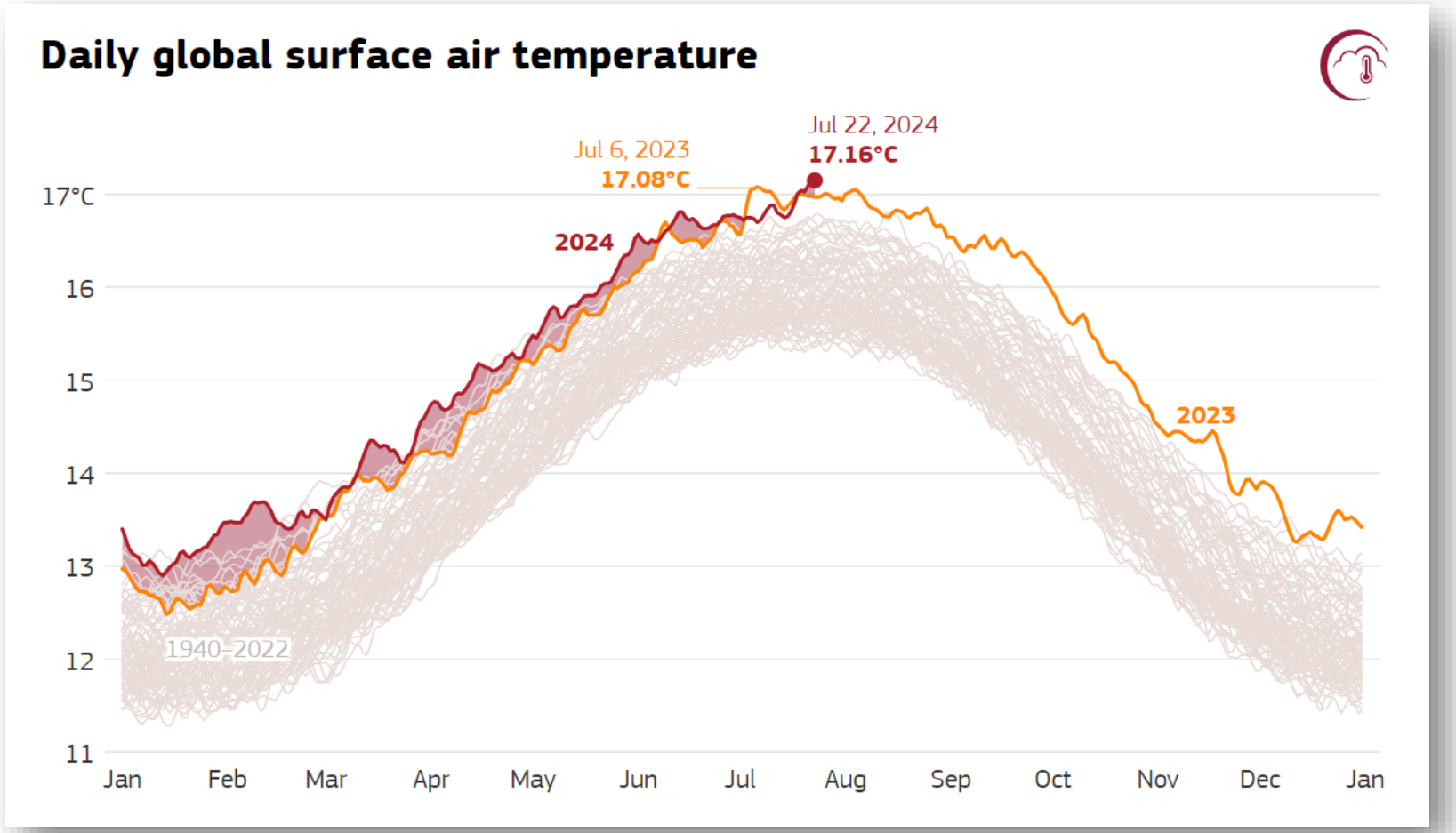
eurac research

Climate Change and Natural Disasters

Consequences for climate risk assessment

Marc Zebisch, Eurac Research

Current heat wave – new records - global



The Earth has just experienced its warmest day in recent history, according to the Copernicus Climate Change Service (C3S) data. On 22 July 2024, the daily global average temperature reached a new record high in the ERA5 dataset, at 17.16°C. This exceeds the previous records of 17.09°C, set just one day before on 21 July 2024, and 17.08°C, set a year earlier on 6 July 2023.*

Flood in Pakistan in August 2022

UN and Pakistan appeal for $160m to help flooding victims

Call for emergency funding as nearly half a million people displaced and estimated $10bn damage to economy

Women wade through a flooded area in the Shikarpur district of Sindh province on Tuesday. Photograph: Fareed Khan/AP

The Guardian, Tue 30 Aug 2022

- more than 3 – 8 times of usual rainfall in August,
- over 33 million people affected
- 1.7 million homes destroyed
- ~ 1500 people killed
- Damage > 30 billion US$

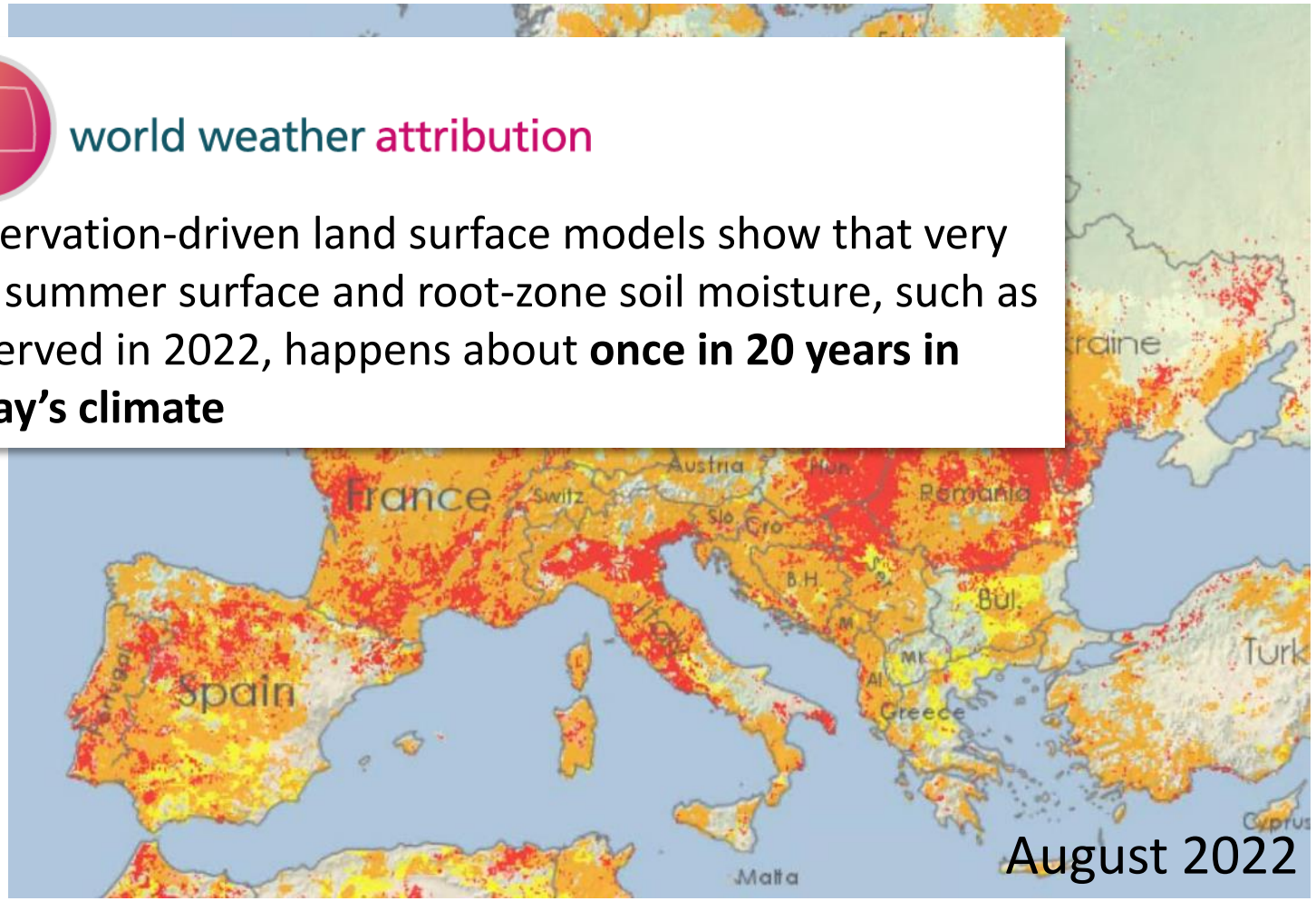
world weather attribution

- climate change could have increased the rainfall intensity up to 50%
- Additional reason for high number of victims and damage:
  high exposure and high vulnerability

Summer drought and heatwave in Europe in 2022

world weather attribution

Observation-driven land surface models show that very low summer surface and root-zone soil moisture, such as observed in 2022, happens about **once in 20 years in today's climate**



Copernicus
Europe's eyes on Earth

The drought episode that affected Europe in 2022 could well be the worst in **500 years**.

- Watch
- Warning
- Alert
- Full recovery
- Temporary soil moisture recovery
- Temporary fAPAR recovery

Summer drought and heatwave in Europe in 2022

Wildfires in the EU: 2022 was the second-worst year, a warning from a changing climate

In 2022, land roughly the size of Corsica was scorched by wildfires in the EU, according to the latest JRC report on fires in the pan-European region.

European Commission

EU Science Hub

COPERNICUS
Emergency Management Service

Rapid Damage Assessment

Select a date-range

Last 1 Day | Last 7 Days | Last 30 Days | Fire Season

From: 01 Jan 2022 To: 05 Sep 2022

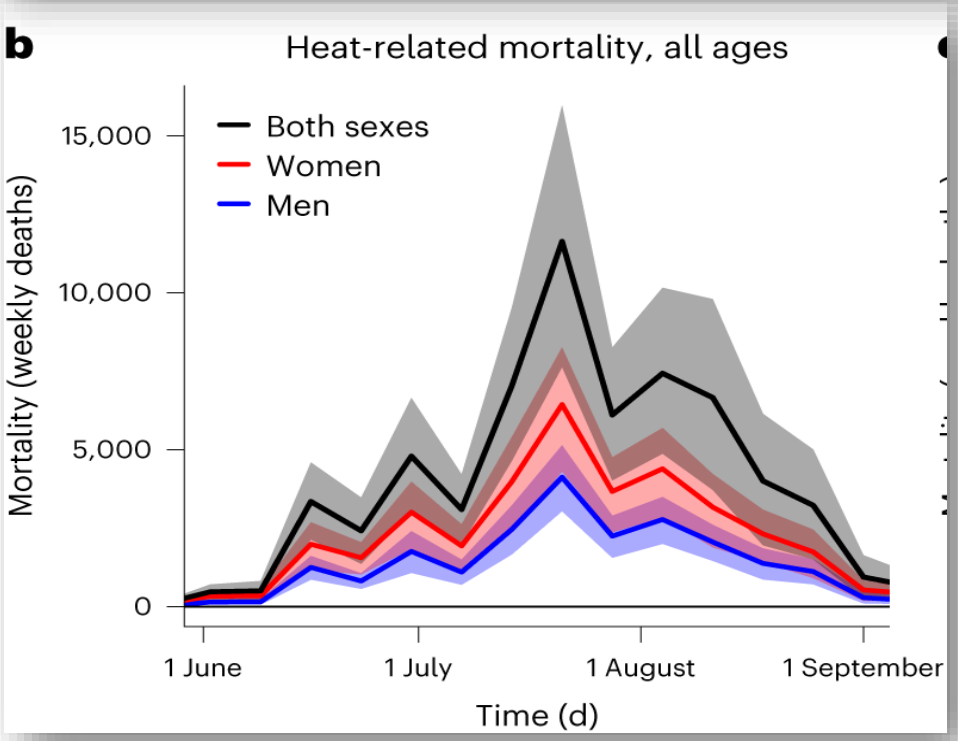
ACTIVE FIRES
MODIS VIIRS

BURNT AREAS
MODIS/SENTINEL2 (supervised) VIIRS

Burnt Area Locator

FUELS

Summer drought and heatwave in Europe in 2022



- More than 60’000 people died due to heatwave in Summer 2022 in Europe
- Italy: more than 18’000
- Mainly elderly people and other vulnerable groups (people with chronical diseases)

Local impacts: forest damage in South Tyrol

Vaia Storm October 2018 + Heavy snow load Nov 2019+20 + Drought 2022 → bark beetle attack 2022

> 10’000 ha forest affected

All pictures: Abteilung Forstwirtschaft Provinz BZ

Local impacts: forest damage in South Tyrol

→ Loss of protection function against natural hazards (rockfall, landslides, avalanches)

Economic losses from climate extremes

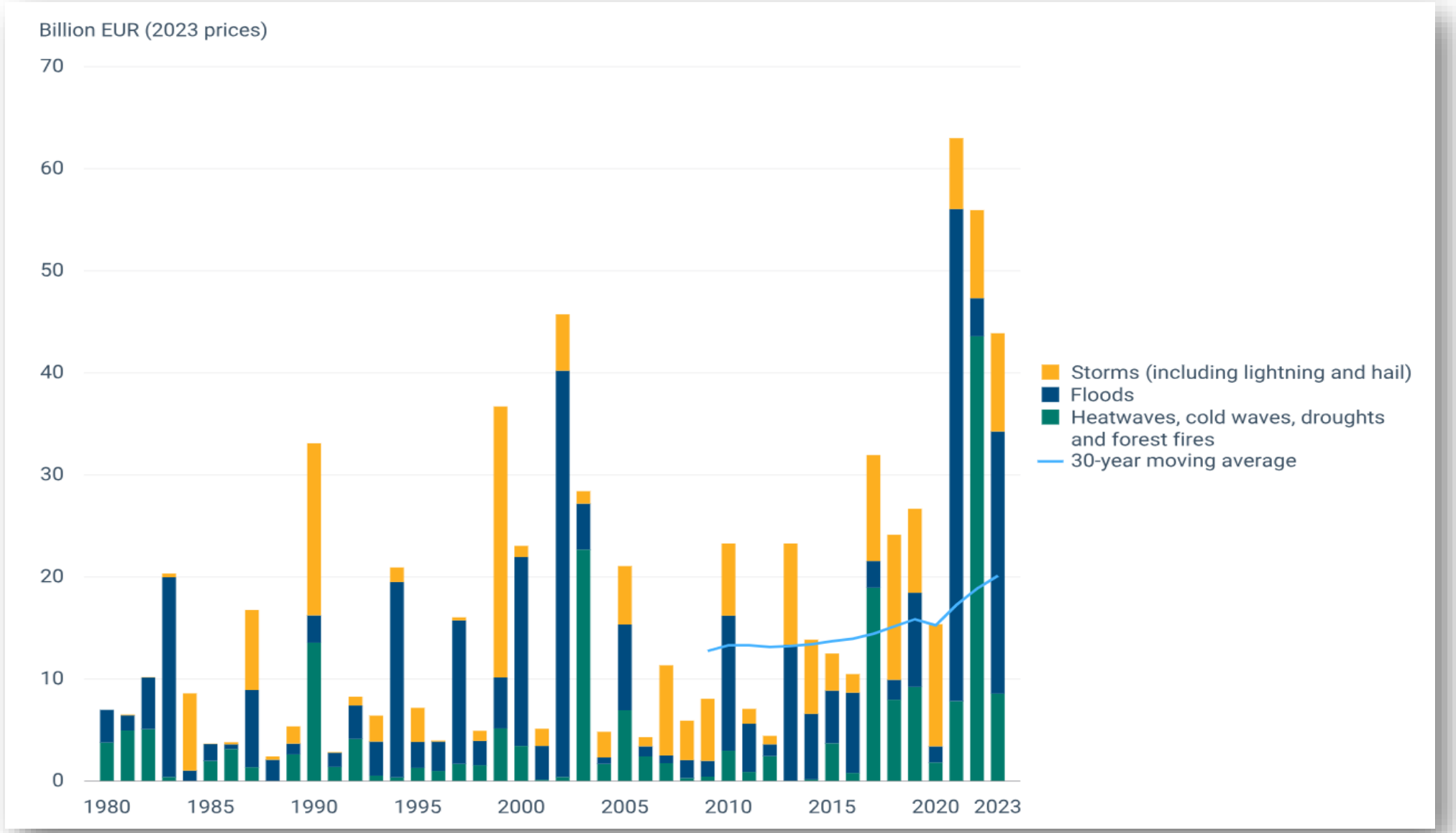
European Environment Agency

Economic losses from weather- and climate-related extremes in Europe

Published 14 Oct 2024

Weather- and climate-related extremes caused economic losses of assets estimated at EUR 738 billion during 1980 - 2023 in the European Union, with over EUR 162 billion (22%) between 2021 and 2023. Analysing trends in economic losses is challenging, primarily due to large annual variability. Statistical analyses revealed, that economic losses increase over time and the last three years are all in the top five of years of highest annual economic losses. As severe weather- and climate-related extreme events are expected to intensify further, it seems unlikely that associated economic losses will reduce by 2030.

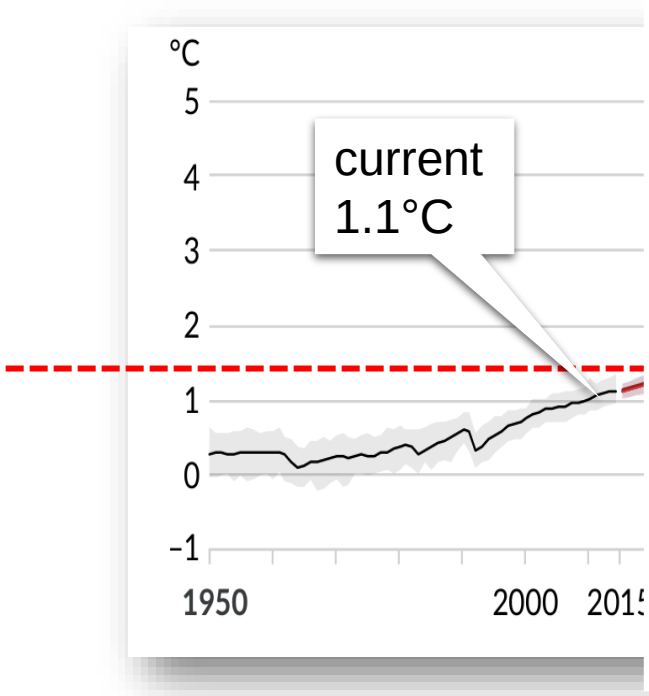
Economic losses from climate extremes



Where are we heading to?

global warming for different emission scenarios

warming relative to 1850 – 1990 average



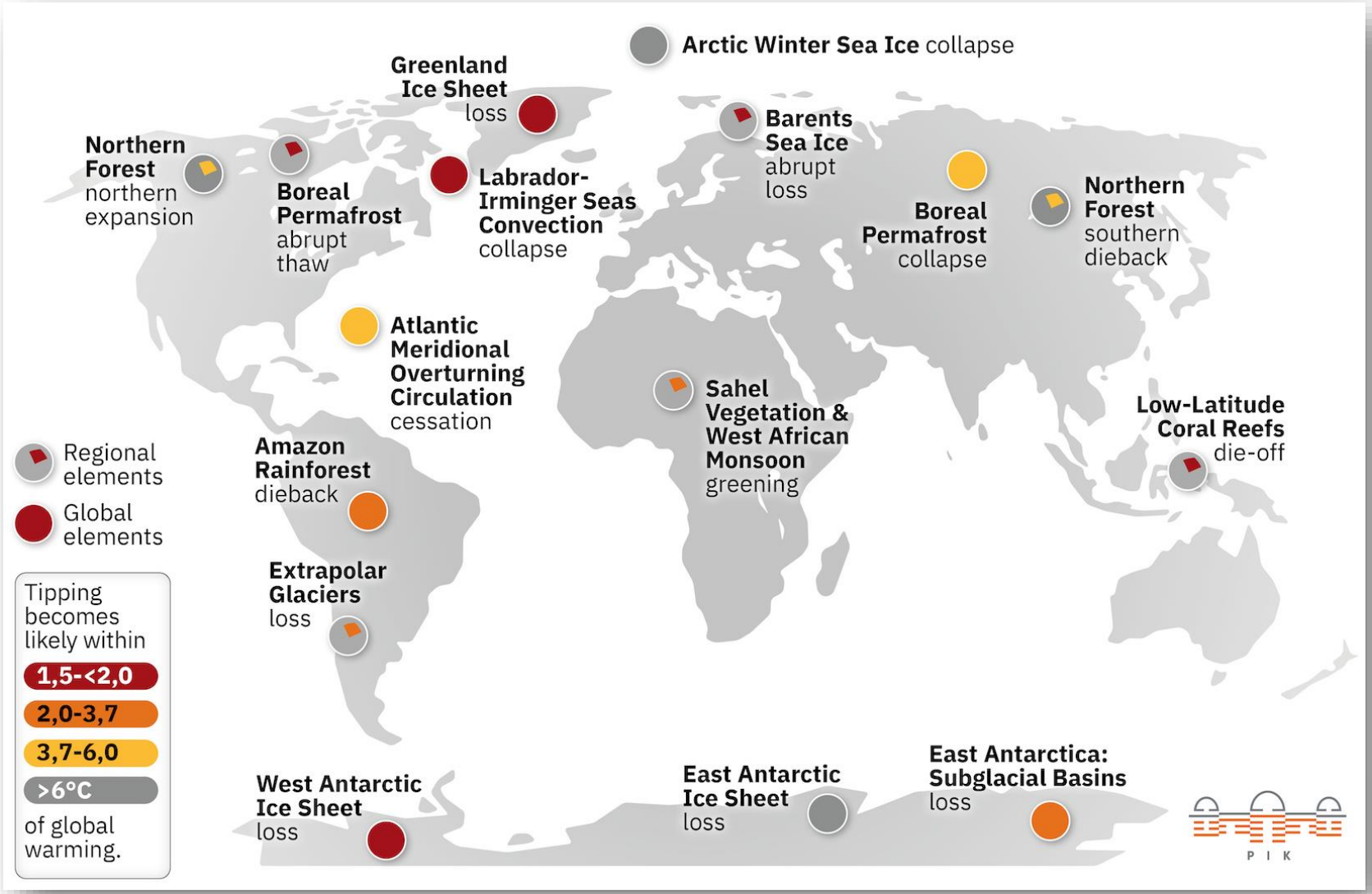
high emissions → ~ + 4.4°C

Most likely warming under current reduction targets → ca. + 2.5-3°C

very low emissions → ~ + 1.4°C

IPCC 2021

Tipping points – the writing on the wall?



Tipping Points

Things are getting dangerous at > 1.5°-2 C global warming

Example:
Above +1.5°C irreversible melting of Greenland ice sheet
→ up to 7m sea level rise
(> 1000 years)

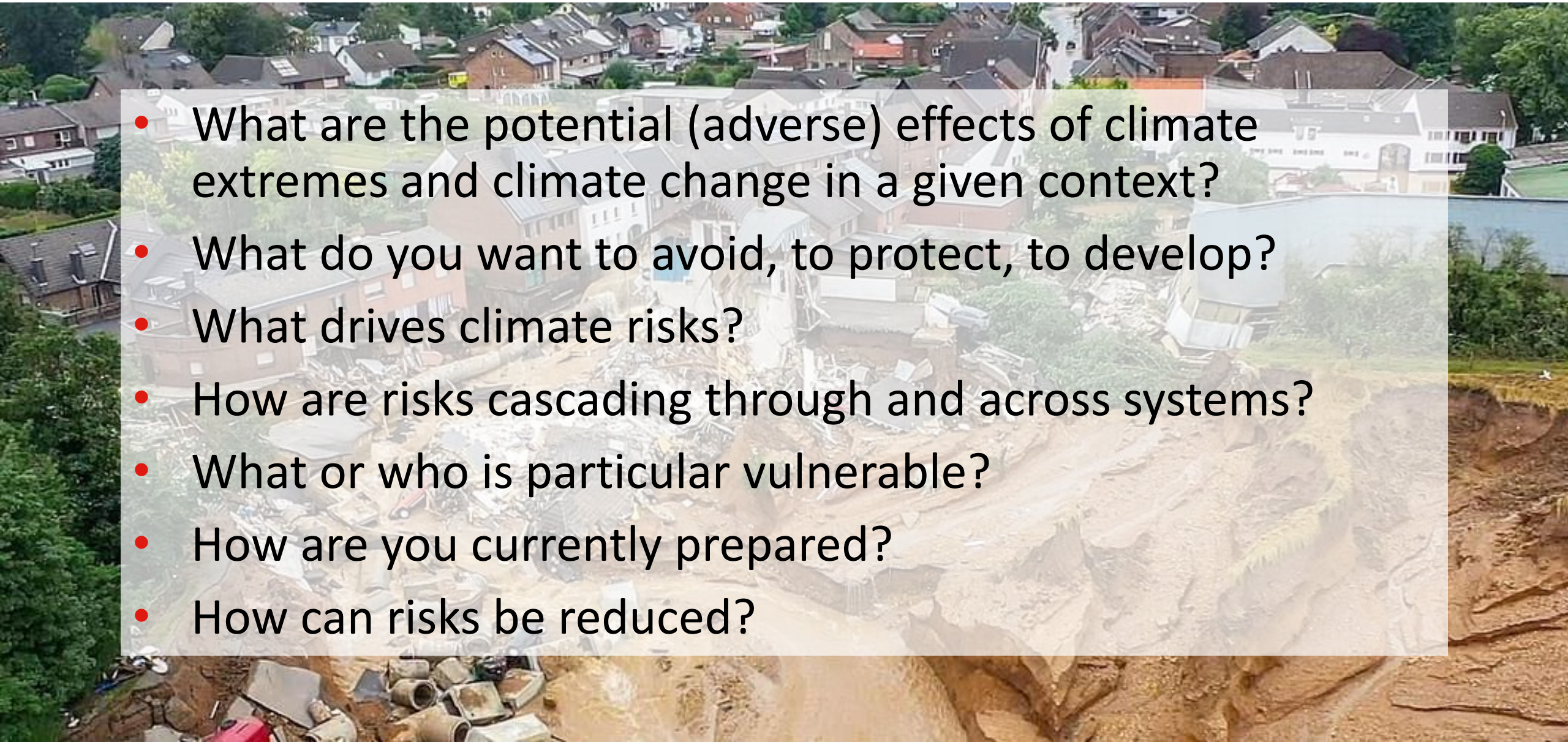
Climate tipping points – too risky to bet against

The growing threat of abrupt and irreversible climate changes must compel political and economic action on emissions.

Understanding Climate Risks

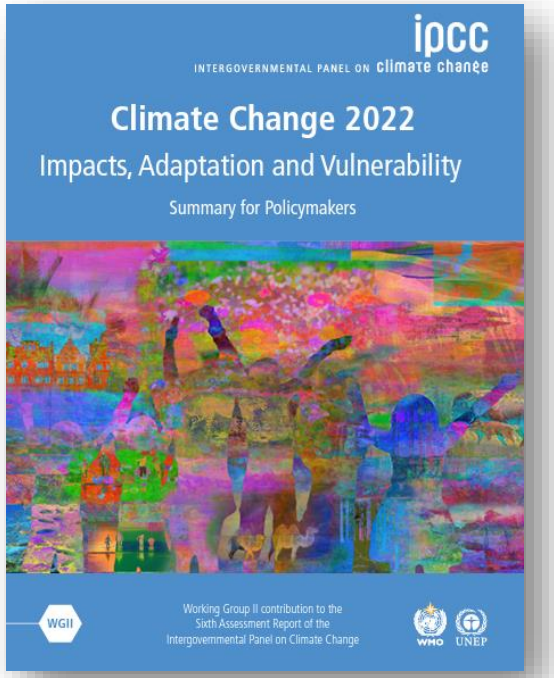
and discussing solutions for climate change adaptation

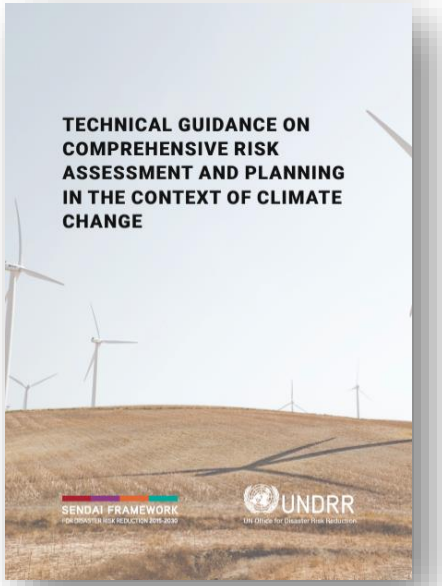
Key questions of a Climate Risk Assessment (CRA)

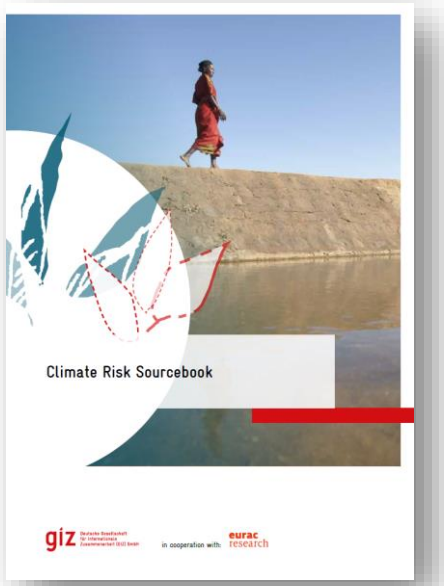


- What are the potential (adverse) effects of climate extremes and climate change in a given context?
- What do you want to avoid, to protect, to develop?
- What drives climate risks?
- How are risks cascading through and across systems?
- What or who is particular vulnerable?
- How are you currently prepared?
- How can risks be reduced?

From IPCC climate risk concept to CRA with impact chains

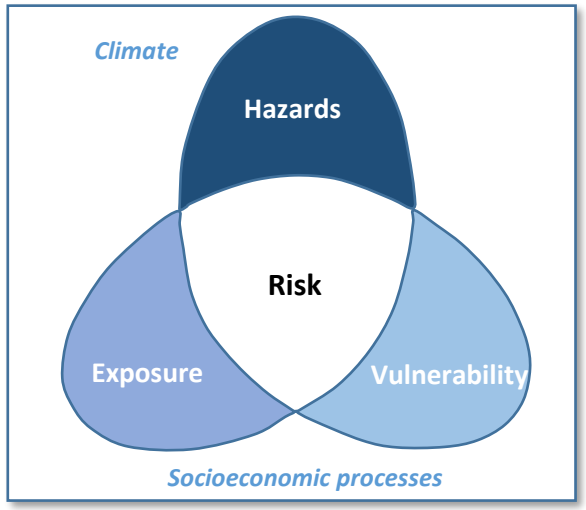


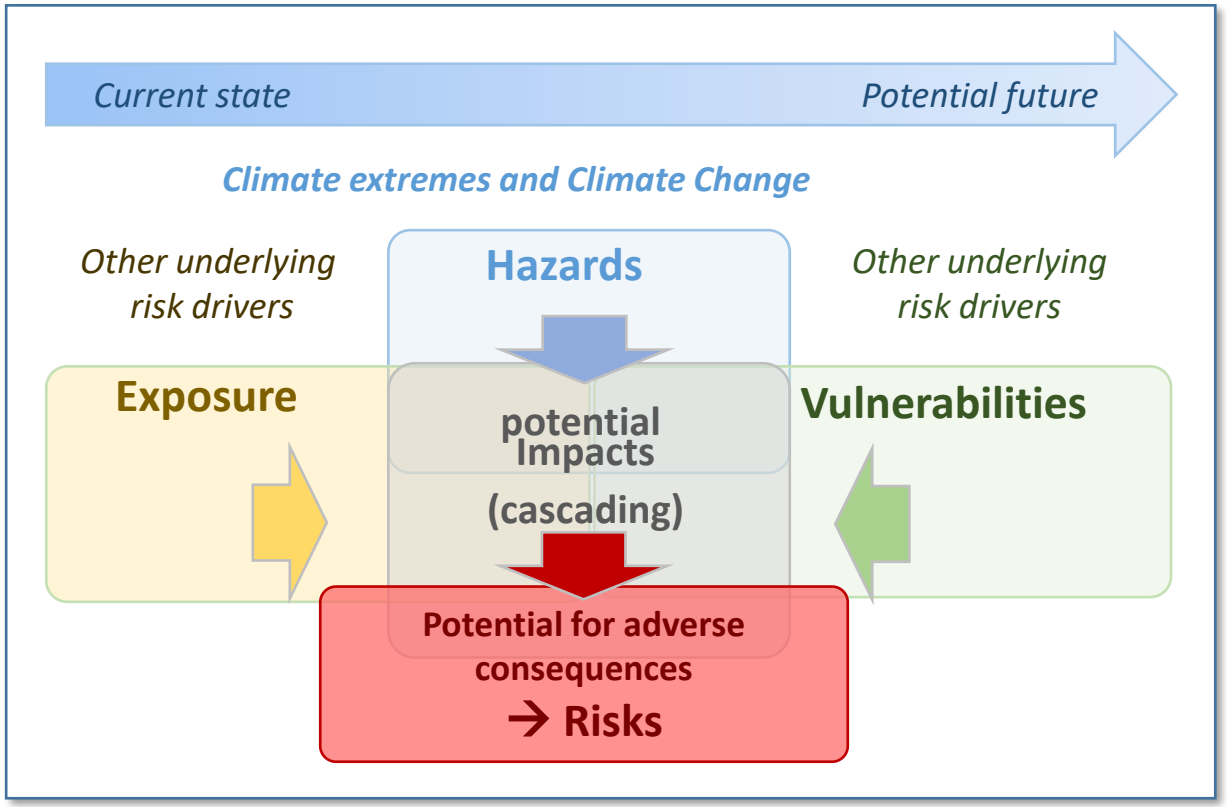




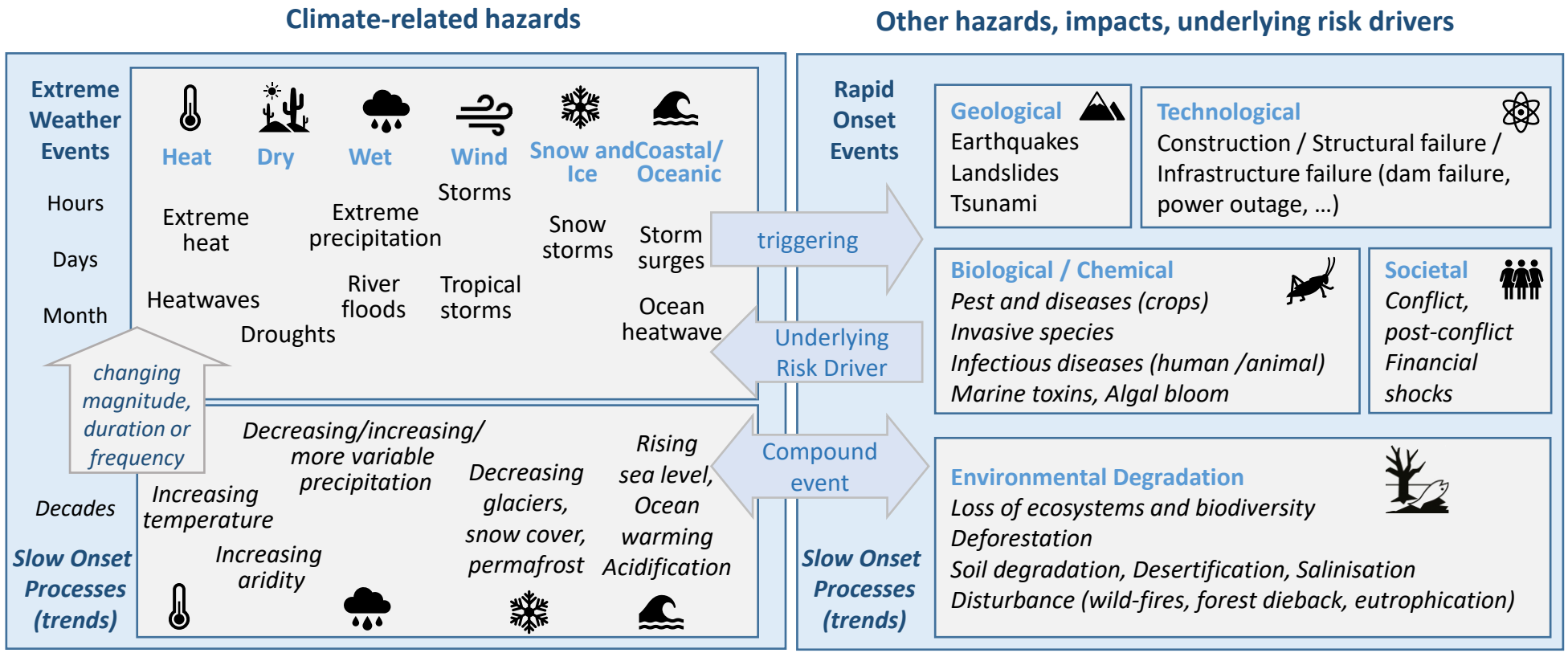
What drives Climate Risk?

In the context of climate change impacts, risks result from dynamic interactions between **climate-related hazards** with the **exposure** and **vulnerability** of the affected human or ecological system to the hazards.



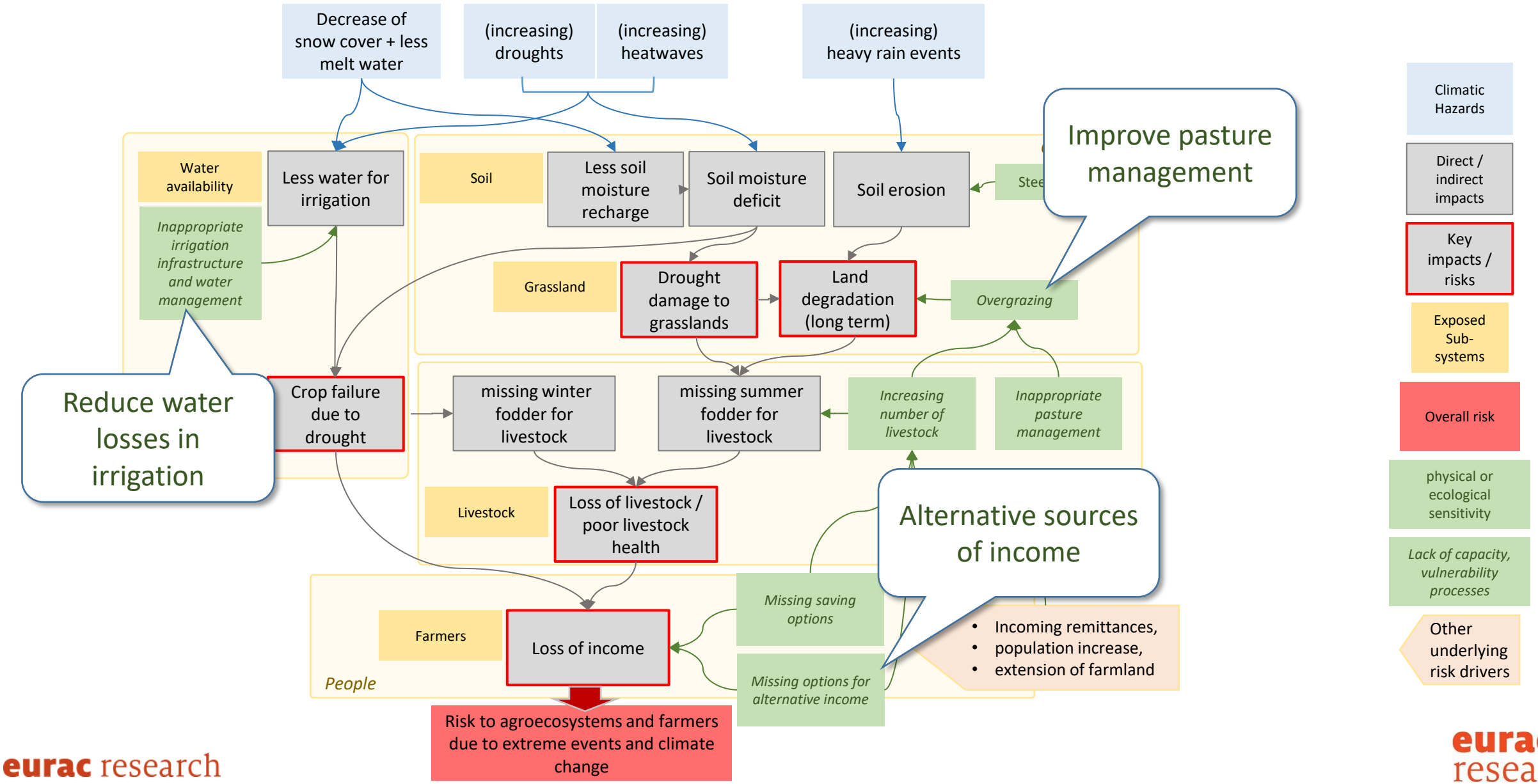


Hazard

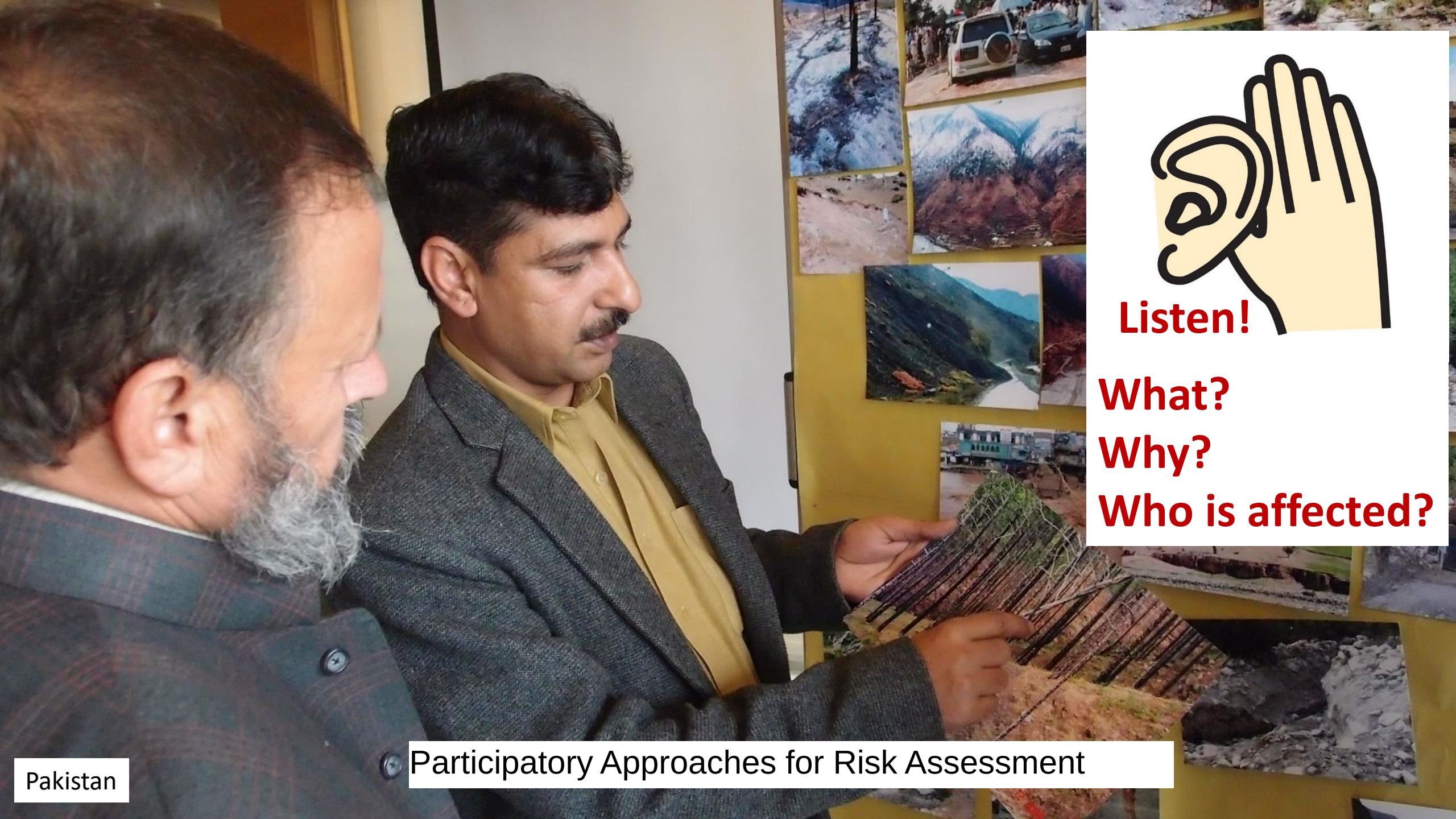


Climate Change as underlying risk driver

Impact chains as a central tool



eurac research



Pakistan

Participatory Approaches for Risk Assessment

Azerbaijan

Participatory Approaches for Risk Assessment

Prioritize Impacts and Risks

Azerbaijan

Participatory Approaches for Risk Assessment

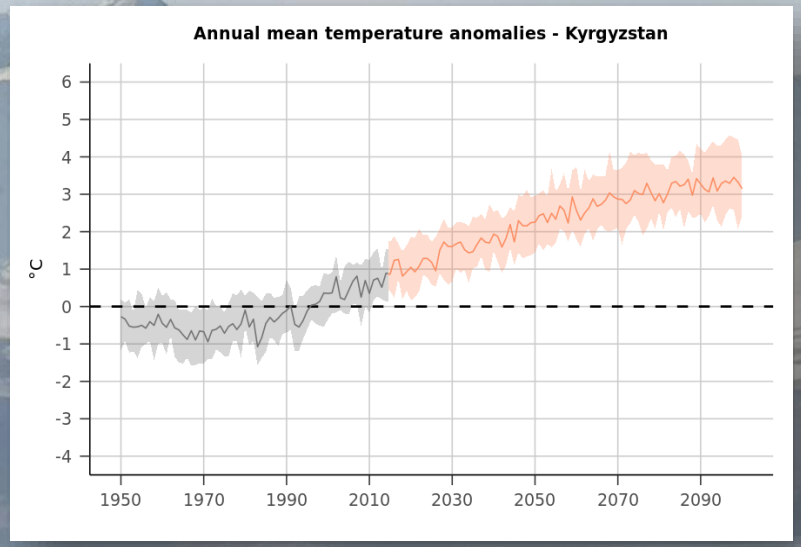
Azerbaijan

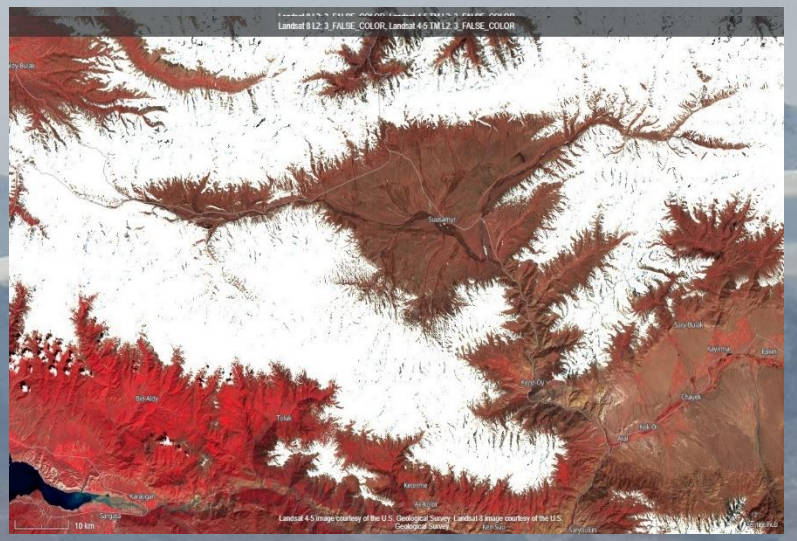
Participatory Approaches for Risk Assessment


暴露を特定し、インパクトチェーンを完成させます
高温
雨が少ない
雨が多い
強い風
(台風など)
Strong wind
(typhon etc.)
海面上昇
Sea level up
暖冬
Warm winter
Japan

Climate Risk Assessment in Central Asia

Climate Risk Assessment in Central Asia



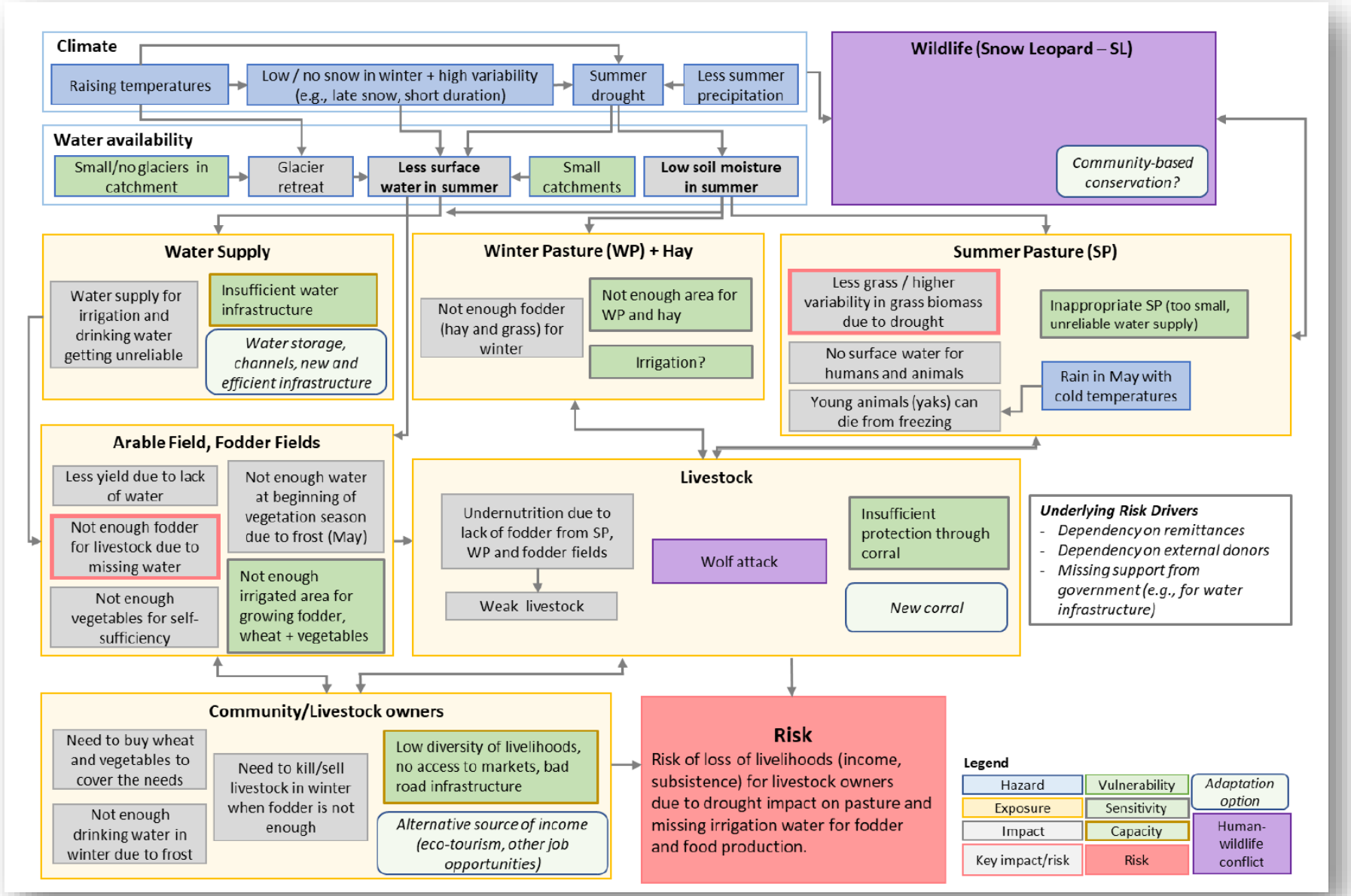


impact chains as the backbone of risk analysis

Why? → understanding risk

Impact Chains
For each key risk
or risk cluster + interpretation

- Exposed elements, subsystems, functions
- Hazards,
- Impact Chains
- Vulnerabilities + Adaptation gaps
- Underlying Risk Drivers
- Adaptation Options



Risk Evaluation

Severity

Assessment of Hazard, Exposure, Vulnerability, Risk Magnitude
+ Frequency
+ Time frame of Risk vs Adaptation
+ Potential for adaptation
- For current + future Situation(s)
- For each sub-unit
- For each key risk

Expert based integration

+ confidence
+ critical settings / hotspots

Table 9 Comprehensive Risk Assessment for Suusamyr Village District

Risk of loss of livelihoods (income, subsistence) for livestock owners in Suusamyr Village District						
	Current situation			**Future (2030-2050)**		
	Pasture degradation (drought/low soil moisture)	Lack of fodder (drought/lack of surface water)	Increased incidents of livestock diseases (heat)	Pasture degradation (drought/soil moisture)	Lack of fodder (drought/lack of surface water)	Increased incidents of livestock diseases (heat)
Hazard	High	High	Moderate	Very high	Very high	High
Exposure	High	High	High	Very high	Very high	Very high
Vulnerability - Exposed systems - Community	Moderate	Moderate	Moderate	High	High	High
	High			High		
Risk	High	High	High	Very high	Very high	High
Risk assessed by the communities	Low/ Moderate/ Very high	Low / Very high	Moderate	Moderate/ High/ Very high	Very high	Very high
Confidence of assessment	Moderate – Low			Moderate		
Critical settings	Small livestock owners with rain-fed or poorly irrigated fields, inefficient irrigation systems, livestock breeding on already degraded pastures without rotation. The future risk depends very much on the further increase in the number of livestock.					

EUROPEAN CLIMATE RISK ASSESSMENT

A comprehensive assessment of current and future climate risks in Europe

© António Tedim, Well with Nature EEA

European Commission

European Environment Agency

European Environment Agency
European Topic Centre
Climate change adaptation
and LULUCF

Climate Change Service
climate.copernicus.eu

EUCRA main findings and key messages

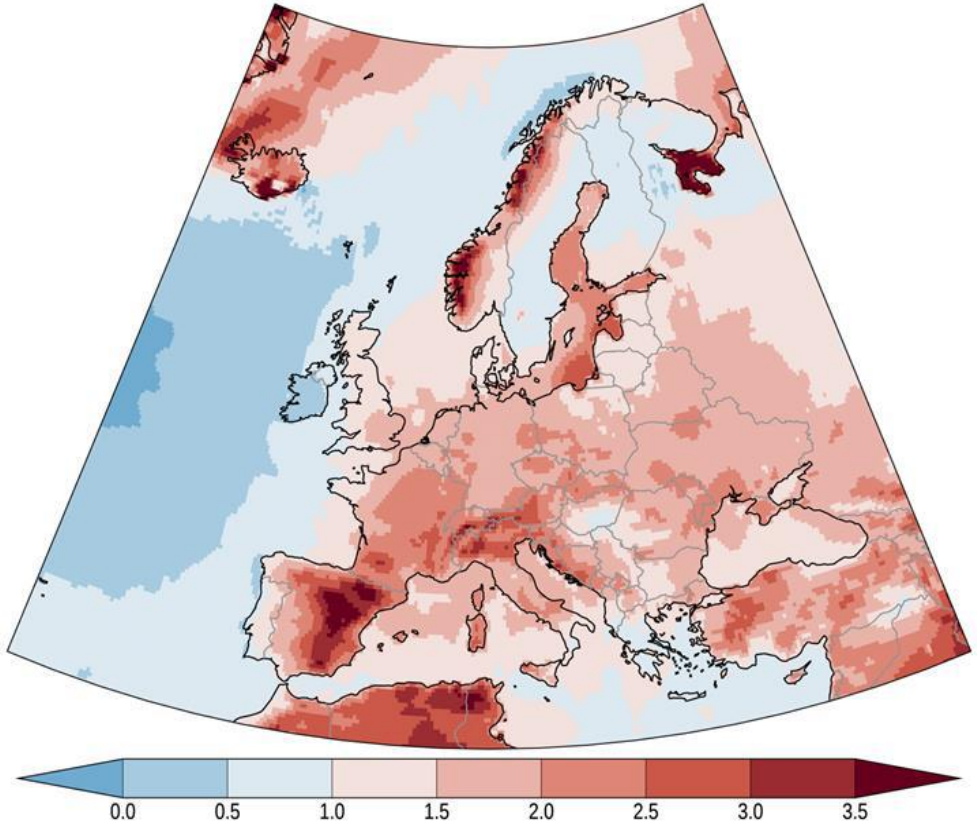
Europe is not sufficiently prepared for rapidly growing climate risks

- Climate risks are growing rapidly as we approach 1.5 degrees global warming.
- Europe is the fastest warming continent.
- Climate risks are threatening ecosystems, water resources, food and energy security, infrastructure, financial stability, and people's health.

European Environment Agency

Global warming is accelerating – Europe is warming much faster than the global average

- 2023 was the warmest year on record by a huge margin; it is almost certain to have been the warmest year in the last 100,000 years.
- Each month since June 2023 was warmer than the corresponding month in any previous year.
- In each month since April 2023, the world's oceans were warmer than ever before recorded

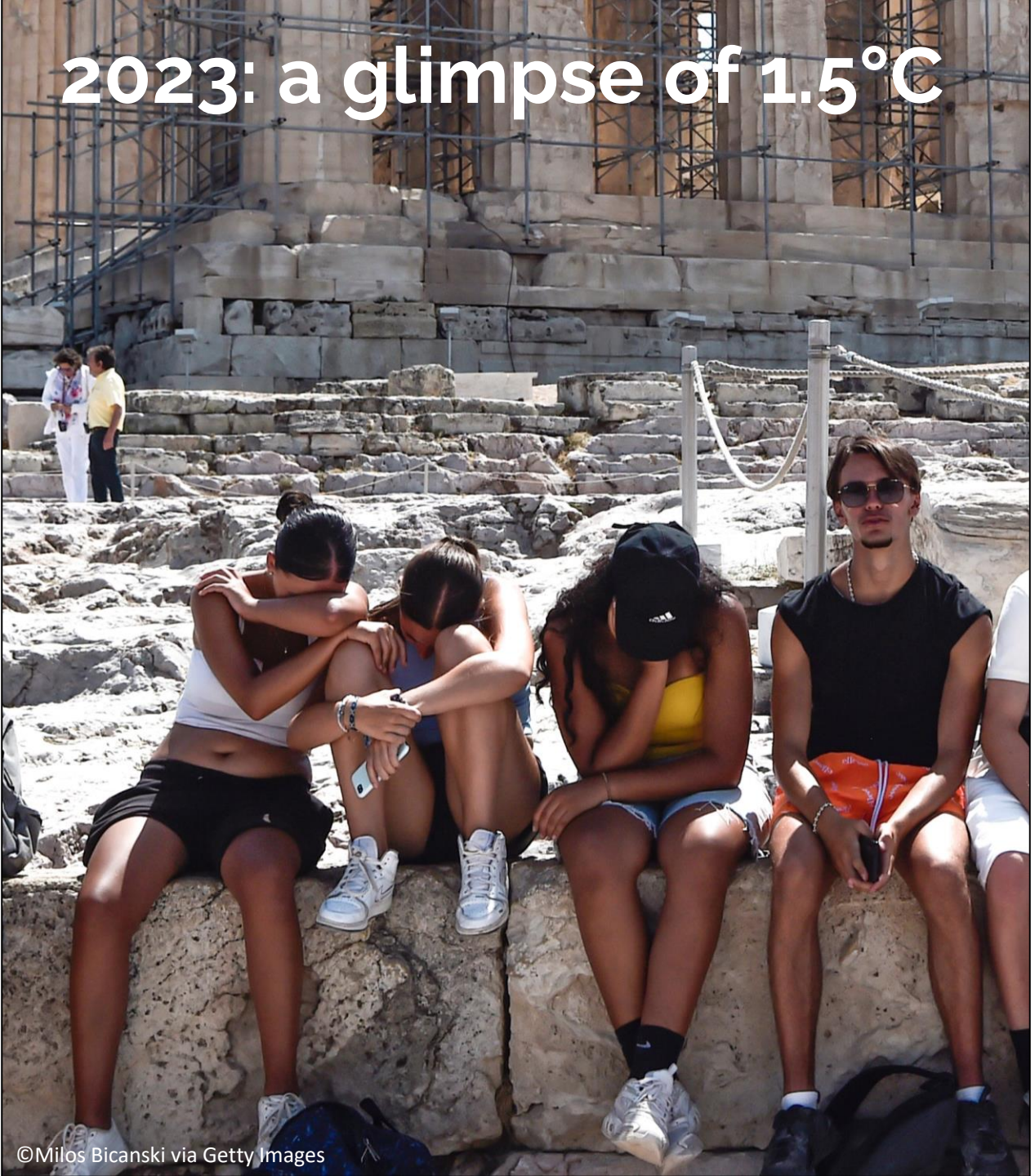


Rate of change in temperature over 1950-2022 compared to global warming (multiplication)

Source:
Copernicus Climate Change Service

European Environment Agency

2023: a glimpse of 1.5°C

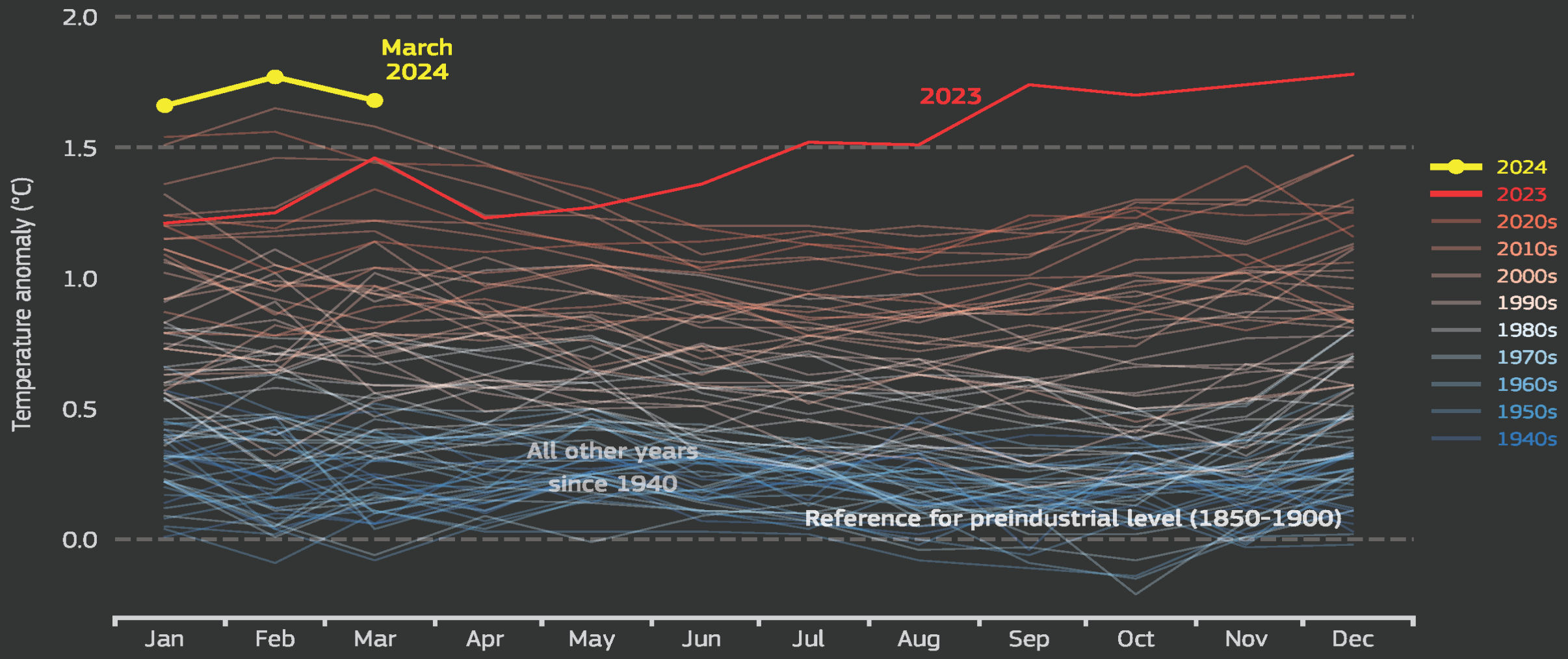


©Milos Bicanski via Getty Images

©Antonio Masiello via Getty Images

Monthly global surface air temperature anomalies

Data: ERA5 1940–2024 • Reference period: 1850-1900 • Credit: C3S/ECMWF



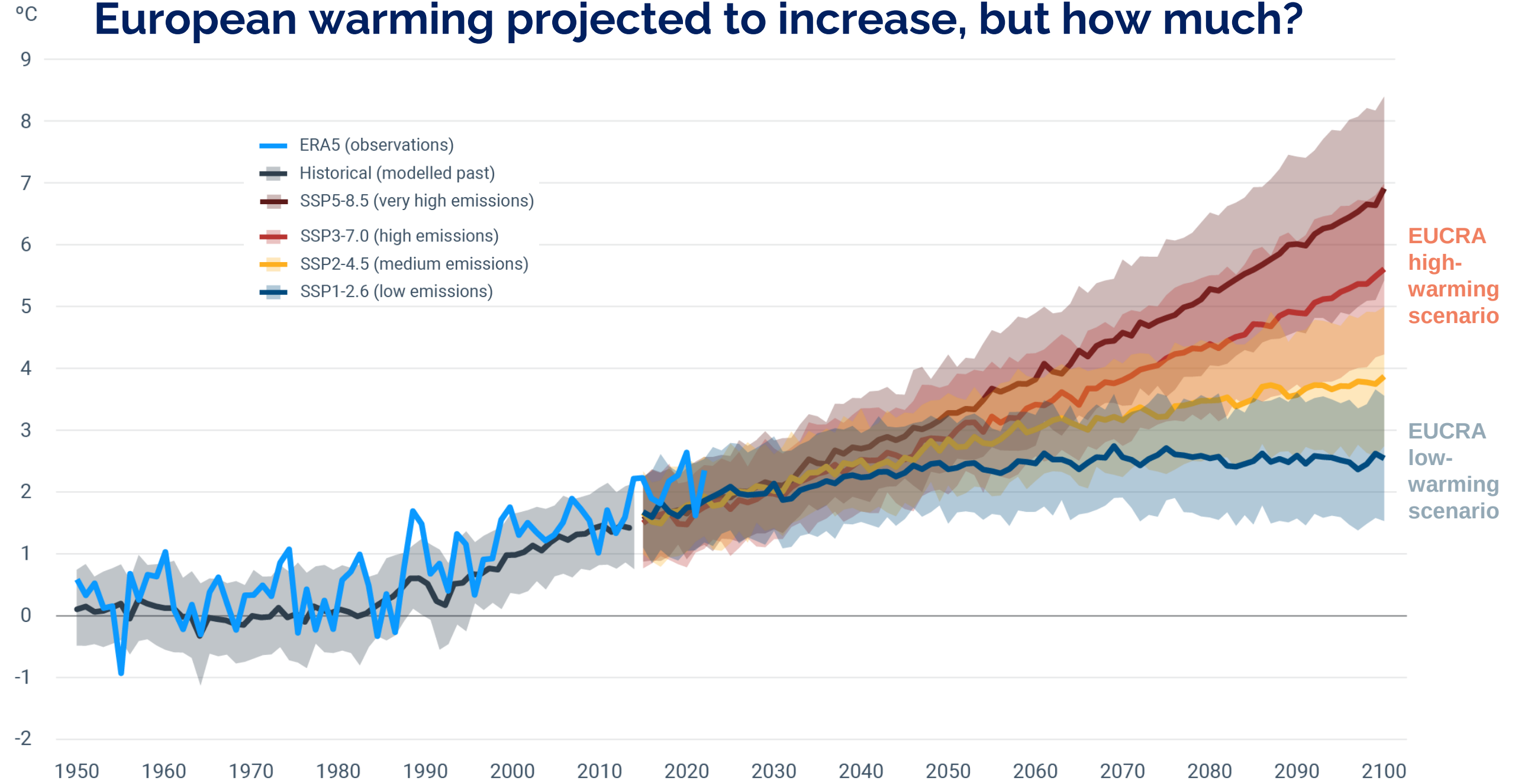
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Climate Change Service
climate.copernicus.eu

European warming projected to increase, but how much?

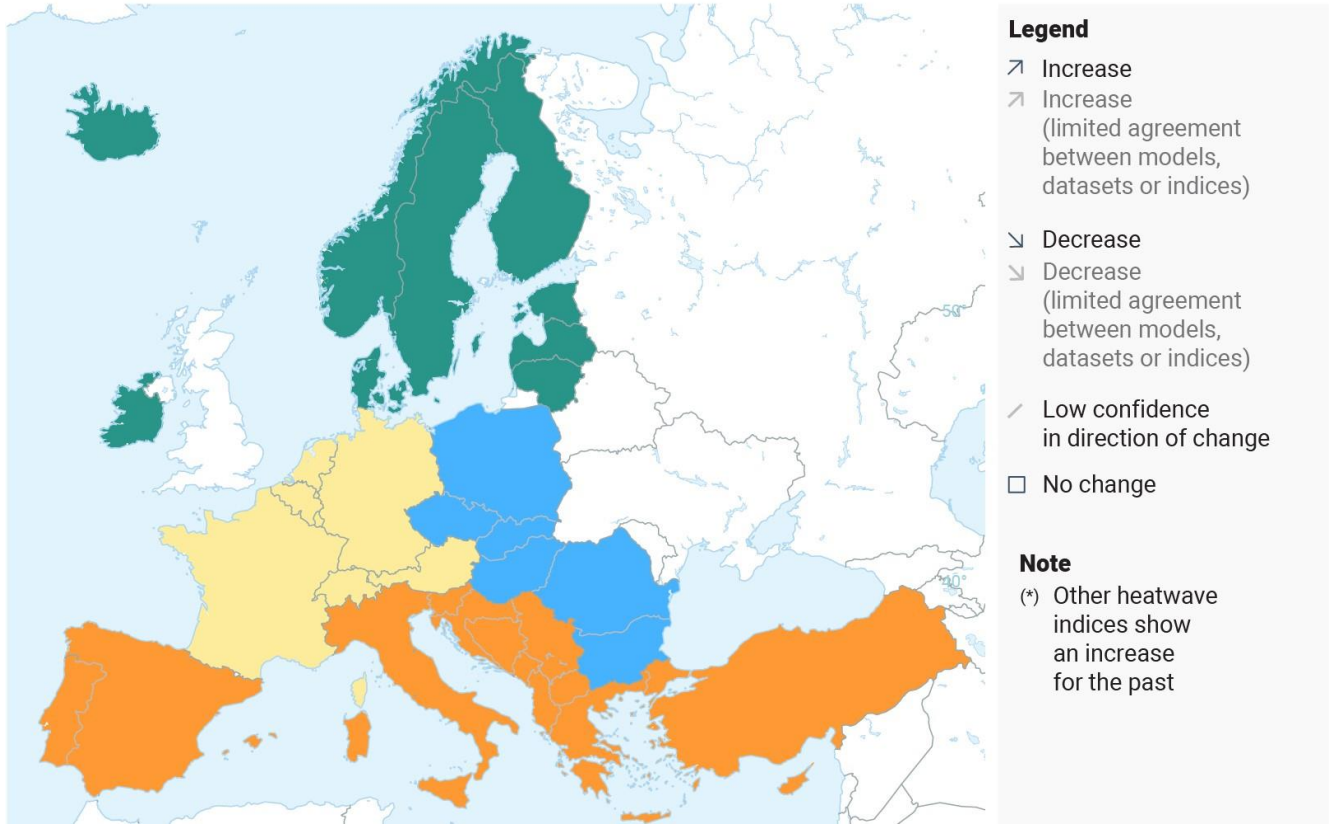


Source: Copernicus climate change service based on CMIP6

Climatic risk drivers are accelerating in all regions

Land regions	Northern Europe			Western Europe			Central-Eastern Europe			Southern Europe		
	Past	Future		Past	Future		Past	Future		Past	Future	
		Low	High		Low	High		Low	High		Low	High
Mean temperature	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Heat wave days	□(*)	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Total precipitation	↗	↗	↗	↗	⟋	↘	↗	↗	⟋	↘	↘	↘
Heavy precipitation	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗
Drought	↗	↘	↘	↗	⟋	↗	↗	⟋	↗	↗	↗	↗

European regional seas	Past	Future
Sea surface temperature	↗	↗
Sea level	↗	↗

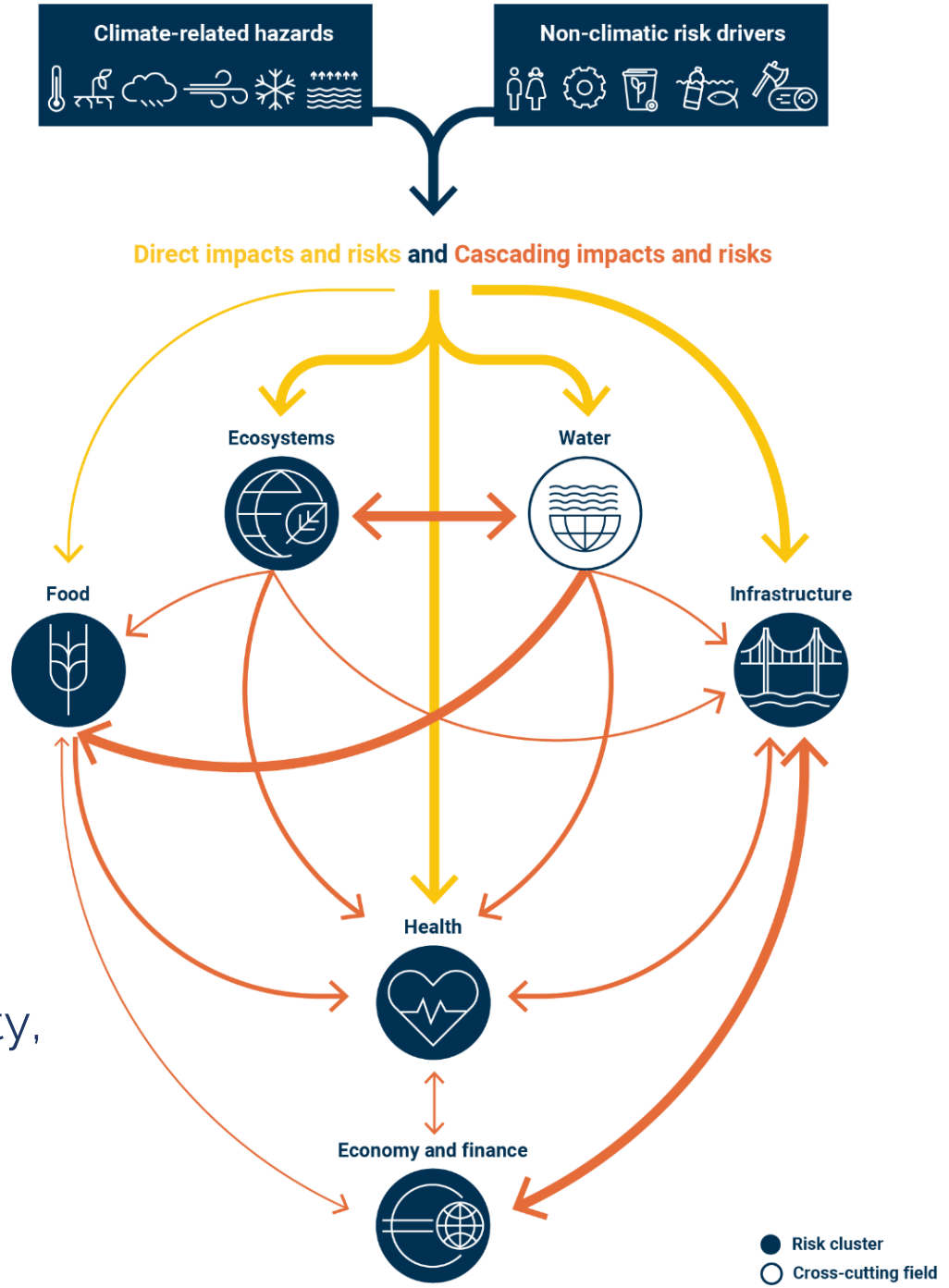


- **Heatwaves** are getting worse.
- **Rain patterns** are changing, with both downpours and dry spells increasing in magnitude.
- **Sea level rise** is accelerating and threatening coastal regions.
- **Hotspot regions** for multiple climate risks:
  - Southern Europe
  - Low-lying coastal regions
  - EU outermost regions

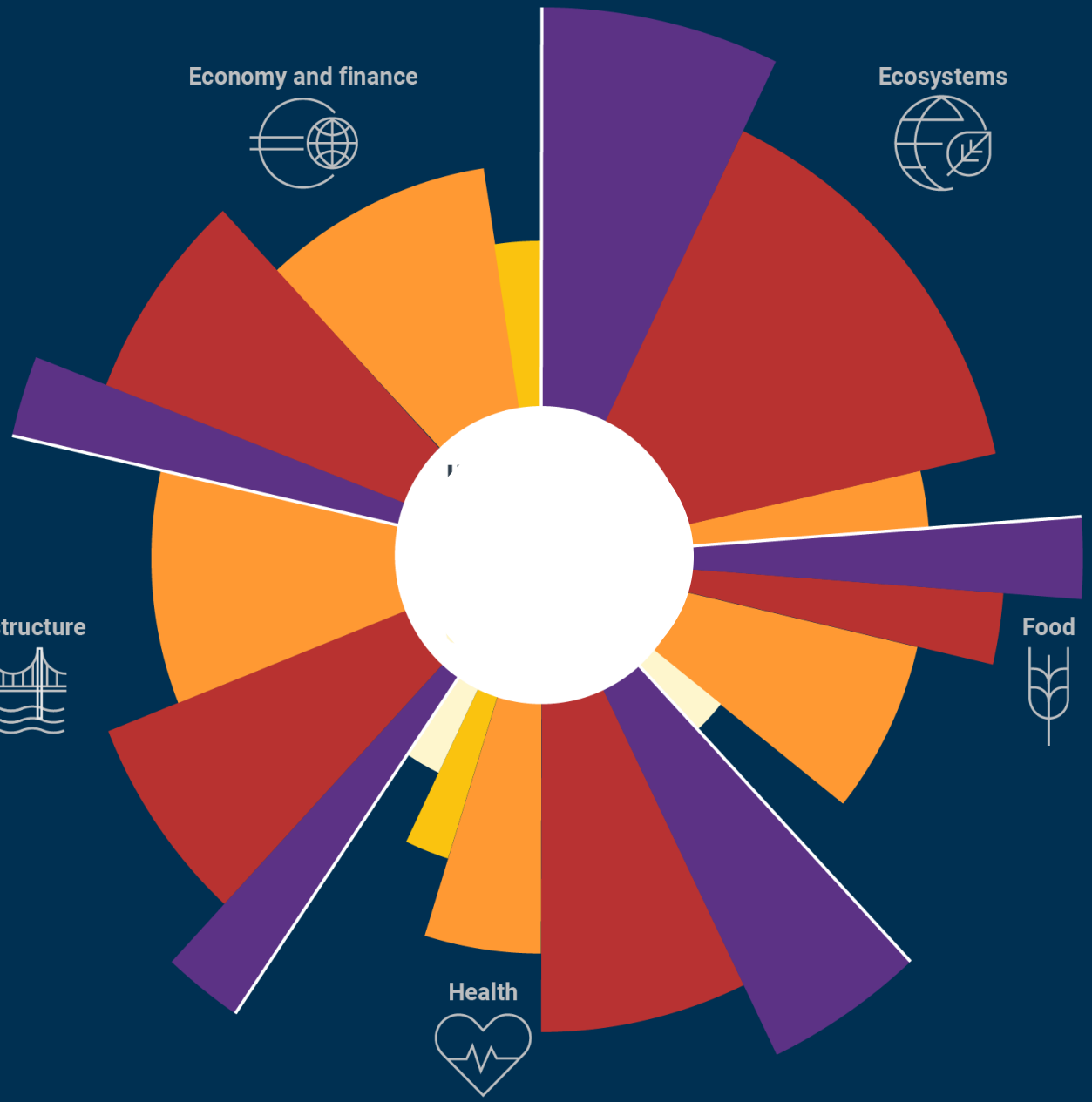
European Environment Agency

Climate risks can cascade from one system to another

- Climate risks are determined by **climate-related hazards** (heatwaves, floods, etc.), **non-climatic risk drivers** (land use, etc.) as well as **how prepared we are**.
- Climate change is a **risk multiplier** that can exacerbate existing risks and crises.
- **Cascading climate risks** can lead to system-wide challenges affecting whole societies, with vulnerable social groups most affected.
- For example, a **mega-drought** can lead to water scarcity, widespread crop losses, forest fires, poor air quality, disruptions of energy and transportation infrastructure, and threats to financial markets and stability.



Priorities for EU policy on climate adaptation



Urgent action is needed in all five risk clusters

Urgency to act:

- Urgent action needed
- More action needed
- Further investigation
- Sustain current action
- Watching brief

European Environment Agency

Major challenges in all five assessed clusters

Ecosystems

- Coastal ecosystems
- Marine ecosystems
- Biodiversity/carbon sinks due to wildfires (1)
- Biodiversity/carbon sinks due to wildfires
- Species distribution shifts
- Ecosystems/society due to Invasive species
- Soil health
- Aquatic and wetland ecosystems
- Biodiversity/carbon sinks due to droughts and insect outbreaks
- Cascading impacts from forest disturbances

Food

- Crop production (1)
- Crop production
- Fisheries and aquaculture
- Food security due to higher food prices
- Food security due to climate impacts outside Europe
- Livestock production

Health

- Heat stress - general population
- Population/built enviromnent due to wildfires (1)
- Population/built enviromnent due to wildfires
- Well-being due to non-adapted buildings
- Heat stress - outdoor workers (1)
- Pathogens in coastal waters
- Health systems and infrastructure
- Infectious diseases
- Heat stress - outdoor workers

Infrastructure

- Pluvial and fluvial flooding
- Coastal flooding
- Damage to infrastructure and buildings
- Energy disruption due to heat and drought (1)
- Energy disruption due to heat and drought
- Energy disruption due to flooding
- Marine transport
- Land-based transport

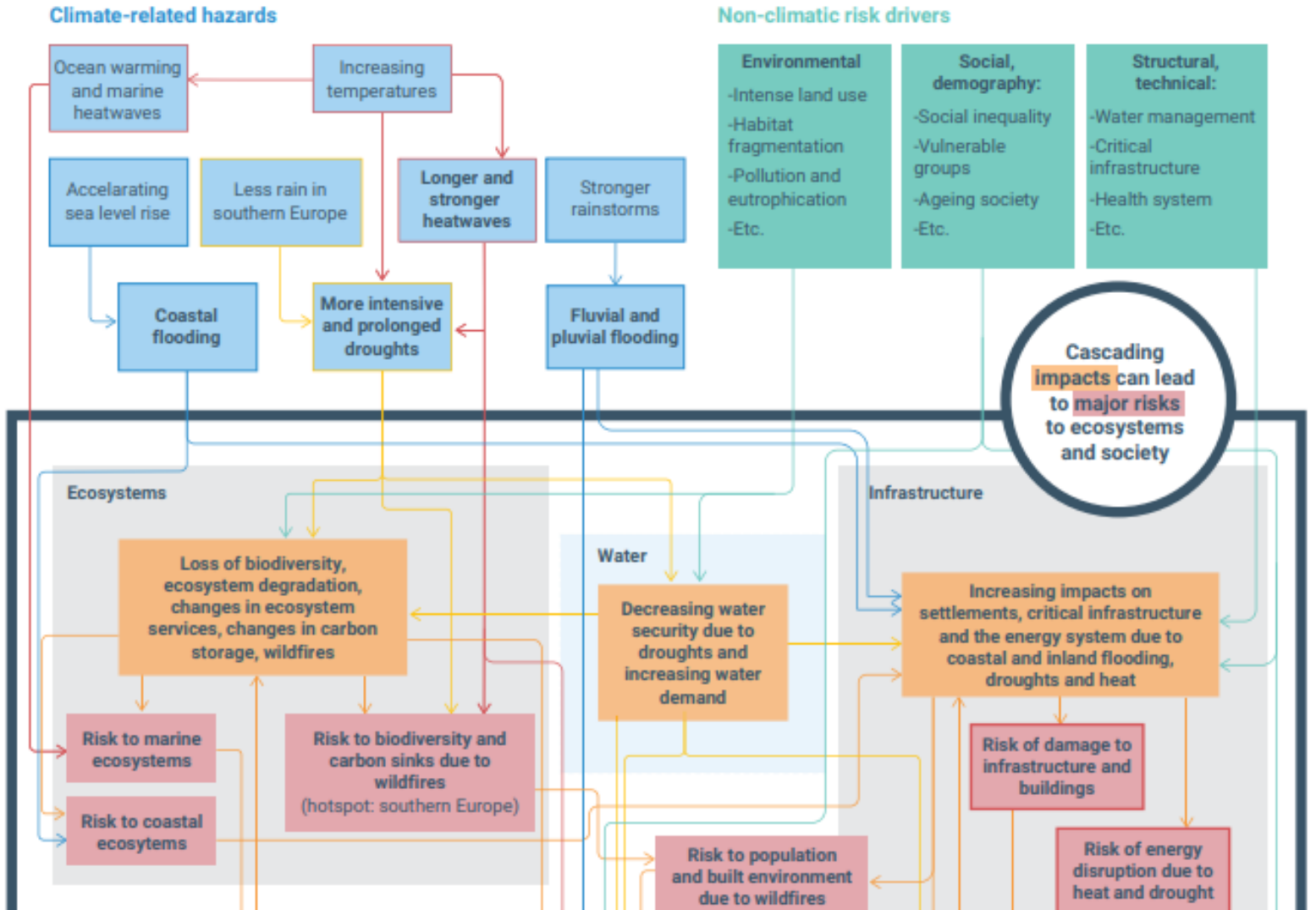
Economy and finance

- European solidarity mechanism
- Public finances
- Property and insurance markets
- Population/economy due to water scarcity (1)
- Population/economy due to water scarcity
- Pharmaceutical supply chains
- Supply chains for raw materials and components
- Financial markets
- Winter tourism

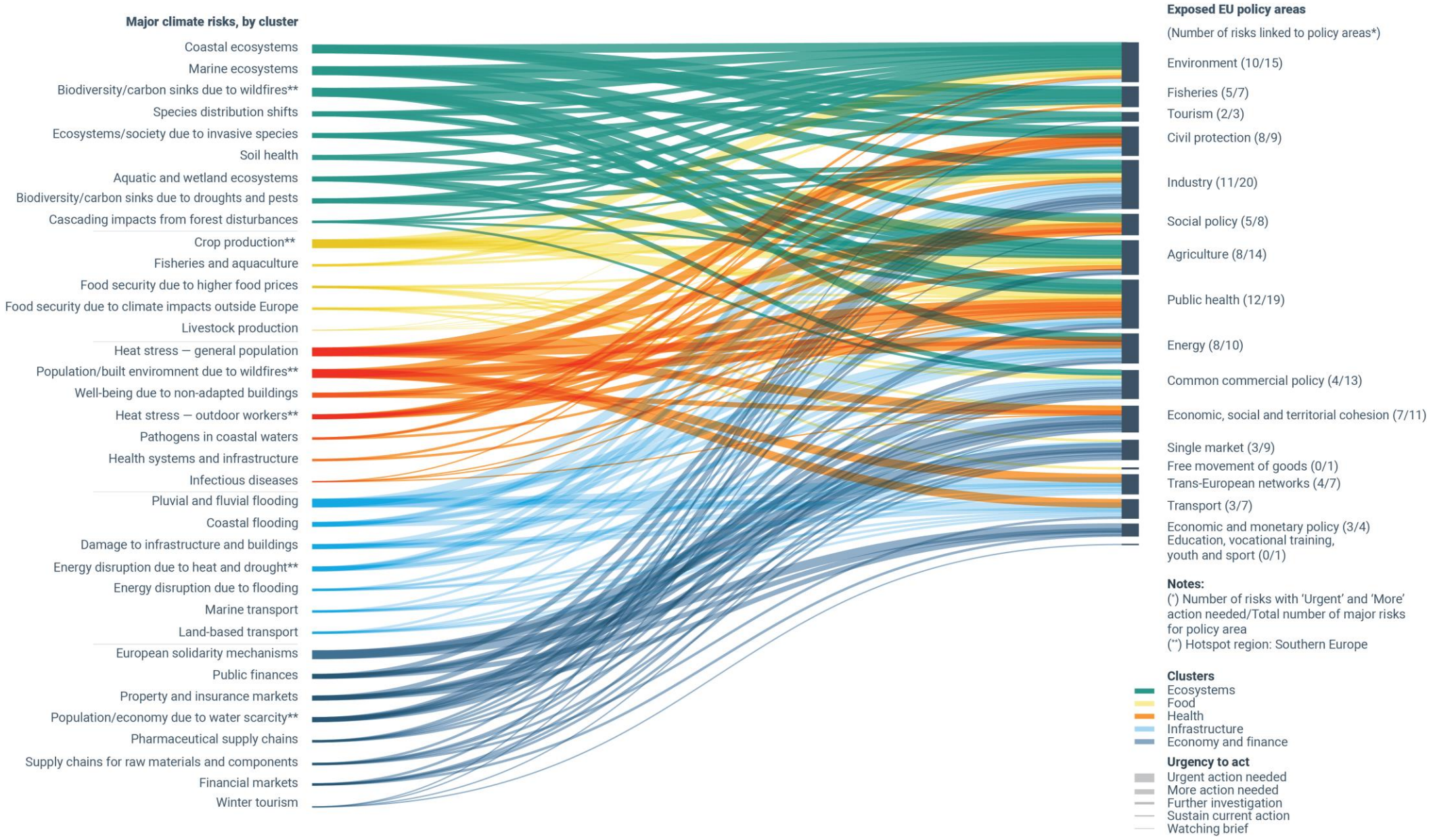
Note: (1) Hotspot region: Southern Europe

Systemic understanding of climate risk and drivers

Figure 18.2 **Impact chain including cascading impacts and risks across five risk clusters**



Nearly all EU policy areas are exposed to climate risks



eurac
research