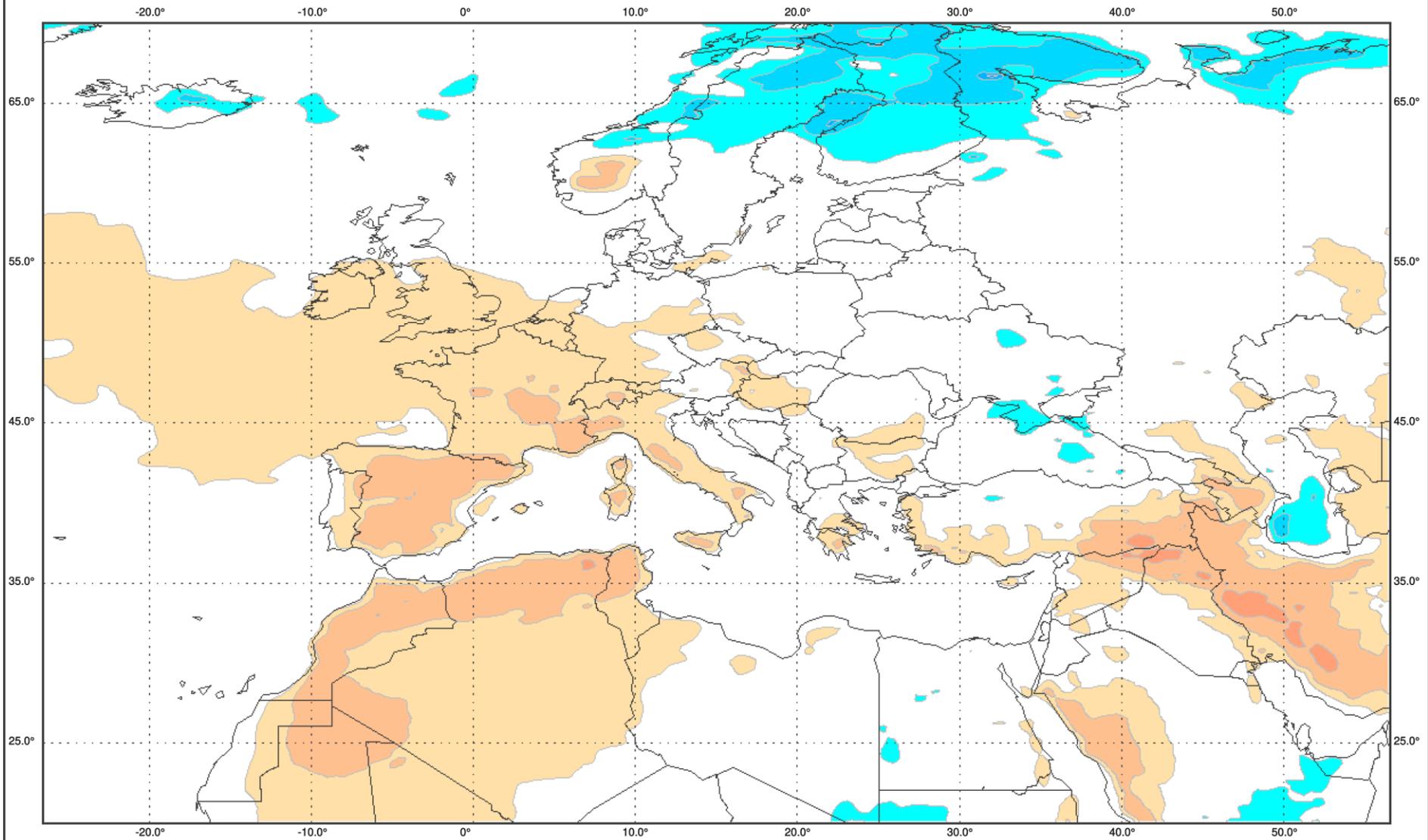
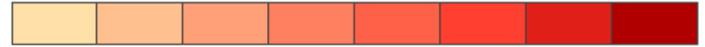
Map processed by EFFIS System based on ECMWF Monthly Forecast System initiated on 18 April 2022

Estimated deviation (anomaly) of the mean from model climate in Celsius degrees

-8.00 -7.00 -6.00 -5.00 -4.00 -3.00 -2.00 -1.00 -0.50



0.50 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00



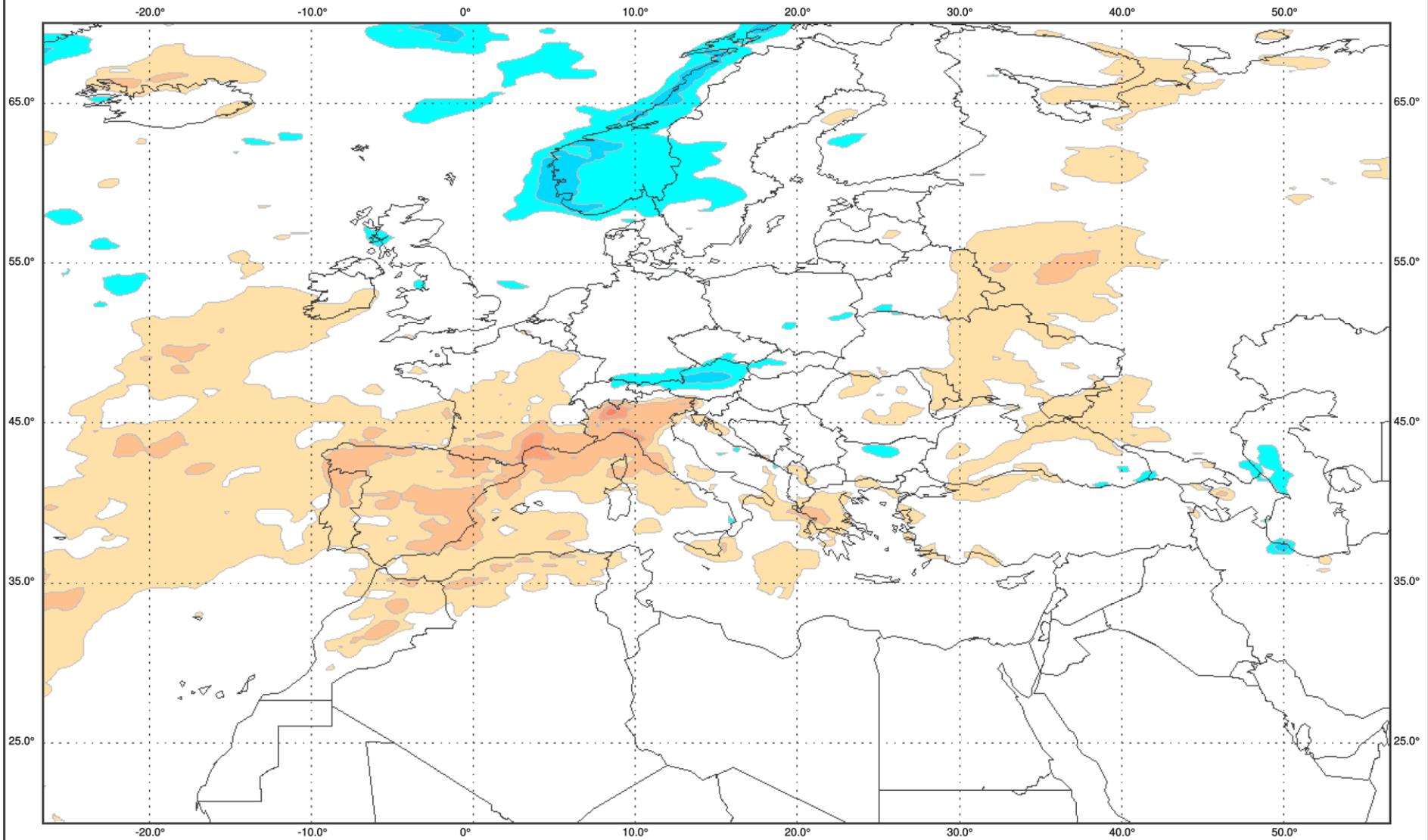
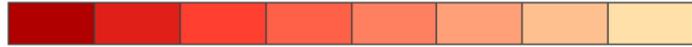
Seasonal Rain Anomalies valid for month: September 2022

Map processed by EFFIS Sytem based on ECMWF Seasonal Forecast System (S5) initiated on 01 April 2022

Estimated deviation (anomaly) of the mean from model climate in millimeters (mm)

-125.00 -100.00 -75.00 -50.00 -40.00 -30.00 -20.00 -10.00 -5.00

5.00 10.00 20.00 30.00 40.00 50.00 75.00 100.00 125.00



Article

Framework for Climate Change Adaptation of Agriculture and Forestry in Mediterranean Climate Regions

André Vizinho ^{1,*} , David Avelar ¹, Cristina Branquinho ¹ , Tiago Capela Lourenço ¹ , Silvia Carvalho ¹, Alice Nunes ¹ , Leonor Sucena-Paiva ¹, Hugo Oliveira ¹ , Ana Lúcia Fonseca ¹ , Filipe Duarte Santos ¹ , Maria José Roxo ² and Gil Penha-Lopes ¹

Vizinho, A.; Avelar, D.; Branquinho, C.; Capela Lourenço, T.;
Carvalho, S.; Nunes, A.; Sucena-Paiva, L.; Oliveira, H.; Fonseca, A.L.; Duarte
Santos, F.; et al.

Framework for Climate Change Adaptation of Agriculture and Forestry in
Mediterranean Climate Regions.

Land **2021**, *10*, 161.

<https://doi.org/10.3390/land10020161>

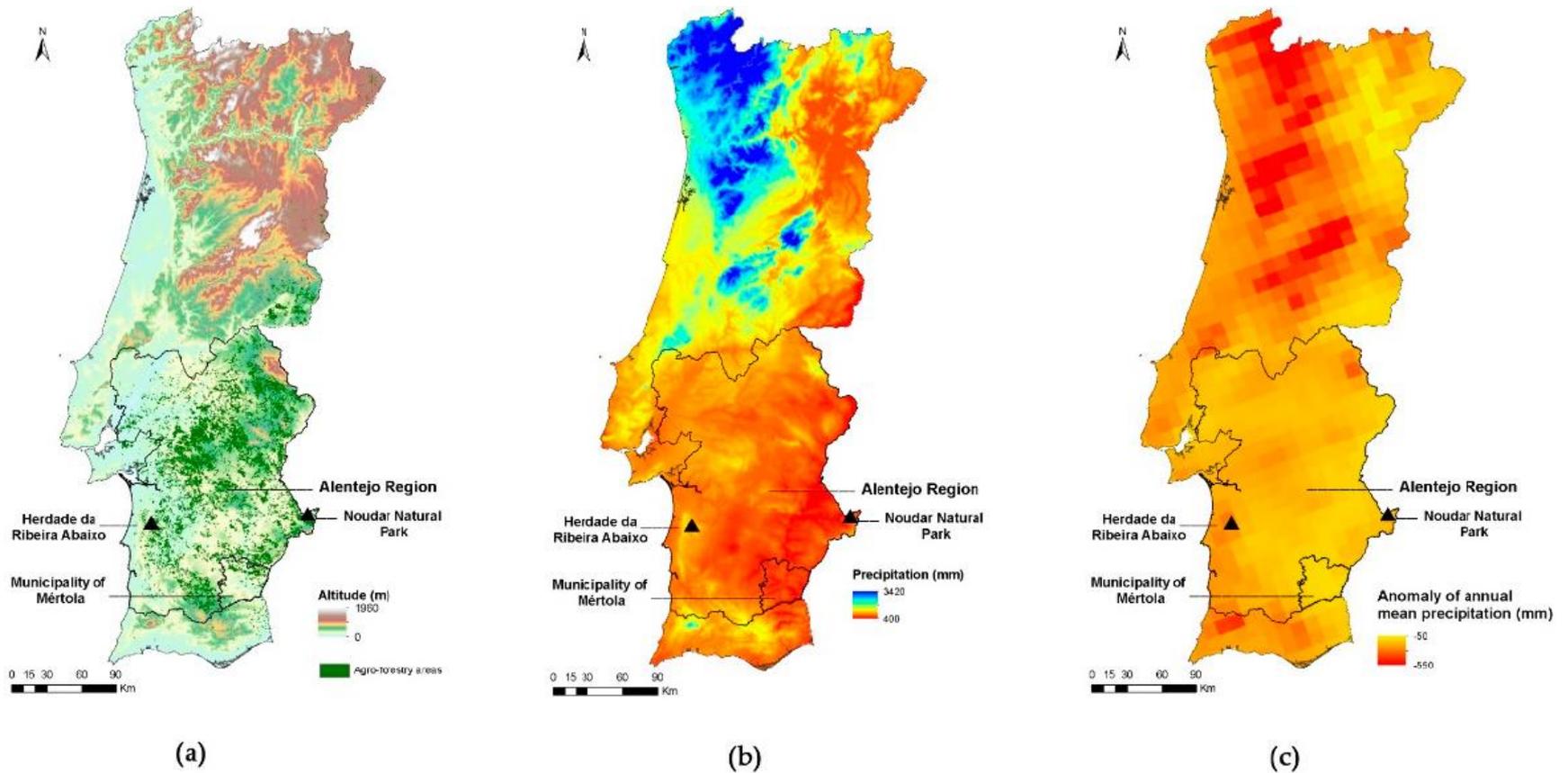


Figure 1. Map of Portugal with the location of the case studies of Mertola Municipality, Herdade da Ribeira Abaixo farm, and Herdade da Coitadinha/Natural Park of Noudar farm, within the study area of Alentejo region. (a) Altitude and agroforestry areas (from Corine land cover 2018); (b) observed annual mean precipitation for the period 1971–2000; (c) anomaly of annual mean precipitation for the period 2071–2100 under RCP8.5 scenario (datasets from IPMA, 2018).

Obrigado pela vossa atenção