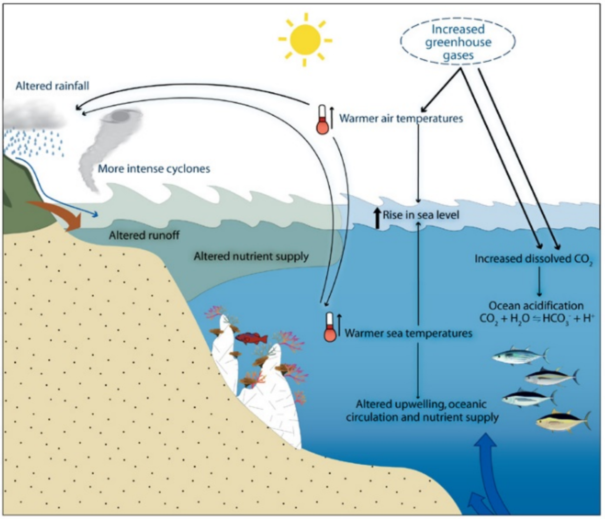

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Climate change and impact on the fisheries sector

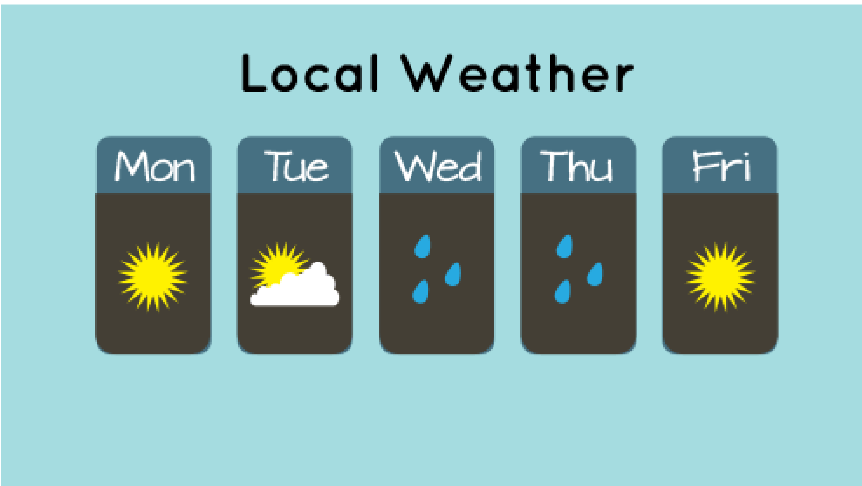
Presentation for MEDAC WG1, online meeting of 30 September 2020

Dr. George Triantaphyllidis, Greece

GeorgeTrianta@hotmail.com

What is climate change?

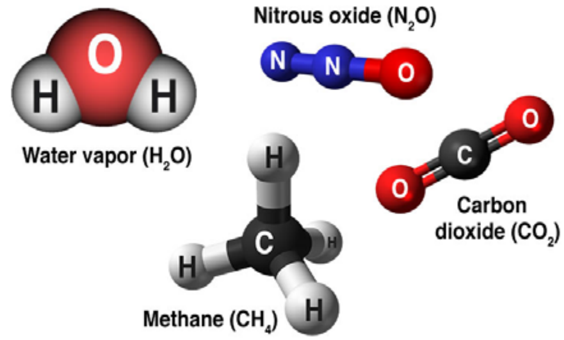
Climate change describes a change in the average conditions — such as temperature and rainfall — in a region over a long period of time.



Alaska's Muir glacier in August 1941 and August 2004. Significant changes occurred in the 63 years between these two photos. *Source: USGS*

The greenhouse effect

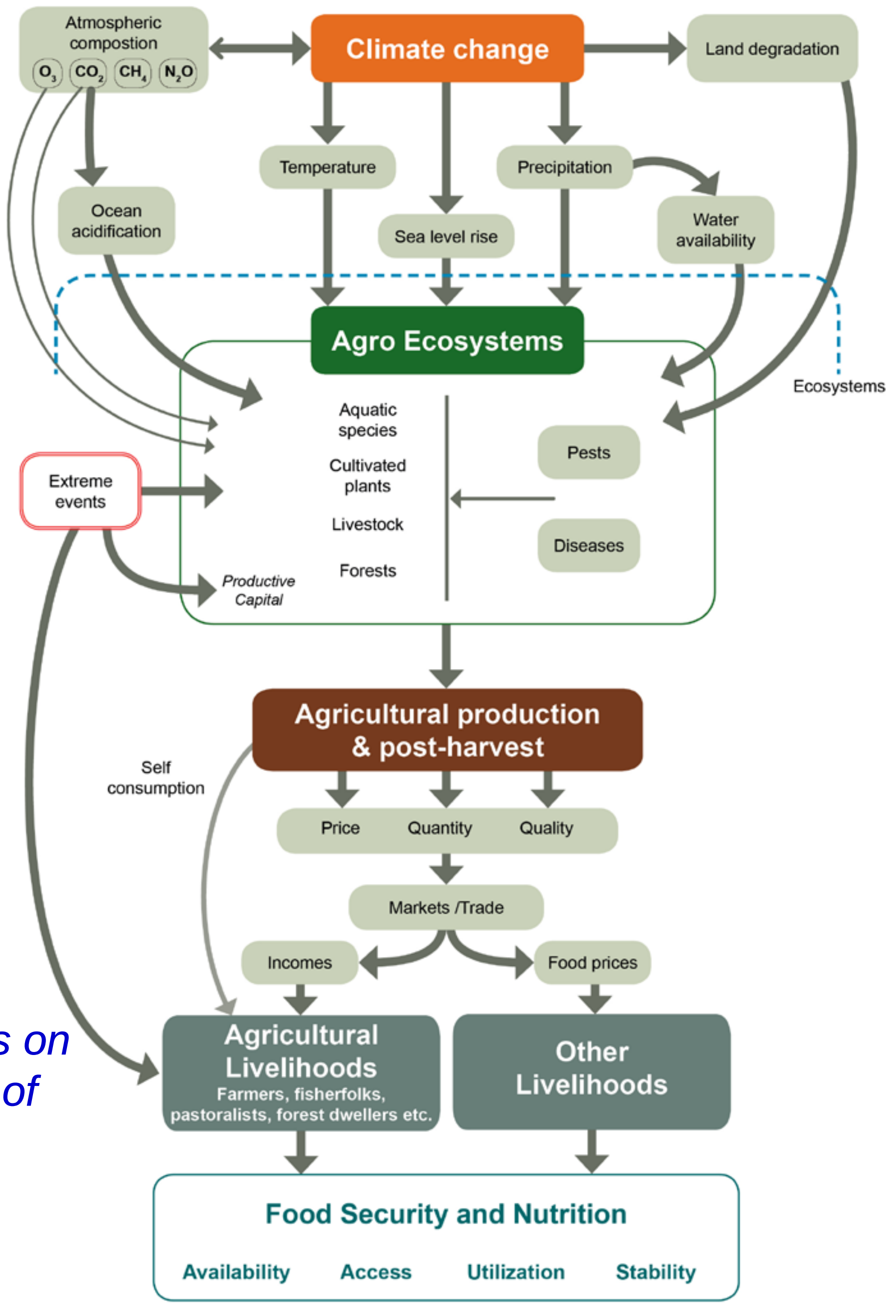
Source: NASA



Consequences of changing the natural atmospheric conditions

- On average, Earth will become warmer. Some regions may welcome warmer temperatures, but others may not.
- Warmer conditions will probably lead to more evaporation and precipitation overall, but individual regions will vary, some becoming wetter and others dryer.
- A stronger greenhouse effect will warm the ocean and partially melt glaciers and ice sheets, increasing sea level. Ocean water also will expand if it warms, contributing further to sea level rise.
- Outside of a greenhouse, higher atmospheric carbon dioxide (CO_2) levels can have both positive and negative effects on crop yields. Some laboratory experiments suggest that elevated CO_2 levels can increase plant growth. However, other factors, such as changing temperatures, ozone, and water and nutrient constraints, may more than counteract any potential increase in yield. If optimal temperature ranges for some crops are exceeded, earlier possible gains in yield may be reduced or reversed altogether.

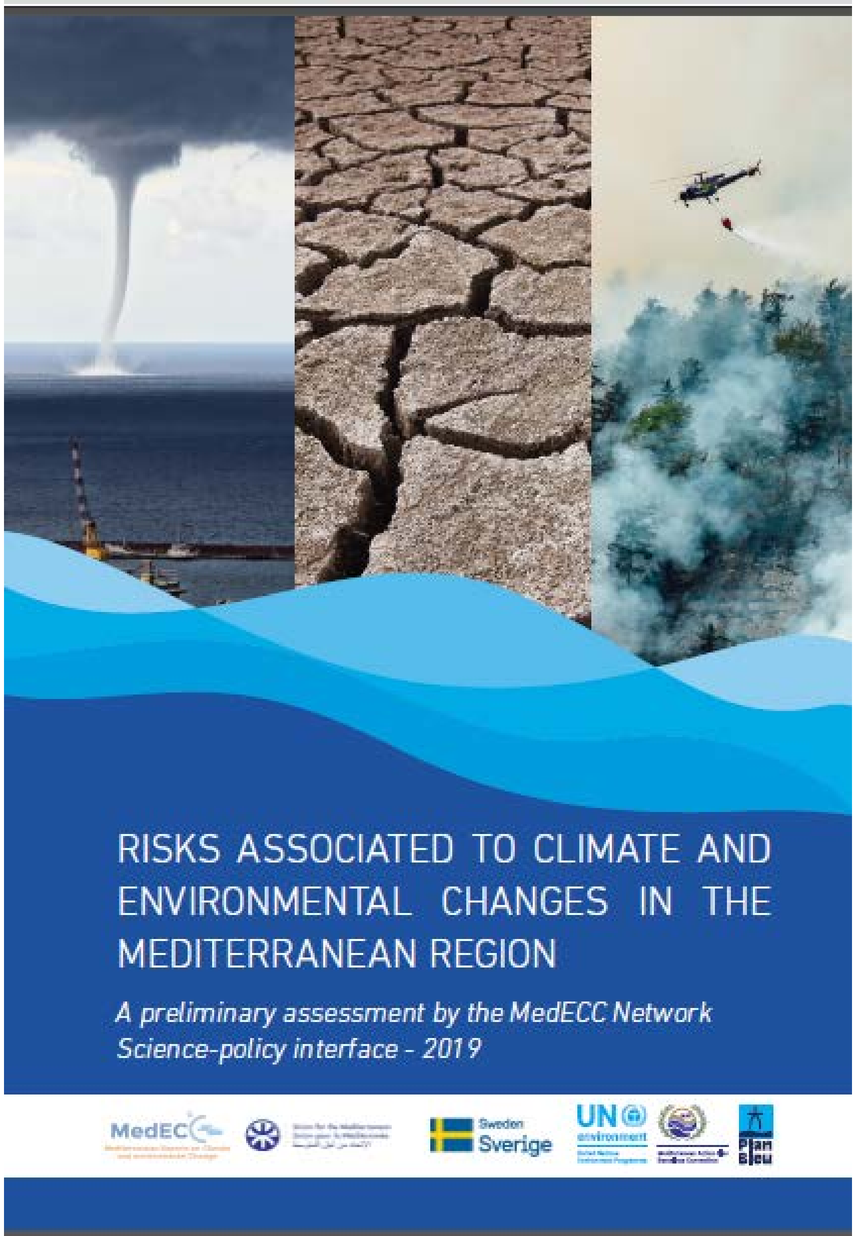
Consequences of changing the natural atmospheric conditions



Source: FAO
Climate change impacts on food security: overview of latest knowledge

Schematic representation of the cascading effects of climate change impacts on food security and nutrition. A range of physical, biological and biophysical impacts bear on ecosystems and agro-ecosystems, translating into impacts on agricultural production. This has quantity, quality and price effects, with impacts on the income of farm households and on purchasing power of non-farm households. All four dimensions of food security and nutrition are impacted by these effects.

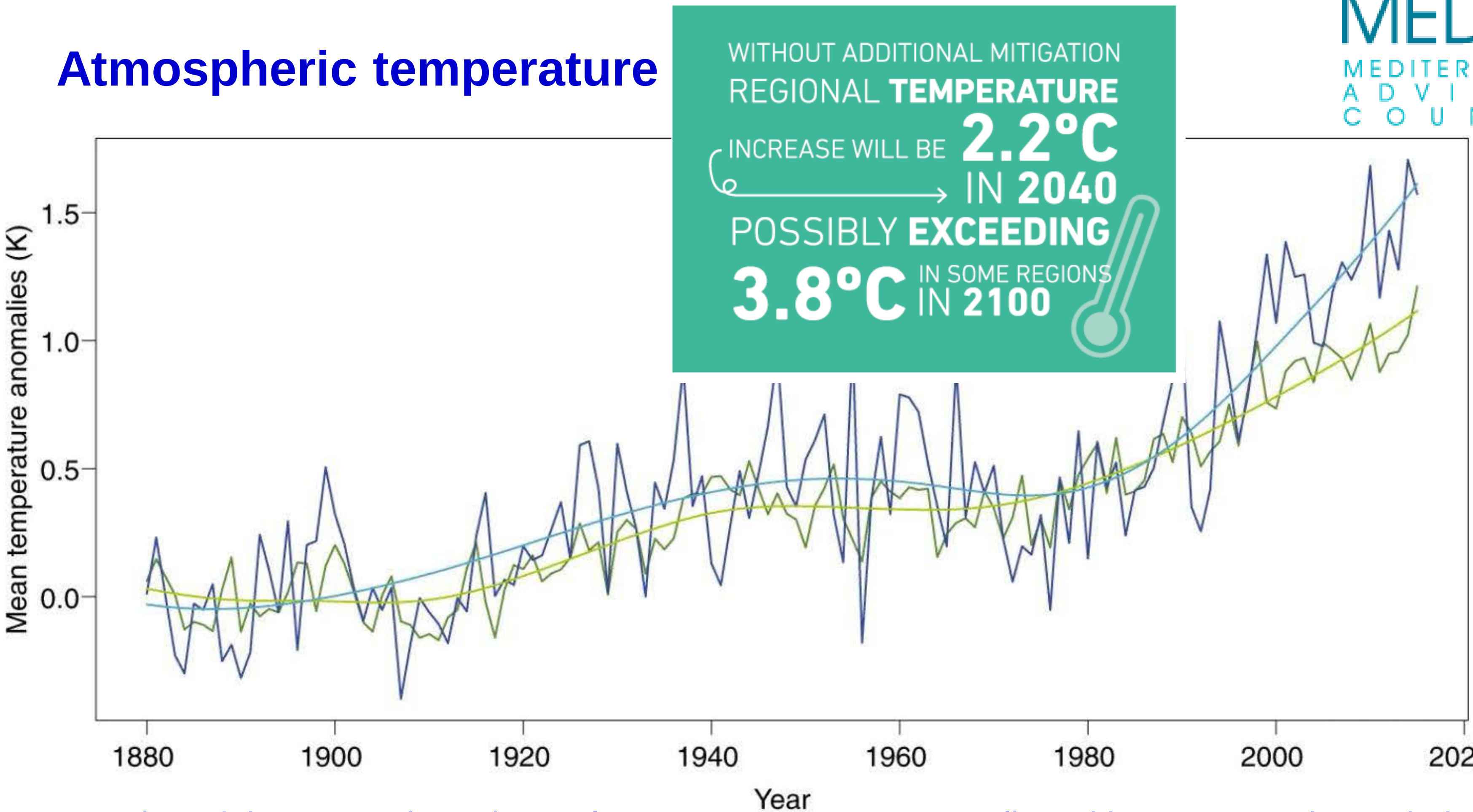
What will be the impact of climate change in the Mediterranean region?



- Air temperature
- Precipitation
- Sea temperature
- Sea level
- Acidification

What will be the impact of climate change in the Mediterranean region?

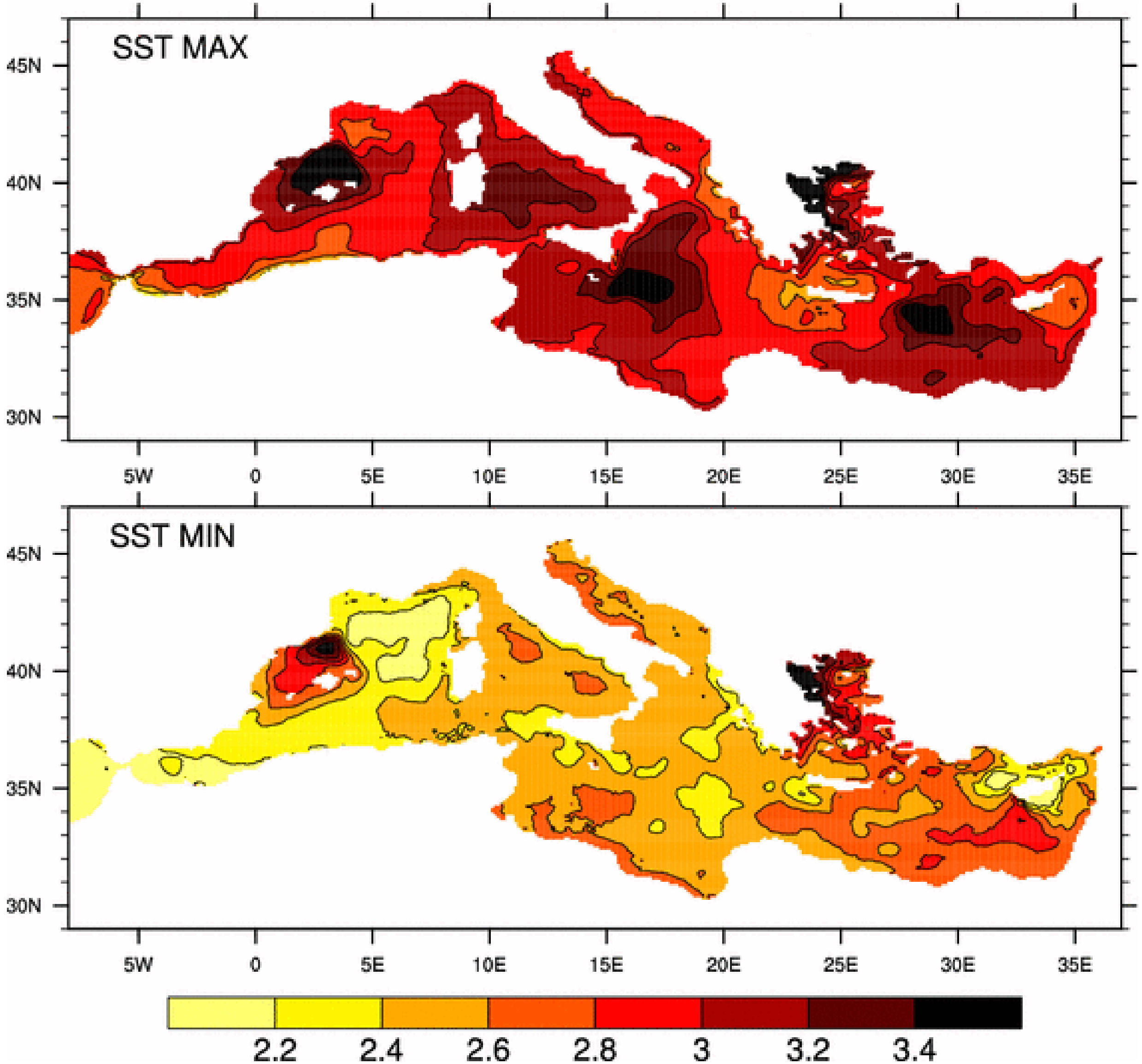
Atmospheric temperature



Warming of the atmosphere (annual mean temperature anomalies with respect to the period 1880-1899), in the Mediterranean Basin (blue lines, with and without smoothing) and for the globe (green line). In the Mediterranean region, average annual temperatures are now approximately 1.5° C higher than during the period 1880-1899, well above current global warming trends.

Source: MedECC 2019 citing Cramer et al. (2018). Nature Climate Change, 8, 972-980.

What will be the impact of climate change in the Mediterranean region?
Sea surface temperature (SST)



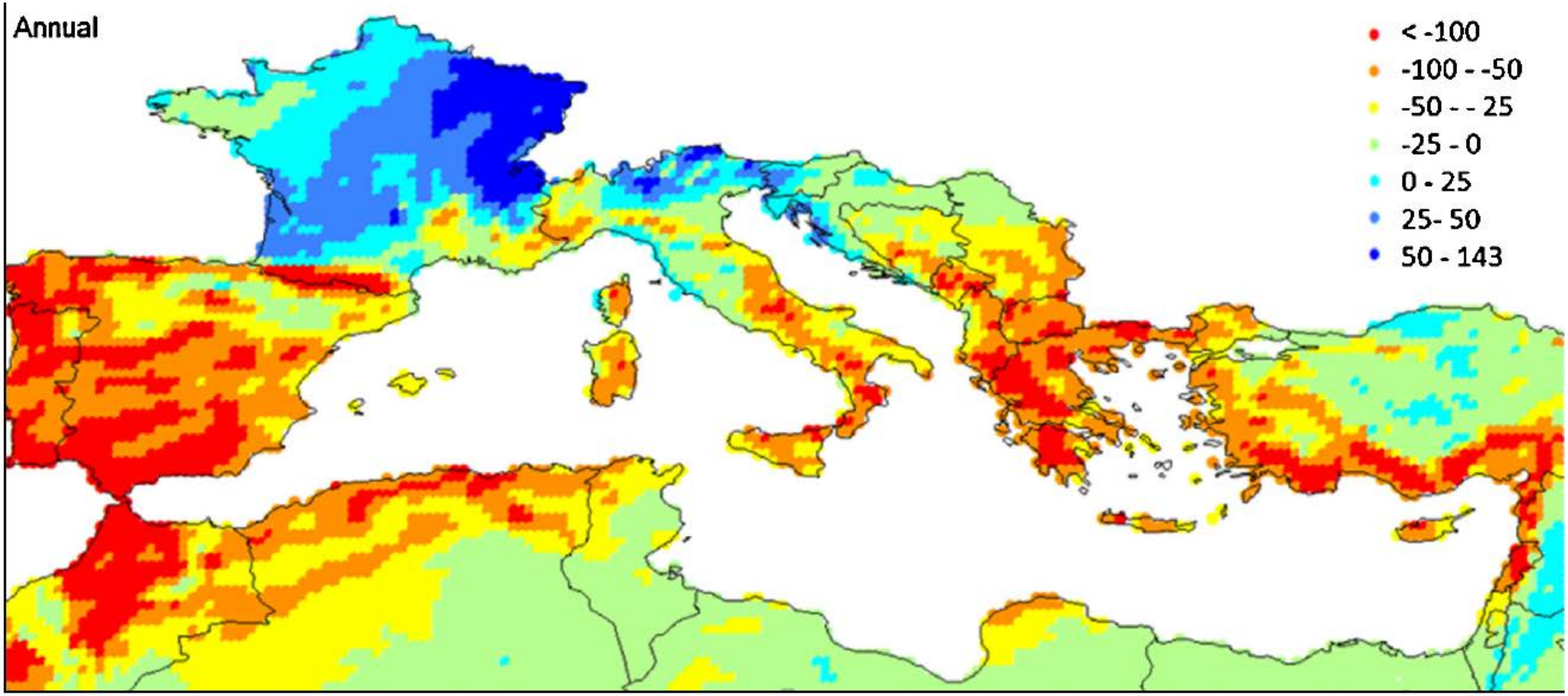
Expected minimum and maximum changes in sea surface temperature for the 2070–2099 period (vs. 1961–1990).

The largest (maxima) or smaller (minima) anomaly out of the 6 scenario simulations is represented (ºC).

Source: Adloff et al. (2015). Climate Dynamics, 45(9-10), 2775-2802

What will be the impact of climate change in the Mediterranean region?

Precipitation

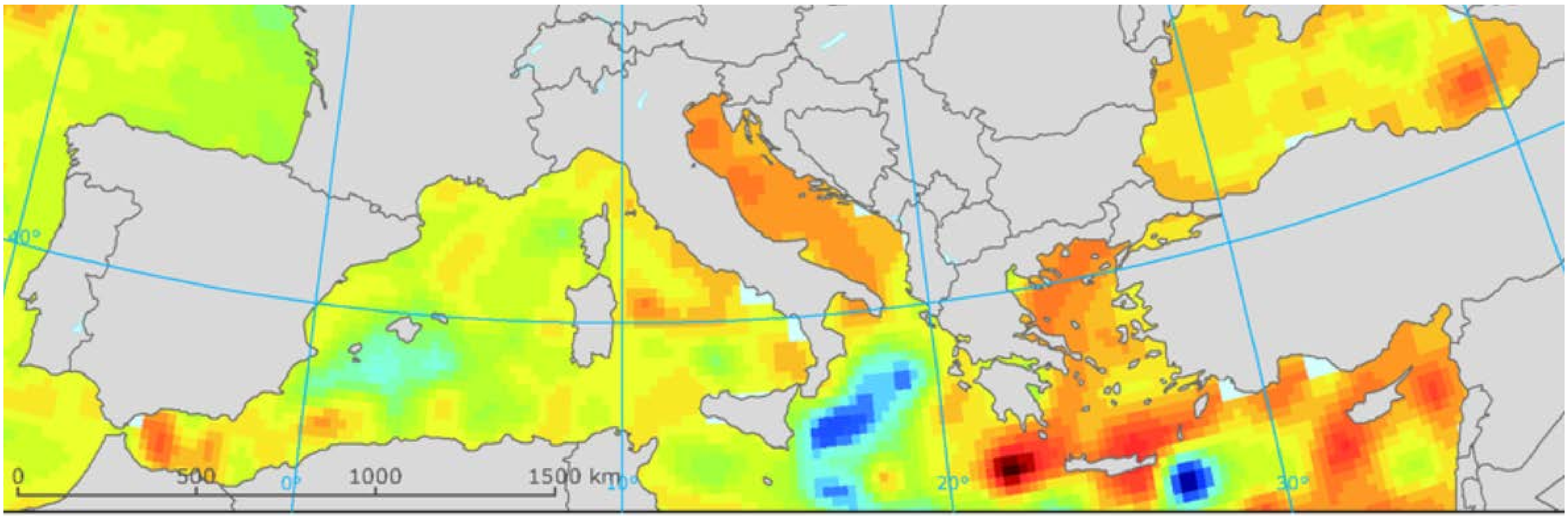


Spatial pattern of the mean annual and seasonal precipitation differences (mm) between 2050 and 2000.

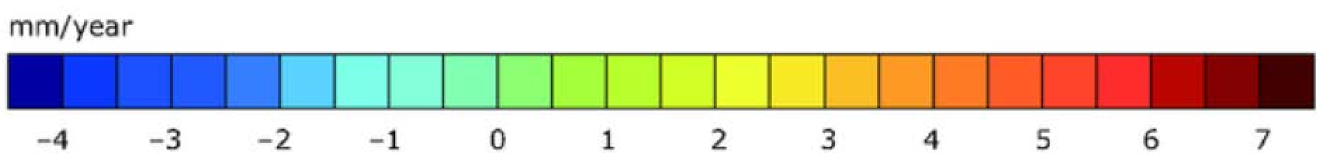
Source: Saadi, S., et al. Agricultural Water Management (2014), http://dx.doi.org/10.1016/j.agwat.2014.05.008

What will be the impact of climate change in the Mediterranean region?

Sea level rise



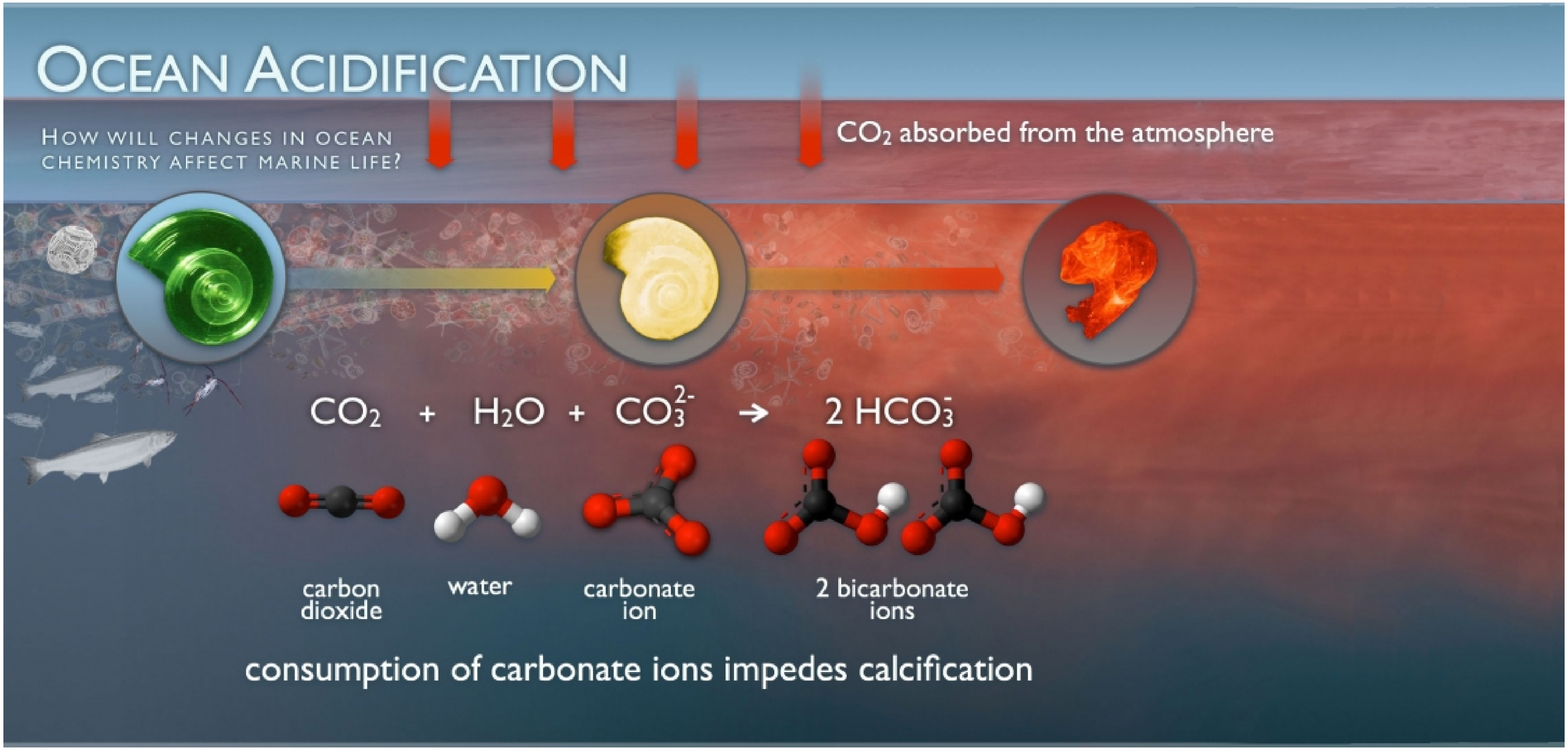
Trend in absolute sea level in European seas based on satellite measurements (1992–2013)



Source: **European Environment Agency**

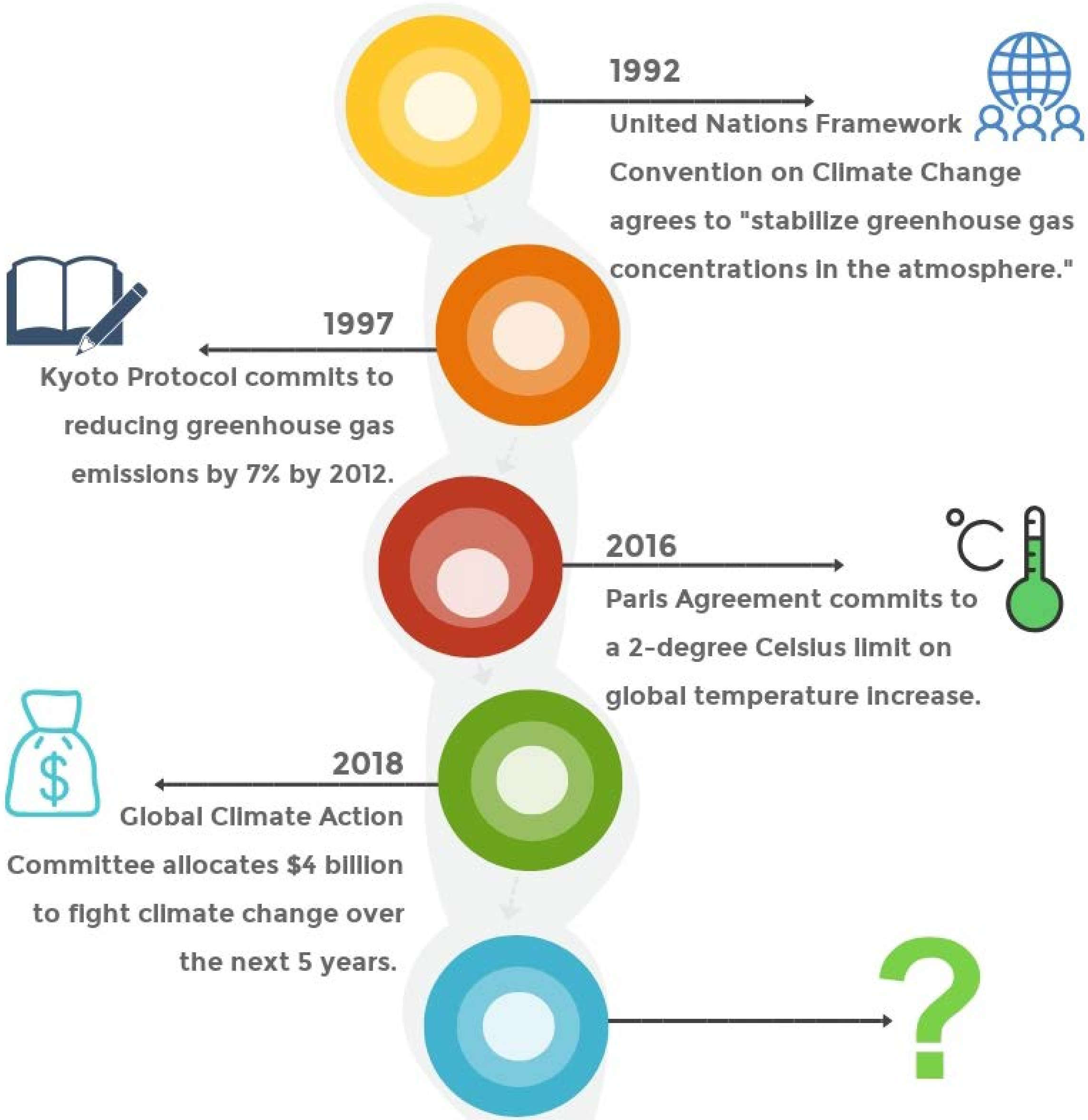
What will be the impact of climate change in the Mediterranean region?

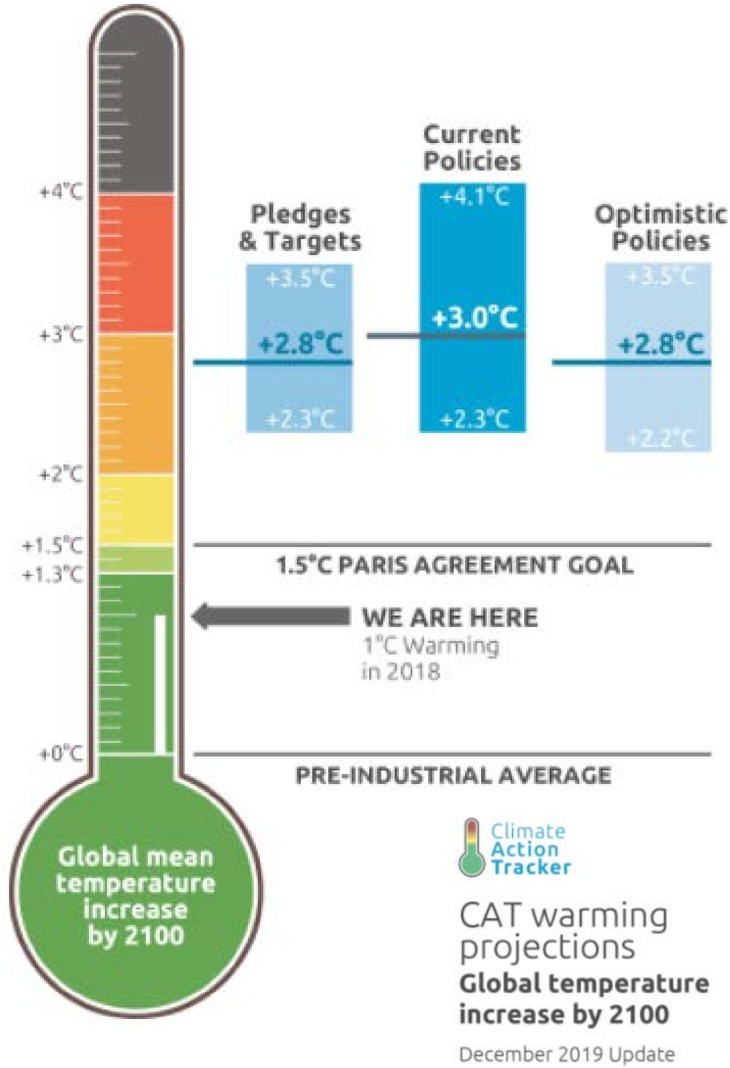
Acidification



Source: NOAA

UN Climate Agreements. A brief history





Infographic by Leah Worthington

Tracking progress towards the globally agreed aim of holding warming well below 2° C, and pursuing efforts to limit warming to 1.5° C.

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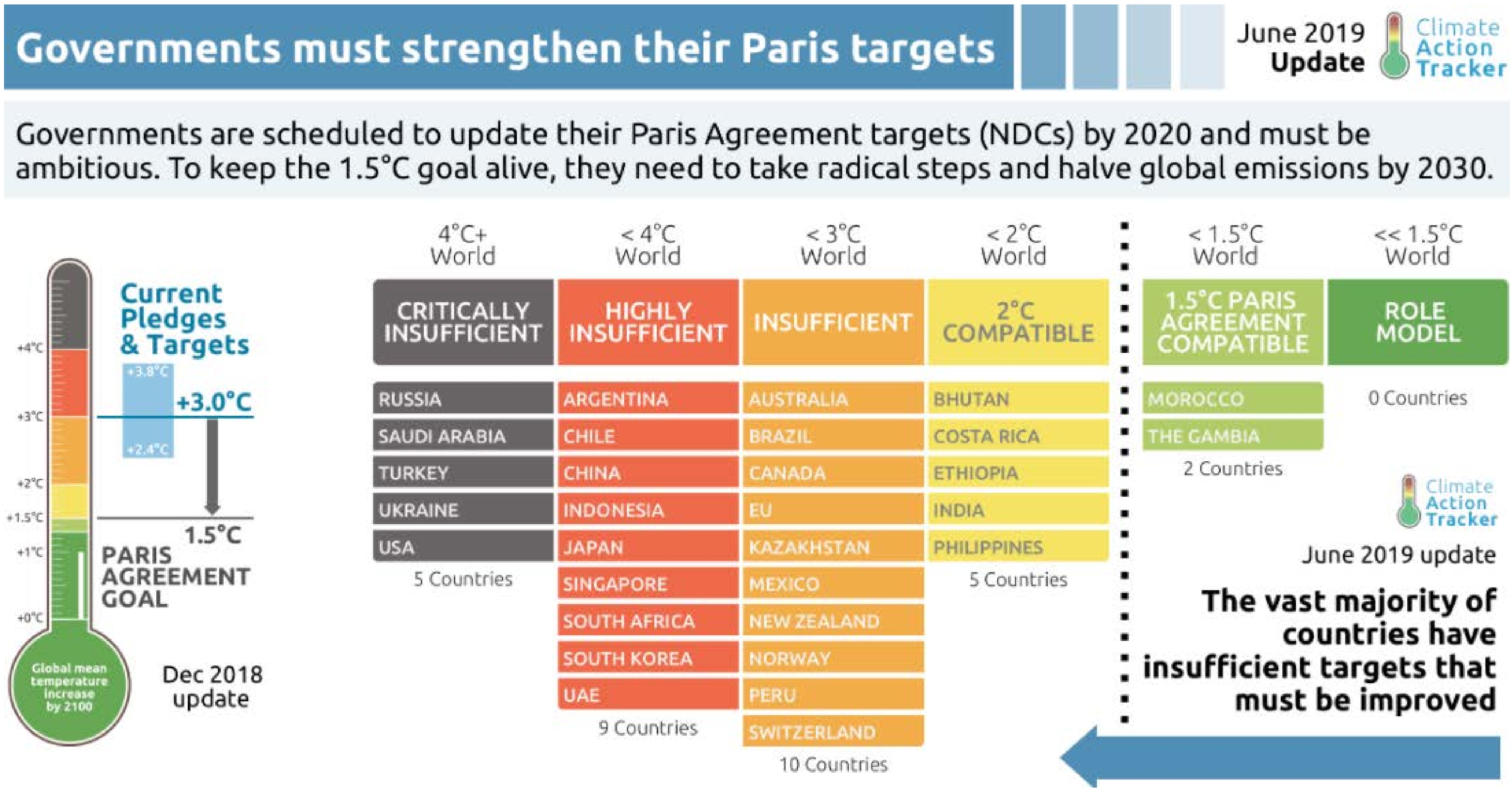
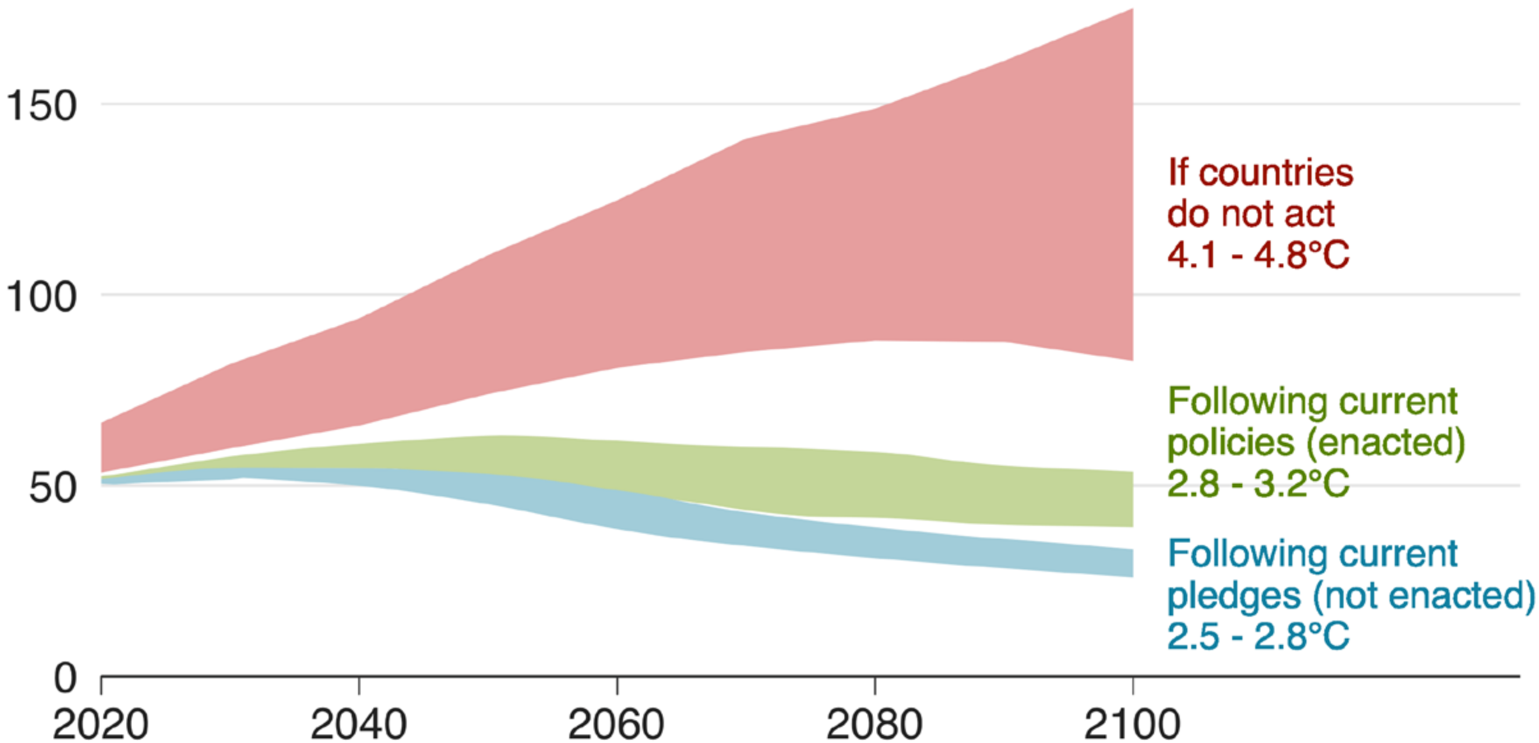


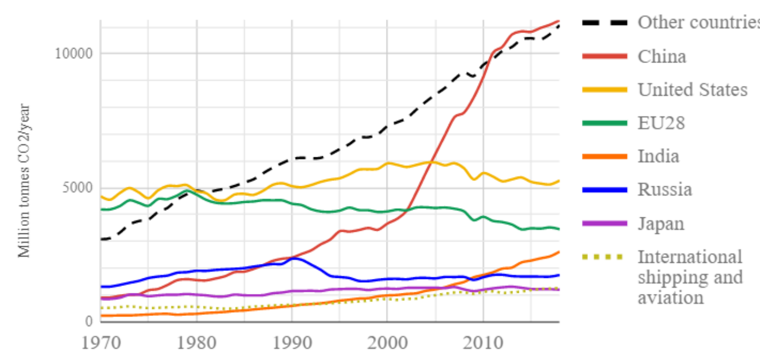
Source: Climate Action Tracker

How much worse will the problem get?

Emissions* and expected warming by 2100



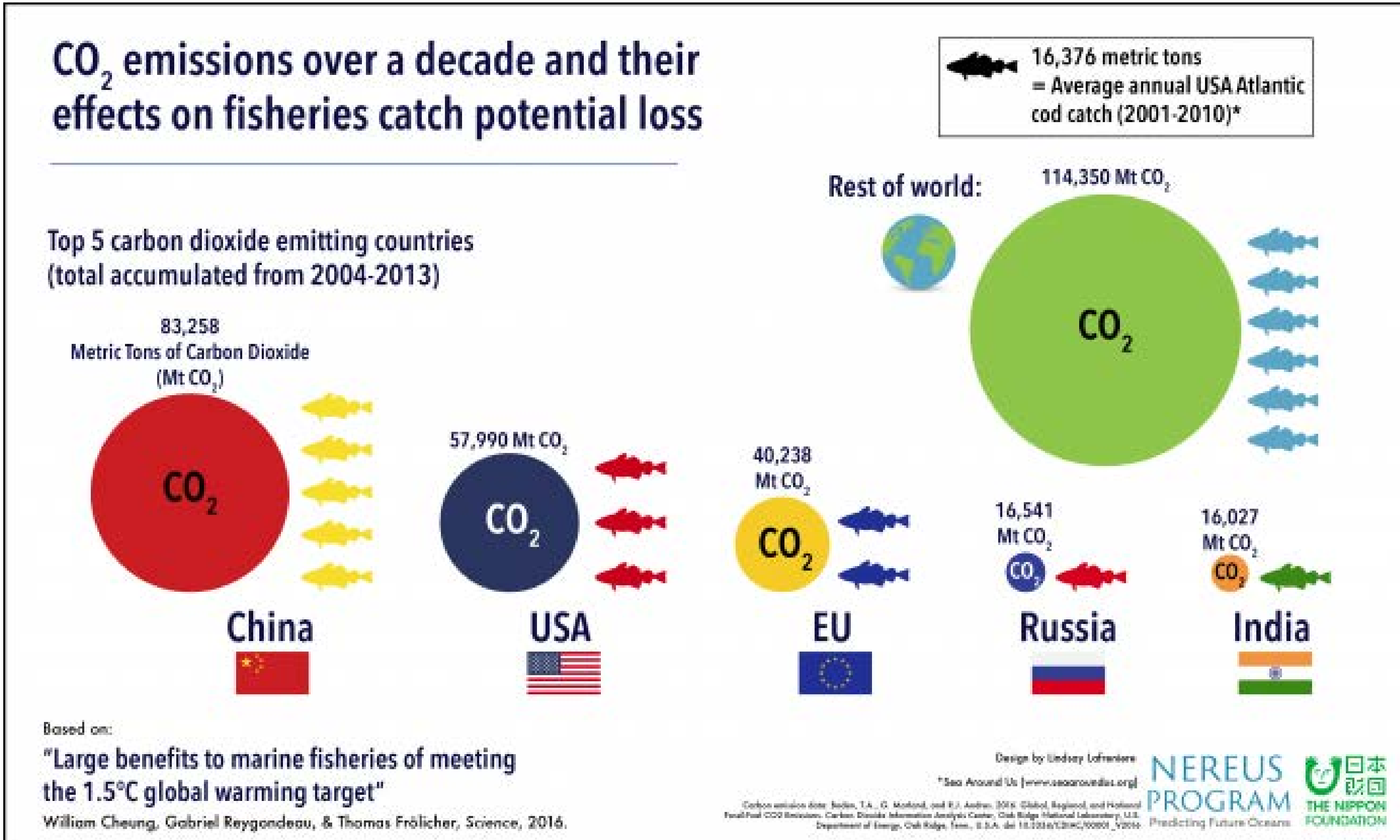
World fossil carbon dioxide emission 1970-2018



***Emissions are in Gigatonnes of CO_2 equivalent**

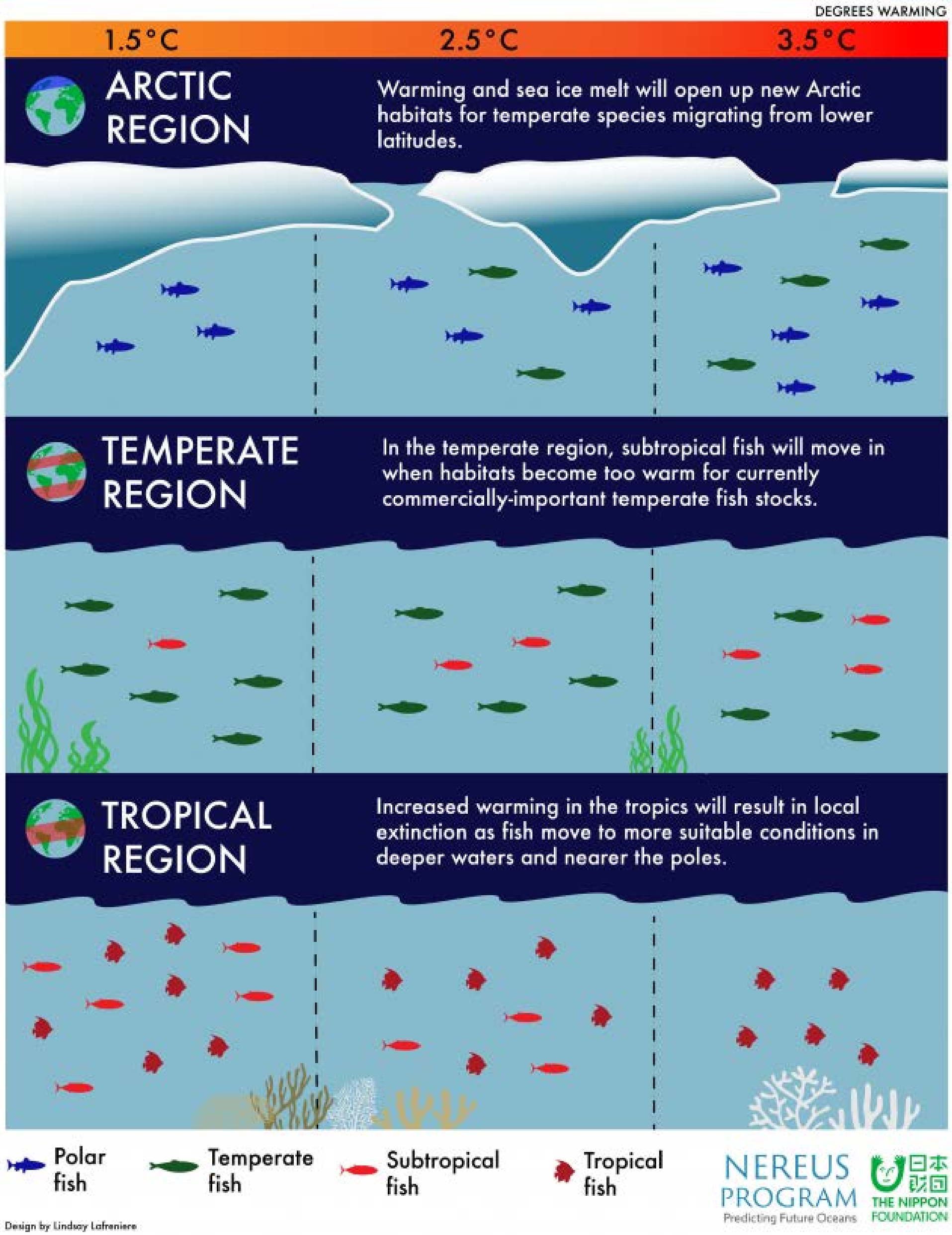
Source: Climate Action Tracker

1.5° C Paris Agreement target could net six million tonnes of fish annually



Source: Cheung et al., 2016, Science

Large benefits to marine fisheries of meeting the 1.5 ºC global warming target



Source: Cheung et al., 2016, Science

What will be the impact in the fisheries sector in the Mediterranean region?

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Drivers

Climate Anthropogenic
- Increase in SST
- Increase in SSS
- Increase heat waves
- Changes in the precipitation/runoff
- Sea level rise
- Vertical mixing/stratification
- Extreme weather events
- Mesoscale circulation
- Pollution
- Fishing
- Biotoxins

Socio-economic & Institutional
- Governance
- Fisheries policies/management
- Markets
- Economic status
- Consumption patterns
- Fishery dependency
- Fishery diversity
- Technological advances
- Illegal, unreported and unregulated activities (IUU)
- Lack of skills, education

Effects on → Impacts on

Fisheries resources → Catches composition; Production; Geographic distribution; Species phenology; Presence of NIS; Etc

Fishing operations → Working conditions; Days at sea; Operational costs; Cost of post harvesting; Etc

Communities & livelihoods → Landing value; Employment; Safety of communities; Market opportunities; Culture and heritage; Etc

Wider society & economic implications → Health issues; Food security; National income; Tourism activities; Recreational fisheries

Adapted from Badjeck et al. 2010

Tomaso Fortibuoni, 2020

ClimeFish

https://climefish.eu/wp-content/uploads/sites/18/2020/03/5g._Parallel_Session_Marine_Fisheries_-_Mediterranean_-_FAO_-

This project has received funding from the European Union´s Horizon 2020 research and innovation action under grant agreement no. 677039

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What will be the impact in the fisheries sector in the Mediterranean region? Alien (non indigenous species)

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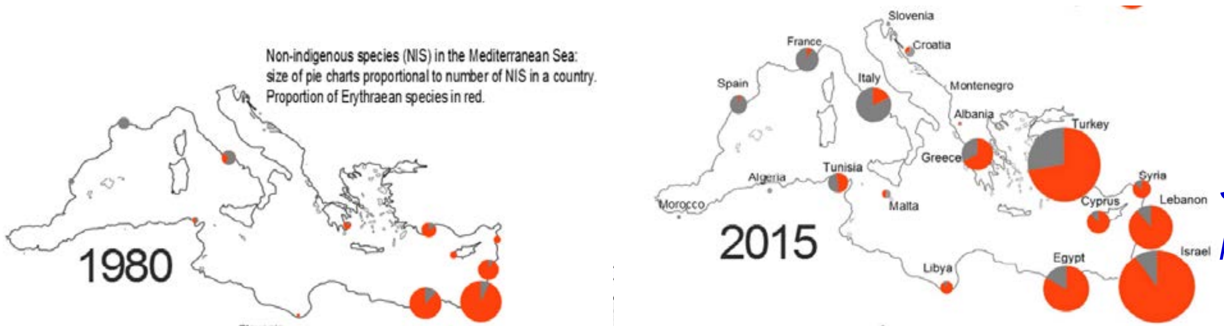
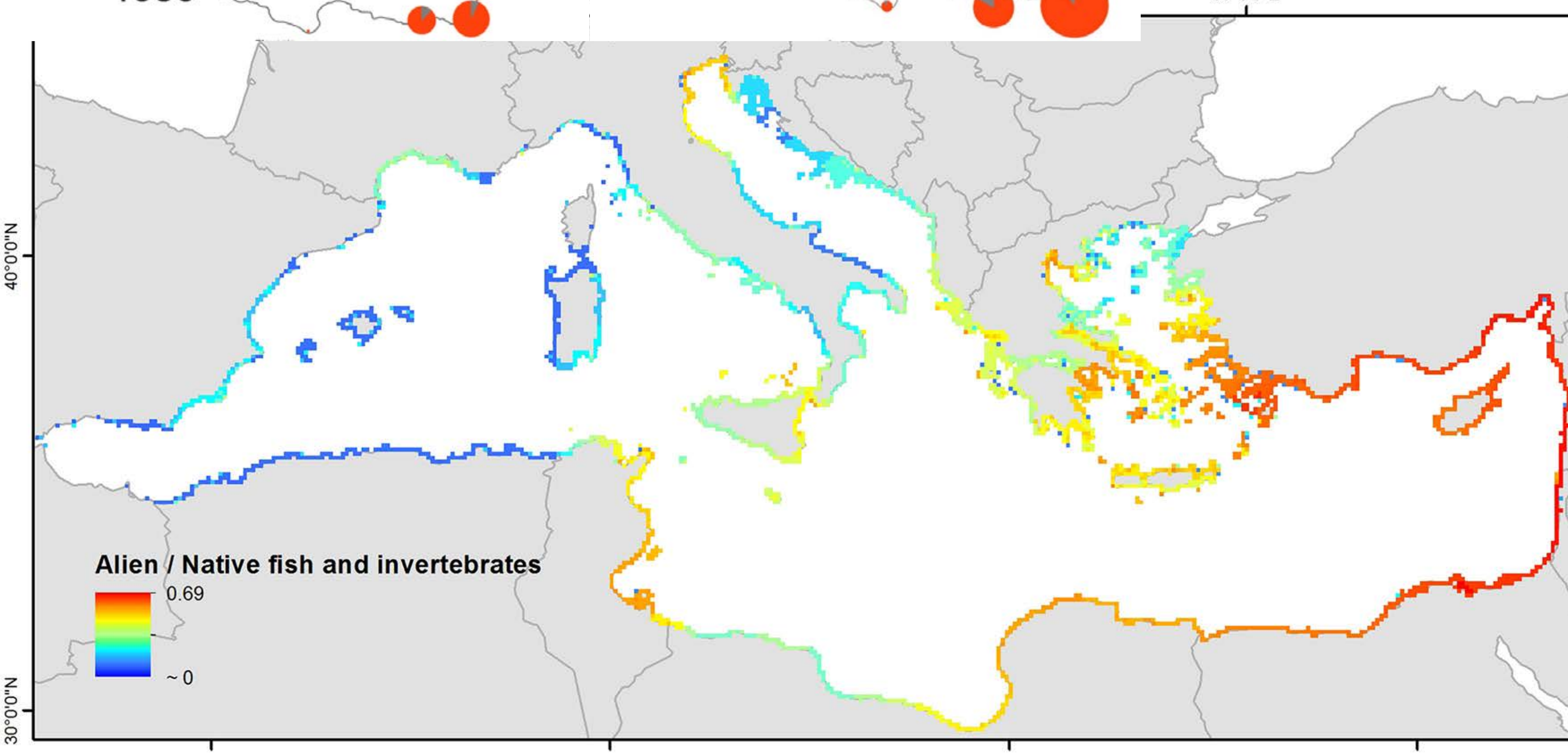


Source: Galil et al., 2018.

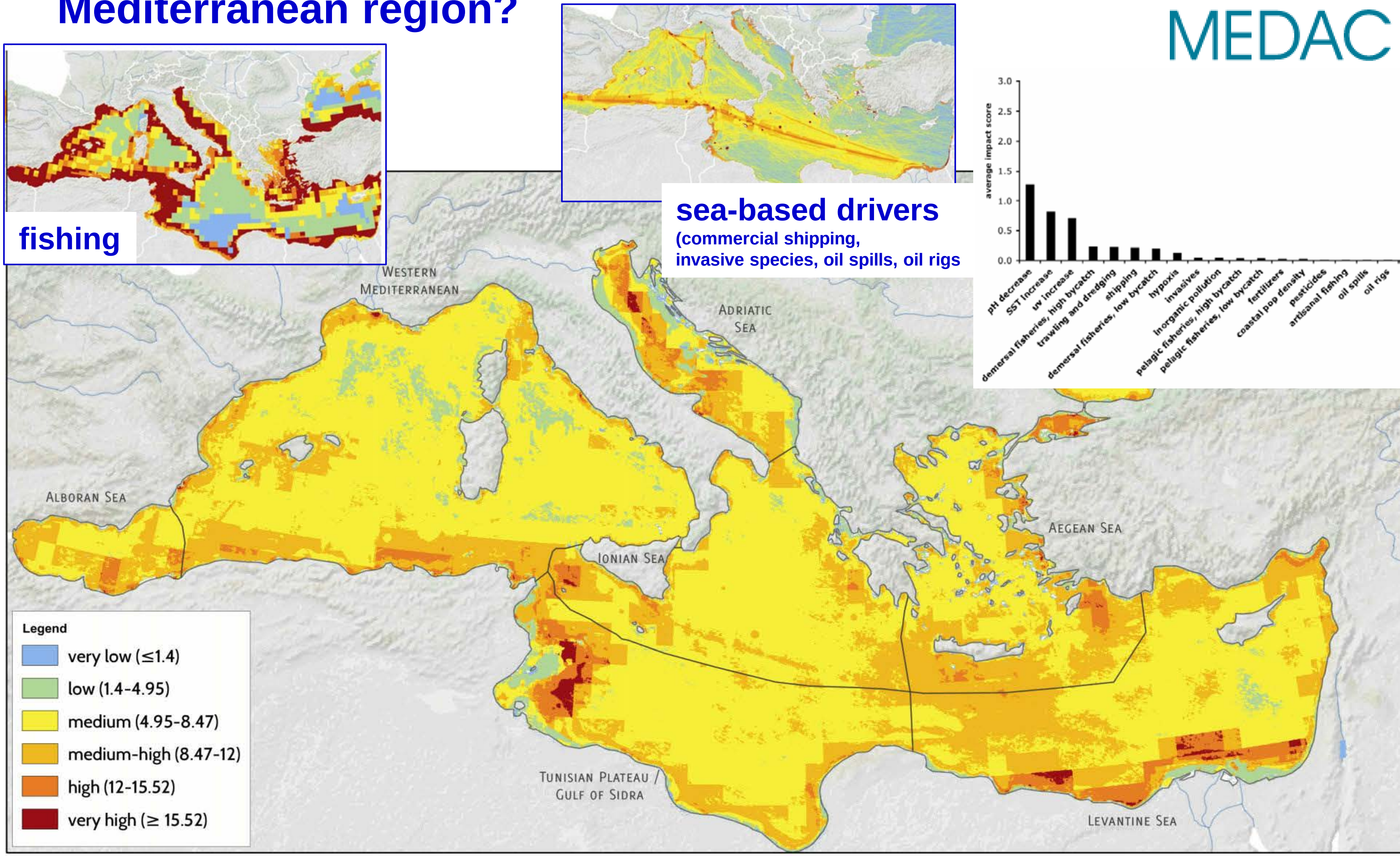
https://doi.org/10.1016/j.ecss.2015.12.021



Alien-to-native ratio of fish and invertebrates richness in the coastal areas of the Mediterranean Sea.

Source: Katsanevakis et al., 2014. doi: 10.3389/fmars.2014.00032

What will be the impact in the fisheries sector in the Mediterranean region?



Spatial distribution of cumulative impacts to marine ecosystems of the Mediterranean

Source: Micheli et al., 2013

What will be the impact in the fisheries sector in the Mediterranean region?

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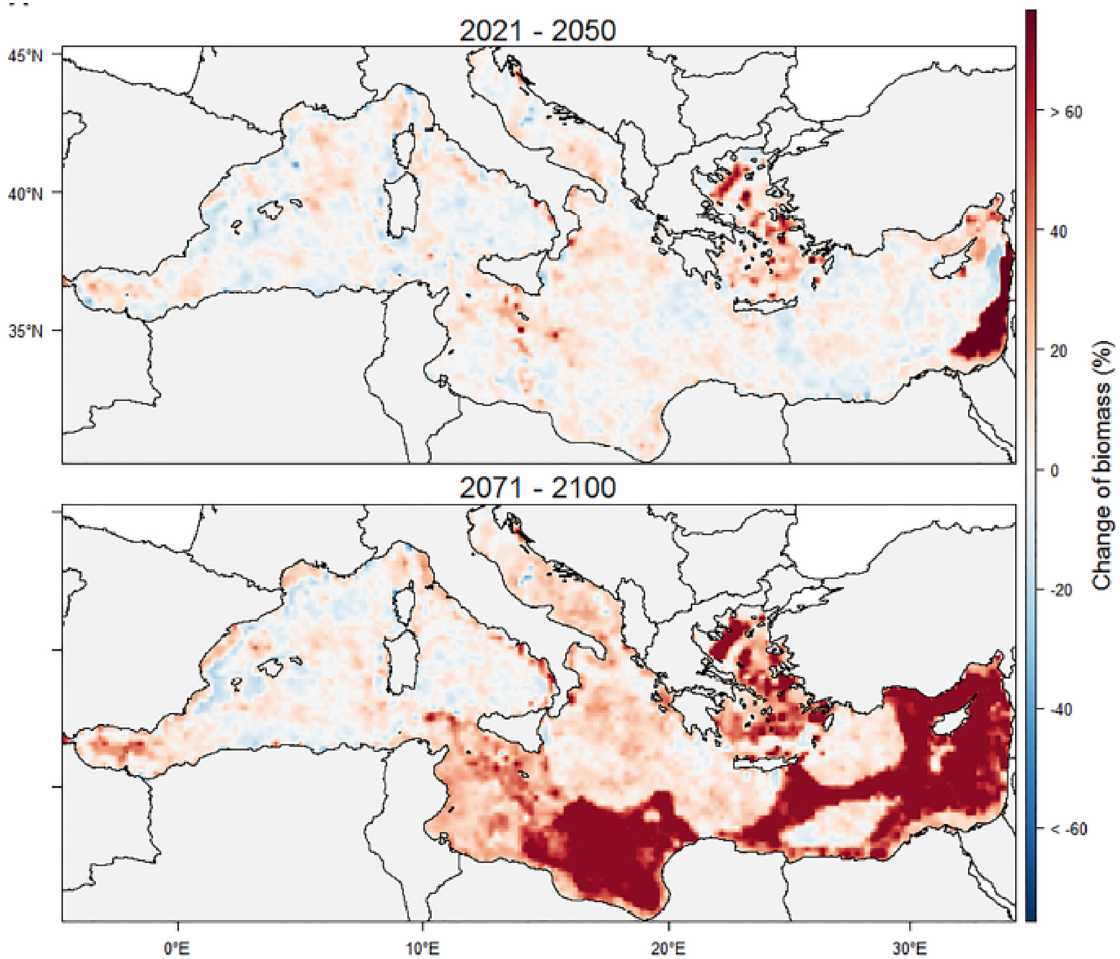
Country	area (km²)	very low	low	med	med-high	high	very high
Slovenia	266.2	0.0	10.2	22.7	0.0	0.8	66.3
Cyprus	95,833.6	1.8	4.4	0.7	12.2	63.3	17.6
France	480,103.7	0.4	4.1	26.2	26.7	27.6	14.9
Italy	700,184.6	0.0	6.3	14.0	44.6	21.4	13.7
Spain	744,352.6	0.0	6.6	7.2	40.0	33.9	12.2
Bulgaria	48.050.1	5.3	14.9	15.7	33.6	22.5	8.0
Greece	615,025.4	0.8	9.0	9.7	51.3	21.3	7.9
Monaco	390.6	0.0	0.0	0.8	60.2	32.8	6.3
Malta	68,240.6	0.9	2.9	37.5	34.8	19.0	4.8
Romania	41,509.7	1.4	16.5	20.5	47.5	12.8	1.2

Percent of national territorial waters of Mediterranean and Black Sea EU member states within different impact categories: very high impact (Ic.15.52); high impact (12–15.52); medium-high impact (8.47–12); medium impact (4.95–8.47); low impact (1.4–4.95); and very low impact (<1.4).

Source: Micheli et al., 2013

What will be the impact in the fisheries sector in the Mediterranean region?

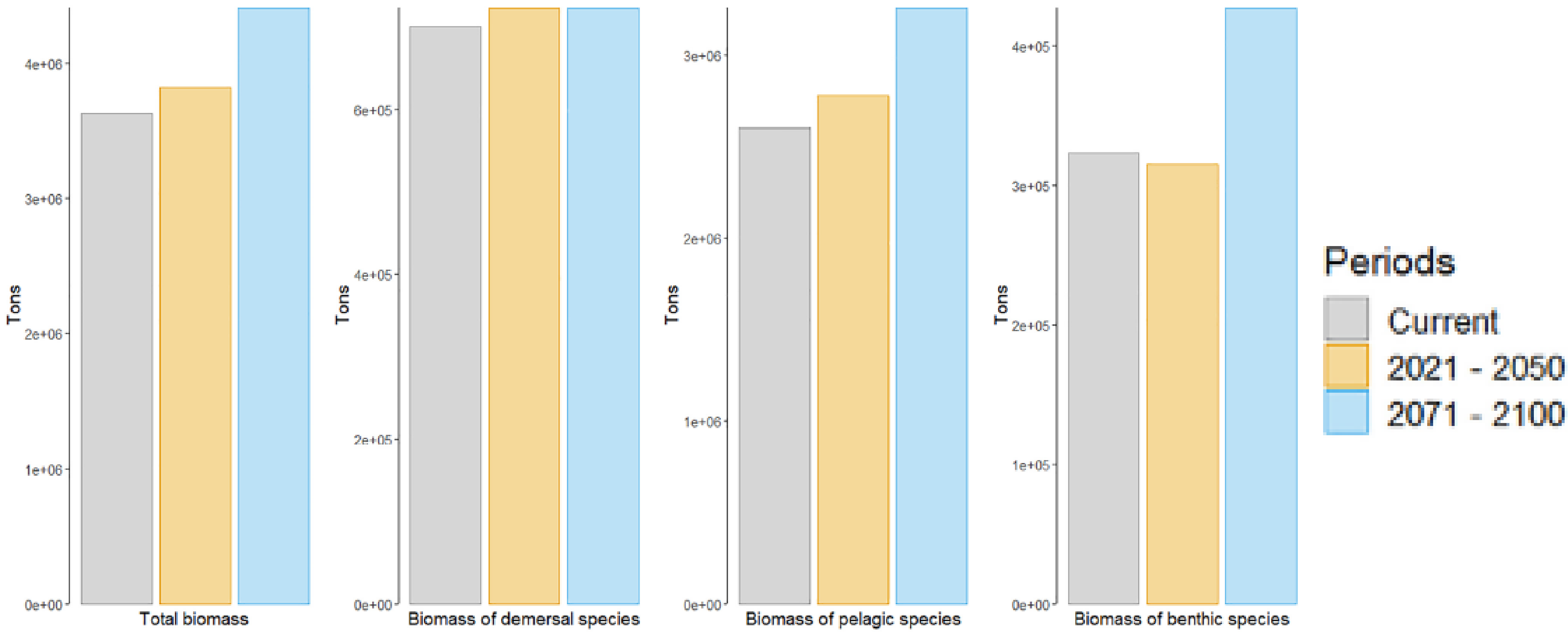


Projected relative change in biomass between the current period (2006–2013) and the future (2021–2050 top; 2071–2100, bottom) under the emission scenario RCP8.5.

Source: Moullec et al., (2019). An End-to-End Model Reveals Losers and Winners in a Warming Mediterranean Sea. Front. Mar. Sci. 6:345. doi: 10.3389/fmars.2019.00345

What will be the impact in the fisheries sector in the Mediterranean region?

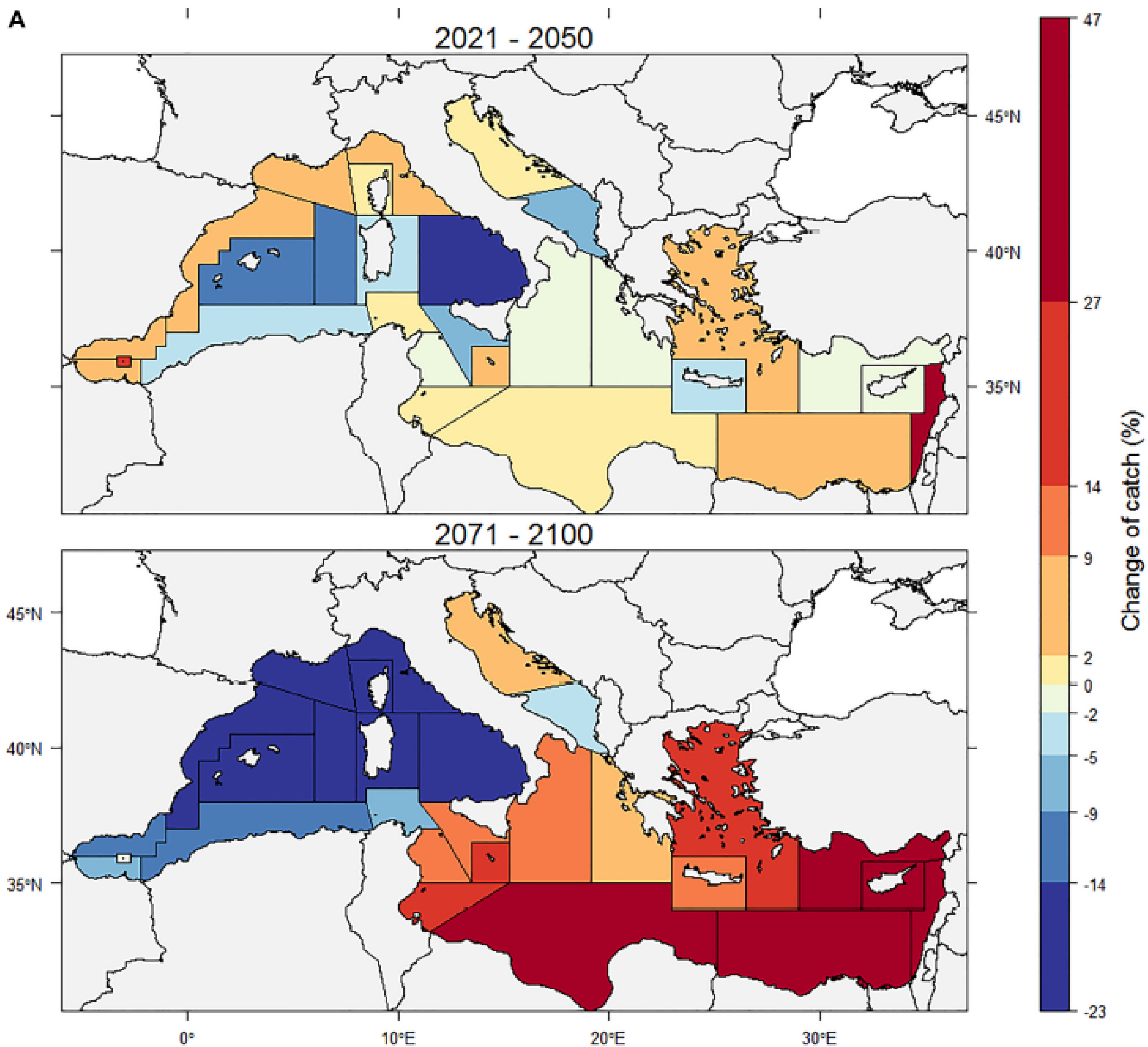
Total Biomass Demersal Biomass Pelagic Biomass Benthic Biomass



Total biomass and biomass of pelagic, demersal, and benthic species for current (2006–2013) and future time periods (2021–2050, top; 2071–2100, bottom) under emission scenario RCP8.5.

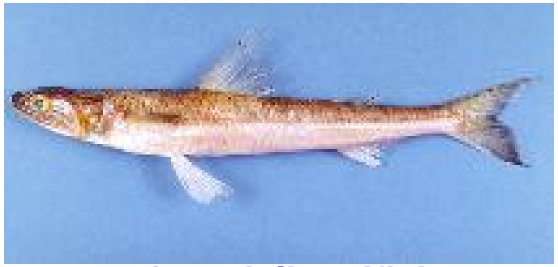
Source: Moullec et al., (2019). An End-to-End Model Reveals Losers and Winners in a Warming Mediterranean Sea. Front. Mar. Sci. 6:345. doi: 10.3389/fmars.2019.00345

What will be the impact in the fisheries sector in the Mediterranean region?



Relative changes in catches (all exploited species confounded) by GSA between the current period (2006–2013) and the future (2021–2050, top; 2071–2100, bottom) under emission scenario RCP8.5.

Red-eye round herring



Brushtooth lizardfish

Source: Moullec et al., (2019). An End-to-End Model Reveals Losers and Winners in a Warming Mediterranean Sea. Front. Mar. Sci. 6:345. doi: 10.3389/fmars.2019.00345

Vulnerability Assessment of Climate Change

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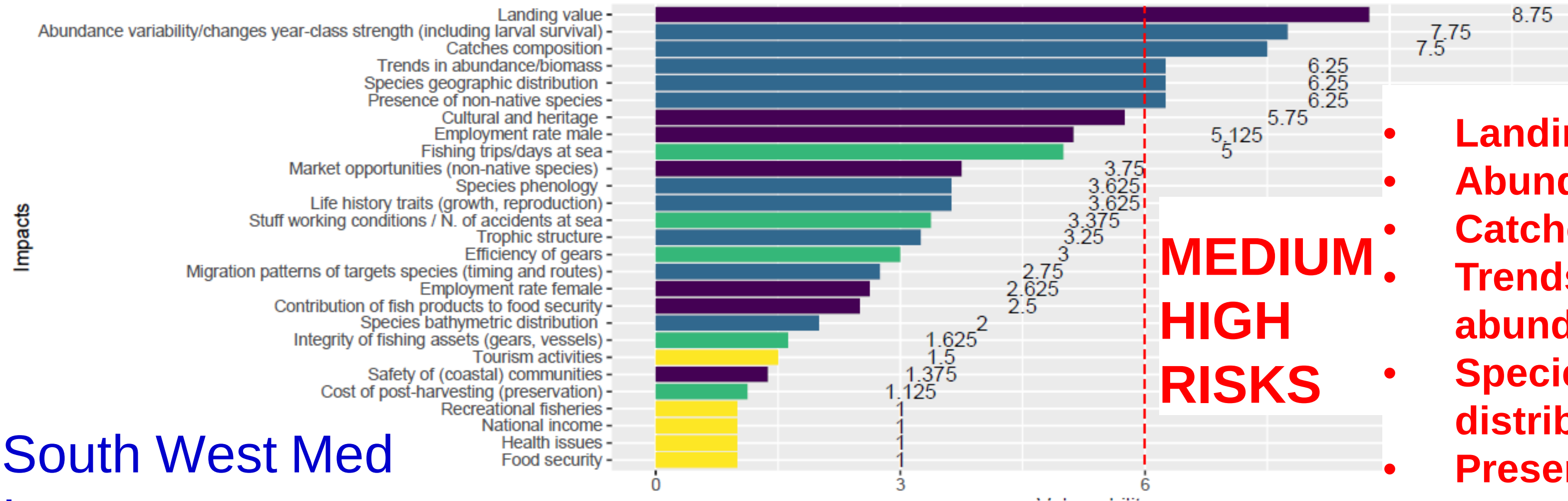
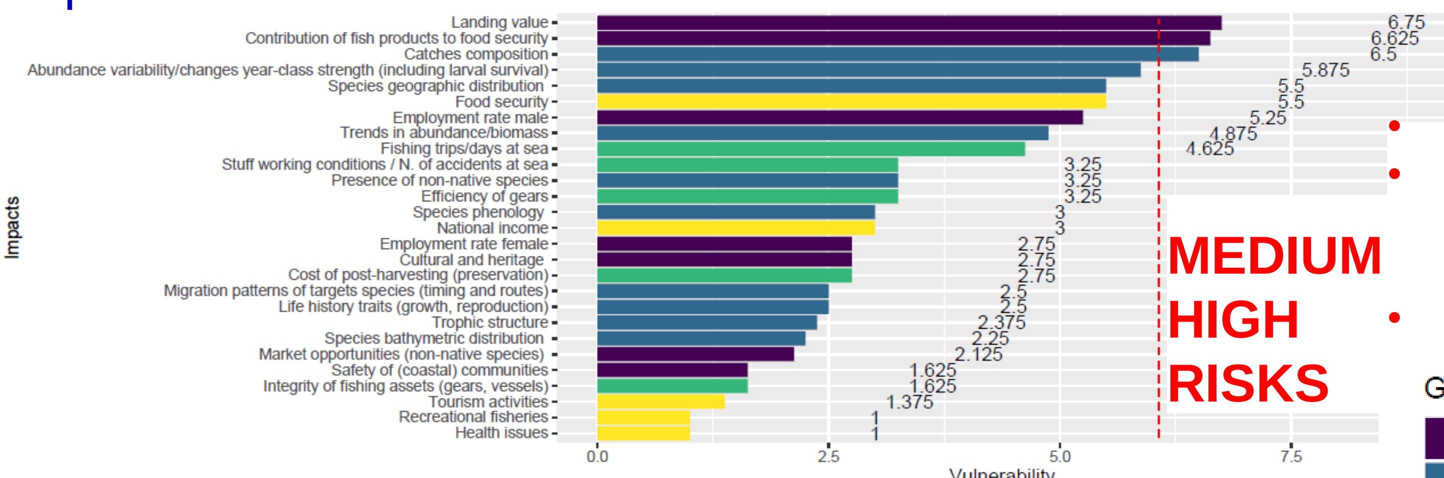
North West Med Impacts

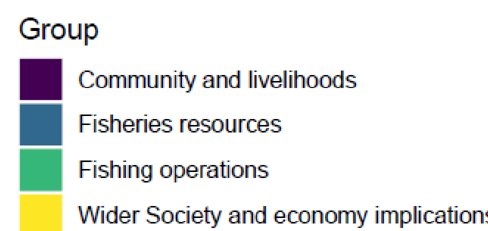


- **Landing value**
- **Abundance variability**
- **Catches composition**
- **Trends in abundance/biomass**
- **Species geographic distribution**
- **Presence of non-native species**

South West Med Impacts



- **Landing value**
- **Contribution of fish products to food security**
- **Catches composition**



Source: Tomaso Fortibuoni, 2020

https://climefish.eu/wp-content/uploads/sites/18/2020/03/5g._Parallel_Session_-_Marine_Fisheries_-_Mediterranean_-_FAO_-_ClimeFish_2020_Forum_-_T._Fortibuoni.pdf

Tools and Methods for Adaptation
Including Socioeconomic Implications

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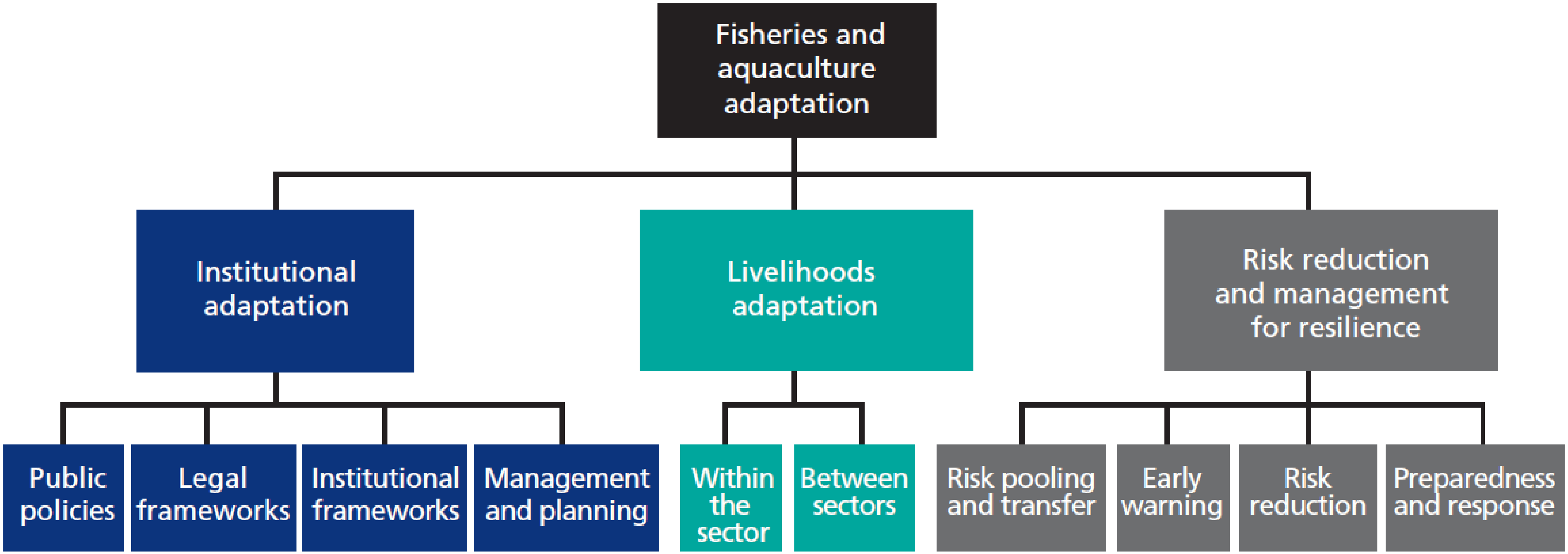
Conceptualization of the expanded understanding of vulnerability. Vulnerability here includes the impacts of climate and socio-economic processes on risk



Categories of adaptation activities (from analysis of case studies)

Source: Oppenheimer *et al.*, 2014

Source: FAO 2018,
Chapter 25, Florence Poulain, Amber Himes-Cornell and Clare Shelton
Impacts of climate change on fisheries and aquaculture
FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.

Types and selected examples of adaptation tools and approaches in capture fisheries - 1

INSTITUTIONS
Public policies
Public investments (e.g. research, capacity building, sharing best practices and trials, communication)
Climate change adaptation policies and plans address fisheries
Provide incentives for fish product value addition and market development
Remove harmful incentives (e.g. for the expansion of fishing capacity)
Address poverty and food insecurity, which systemically limit adaptation effectiveness
Legal frameworks
Flexible access rights to fisheries resources in a changing climate
Dispute settlement arrangements
Adaptive legal rules
Regulatory tools (e.g. adaptive control of fishing pressure; move away from time-dependent effort control)
Institutional frameworks
Effective arrangements for stakeholders engagement
Awareness raising and capacity building to integrate climate change into research/management/policy/ rules
Enhanced cooperation mechanisms including between countries to enhance the capacity of fleets to move between and across national boundaries in response to change in species distribution

Source: FAO 2018,
Chapter 25, Florence Poulain, Amber Himes-Cornell and Clare Shelton
Impacts of climate change on fisheries and aquaculture
FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.

Types and selected examples of adaptation tools and approaches in capture fisheries - 2

Diversify patterns of fishing activities with respect to the species exploited, location of fishing grounds and gear used to enable greater flexibility
Private investment in adapting fishing operations, and private research and development and investments in technologies e.g. to predict migration routes and availability of commercial fish stocks
Adaptation oriented microfinance
Between sectors
Livelihood diversification (e.g. switching among rice farming, tree crop farming and fishing in response to seasonal and interannual variations in fish availability)
Exit strategies for fishers to leave fishing
RISK REDUCTION AND MANAGEMENT FOR RESILIENCE
Risk pooling and transfer
Risk insurance
Personal savings
Social protection and safety nets
Improve financial security
Early warning
Extreme weather and flow forecasting
Early warning communication and response systems (e.g. food safety, approaching storms)
Monitoring climate change trends, threats and opportunities (e.g. monitoring of new and more abundant species)

Source: FAO 2018,
Chapter 25, Florence Poulain, Amber Himes-Cornell and Clare Shelton
Impacts of climate change on fisheries and aquaculture
FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.

Types and selected examples of adaptation tools and approaches in capture fisheries - 3

Risk reduction	
	Risk assessment to identify risk points
	Safety at sea and vessel stability
	Reinforced barriers to provide a natural first line of protection from storm surges and flooding
	Climate resilient infrastructure (e.g. protecting harbours and landing sites)
	Address underlying poverty and food insecurity problems
Preparedness and response	
	Building back better in post-disaster recovery
	Rehabilitate ecosystems
	Compensation (e.g. gear replacement schemes)

Source: FAO 2018,
Chapter 25, Florence Poulain, Amber Himes-Cornell and Clare Shelton
Impacts of climate change on fisheries and aquaculture
FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.

Overview of practical options for reducing vulnerability in fisheries

Impact area	Potential responses
Capture fisheries	
Reduced yield	Access higher-value markets; shift/widen targeted species; increase fishing capacity/effort*; reduce costs/increase efficiency; diversify livelihoods, exit fishery
Increased yield variability	Diversify livelihoods; implement insurance schemes; promote adaptive management frameworks
Change in distribution	Migrate fishing effort/strategies and processing/distribution facilities; implement flexible allocation and access schemes
Sea-level change, flooding, and surges	New/improved physical defences; managed retreat/accommodation; rehabilitation and disaster response; integrated coastal management; early warning systems and education
Increased dangers of fishing	Weather warning systems; improved vessel stability/safety/communications
Social disruptions/new fisher influx	Support existing/develop new local management institutions; diversify livelihoods

*Note: Some autonomous adaptations to declining and variable yields may directly risk exacerbating overexploitation of fisheries by increasing fishing pressure or impacting habitats.

Source: FAO 2016
Climate change impacts on food security: Risks and responses

Thank you very much!

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ΠΑΝΕΛΛΗΝΙΑ ΕΝΩΣΗ ΠΛΟΙΟΚΤΗΤΩΝ ΜΕΣΗΣ ΑΛΙΕΙΑΣ
PANHELLENIC UNION OF MIDDLE RANGE FISHERIES SHIP OWNERS