



# **Climate risks: current knowledge, fundamental gaps and implications for finance**

***Climate change and sustainable finance conference, UZH***

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*Environment and Climate: Impact, Risks and Adaptation (Eclim)*

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**University of  
Zurich<sup>UZH</sup>**



# Climate year

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## 2019 Australia bushfires



The Conversation, ABC, stuff.co.nz, Munich Re 2015



# Increasingly existential narratives

«It's worse, much worse than you think»

The  
Uninhabitable  
Earth  
*Life After Warming*  
David  
Wallace-Wells



Jared Diamond: There's a 49 Percent Chance the World As We Know It Will End by 2050



New York Magazine

“We review the major environmental concepts pertinent to apocalyptic events, and conclude that positive feedback loops and multiplicative stresses represent the gravest existential risks, and the risks society is least likely to foresee.”

Karreiva and Carranza, 2018

# Climate urgency and emergency

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What exactly is climate emergency and its underlying (scientific) evidence?



© Jeremy Sutton-Hibbert / Greenpeace



## EMERGENCY: DO THE MATHS

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We define emergency ( $E$ ) as the product of risk and urgency. Risk ( $R$ ) is defined by insurers as probability ( $p$ ) multiplied by damage ( $D$ ). Urgency ( $U$ ) is defined in emergency situations as reaction time to an alert ( $\tau$ ) divided by the intervention time left to avoid a bad outcome ( $T$ ). Thus:

$$E = R \times U = p \times D \times \tau / T$$

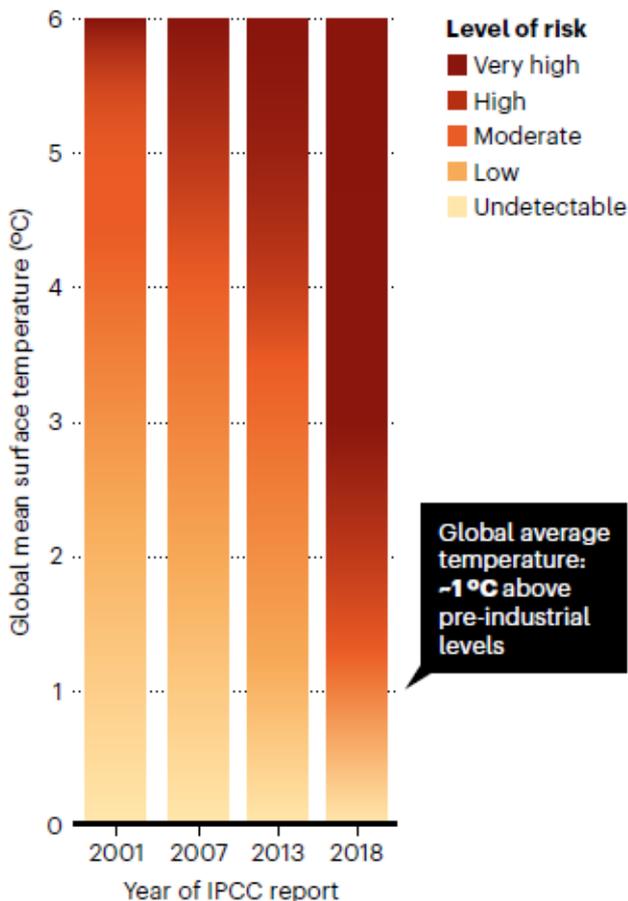
The situation is an emergency if both risk and urgency are high. If reaction time is longer than the intervention time left ( $\tau / T > 1$ ), we have lost control.

# Changing climate risks...

## IPCC assessment of large risks in the climate systems over time

### TOO CLOSE FOR COMFORT

Abrupt and irreversible changes in the climate system have become a higher risk at lower global average temperatures.

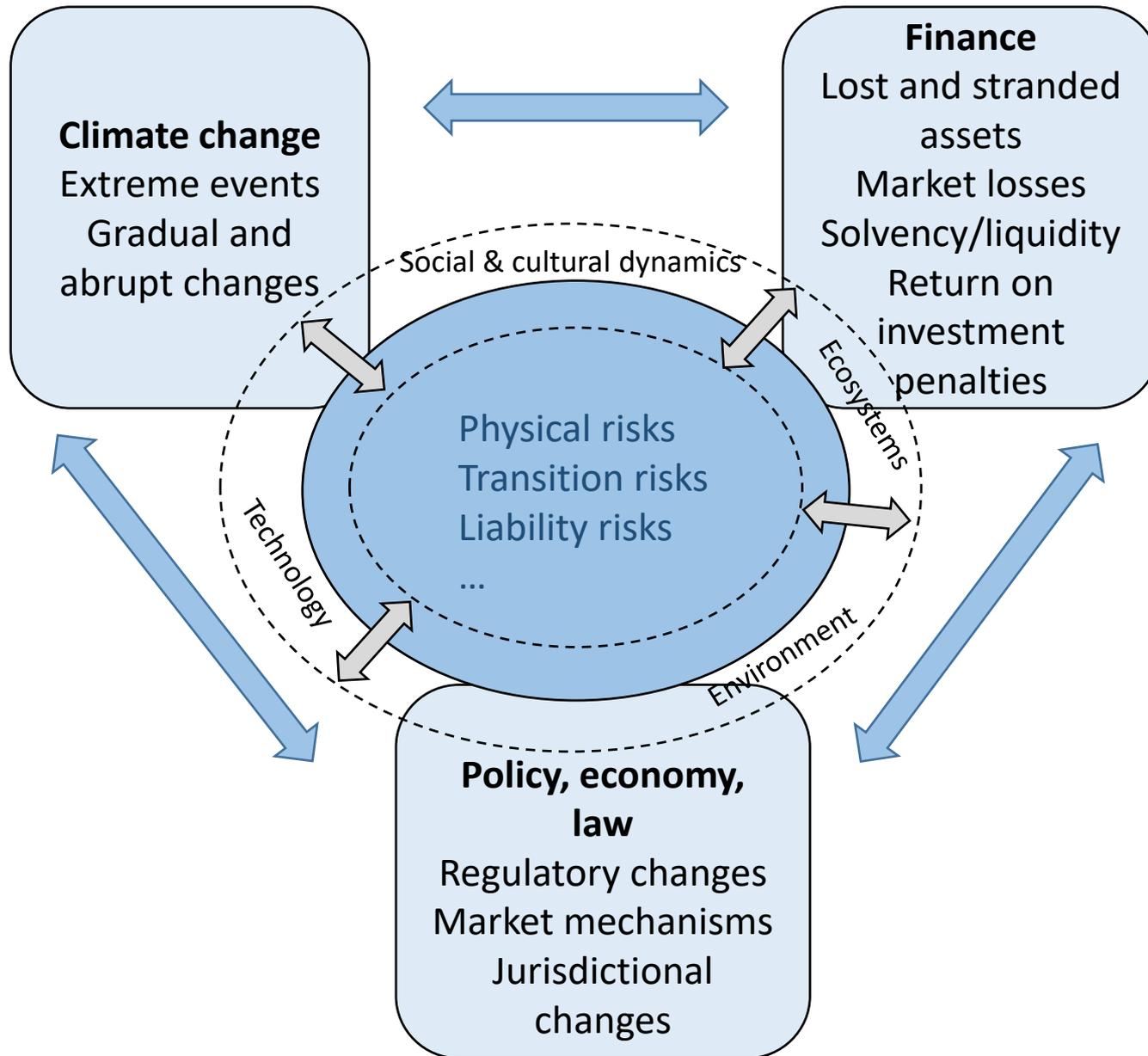


- ⇒ Climate change underestimated, incl a 1°C warming
- ⇒ Missing 'translation' of risk levels (what does high risk actually mean?)

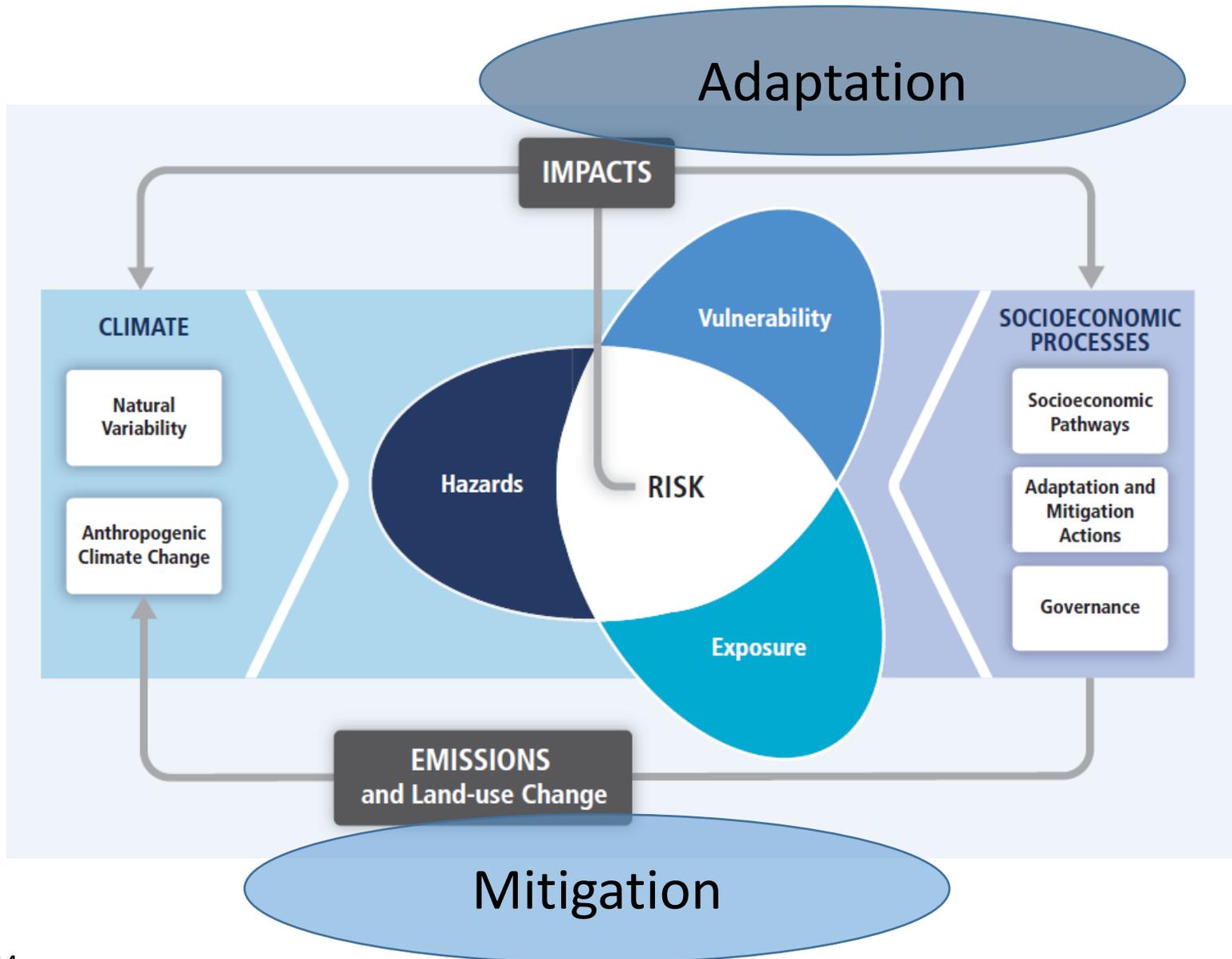
### Current limitations and challenges (IPCC):

- Large, high-end risks and their 'translation'
- Complex, cascading risks
- Limits of adaptation

# Encounters of different risk 'worlds'

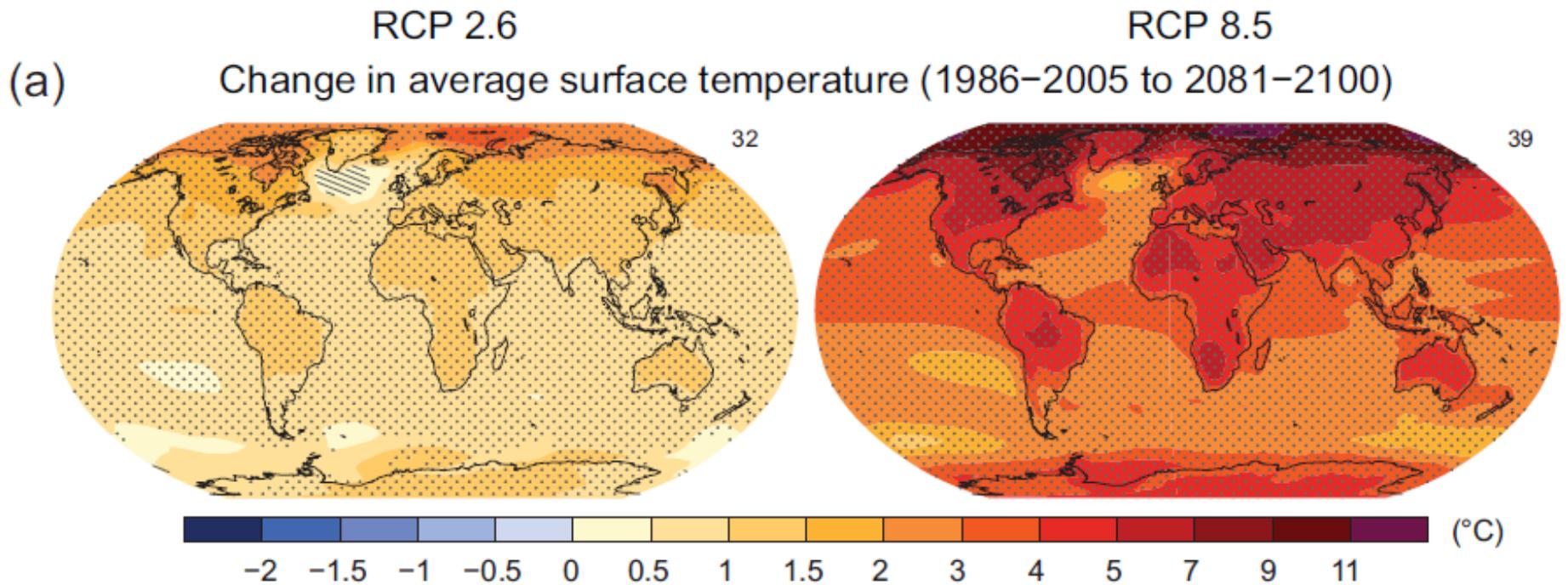


# How climate risks are analyzed and portrayed



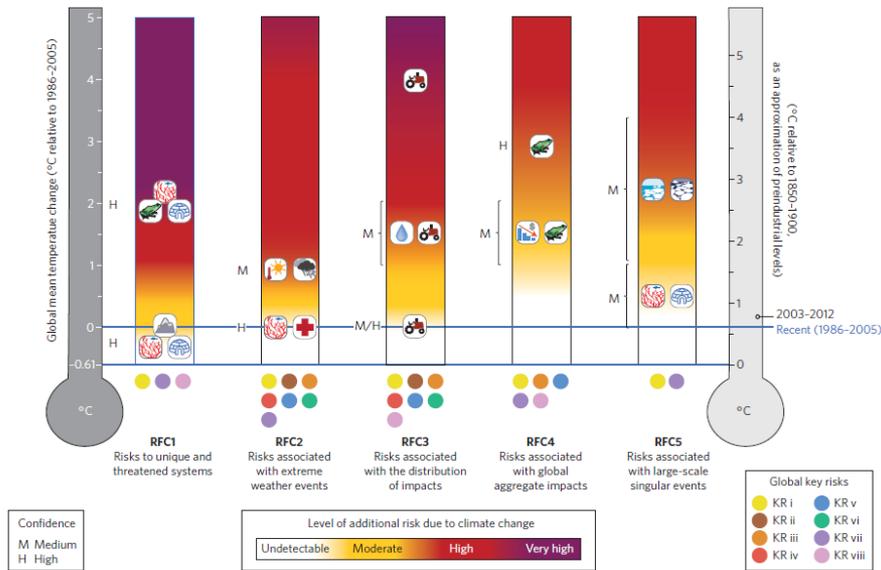
# Low vs high emission scenarios

4°C is not 4°C....

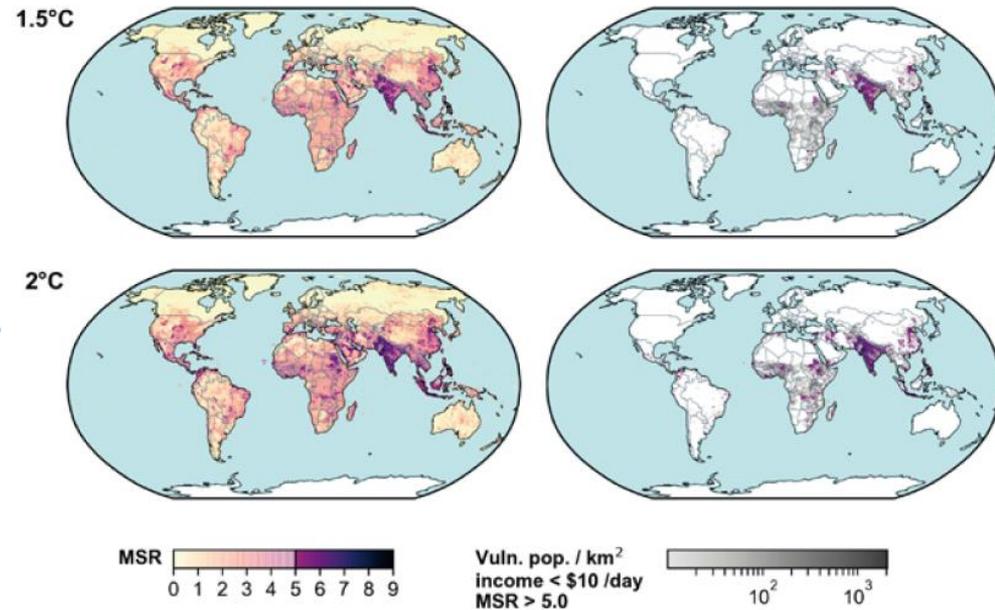


# How climate risks are analyzed and portrayed

## Reasons for Concern Key risks

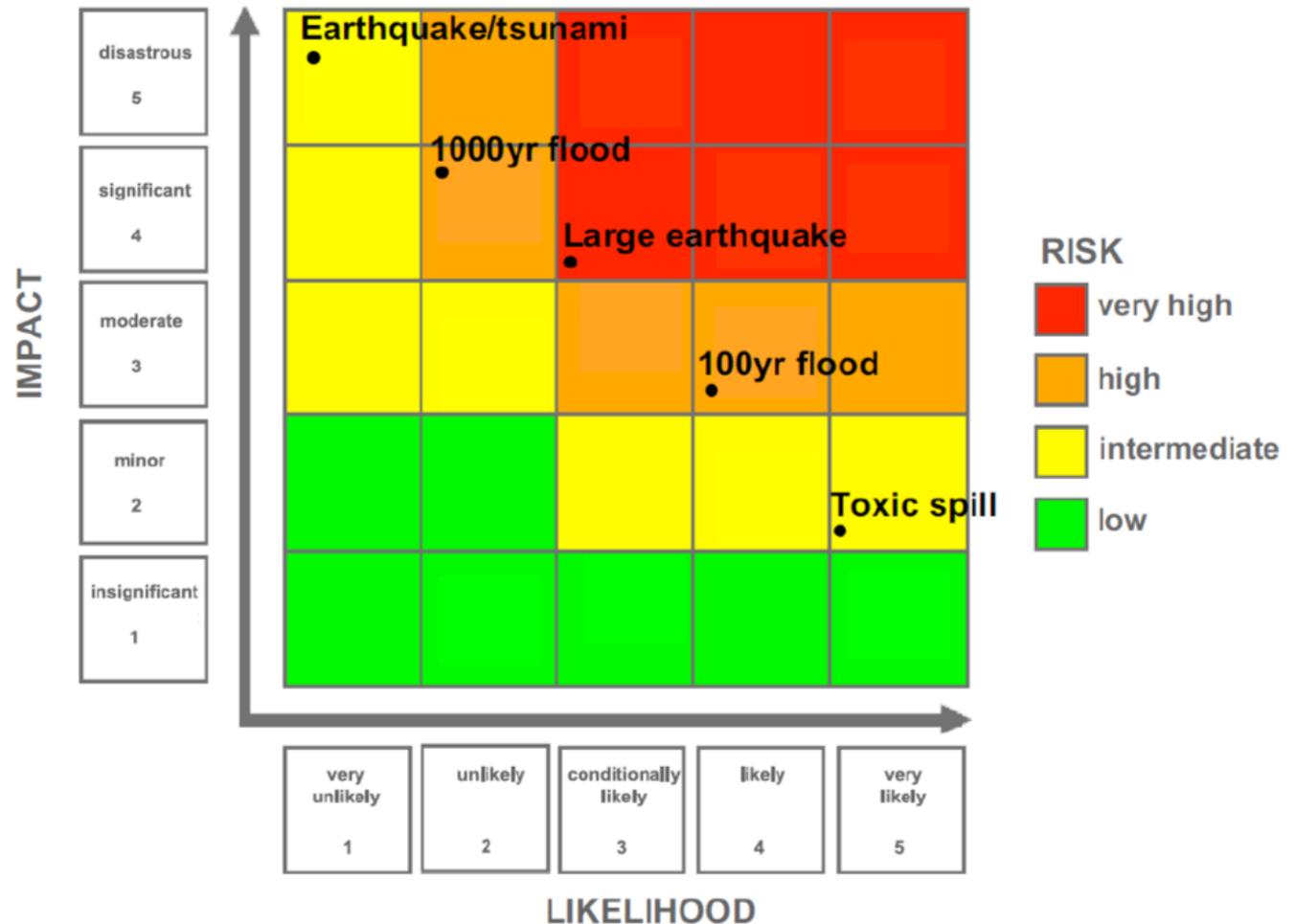


## Multi-sector risks



# Risk assessment

## 'Conventional' ways of risk assessment

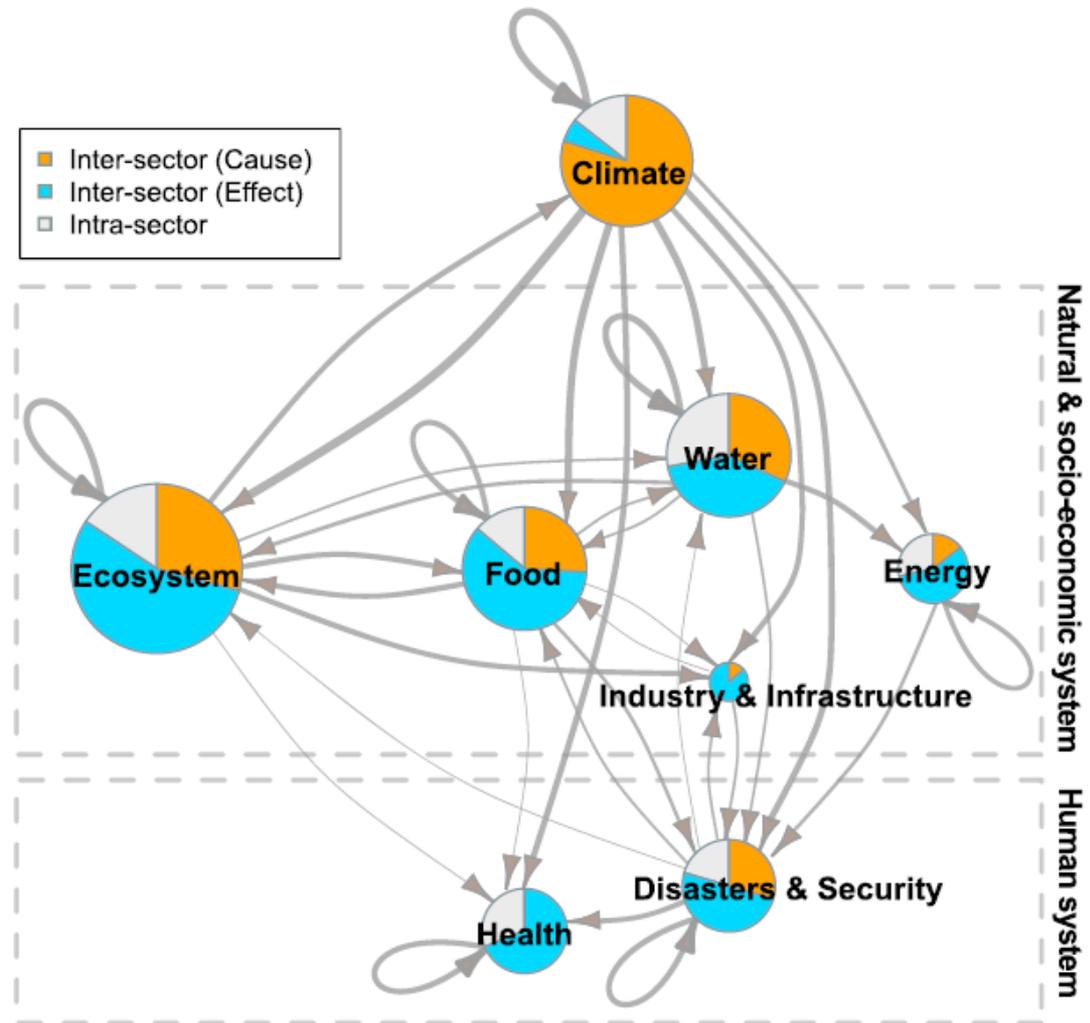


# Complex, interconnected and cascading risks

## Cause-effect relationship of climate risk at sectoral level

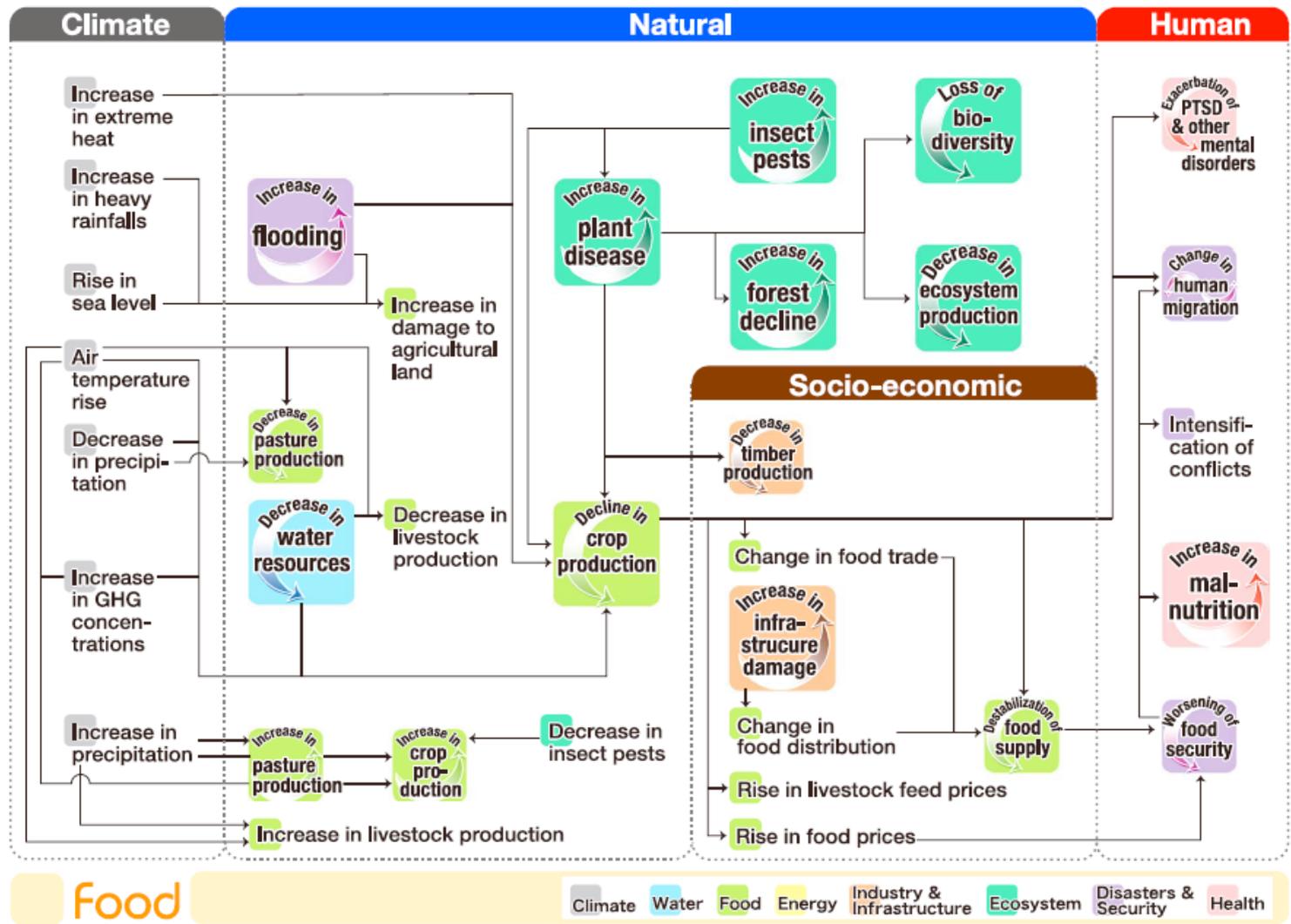


Cascading effects for 2019 Australia bushfires:  
Security, health, ecosystems, infrastructure, tourism  
Including overseas (NZ, South America, ocean)



# Complex, interconnected and cascading risks

## Climate risk interconnections related to the food sector



# Extreme events and disasters

## Extreme events and disasters as major drivers of physical risk



Bahamas, Hurricane Dorian, 2019

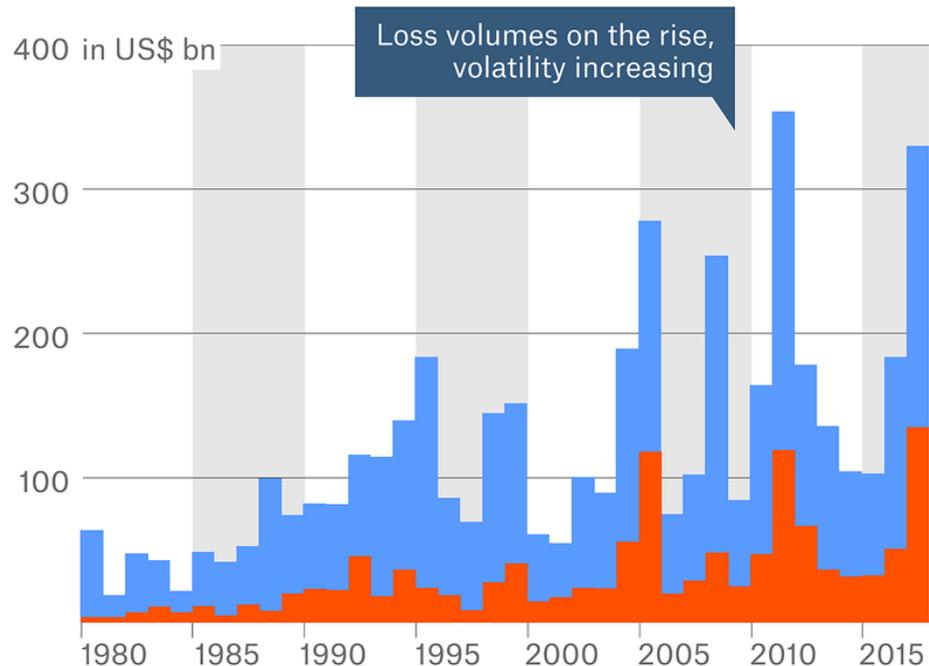


Kedarnath, India, 2013

>6000 people killed by glacier flood

### Overall and insured losses 1980-2017

- Overall losses (in 2016 values)
- Of which insured losses



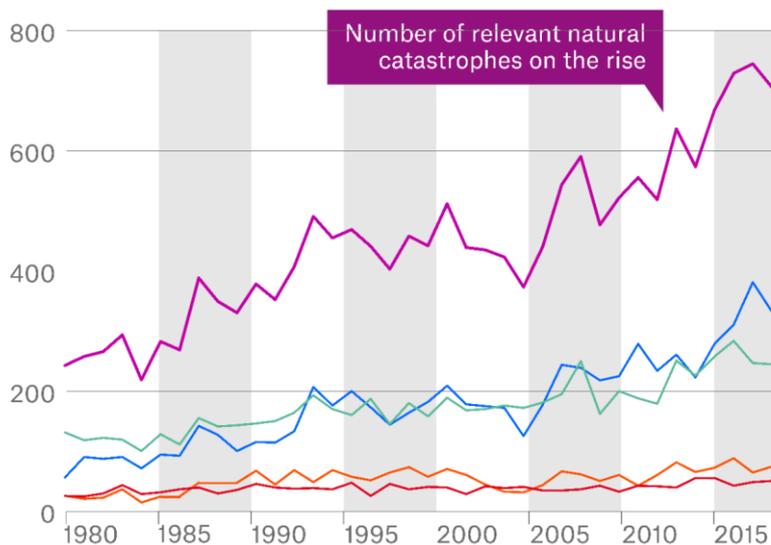
# Extreme events and disasters

## Changes in extreme events and disasters to date

Type	Increase in extreme weather hazard?	Increase in observed losses?
Heat wave	Very likely	Unknown
Heavy precipitation	Likely	Unknown
River floods	Limited/medium evidence	No increase
Drought	Low confidence	Unknown
Tropical cyclones	Low confidence	No increase
Extra-tropical cyclones	Likely poleward shift	No increase
Extreme sea-levels	Likely	Unknown
Wildfires	Unknown	No increase
Convective weather	Unknown	Possible increase?

Natural catastrophes 1980-2017  
Overall number of events

— Climatological    — Hydrological  
— Geophysical        — Meteorological

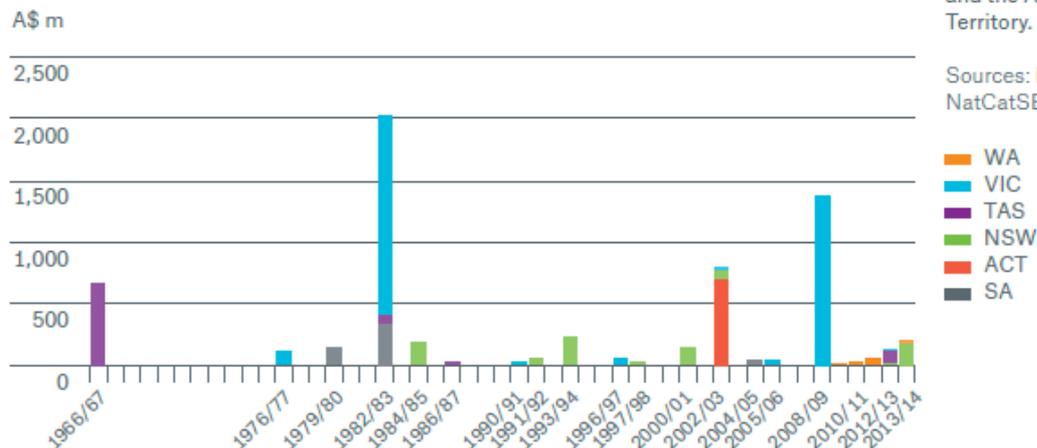


# Extreme events and disasters

Data from 2017 indicates that 97% of disaster funding is spent on post-disaster relief and recovery, with only 3% is invested in mitigating a disaster before it happens. Is Australia prepared for the potential risks of climate change? (Munich RE)



Normalised insured property losses 1967-2014 caused by bushfires

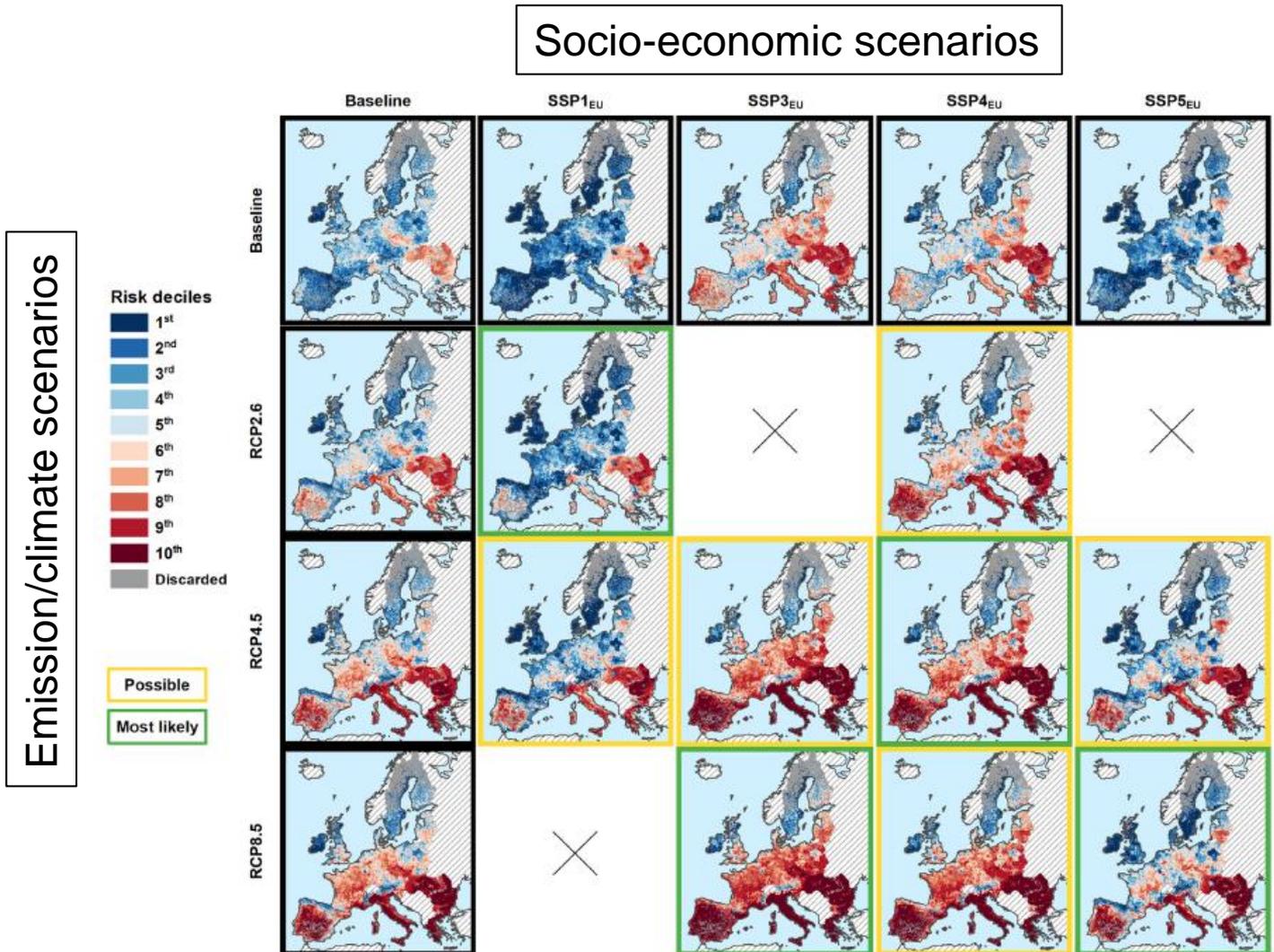


Since the devastating 1967 Tasmanian fires, about half of the normalised insured property losses were caused in Victoria (VIC) and one quarter in New South Wales and the Australian Capital Territory.

Sources: ICA, Munich Re NatCatSERVICE

# Climate risk projections

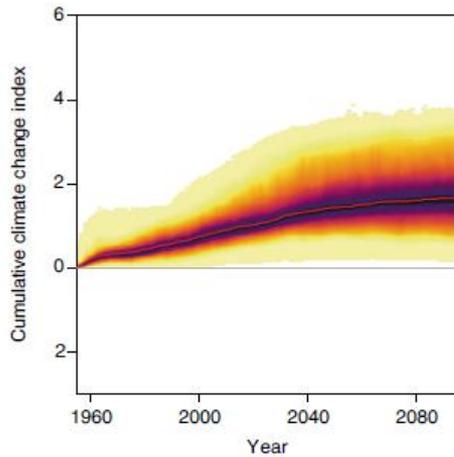
Heat stress risk for Europe for different emission and socio-economic scenarios



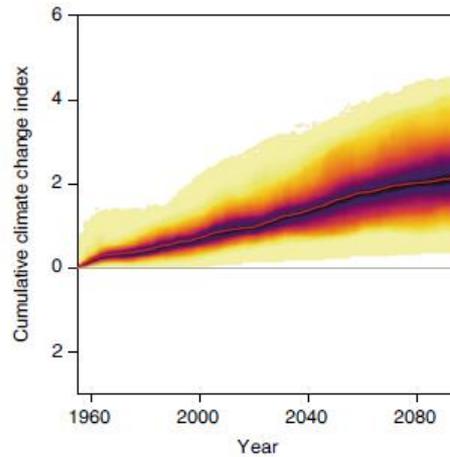
# Climate risk and damage

## Exposure of world population to cumulative climate hazards

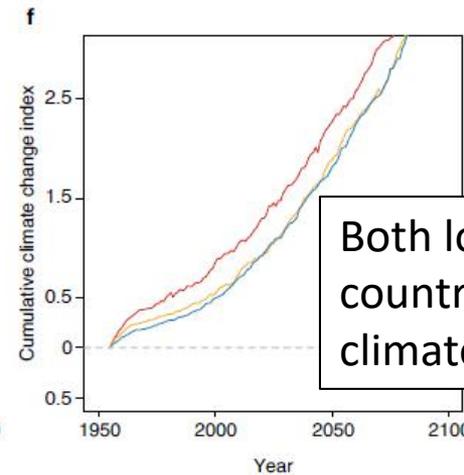
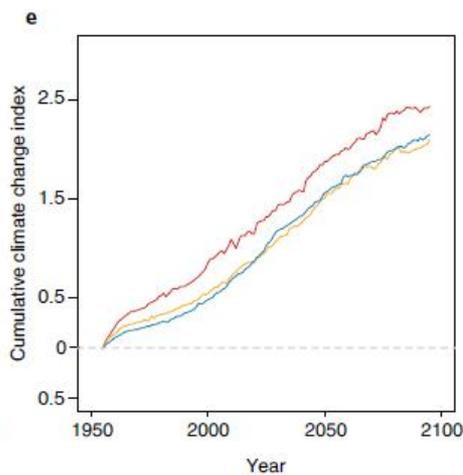
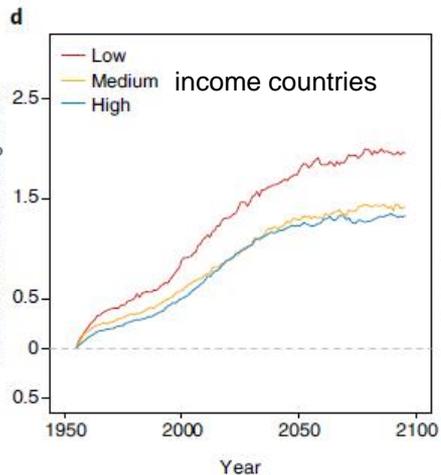
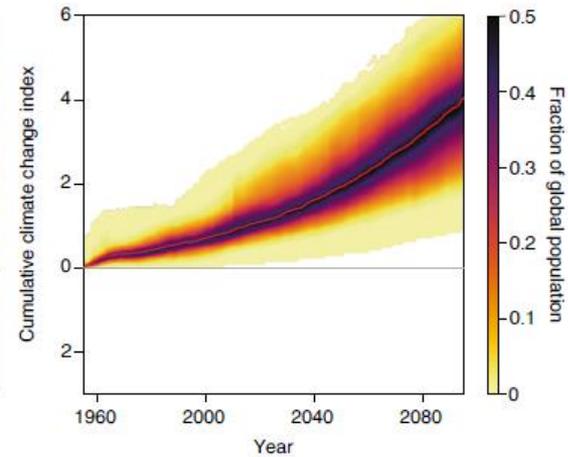
RCP2.6



RCP4.5



RCP8.5



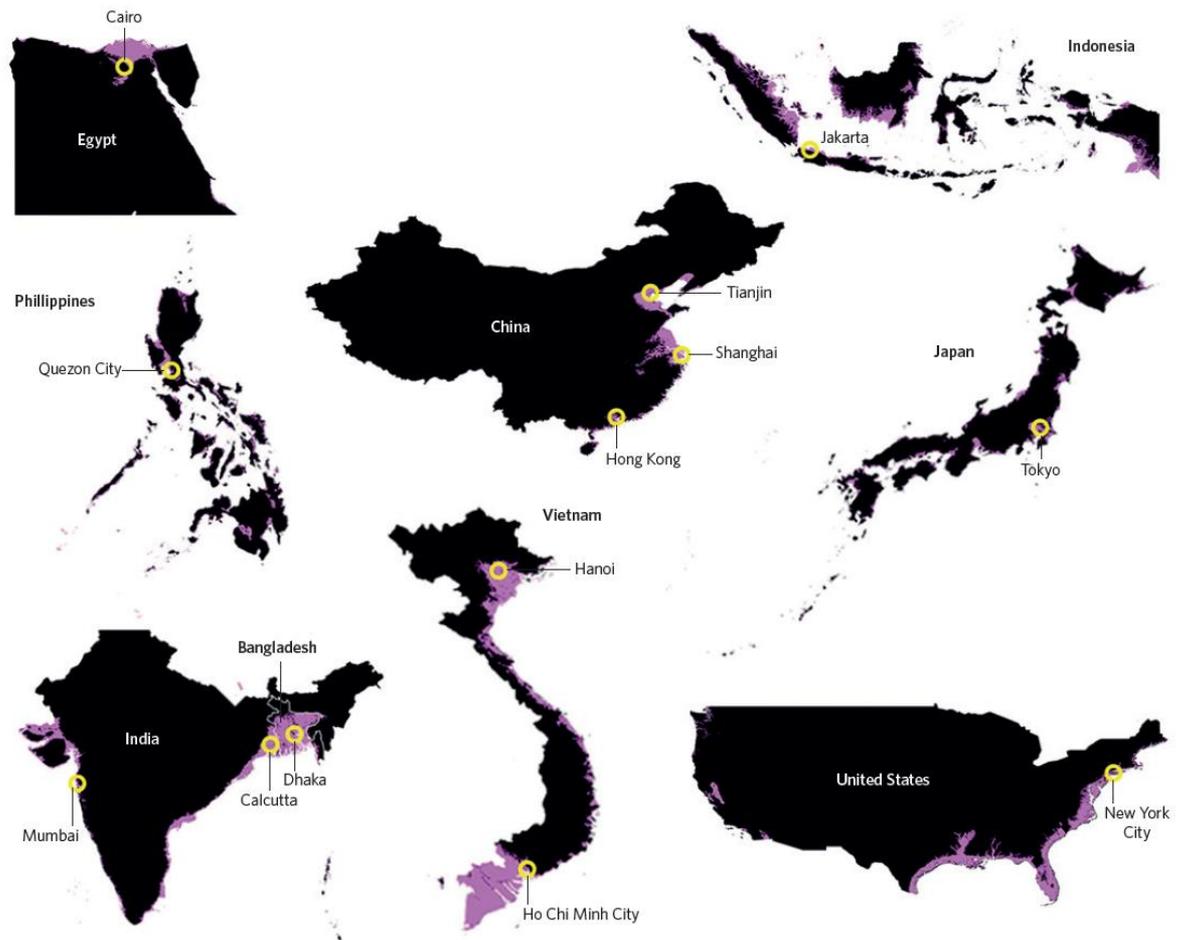
Both low and high-income countries highly exposed to climate hazards

# Climate risk and damage

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Effects of long-term sea level rise for  $\sim 2^{\circ}\text{C}$  scenario

Both low and high income countries heavily affected, 25 megacities with  $>50\%$  of their population affected, overall 1.3 billion people (2010) affected



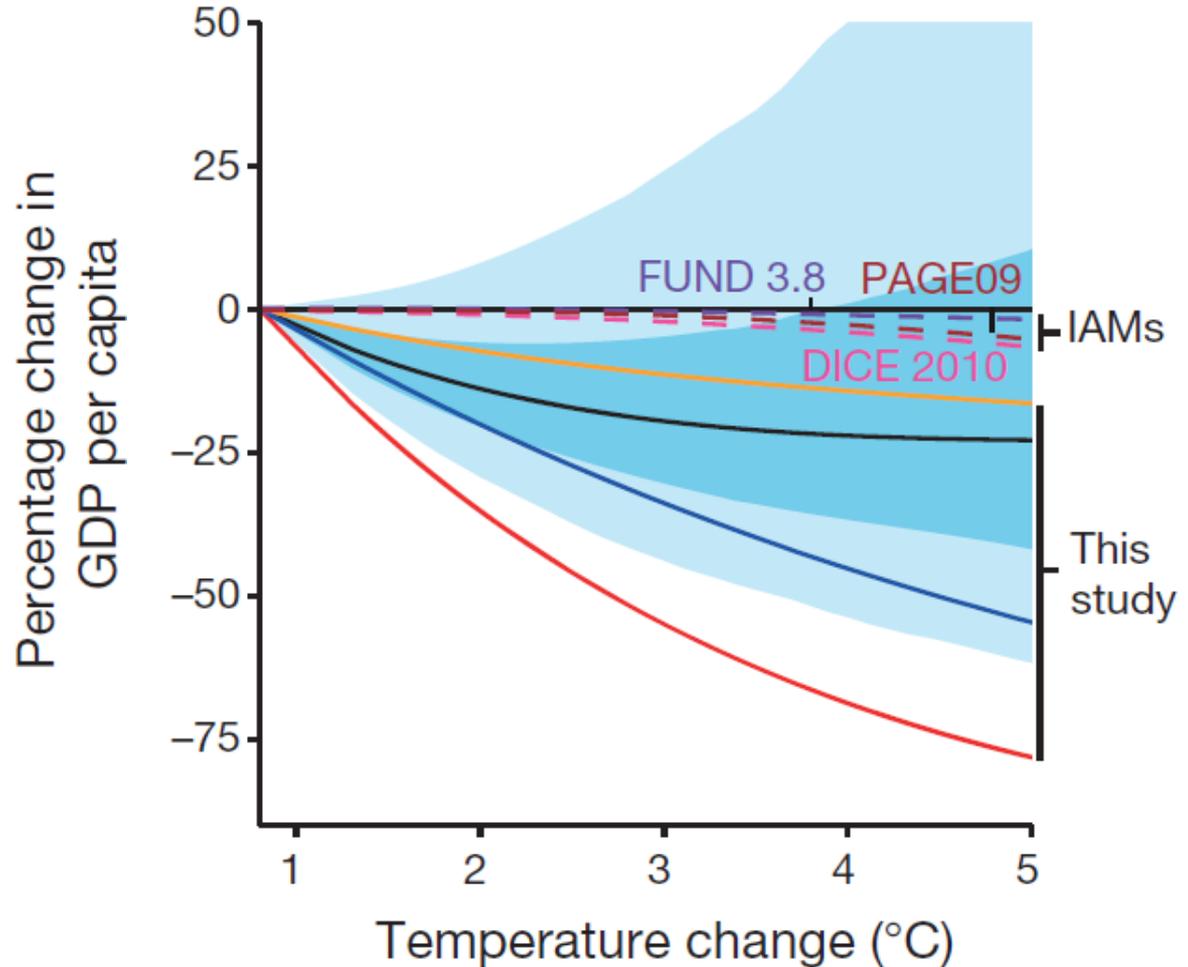
# Climate risk and economic loss & damage

Non-linear effects of temperature change on economic productivity considered.

But:

$$Y = \int_{-\infty}^{\infty} f_i(T) \cdot g_i(T - \bar{T}) dT$$

Y = aggregate economic productivity  
 T = average annual temperature



# Climate risk and economic loss & damage

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“There is increasing concern that economic integrated assessment models (such as DICE, FUND, PAGE) have major disconnects with climate / impact science” (Stern, 2013).

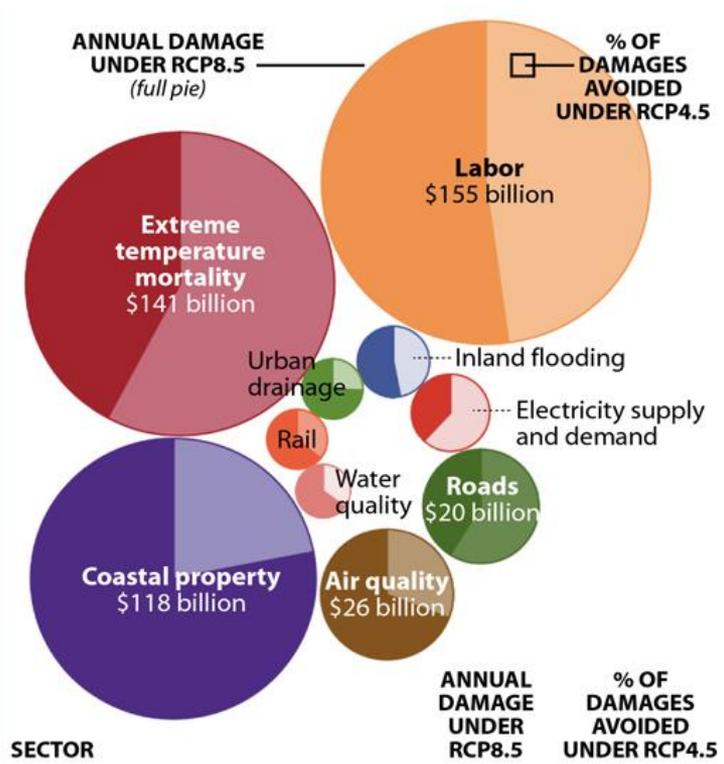
“There is a huge gulf between natural scientists’ understanding of climate thresholds or tipping points and economists’ representations of climate catastrophes in integrated assessment models (IAMs)» (Lenton and Ciscar, 2013).

«Current economic modeling is not remotely consistent with recent research on impacts» (Moyer et al., 2013).

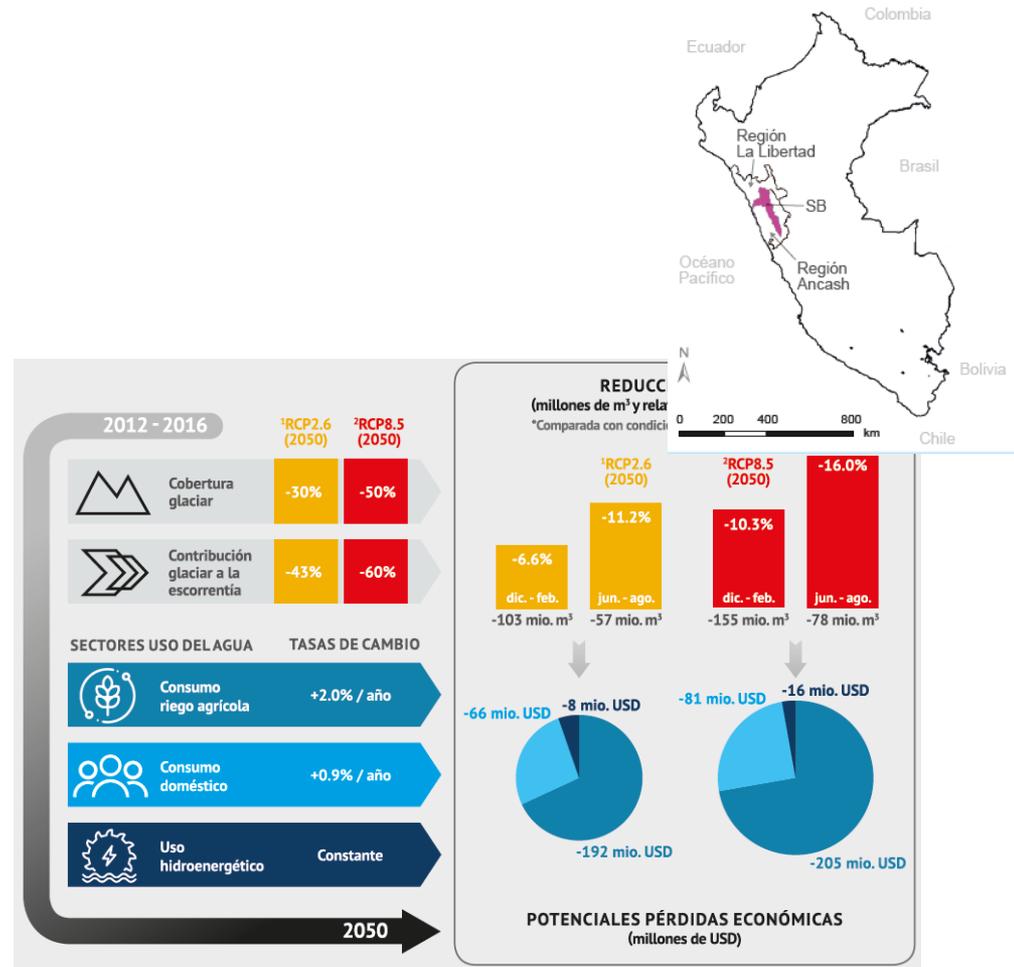
«...’nonmarket’ damages [civil conflict, human health, biodiversity]...are omitted from current damage estimates...Research should explore new methods for measuring key nonmarket outcomes» (Burke et al. 2016).

# Climate risk and economic loss & damage

Impact on the US economy by 2090  
(2018 US Nat. Climate Assessment)

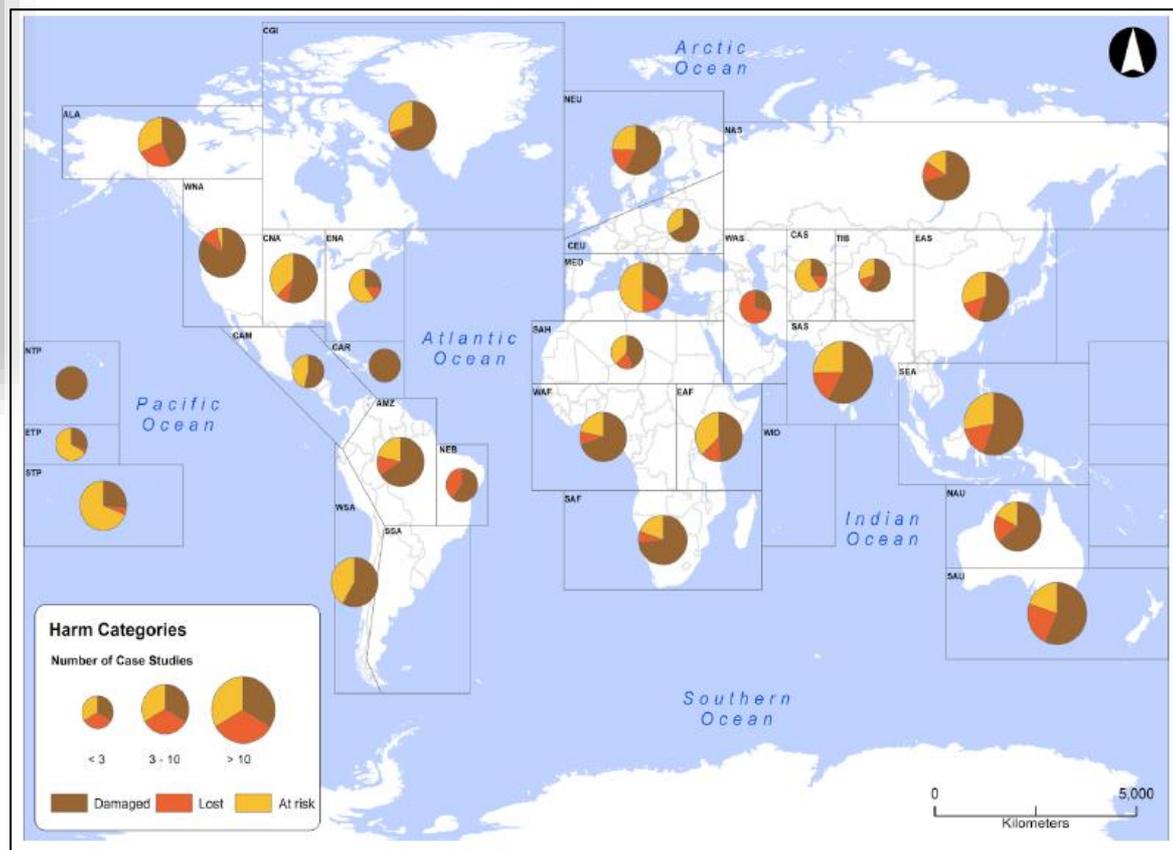


Impact of glacier shrinkage in the Andes of Peru on key economic sectors up to >300 million USD annually by 2050



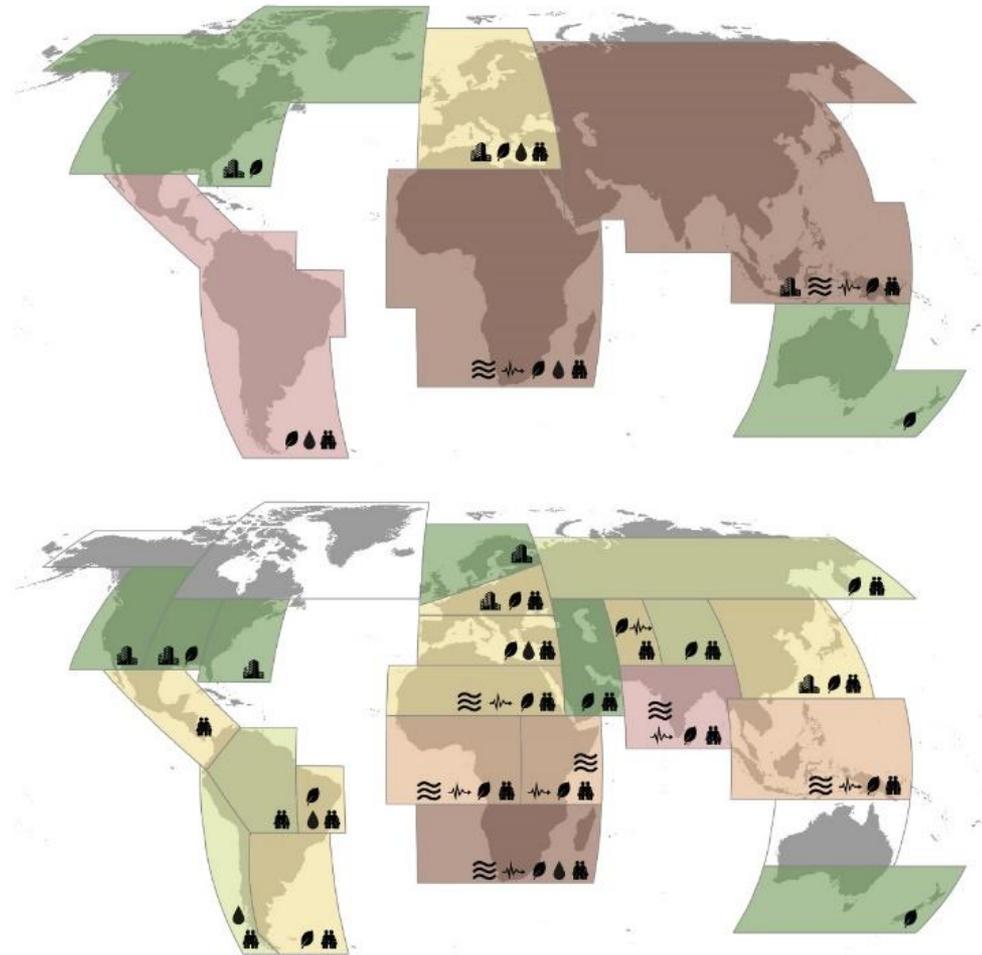
# Climate risk and non-economic loss & damage

And what about non-economic loss and damage?



# Risks from gradual changes (or combined with extremes)

'Vulnerable' global regions to gradual climate change and extreme events

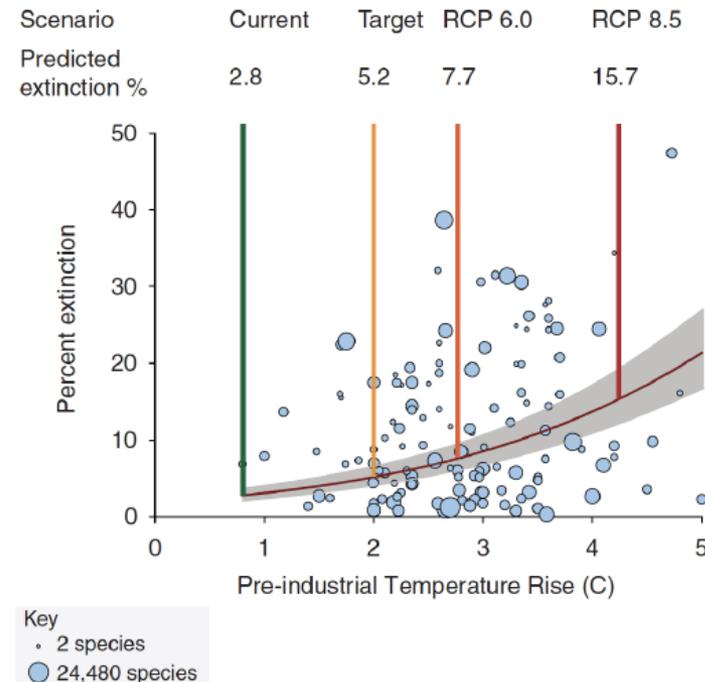


# Risks from gradual changes (or combined with extremes)

Examples of risks to ecosystems as related to climate change:

- High-emission scenarios could increase wildfire frequency on 1/3 to 2/3 of global land by 2100
- Risks of biome shifts due to increased drought and fire risks, incl in tropical rainforests (with little historical precedence)
- Risks of species extinction (substantially higher with high emission scenarios)
- Risk of loss of critical global carbon stocks and carbon sequestration service due to deforestation and climate change
- Degradation and fragmentation of ecosystems exacerbates impacts of climate change

Potential and need for more collaborative research between ecosystem/biodiversity and climate change communities, incl @UZH



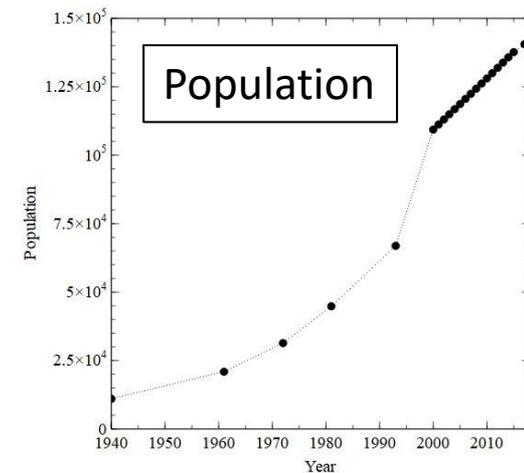
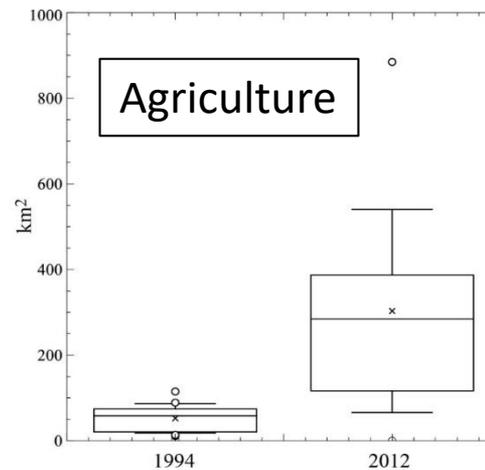
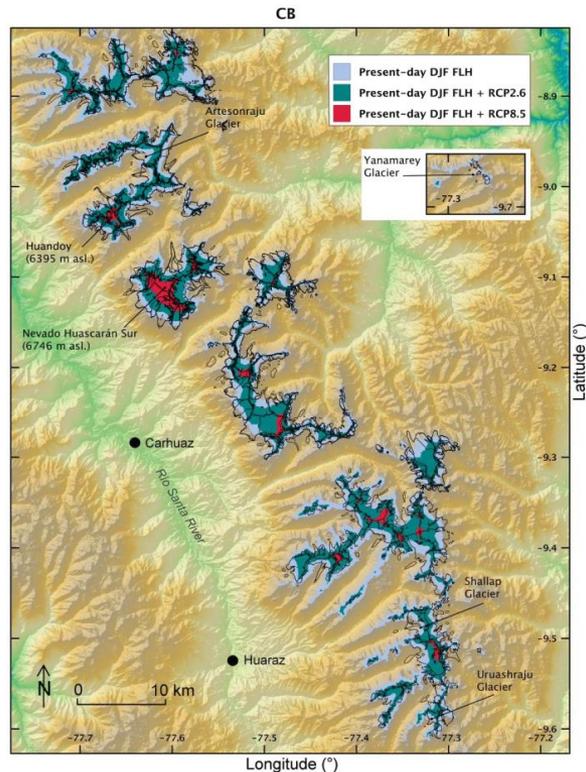
# Risks from gradual changes (or combined with extremes)



>> Low emission scenario: ca. 50% of the glaciers can be conserved

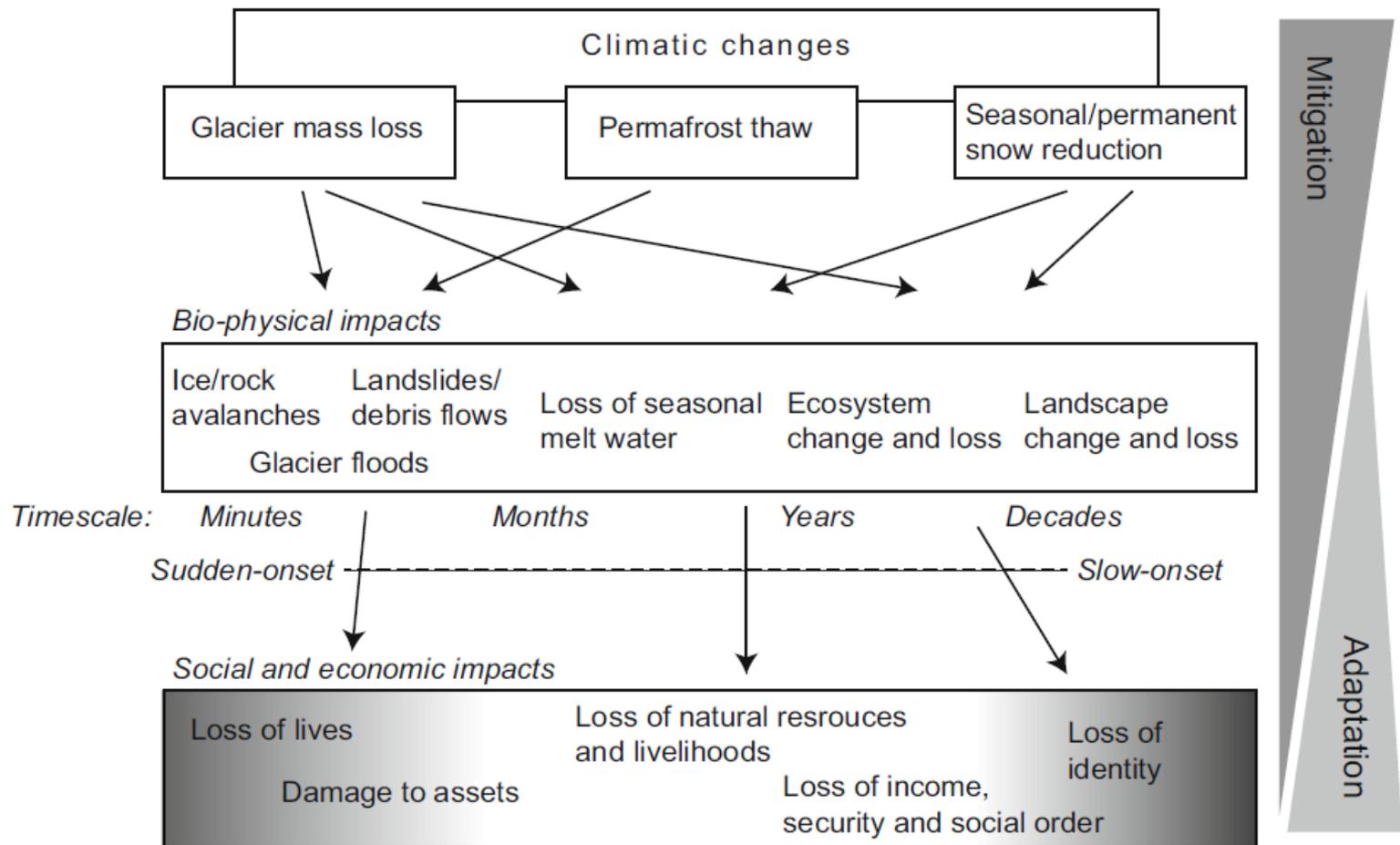
>> High-emission scenario: virtually all glaciers lost

High glacier water dependence of economic sectors in several regions worldwide



# Risks from gradual changes (or combined with extremes)

A closer look at how climate impacts, risks and losses are produced



# Risks from gradual changes (or combined with extremes)

Integrated approaches across natural, ecosystem and social systems are needed



# Liability risks: the RWE case

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## German court to hear Peruvian farmer's climate case against RWE

Decision to hear Saul Luciano Lliuya's case against the energy giant is a 'historic breakthrough with global relevance', campaigners say



Saúl Luciano Lliuya sues RWE for emitting GHG and causing risks of flooding from a glacier lake to his house in Huaraz, Peru.

Claiming reimbursement proportional to the fraction of RWE GHG to global emissions (0.47% resulting in about EUR 20,000).

- First declined by a court in Essen but in November 2017 revised by a higher court in Hamm and declared 'admissible'.
- Basically unprecedented is that a court recognizes that a private company can be held liable for climate change related damages resulting from its GHG emissions, moving a case to the evidentiary stage.
- Potentially huge implications for climate litigation, finance, justice and mitigation and adaptation.

# Liability risks: the RWE case

## German court to hear Peruvian farmer's climate case against RWE

Decision to hear Saul Luciano Lliuya's case against the energy giant is a 'historic breakthrough with global relevance', campaigners say



foto-webcam.eu

Webcam Overview

News (05.02.18)

Was ist eine Foto-Webcam?

Huaraz  
3.050m

Temperature Data

Aventura Quechua

universität innsbruck

University of Zurich

Imprint - Contact

Huaraz - Blick nach Osten  
28.03.18 09:10 UTC+5 24.3°C

Navigation: Home, Search, View, More, 2018, Map, 28, 09:10, Labels

18:00 20:00 22:00 00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00 02:00

## Some points for liability risks and beyond

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- Establishing a causation line from GHG to flood hazards in Huaraz is in principle possible in a qualitative or semi-quantitative way.
- Several confounding factors along the causation line interact (e.g. ENSO, local topography and geology). The anthropogenic GHG signal is stronger in the last 2-3 decades, coinciding with the largest growth of Palcacocha lake volume and thus hazard.
- The massive increase of exposure is a main driver of risk growth. However, the drivers of exposure are multi-dimensional, making definition of responsibilities a challenge.
- Overall, the global responsibility (via GHG and hazard component) is clear. This global responsibility, however, should not reduce the responsibility and commitment of local, regional and national actors to effectively reduce risks and protect the population.
- Climate litigation (tort law) has enormous potential to re-direct financial investments. Lines of evidence/causation are generally increasing with time, with a likely effect on court cases. The RWE case could become precedence of historical dimension.

# Conclusions

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- Departing from the recognition of the existence of different risk ‘worlds’ there is great need and potential to produce new high-impact research.
- In particular high-end and complex cascading risks are poorly researched and understood but likely of major consequences, including on the financial system and especially when interacting with it. More efforts are necessary and critical in view of the existential dimension.
- Adaptation, risk reduction, early detection (warning) and prevention are of fundamental importance and also need more efforts, incl. major global financing mechanisms.
- There is a large collaboration potential within UZH, such as between physical sciences and economics but also critically with humanities, jurisprudence, and others. UZH with its broad and rich disciplinary portfolio is well positioned to be a key player in the debate.
- We also need to think how we prepare and train future generations for the enormous challenges ahead where climate change always needs to be seen in the context of societal and environmental change.