Groupe interacadémique pour le développement

CIHEAM
Centre International de Hautes Études Agronomiques Méditerranéennes

Umberto Fratino : Impact des changements climatiques sur les bassins versants méditerranéens

Résumé

The Mediterranean is home to more than 510 million people and this region is warming 20% faster than the global average. By 2050, water demand is projected to double or even triple. The related impacts will exert additional pressure on already strained ecosystems and on vulnerable economies and societies. Many areas, mainly coastal zones, face heightened disaster risks, including flooding and erosion, and the salinization of river deltas and aquifers that sustain food security and livelihoods. Water resources in the Mediterranean are scarce. They are limited, unevenly distributed and often mismatching human and environmental needs. Three quarters of the resource are located in the northern Mediterranean while three quarters of the needs are in the south and east. As a consequence, 180 million people in the southern and eastern Mediterranean countries suffer from water scarcity. On the other hand, northern countries face additional risks in flood prone areas where urban settlements are rapidly increasing. Climate change, in interaction with other drivers (demographic and socio-economic developments), has mainly negative consequences for the water cycle in the Mediterranean, including reduced runoff and groundwater recharge, increased crop water requirements, increased conflicts among users, and increased risk of overexploitation and degradation.

GID –CIHEAM

Parmenides IX Conference

Sustainable management of Mediterranean watersheds faced with the impacts of societal and climate change

Bari (ITALY) - 19 - 21 October 2021

IMPACT OF CLIMATE CHANGE ON MEDITERRANEAN WATERSHEDS

UMBERTO FRATINO

Politecnico di Bari

Marocco, 2014

Sicily (Italy), October 5, 2021

Greece, October 14 - 15, 2021

The Arabian Desert is covered with rivers.
Oman (cyclone Shaheen)**, July 2021**

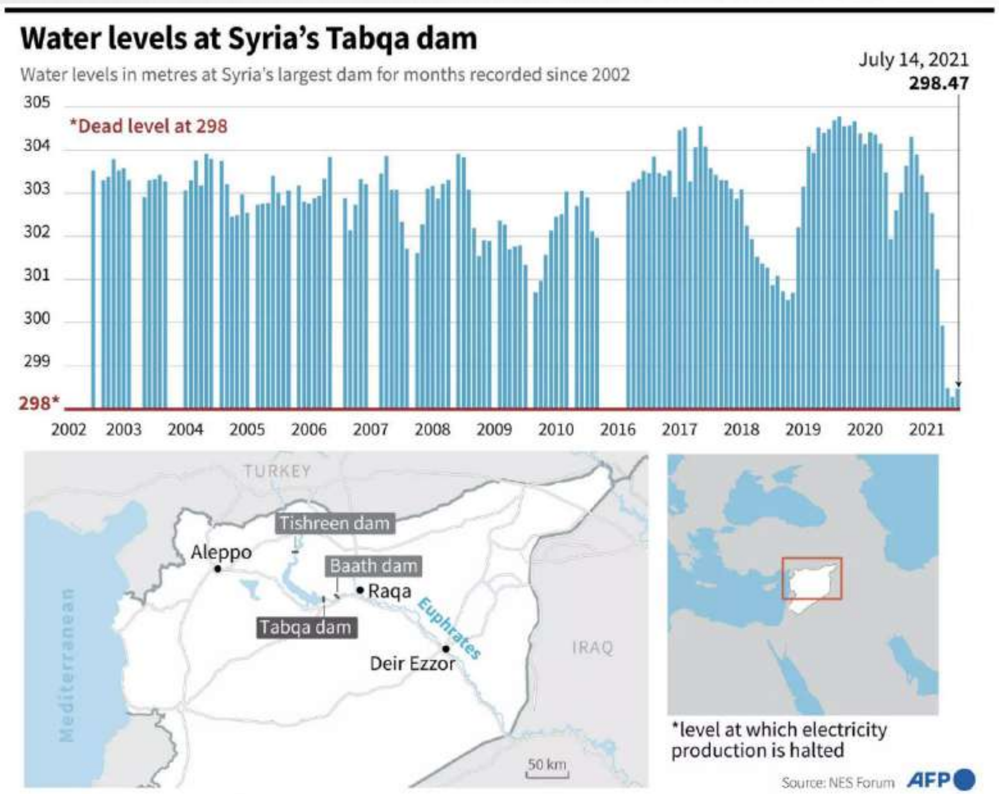
Not only floodings. What's about droughts?

The Entrepeñas reservoir in Guadalajara (Spain) during a drought in 2017

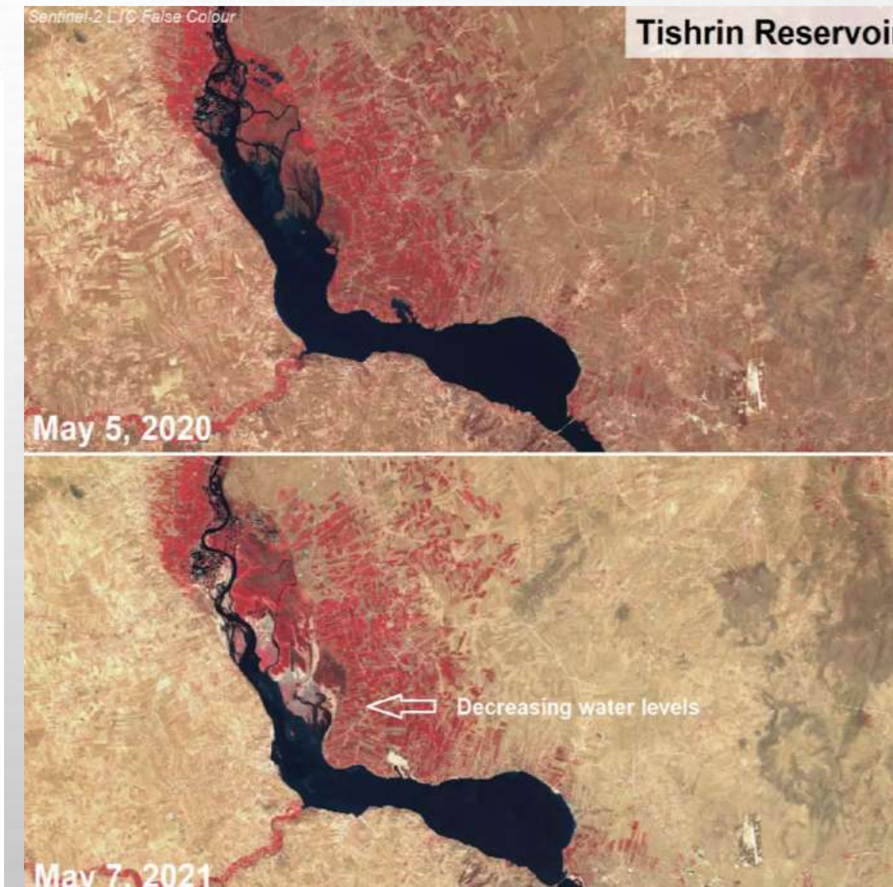
SYRIA: Severe drought in Eufrathes River – 2021

Hydrological drought or geopolitics related issues?

Discharge drops from 500 to 200 m^3/s of water across the border



Water levels at Syria's Tabqa dam AFP



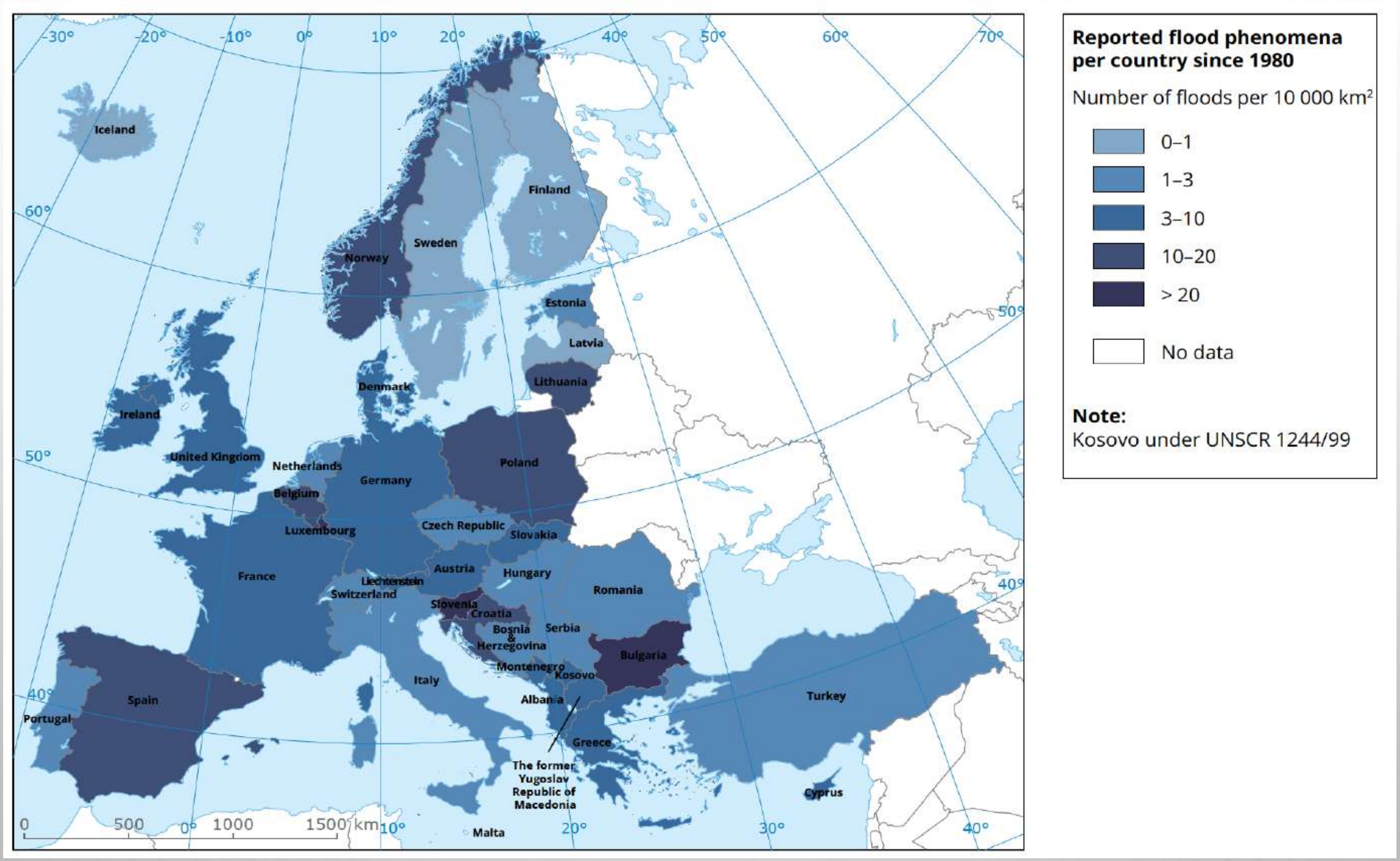
Elsewhere in EUROPE

Cyclists ride through the flooded Danube River
(Budapest, Hungary, June 7, 2010)

In Germany, more than 120 people dead for flooding during the summer 2021

Massive sinkhole caused by a flood event
(Erftstadt, Germany, July 16, 2021) #

A CLEAR EVIDENCE



EEA report, Flood risks and Environmental vulnerability, 2016

WHAT IT HAPPENS? WHY IT OCCURS?

Major flood events in Québec
1996/2011/2017

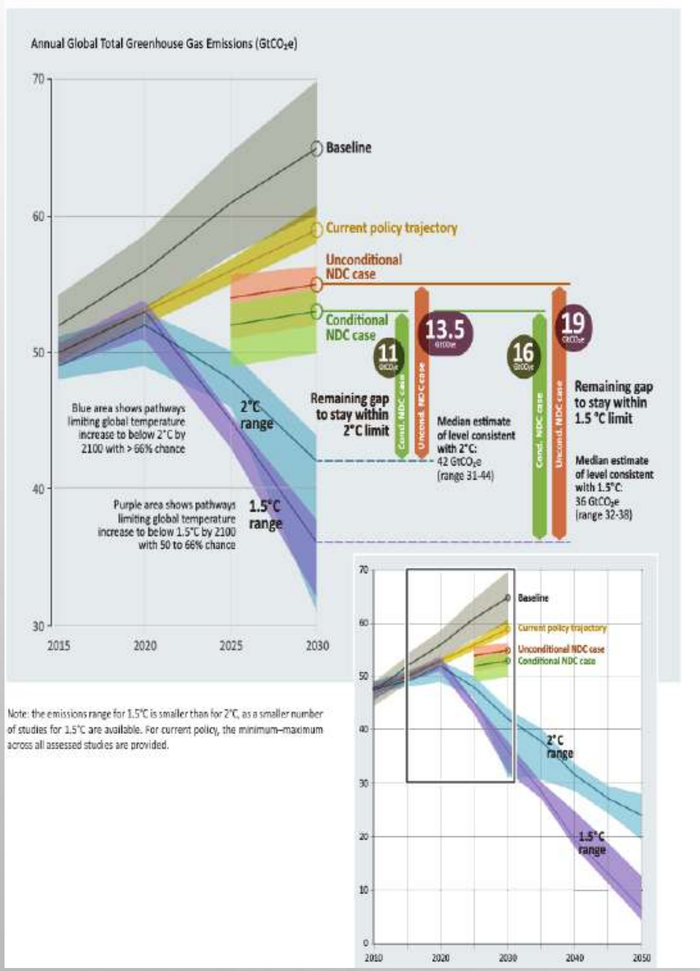
Major flood events in Bavaria
1999/2002/2005/2013/2016

« Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will *very likely* become more intense and more frequent. » - IPCC AR5 report

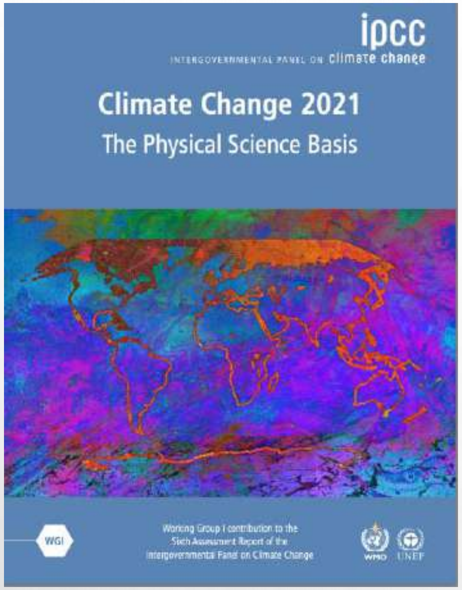
Armin Laschet blamed the devastating weather on global warming. "*We will be faced with such events over and over, and that means we need to speed up climate protection measures ... because climate change isn't confined to one state*," he said.

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

CLIMATE CHANGE?

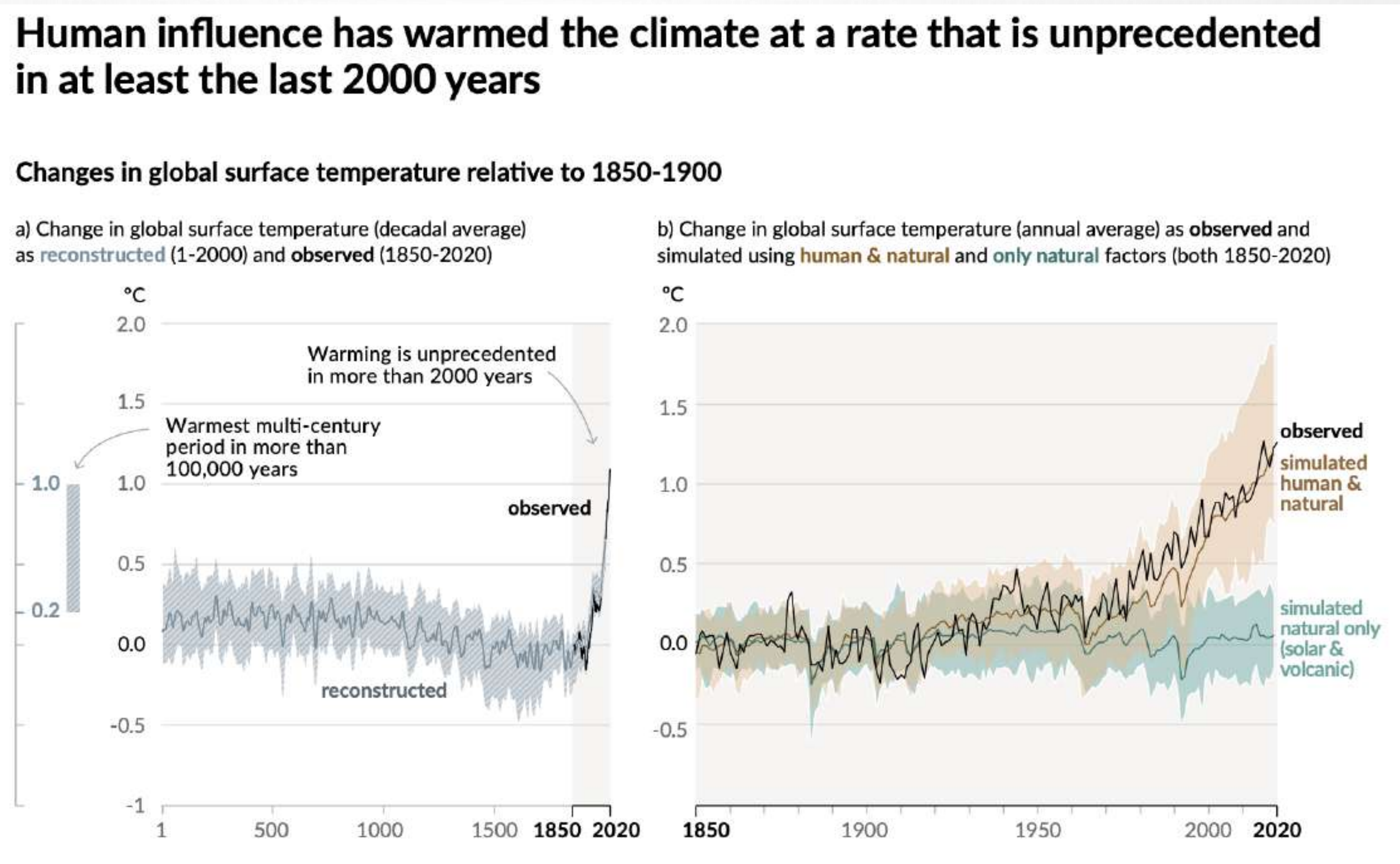


A SCIENTIFIC CERTAINTY



It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

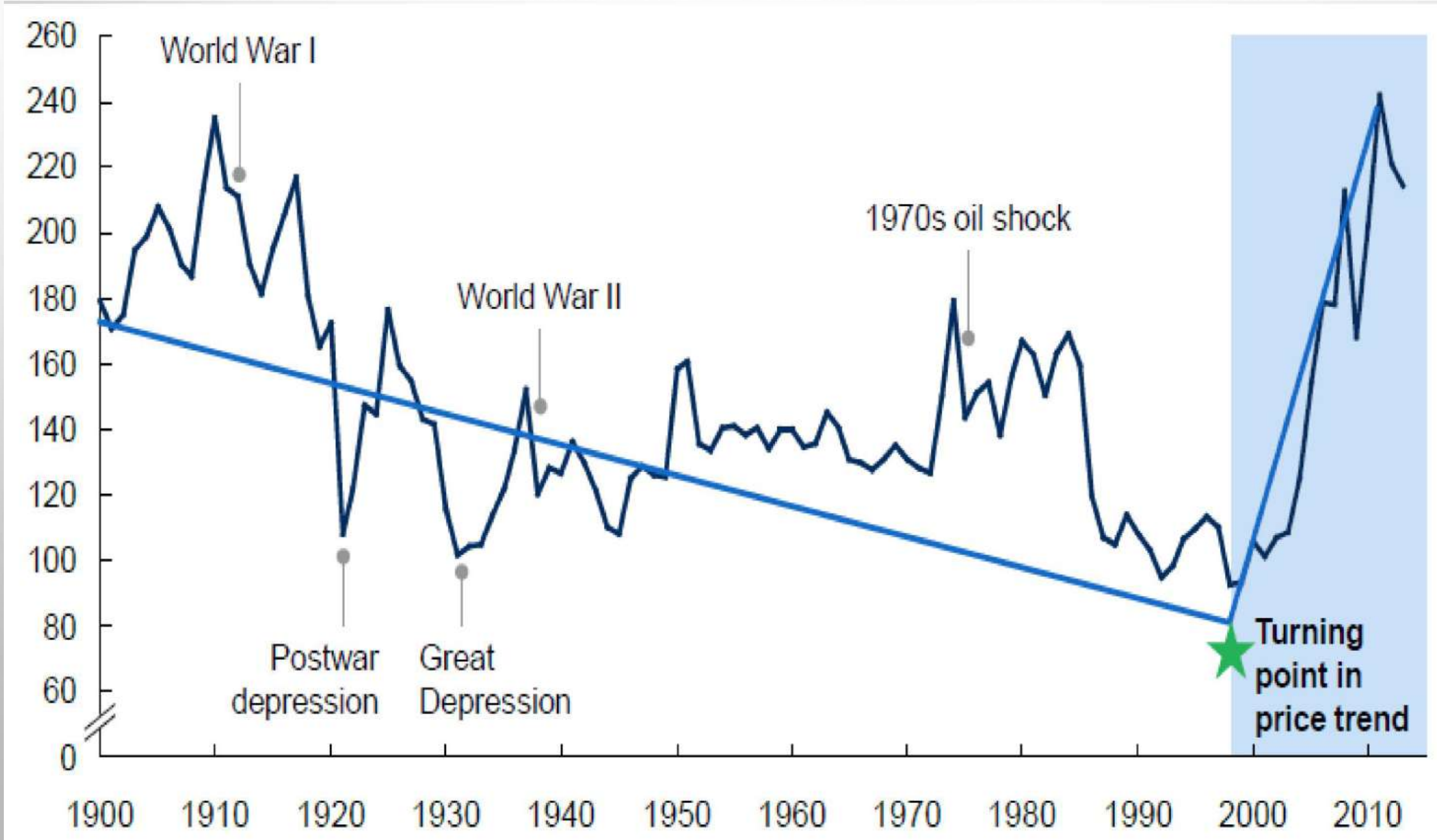
IPCC _ AR6 report
August 7, 2021



UNTIL 2100
FLOOD RISK
MAY INCREASE BY **50%** AND EROSION RISK BY **13%**

A DOUBT:

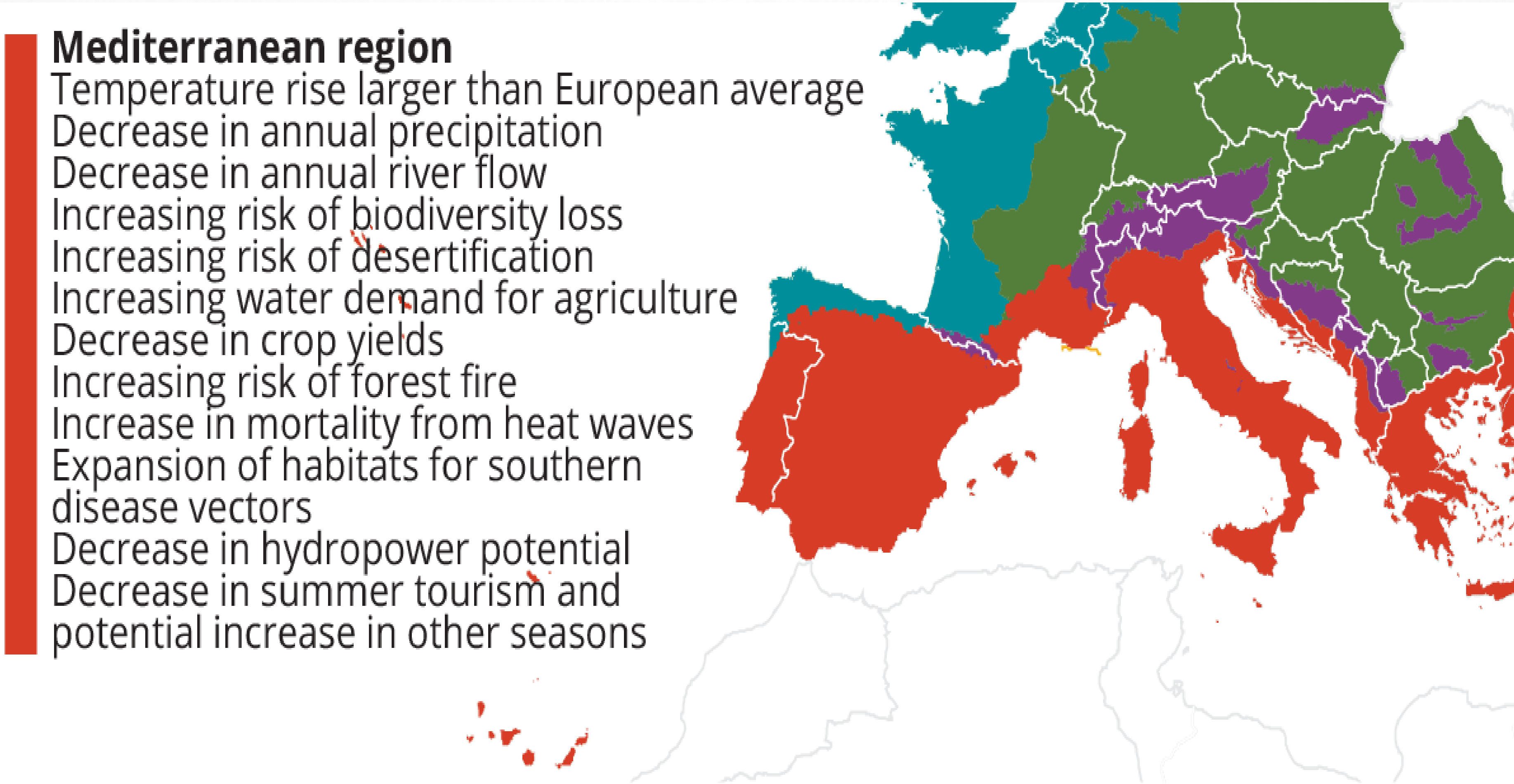
could it be related with the cost of the natural resources?



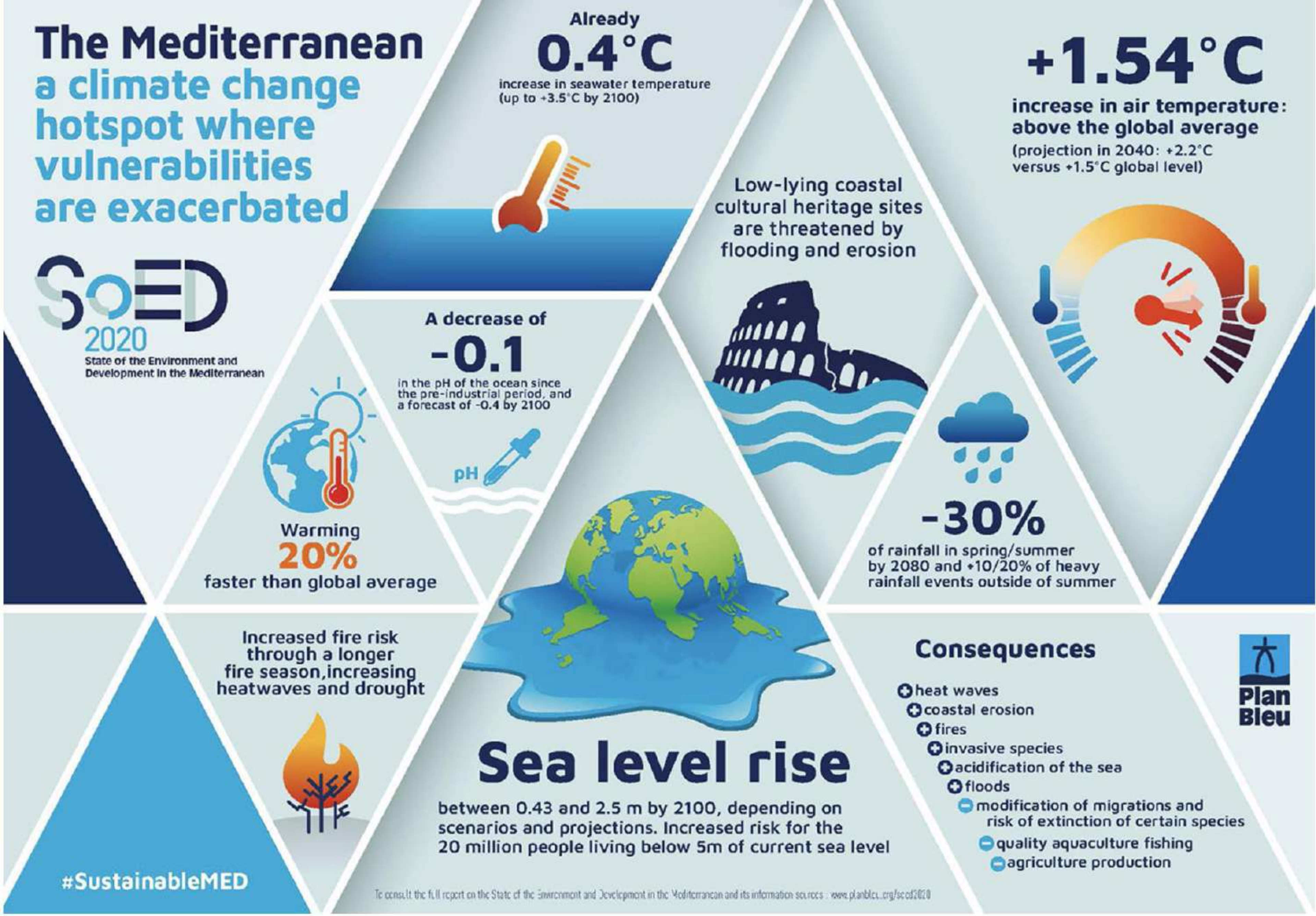
About the Mediterranean Region

The Mediterranean sea is surrounded by 23 countries and it's home to around 510 million people, corresponding to about 7,5% of the global population

What does the CC in Mediterranean region imply?



Source: EEA report, 2018



Source: https://www.unep.org/unepmap/resources/factsheets/climate-change

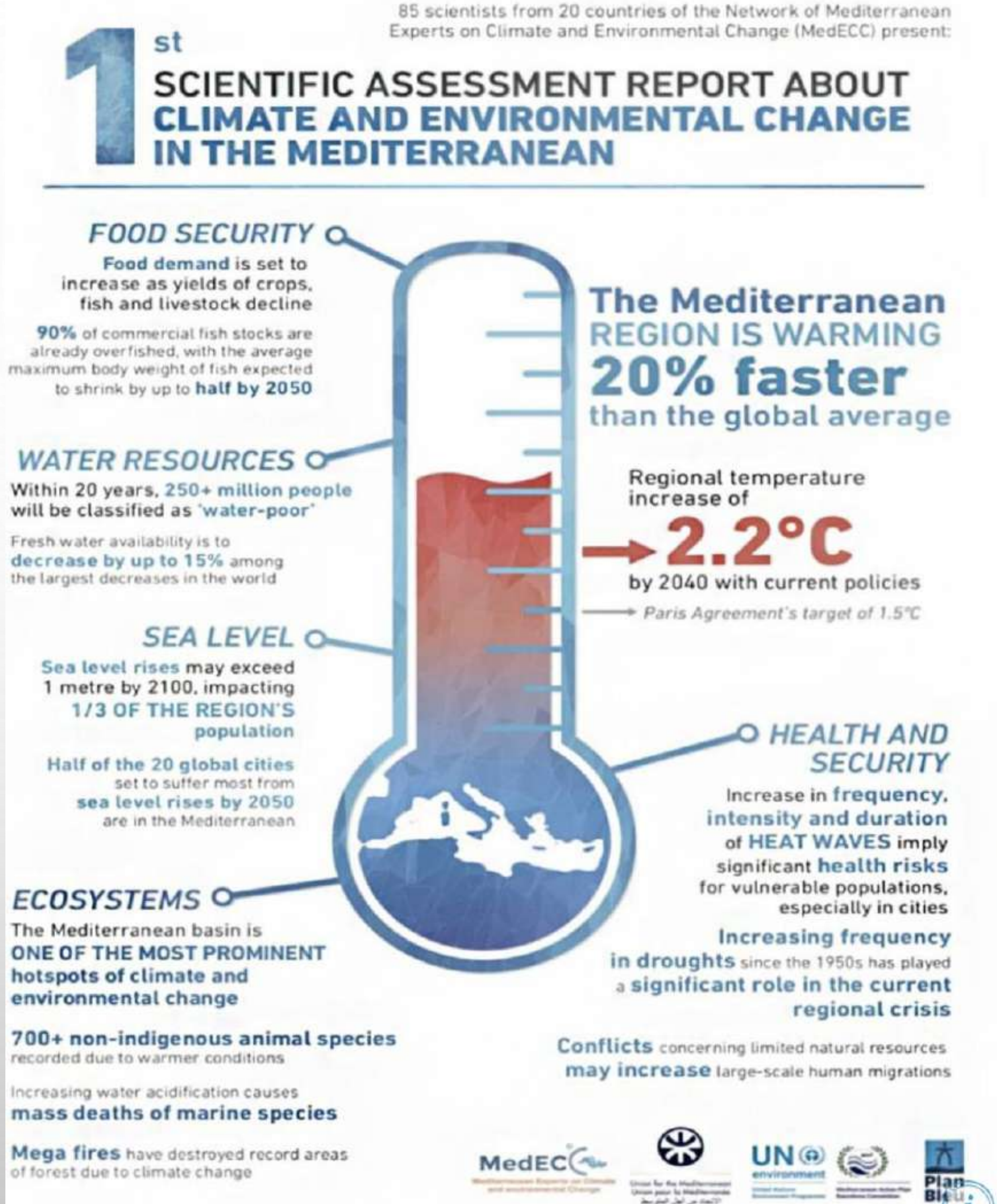
WITHOUT ADDITIONAL MITIGATION REGIONAL **TEMPERATURE** INCREASE WILL BE **2.2°C** IN **2040**

POSSIBLY **EXCEEDING** **3.8°C** IN SOME REGIONS IN **2100**

FRESH WATER AVAILABILITY IN THE **MEDITERRANEAN REGION** IS LIKELY TO **DECREASE** SUBSTANTIALY

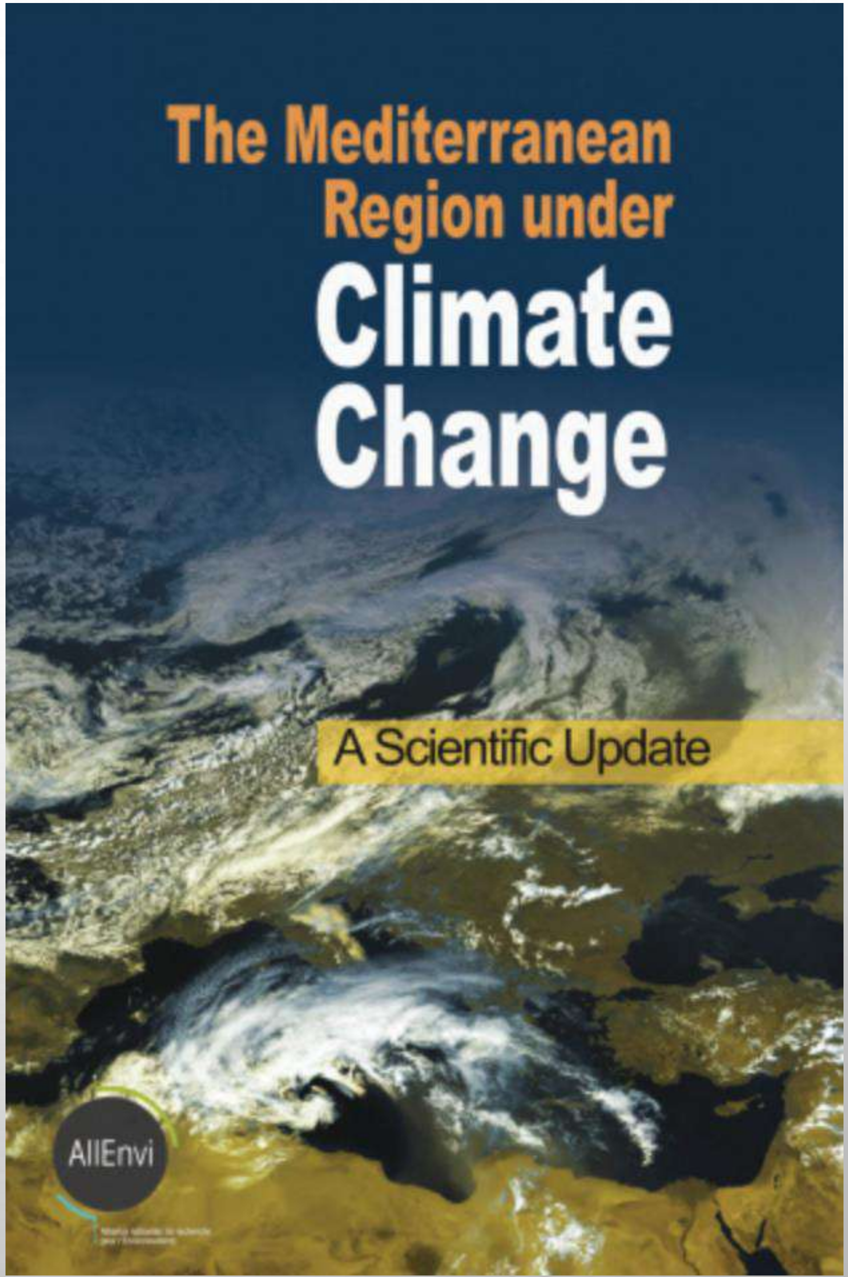
By **2** to **15%** for **2°C warming**

AMONG THE **LARGEST DECEASES** IN THE **WORLD**

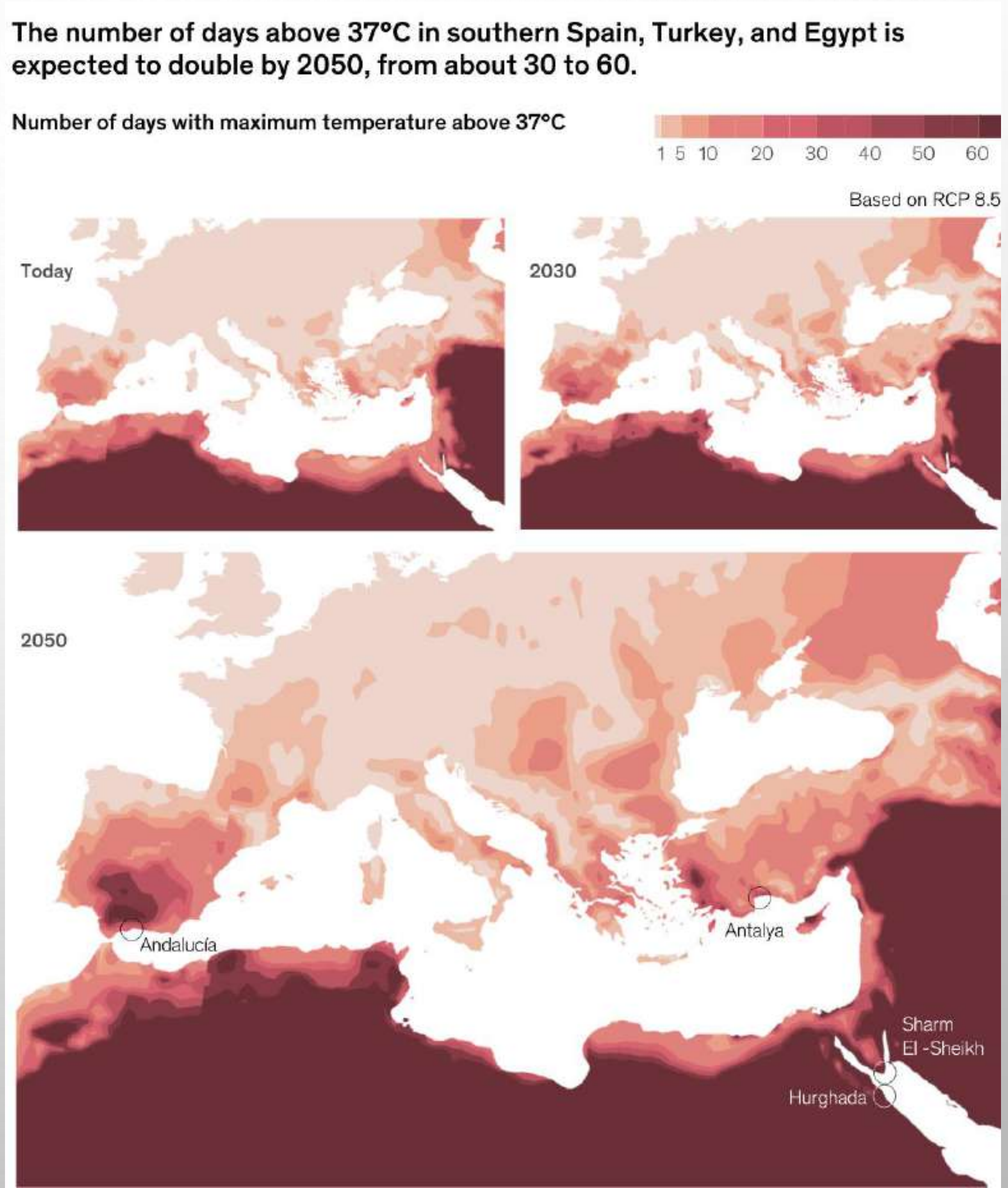


ource: (MedECC, 2019)

Mediterranean climate change has been observed at a magnitude exceeding global means, despite the fact that the emission of greenhouse gases (GHGs) in Mediterranean countries lies at relatively low levels

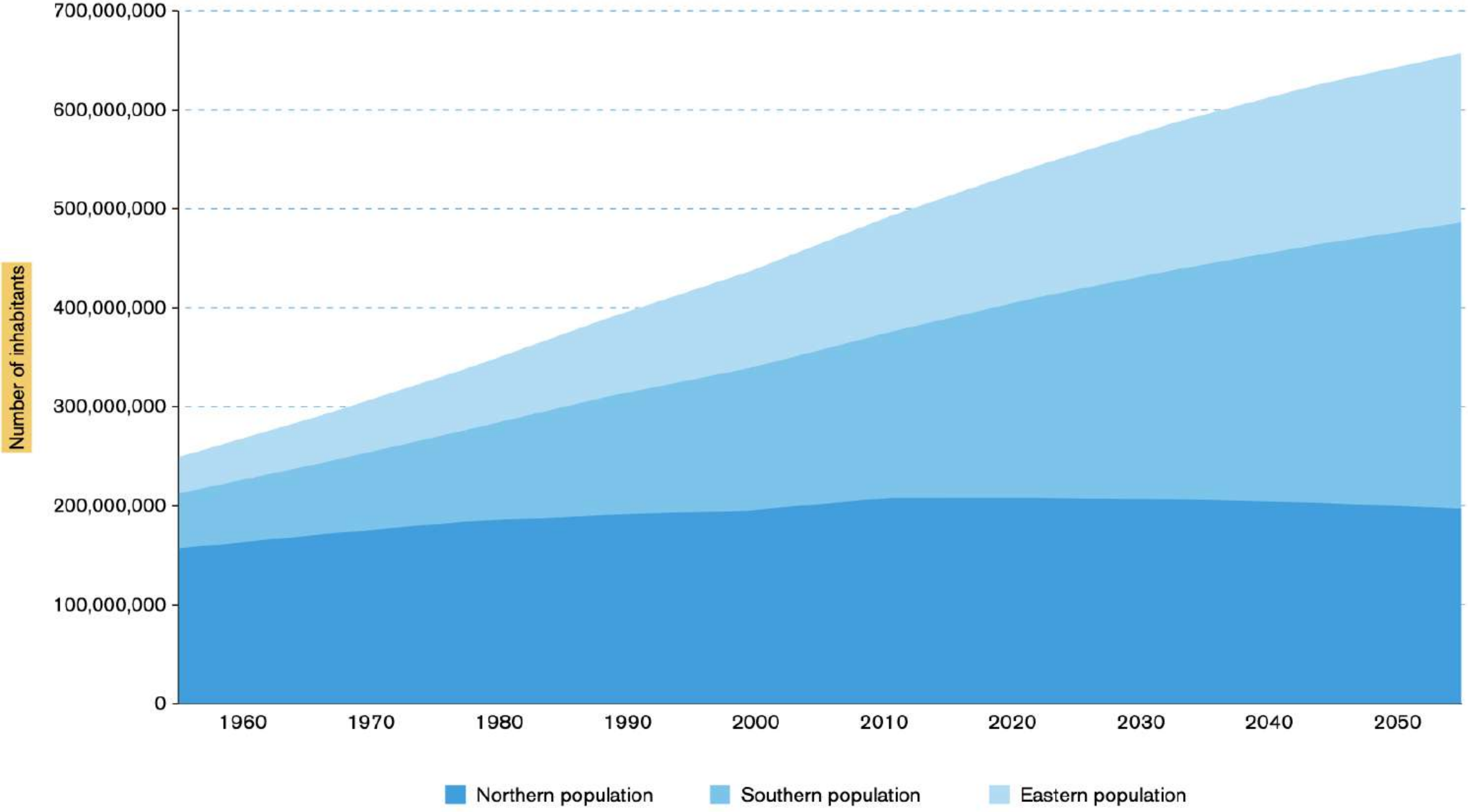


A Mediterranean basin without a Mediterranean climate?



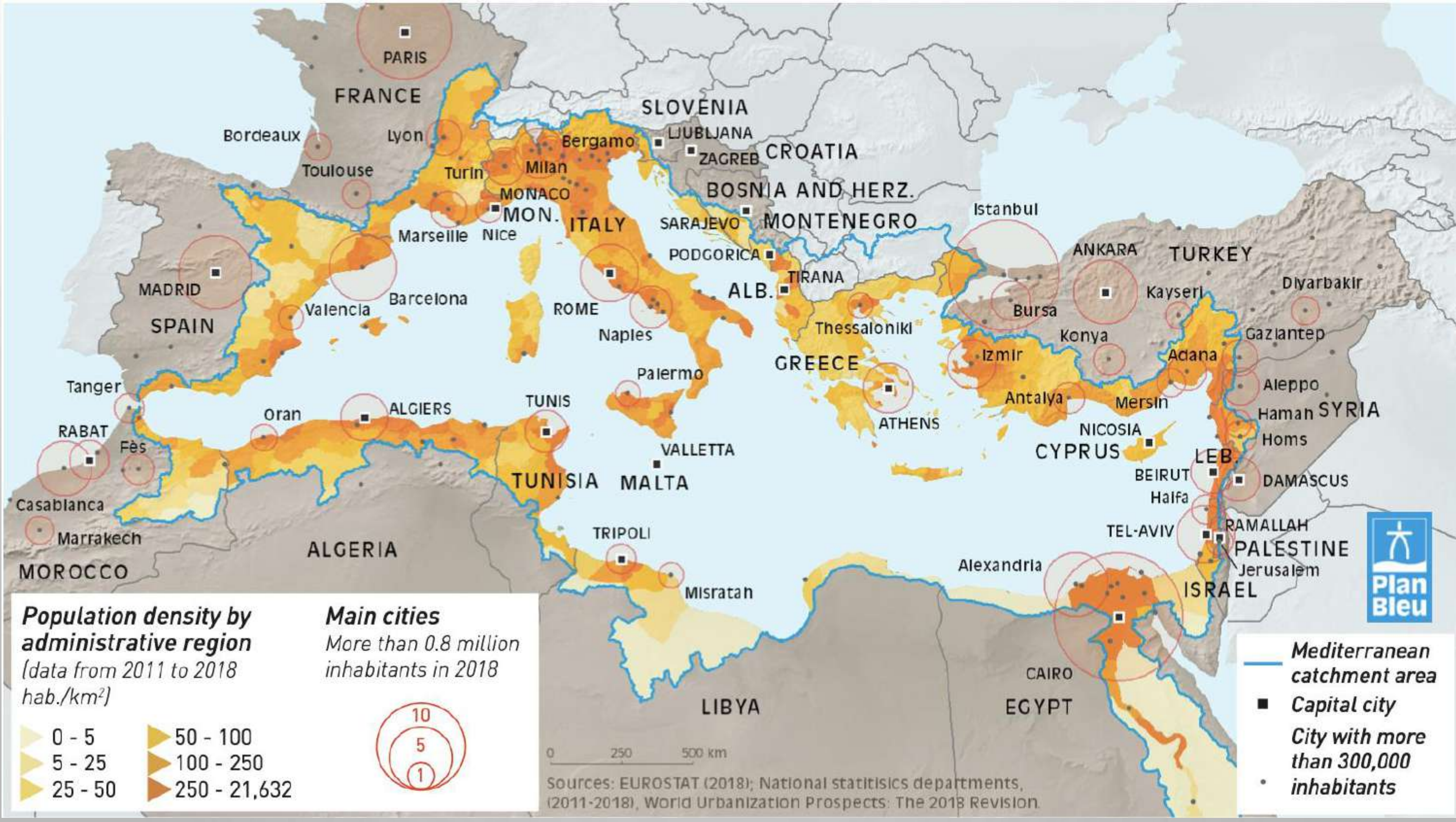
Source McKinsey Sustainability

IS THE MEDITERRANEAN REGION OVERCROWDED?

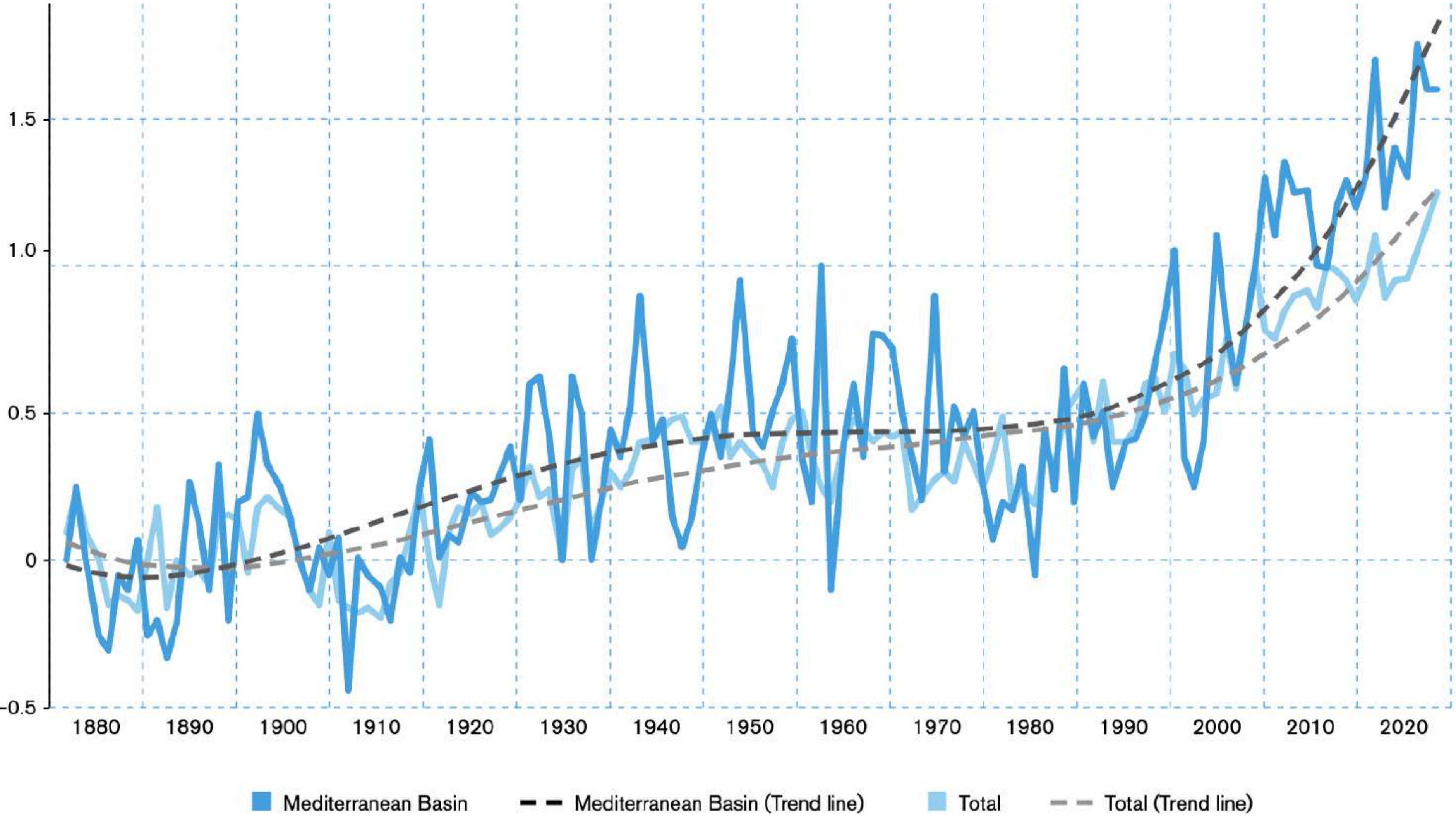


Source: FAO 2018 based on World Bank data (2015)

ANTROPHIC PRESSURE ON COASTAL AREAS OF MEDITERRANEN SEA

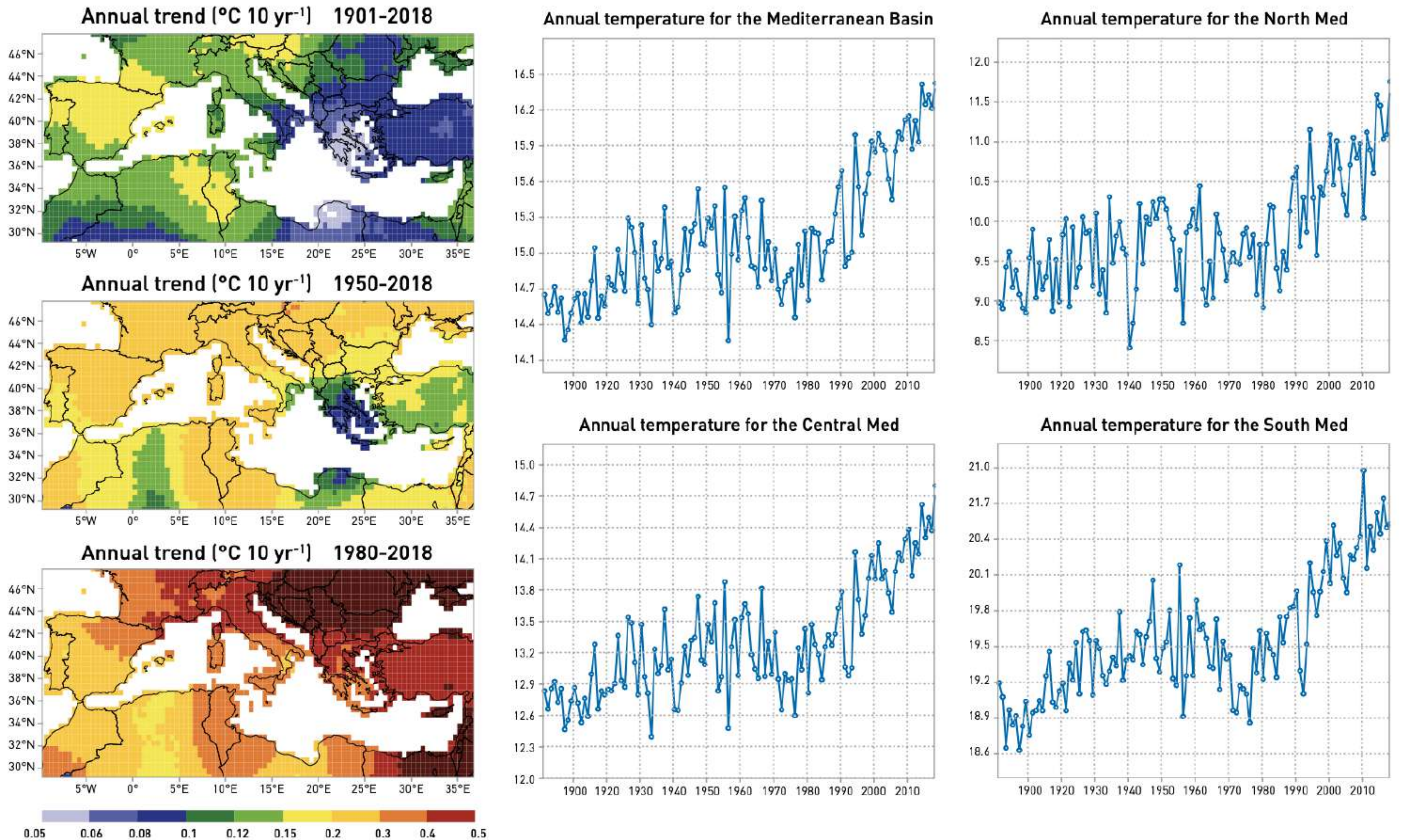


AIR TEMPERATURE : observed trend



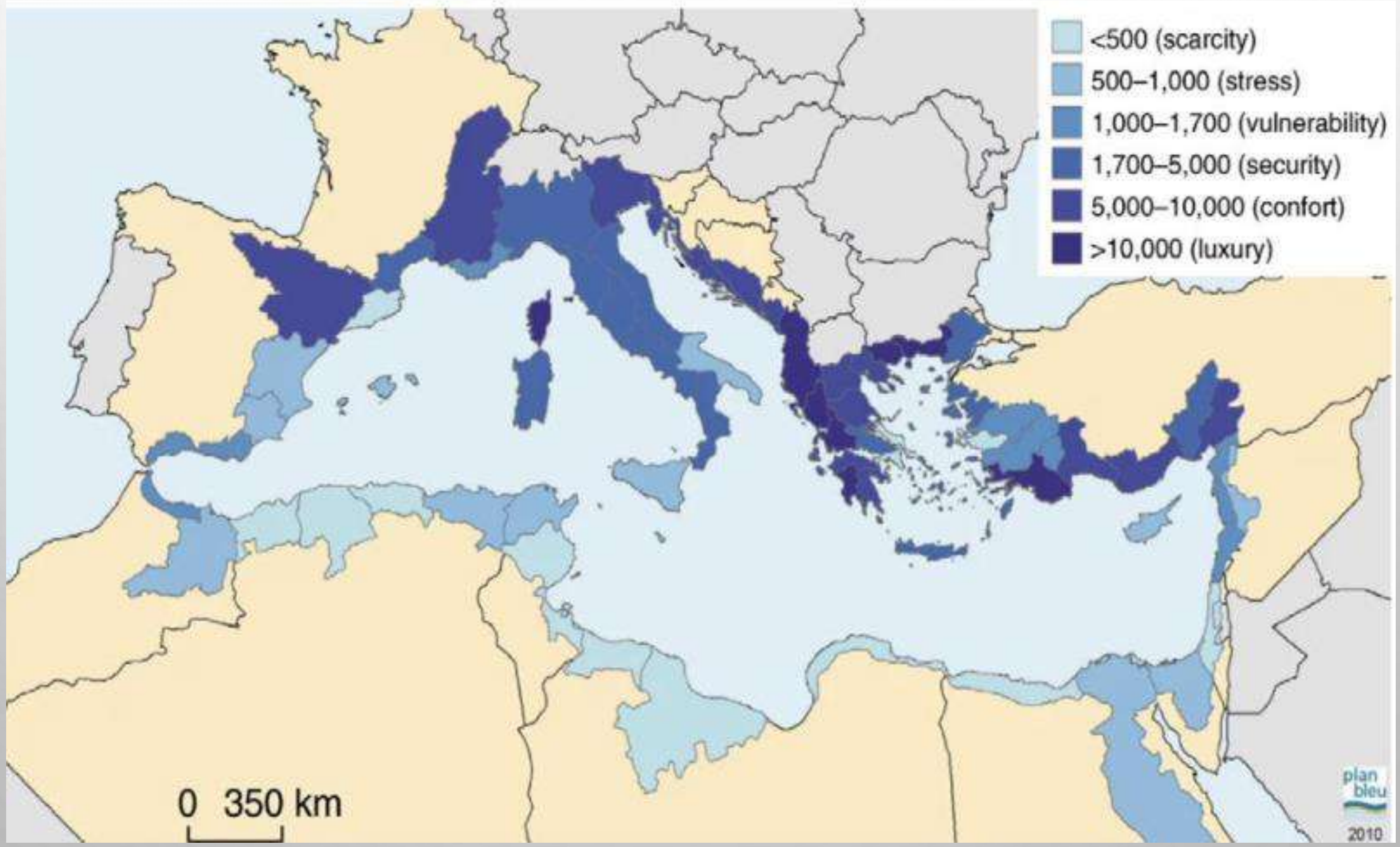
Source: Cramer et al. (2018)

More in details

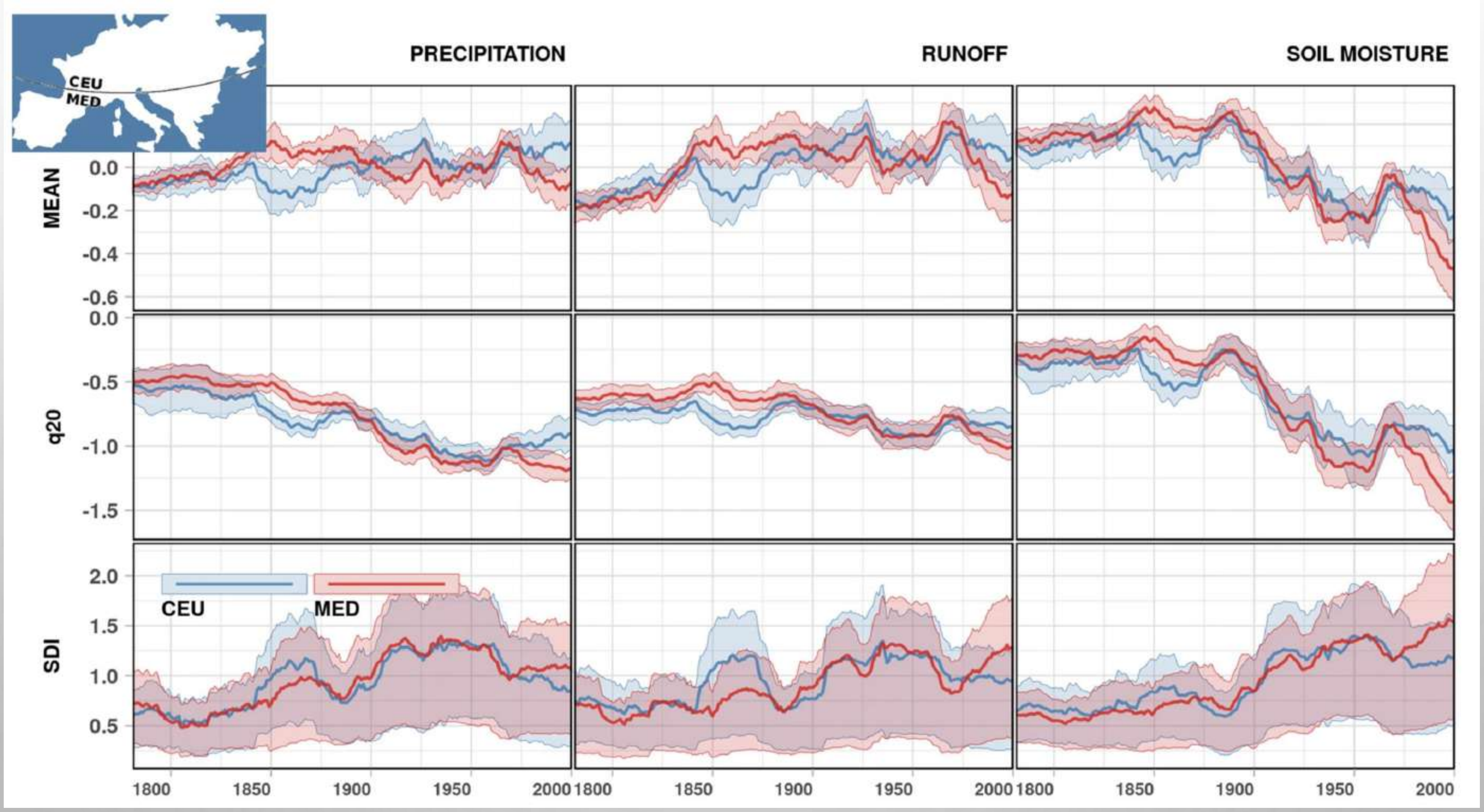


WATER RESOURCES

They are limited, unevenly distributed and often mismatching human and environmental needs.
Three quarters of the resource are located in the northern Mediterranean while three quarters of the needs are in the south and east.



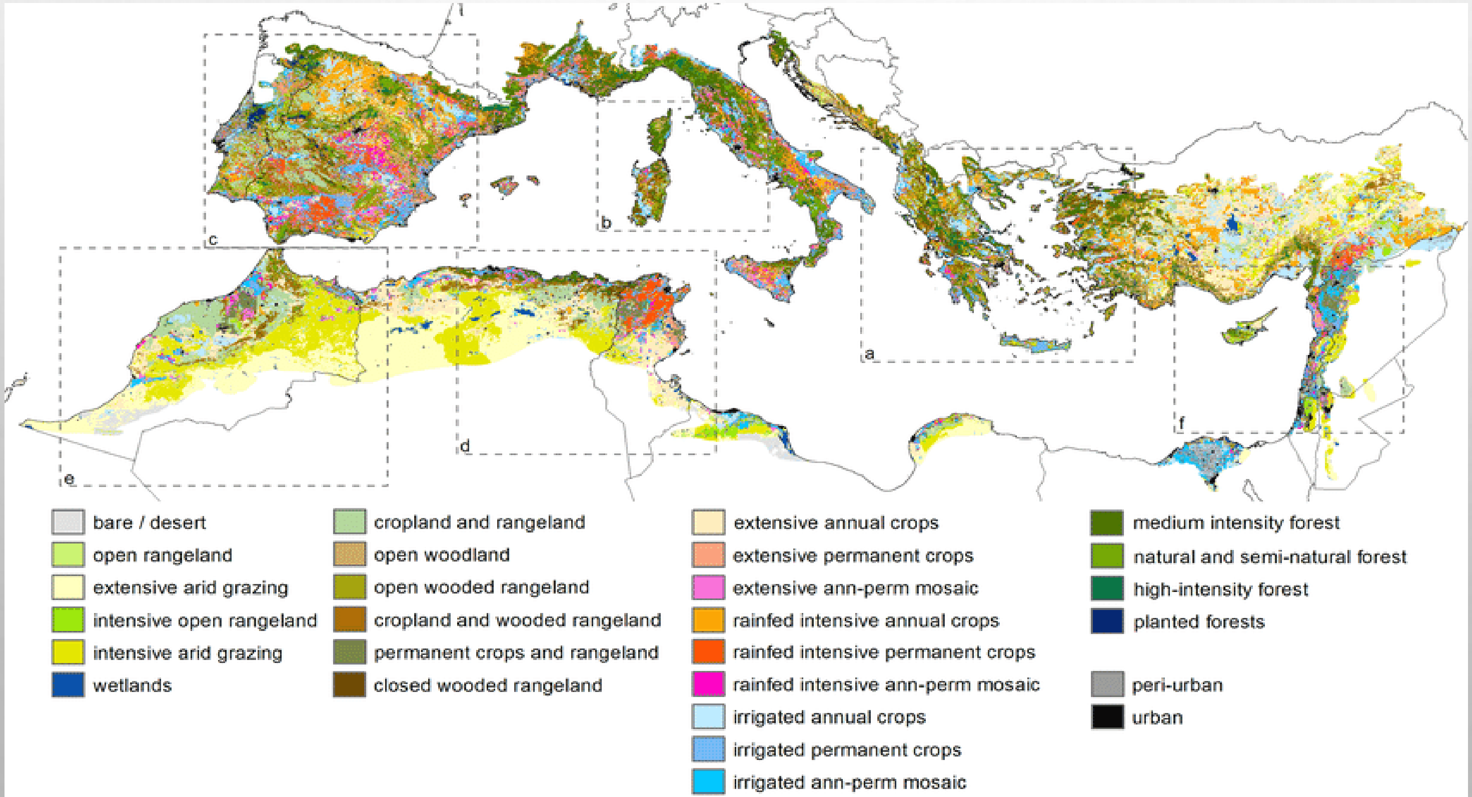
In the Mediterranean region, **water availability** will reduce as a consequence of three main factors: (i) precipitation decrease, (ii) temperature increase, and (iii) population growth.



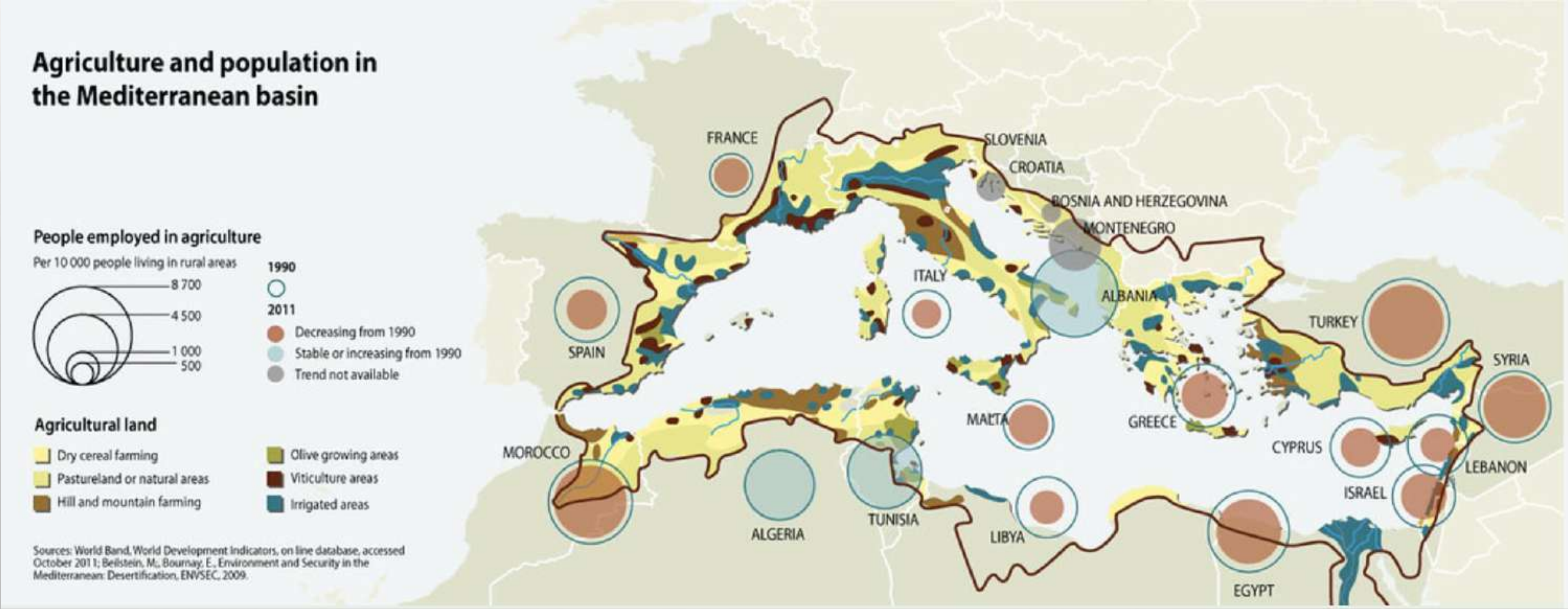
Source: Hanel, M., Rakovec, O., Markonis, Y. *et al.* Revisiting the recent European droughts from a long-term perspective. *Sci Rep* 8**,** 9499 (2018).

IRRIGATION NEEDS

Irrigation is between 50% and 90% of the Mediterranean water demand. Irrigation water requirements in the Mediterranean region are projected to increase between 4 and 18% by the end of the century due to climate change alone (for 2°C and 5°C warming, respectively).

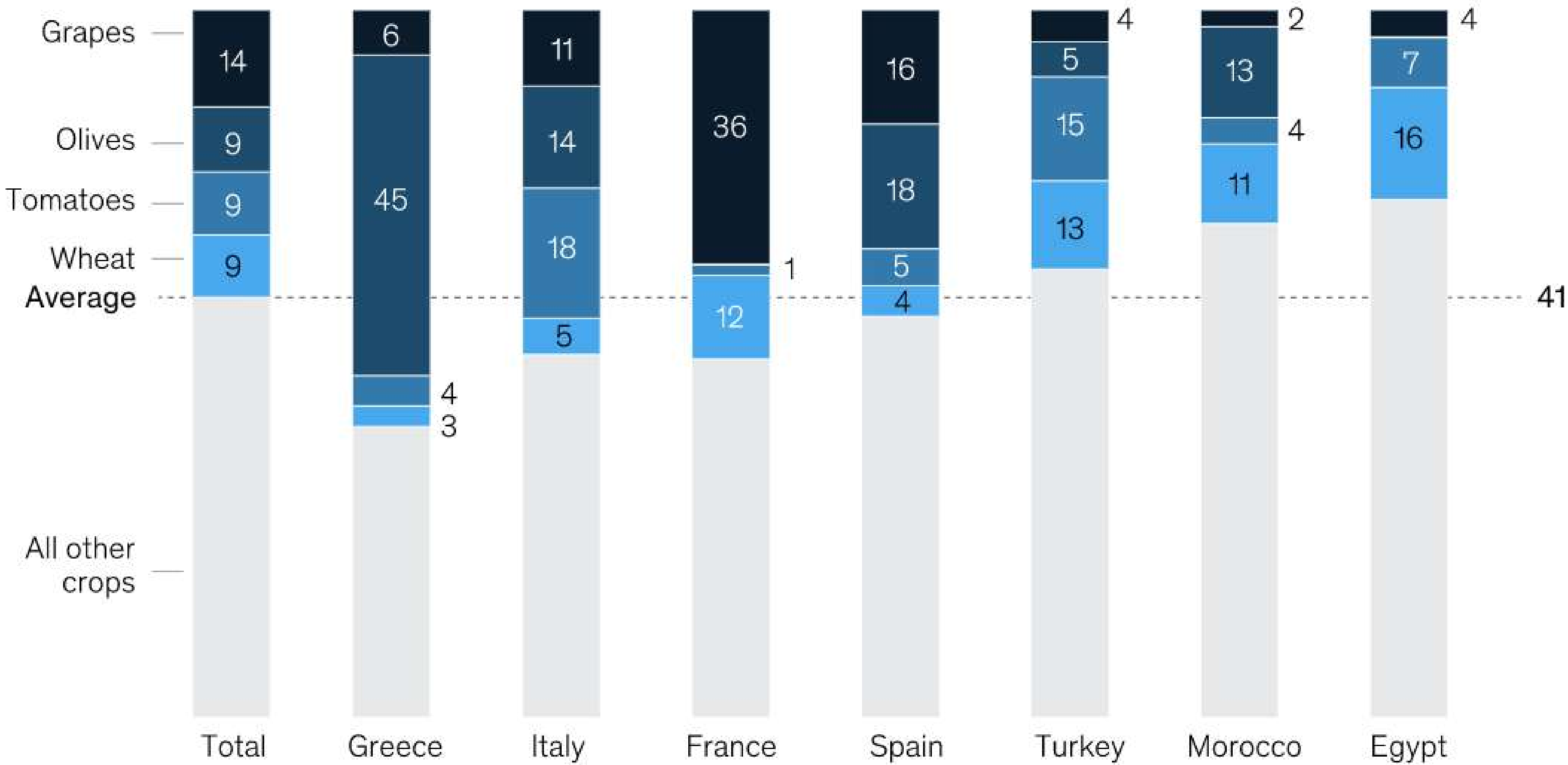


SOCIETAL AND ECONOMIC ASPECTS RELATED TO THE AGRICOLTURAL SECTOR



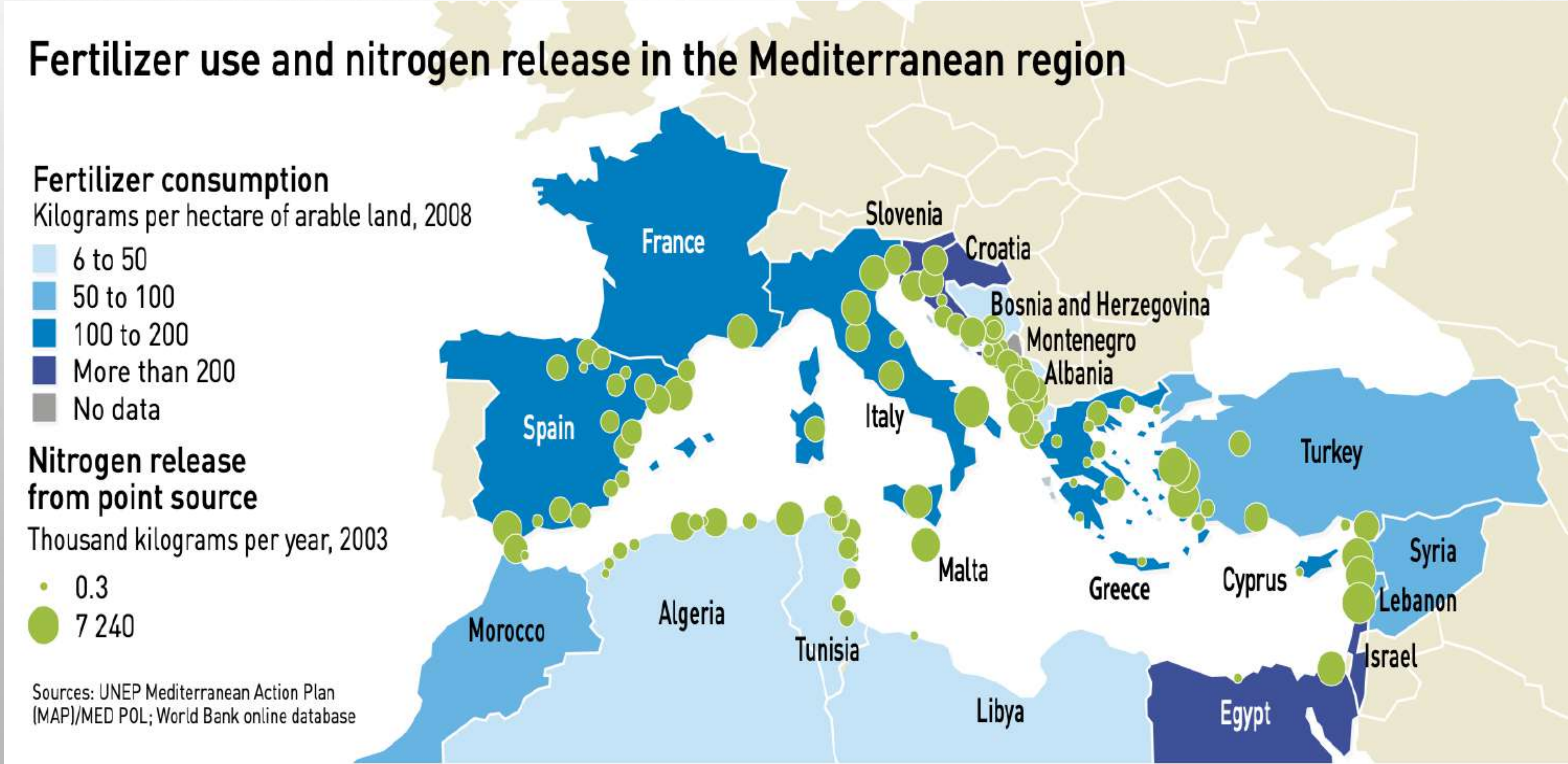
About 40 percent of the Mediterranean region's agricultural production value comes from just four crops: wheat, tomatoes, olives, and grapes.

Crop production value in the Mediterranean region, 2016,[1] % of total gross production value

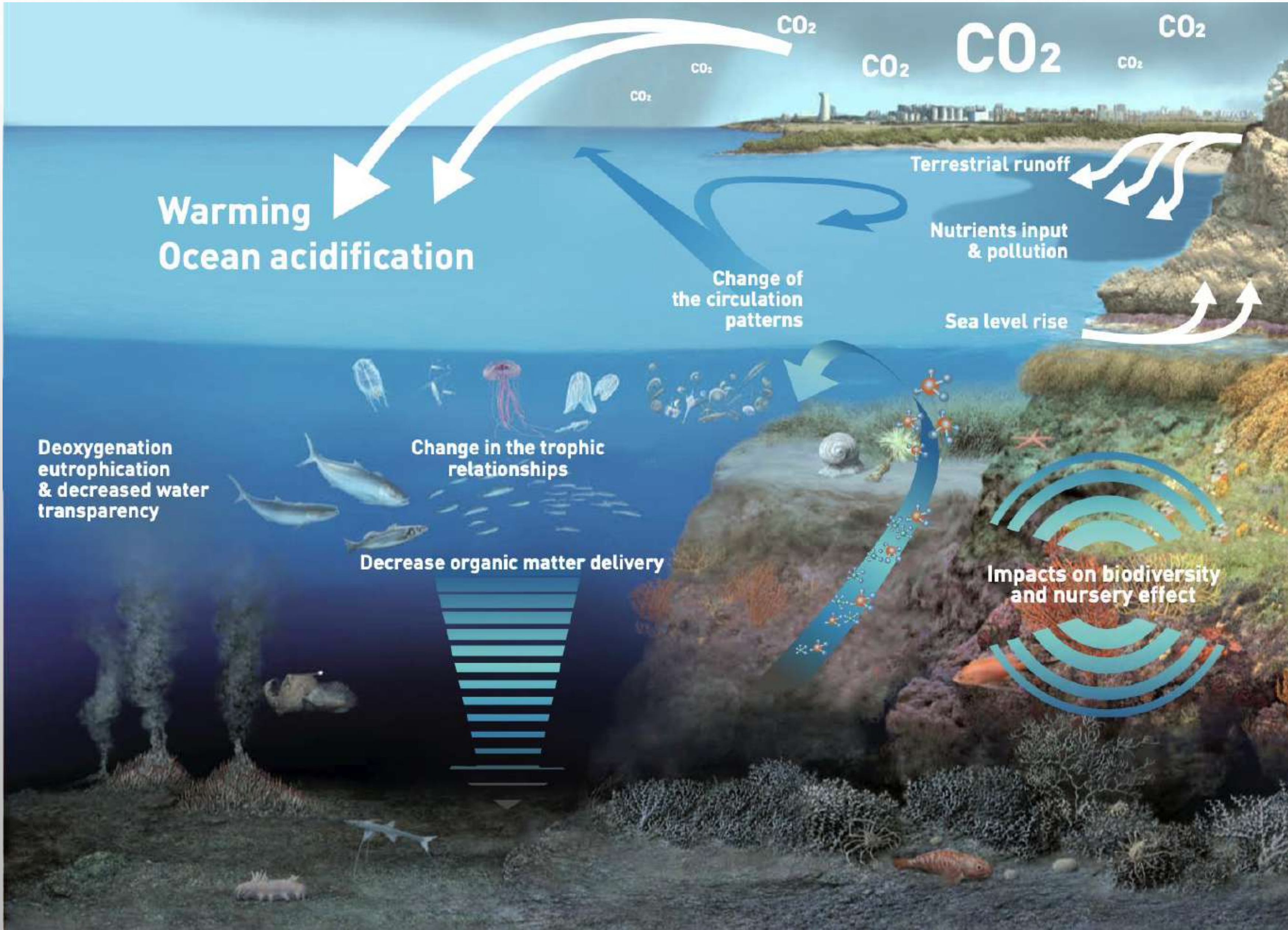


[1]Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Malta, Morocco, Portugal, Slovenia, Spain, Tunisia, Turkey.
Source: FAO; McKinsey Global Institute analysis

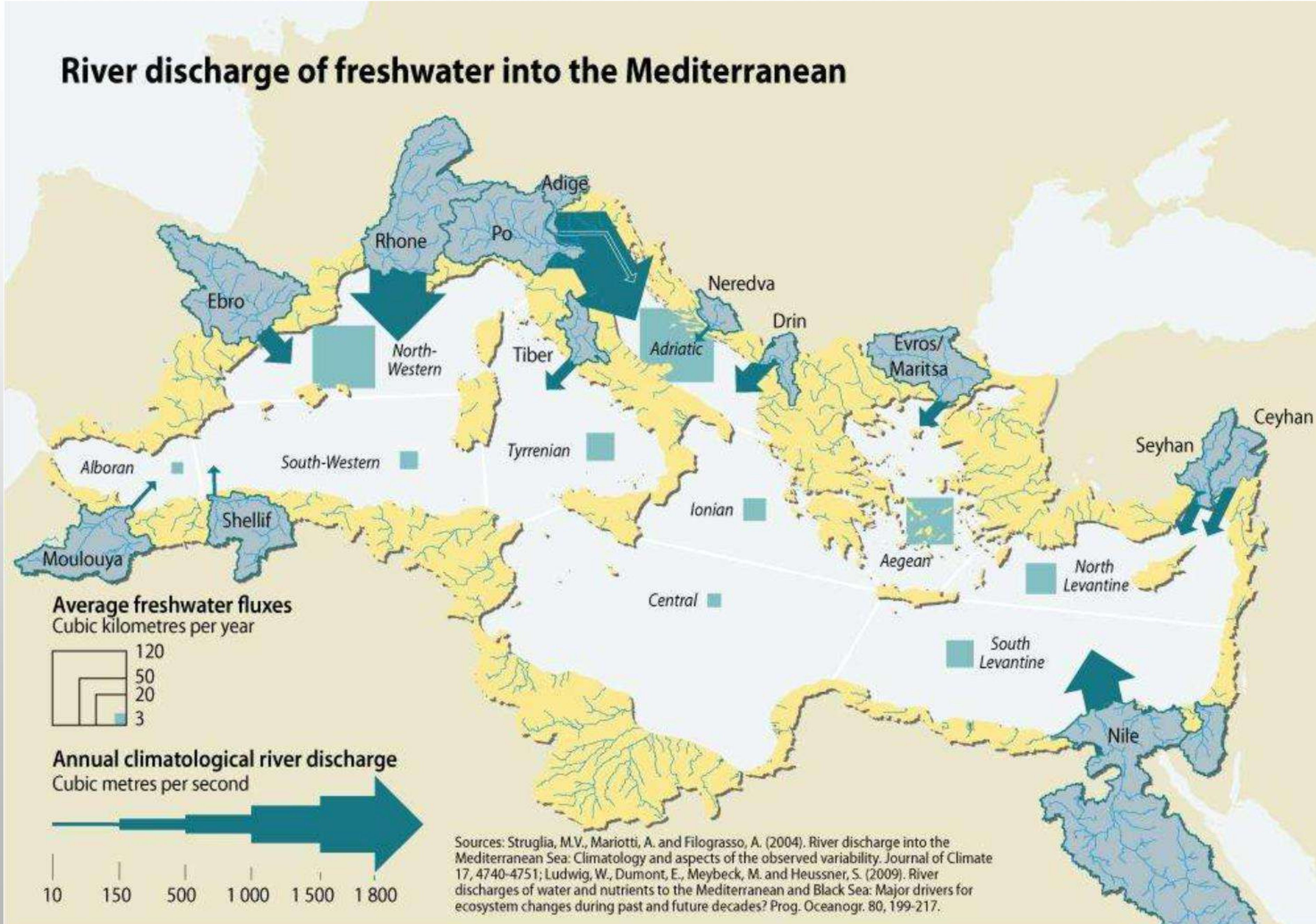
FERTILIZER AND NITROGEN USE HAVE A SIGNIFICANT ENVIRONMENTAL IMPACT



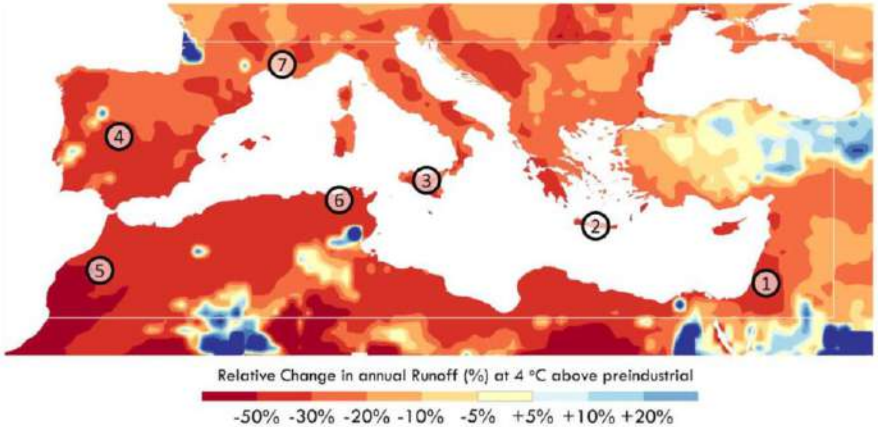
CC AND HUMAN ACTIVITIES IMPACT THE INTEGRITY OF MARINE ECOSYSTEMS



FRESHWATER AVAILABILITY

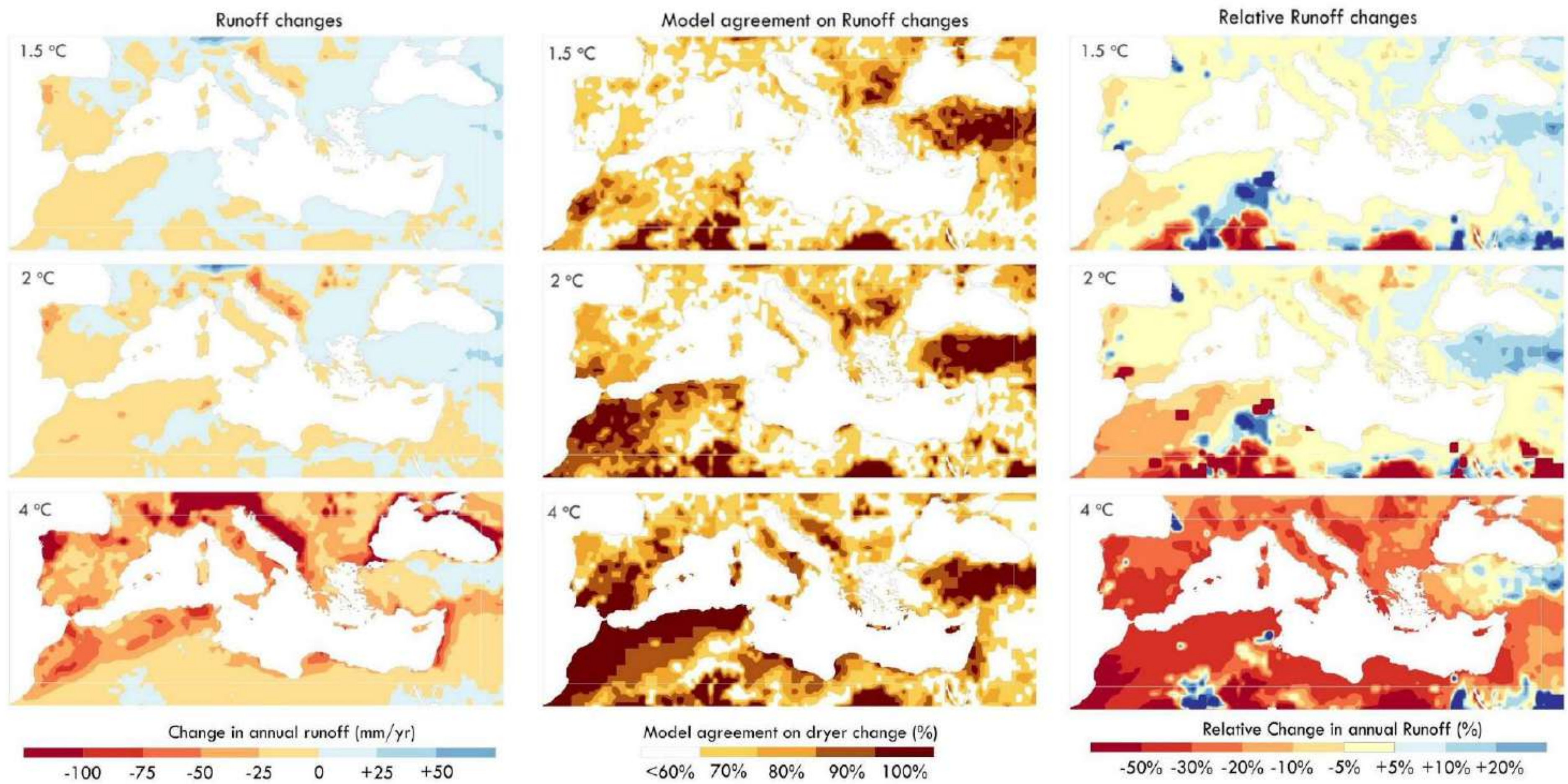


Source: Fader M, et al., 2020: *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* UNEP/MAP



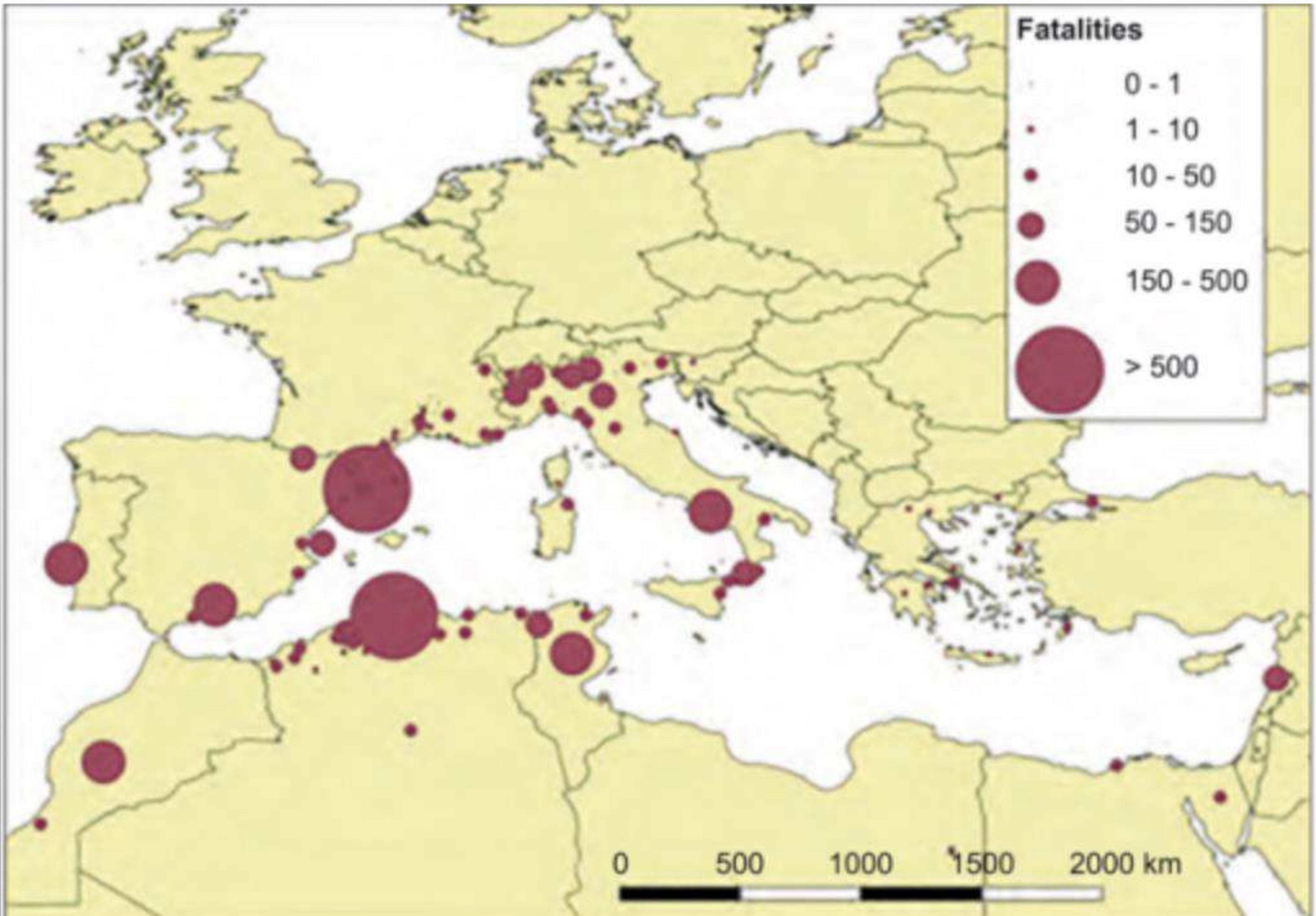
Ref. No Fig. 3.7	Country	Watershed /Region	Size (km^2)	Future/baseline period of reported changes	No of climate models	Relative changes			Reference
						Mean	Max	Min	
1	Israel	Lake Kinneret watershed	800	2050-2079/ 1979-2005	15	-35%	-9%	-51%	(Givati et al. 2019)
2	Greece	Crete	8320	2047-2076/ 1990–2011	5	-27%	-37%	-3%	(Koutroulis et al. 2016)
3	Italy	Imera Meridionale river basin	1782	2080-2100/ 1990-2010	32	-50%	-25%	-80%	(Viola et al. 2016)
4	Spain	Tagus	80000	2071-2100/ 1971-2000	5	-60%	-50%	-75%	(Lobanova et al. 2016)
5	Morocco	Rheraya catchment (high Atlas)	225	1979–2005/ 2049-2065	5	-50%	-35%	-65%	(Marchane et al. 2017)
6	Tunisia	North Tunisia (5 catchments)	81-315	1970-2000/ 2070-2100	8	-50%	-37%	-57%	(Dakhlaoui et al. 2019a, 2019b, 2020)
7	France	Rhône at Beaucaire	98000	1970-2000/ 2070-2100	8	-17%	-30%	-5%	(Dayon et al. 2018)

Model prediction

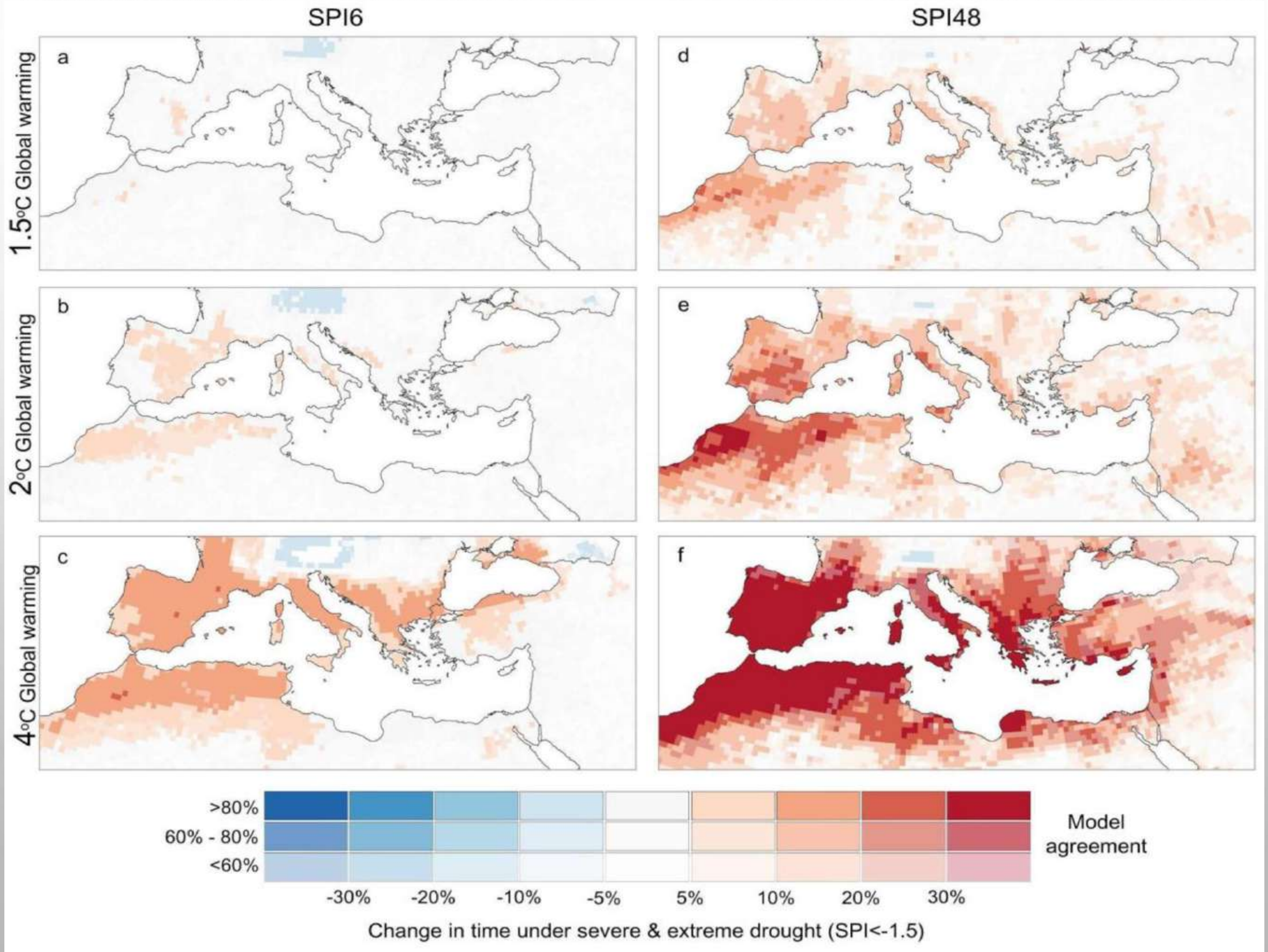


Source: Fader M, et al., 2020: *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* UNEP/MAP

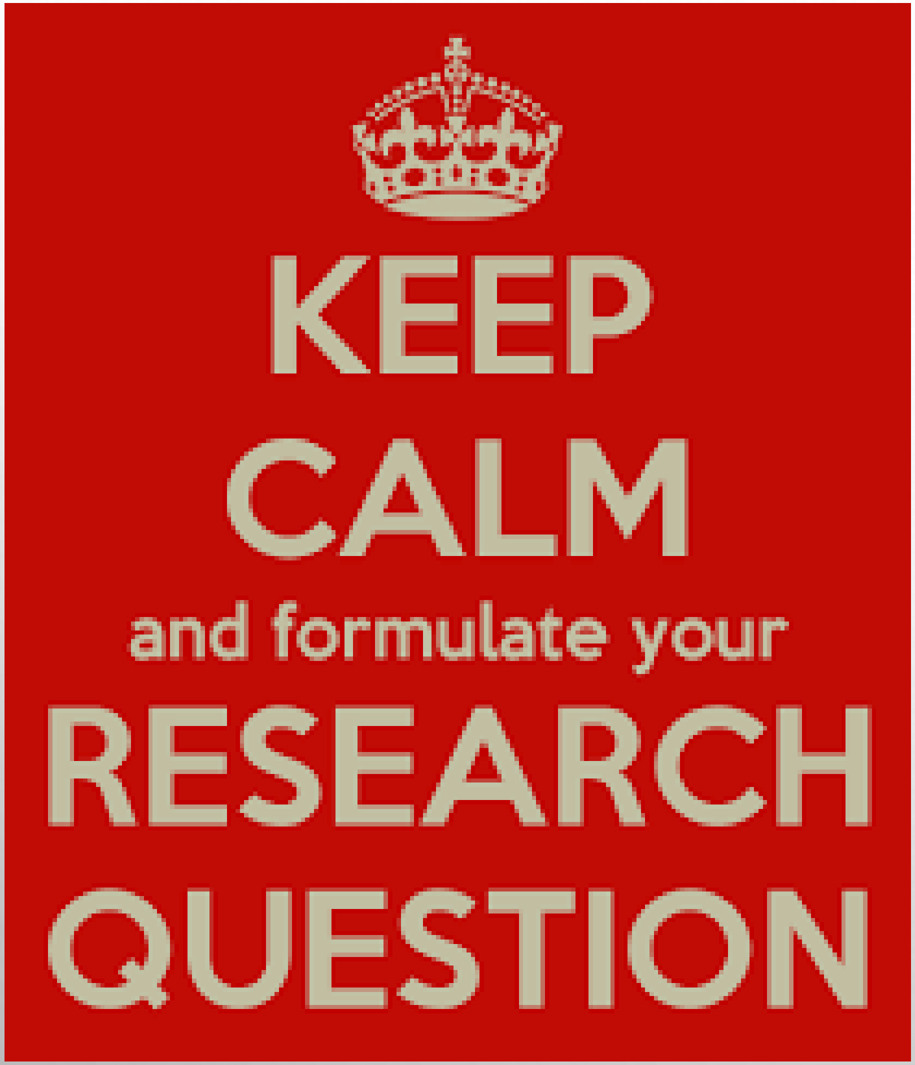
FLOOD FATALITIES



DROUGHT FORECAST



HENCE?


KEEP
CALM
and formulate your
RESEARCH
QUESTION


THE RESEARCH
QUESTION


non-biased
focused
answerable
Good
research
question
pertinent
relevant
intriguing

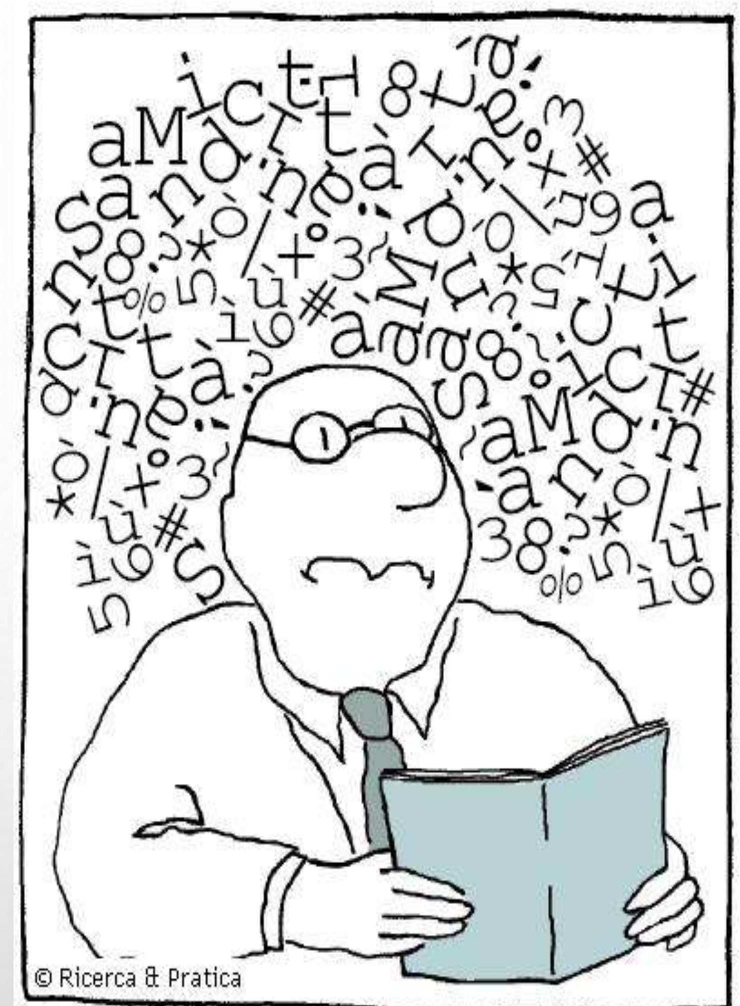
RESEARCH GAPS

1. Analysis of extreme hydrological events in the CC context

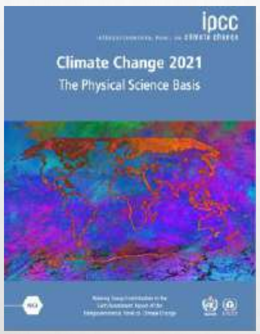
2. Bridging the knowledge gap on IF and HOW CC modifies the size and frequency of extreme events, taking care to recognize the intrinsic effects of natural variability and separate them from those connected to the CC

3. Adapt risk management to the new dynamism at regional level

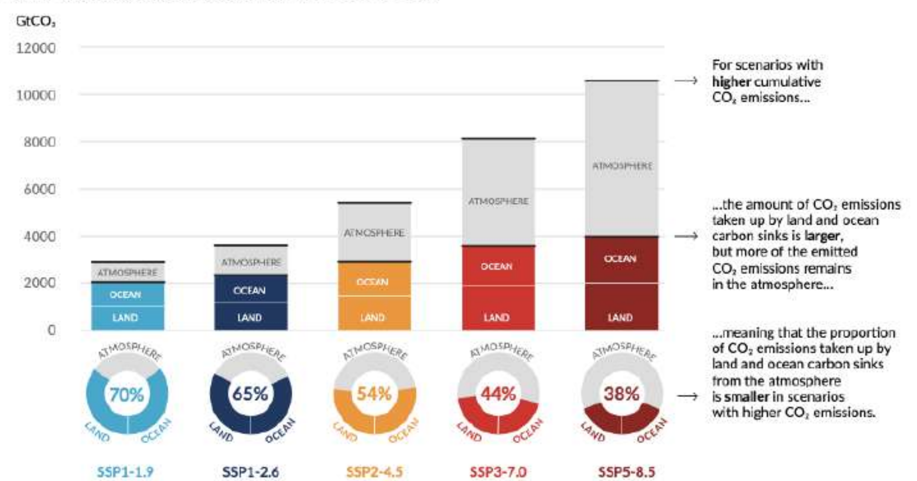
MEANWHILE.....



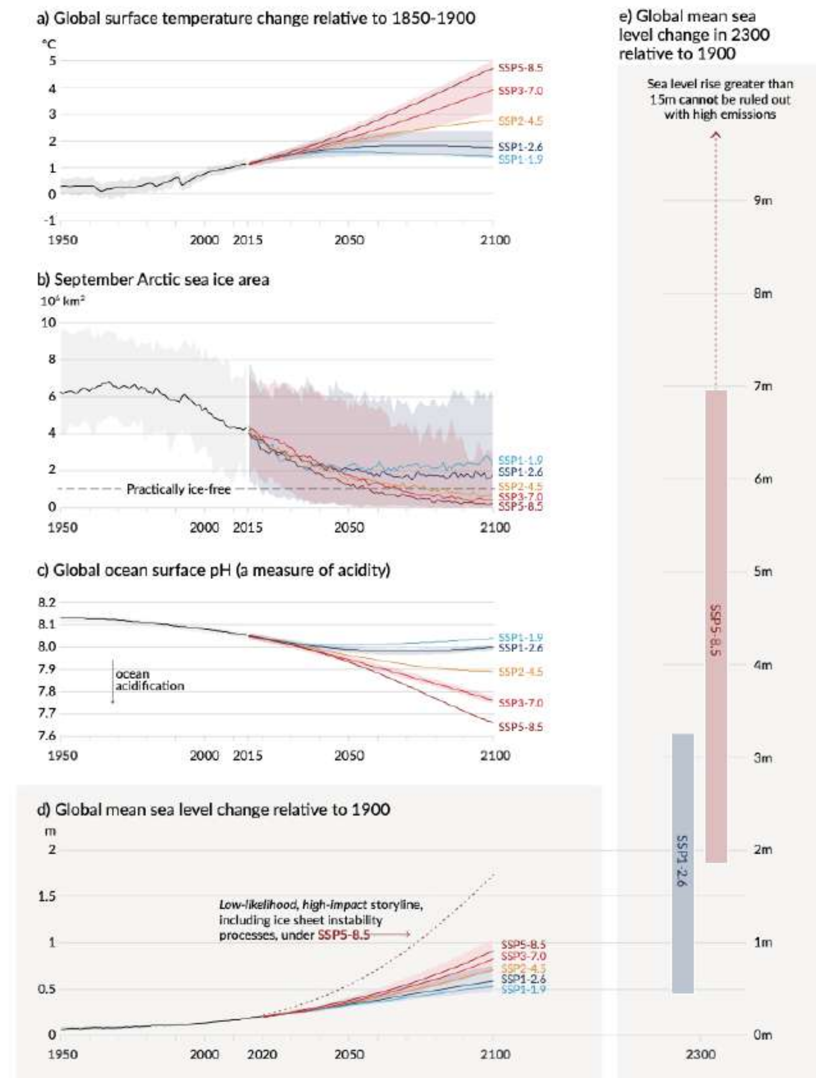
	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7



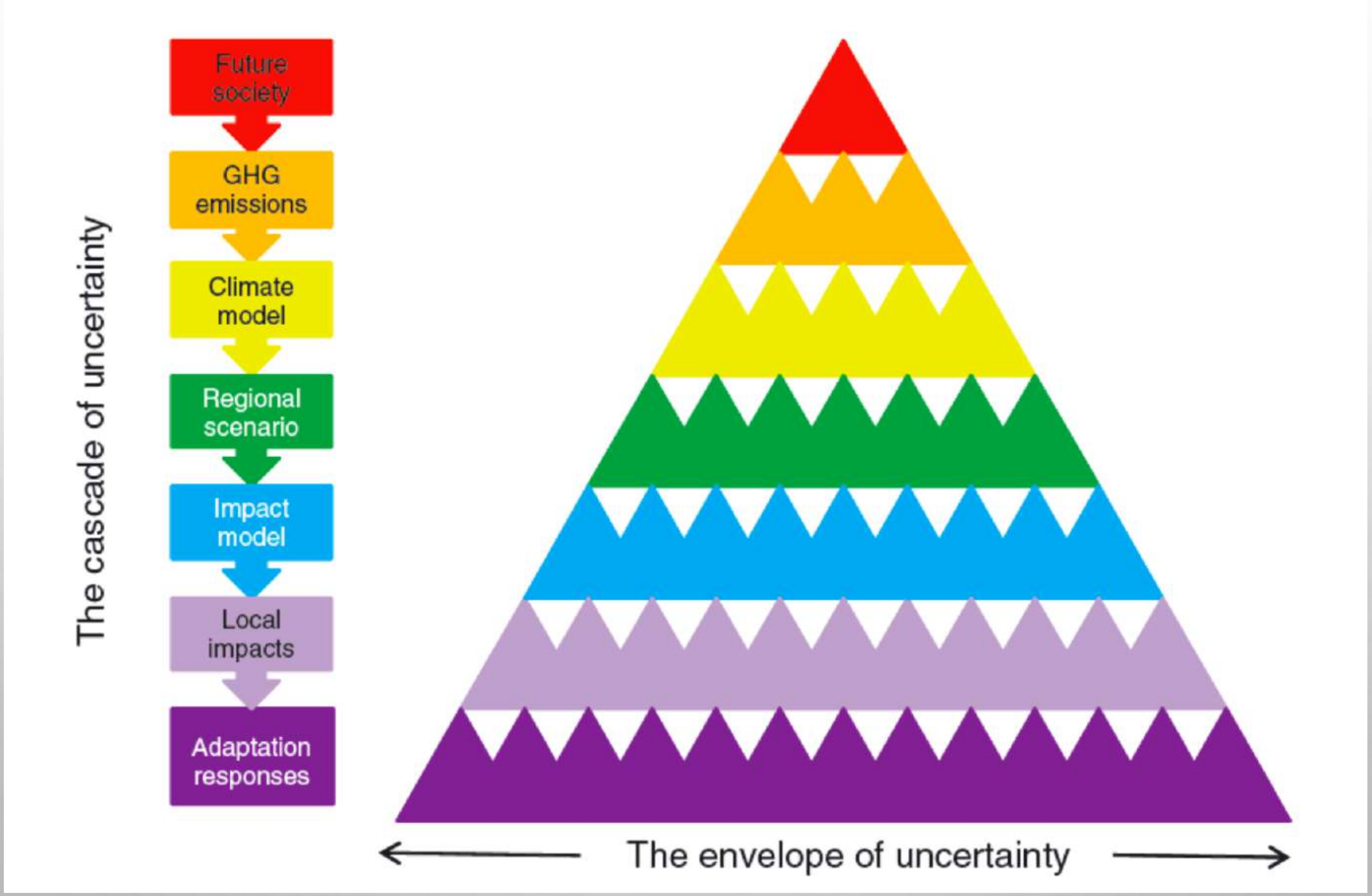
Total cumulative CO_2 emissions **taken up by land and oceans** (colours) and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100



Human activities affect all the major climate system components, with some responding over decades and others over centuries



THE UNCERTAINTY PYRAMID



DOWNSCALING AT REGIONAL LEVEL

Common regional changes

Regardless of future levels of global warming, temperatures will rise in all European areas at a rate exceeding global mean temperature changes, similar to past observations (*high confidence*).

The frequency and intensity of hot extremes, including marine heatwaves, have increased in recent decades and are projected to keep increasing regardless of the greenhouse gas emissions scenario. Critical thresholds relevant for ecosystems and humans are projected to be exceeded for global warming of 2°C and higher (*high confidence*).

The frequency of cold spells and frost days will decrease under all the greenhouse gas emissions scenarios in this report and all time horizons, similar to past observations. (*high confidence*)

Despite strong internal variability, observed trends in European mean and extreme temperatures cannot be explained without accounting for anthropogenic factors. Before the 1980s, warming by greenhouse gases was partly offset by anthropogenic aerosol emissions. Reduced aerosol influence in the recent decades has led to an observable positive trend in shortwave radiation. (*high confidence*)

Observations have a seasonal and regional pattern consistent with projected increase of precipitation in winter in Northern Europe. A precipitation decrease is projected in summer in the Mediterranean extending to northward regions. Extreme precipitation and pluvial flooding are projected to increase at global warming levels exceeding 1.5°C in all regions except the Mediterranean. (*high confidence*)

Regardless of level of global warming, relative sea level will rise in all European areas except the Baltic Sea, at a rate close to or exceeding global mean sea level. Changes are projected to continue beyond 2100. Extreme sea level events will become more frequent and more intense, leading to more coastal flooding. Shorelines along sandy coasts will retreat throughout the 21st century (*high confidence*).

Strong declines in glaciers, permafrost, snow cover extent, and snow seasonal duration at high latitudes/altitudes are observed and will continue in a warming world (*high confidence*).

Multiple climatic impact-drivers have already changed concurrently over recent decades. The number of climatic impact-driver changes is expected to increase with increasing global warming (*high confidence*).

Revisiting the Concepts of Return Period and Risk for Nonstationary Hydrologic Extreme Events

Jose D. Salas, M.ASCE[1]; and Jayantha Obeysekera, M.ASCE[2]

Abstract: Current practice using probabilistic methods applied for designing hydraulic structures generally assume that extreme events are stationary. However, many studies in the past decades have shown that hydrological records exhibit some type of nonstationarity such as trends and shifts. Human intervention in river basins (e.g., urbanization), the effect of low-frequency climatic variability (e.g., Pacific Decadal Oscillation), and climate change due to increased greenhouse gasses in the atmosphere have been suggested to be the leading causes of changes in the hydrologic cycle of river basins in addition to changes in the magnitude and frequency of extreme floods and extreme sea levels. To tackle nonstationarity in hydrologic extremes, several approaches have been proposed in the literature such as frequency analysis, in which the parameters of a given model vary in accordance with time. The aim of this paper is to show that some basic concepts and methods used in designing flood-related hydraulic structures assuming a stationary world can be extended into a nonstationary framework. In particular, the concepts of return period and risk are formulated by extending the geometric distribution to allow for changing exceeding probabilities over time. Building on previous developments suggested in the statistical and climate change literature, the writers present a simple and unified framework to estimate the return period and risk for nonstationary hydrologic events along with examples and applications so that it can be accessible to a broad audience in the field. The applications demonstrate that the return period and risk estimates for nonstationary situations can be quite different than those corresponding to stationary conditions. They also suggest that the nonstationary analysis can be helpful in making an appropriate assessment of the risk of a hydraulic structure during the planned project-life. **DOI: 10.1061/(ASCE)HE.1943-5584.0000820.**

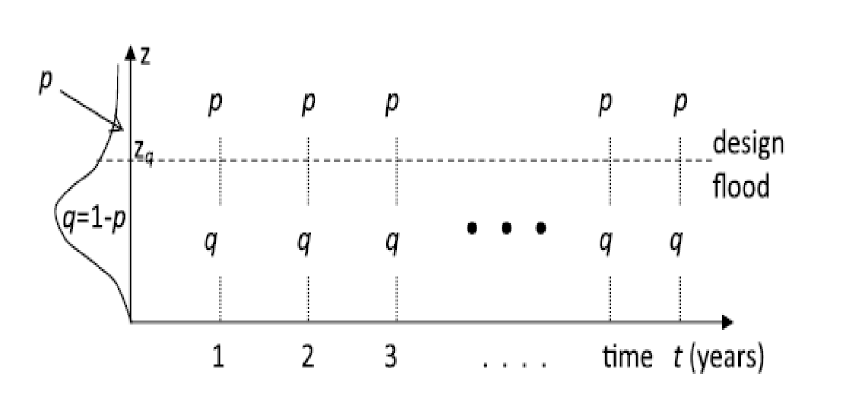
Hydrol. Earth Syst. Sci., 18, 649–671, 2014
www.hydrol-earth-syst-sci.net/18/649/2014/
doi:10.5194/hess-18-649-2014

Hydrology and Earth System Sciences
Open Access

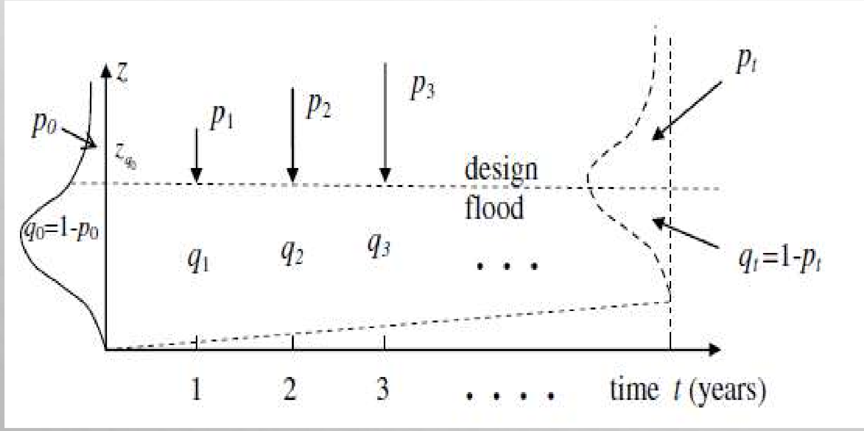
Advancing catchment hydrology to deal with predictions under change

U. Ehret , H. V. Gupta , M. Sivapalan , S. V. Weijs , S. J. Schymanski , G. Blöschl , A. N. Gelfan , C. Harman , A. Kleidon , T. A. Bogaard , D. Wang , T. Wagener , U. Scherer , E. Zehe , M. F. P. Bierkens , G. Di Baldassarre , J. Parajka , L. P. H. van Beek , A. van Griensven , M. C. Westhoff , and H. C. Winsemius

EFFECTS



z
p
p p p p p
z_q
design flood
$q=1-p$
q q q q q
• • •
1 2 3 . . . . time t (years)



z
p_0
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p_1 p_2 p_3
p_t
design flood
$q_0=1-p_0$
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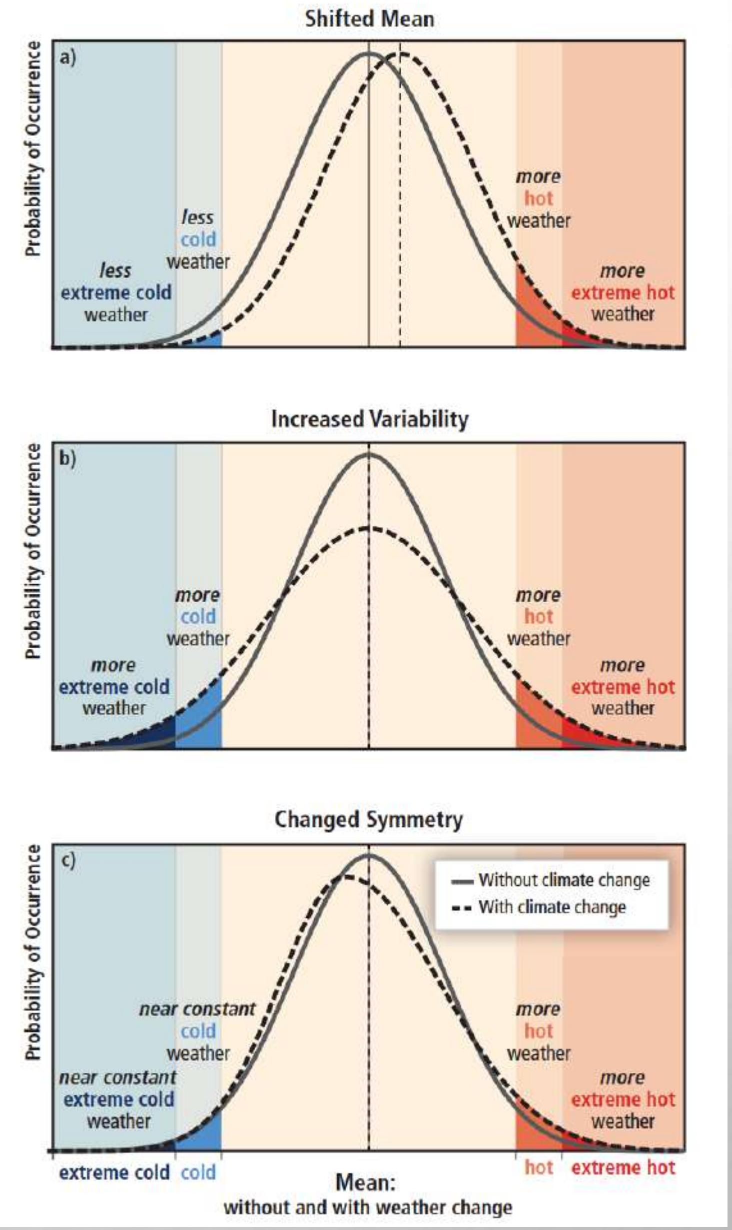
$q_t=1-p_t$
1 2 3 . . . . time t (years)



Shifted Mean
a)
Probability of Occurrence
less extreme cold weather
less cold weather
more hot weather
more extreme hot weather
Increased Variability
b)
Probability of Occurrence
more extreme cold weather
more cold weather
more hot weather
more extreme hot weather
Changed Symmetry
c)
Probability of Occurrence
Without climate change
With climate change
near constant extreme cold weather
near constant cold weather
more hot weather
more extreme hot weather
extreme cold cold
hot extreme hot
Mean: without and with weather change

CONCLUSIONS

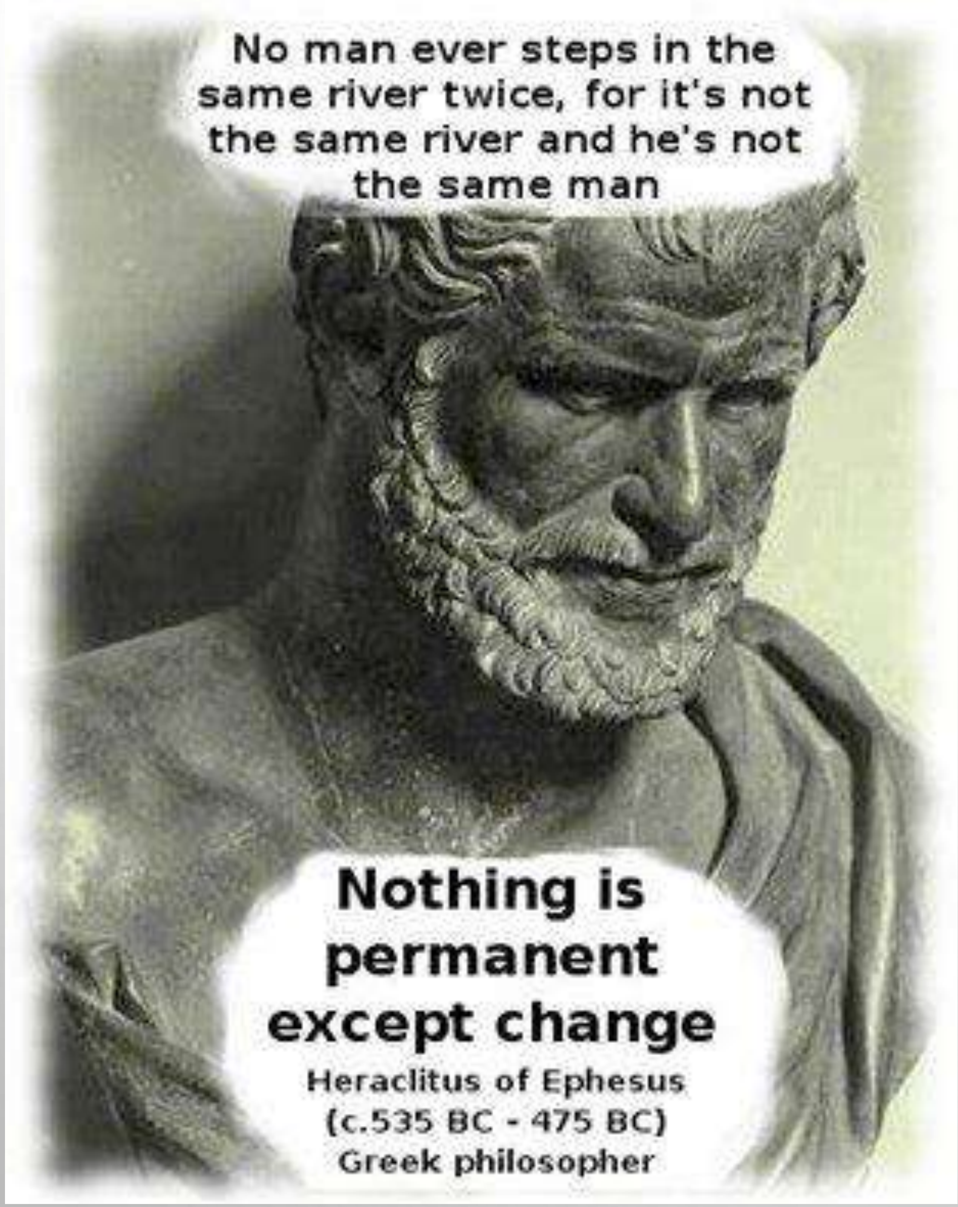
THE ASSESSMENT OF THE CLIMATIC IMPACTS ON THE MEDIUM-LONG TERM FORECAST REQUIRES:

A rigorous evaluation of the observed trends;

An effective regional analysis;

Probabilistic models capable in representing non-stationary phenomena

Promote the rainfall data collection and the river discharge measurements



THANKS

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