

Doctoral course Climate Economics for Engineers

Impacts of climate change

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"Reasons for concern" in the IPCC reports

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)

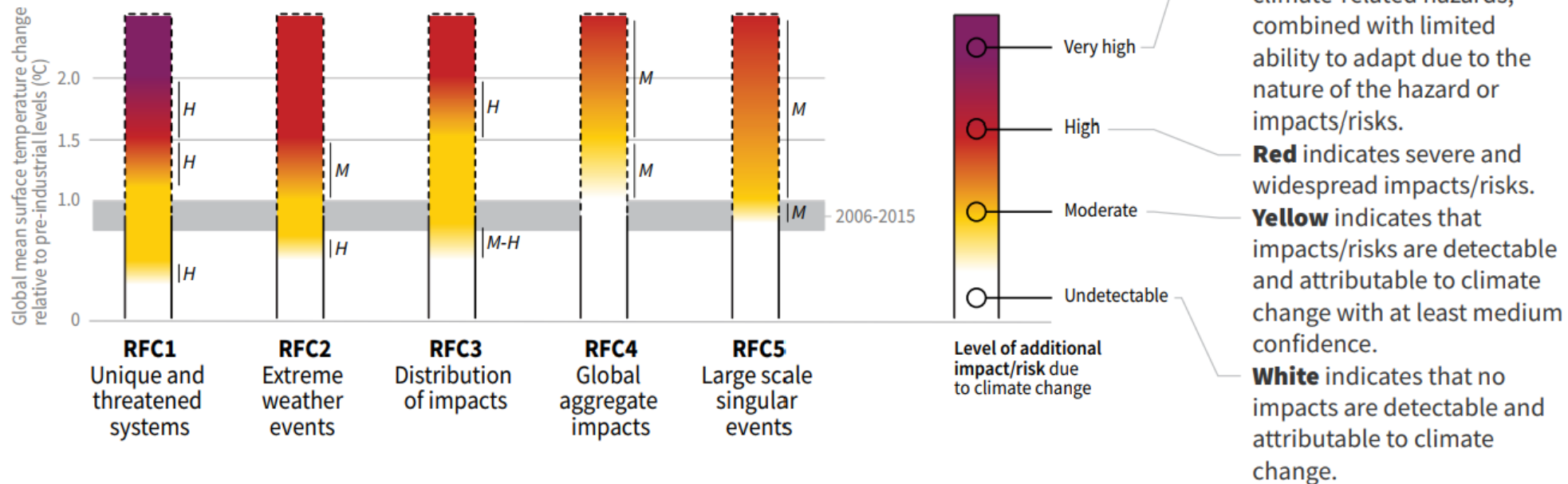


Figure SPM.2 in IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. World Meteorological Organization, Geneva.

Impacts in specific areas

(still only qualitative assessment of physical impacts)

Impacts and risks for selected natural, managed and human systems

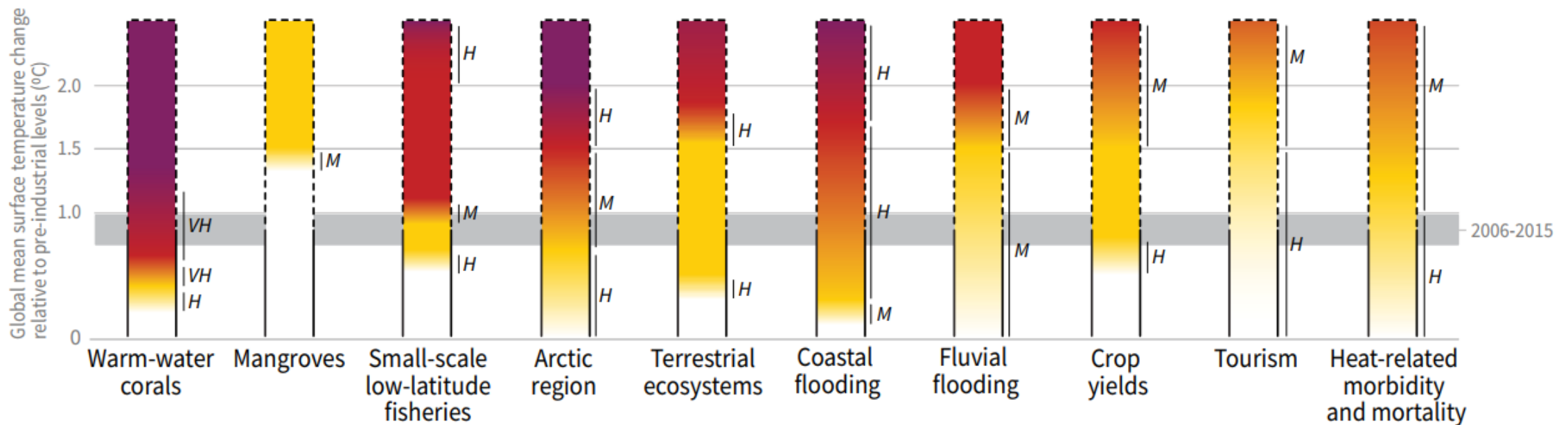
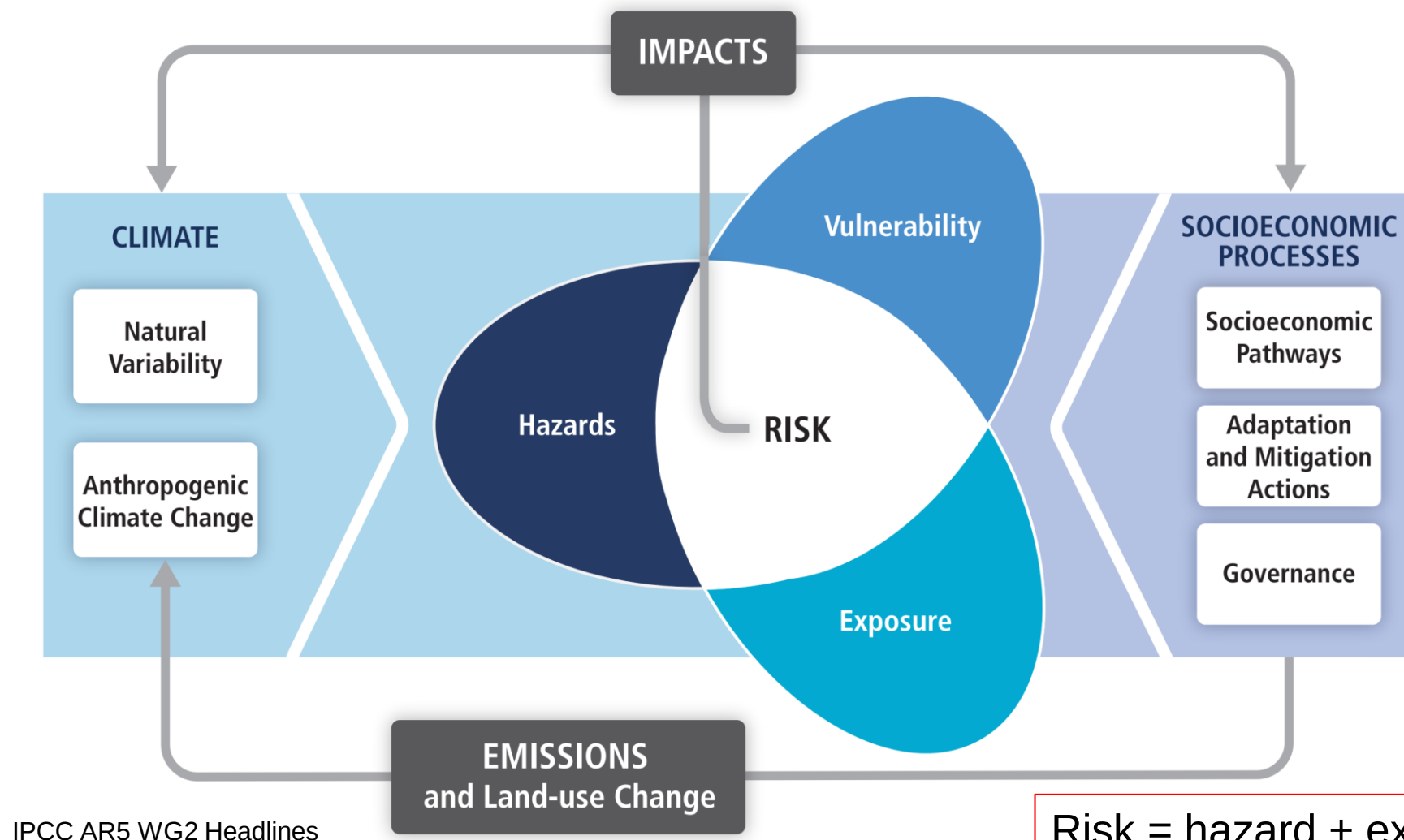


Figure SPM.2 in IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. World Meteorological Organization, Geneva.

The determinants of climate risk



Example

Hazard: rising sea level

Exposure: coastal area

Vulnerability: economic importance of coastal area

$\text{Risk} = \text{hazard} + \text{exposure} + \text{vulnerability}$

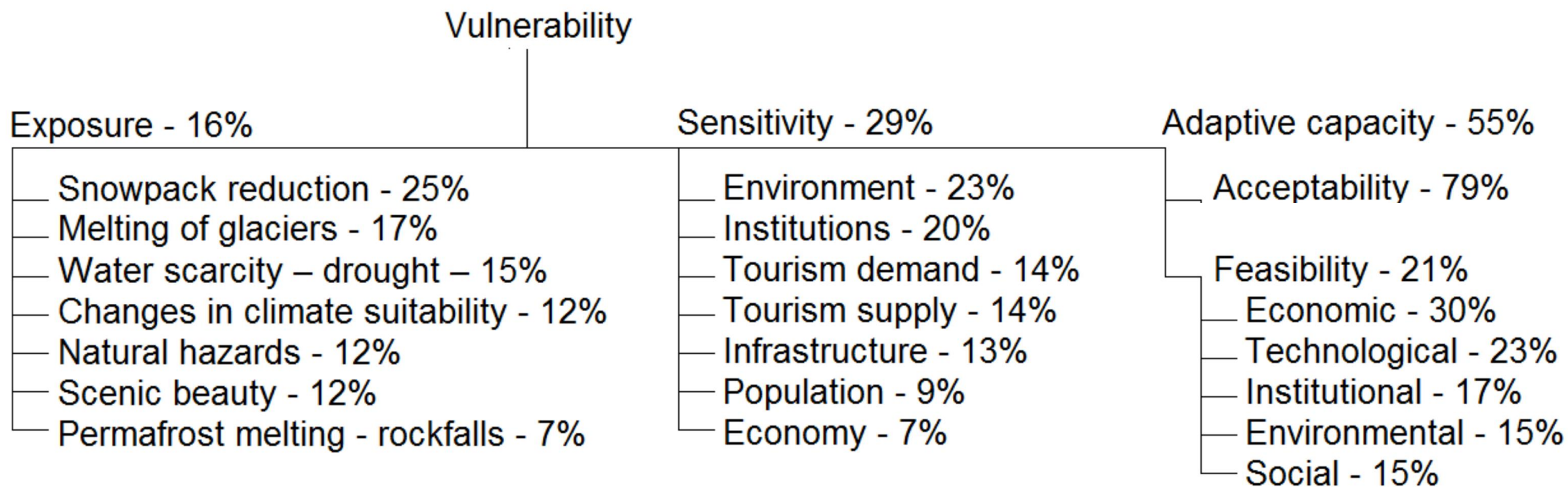
$\text{Hazard} = \text{probability} \times \text{intensity}$

$\text{Severity} = \text{intensity} + \text{exposure} + \text{vulnerability}$

$\text{Risk} = \text{probability} \times \text{severity}$

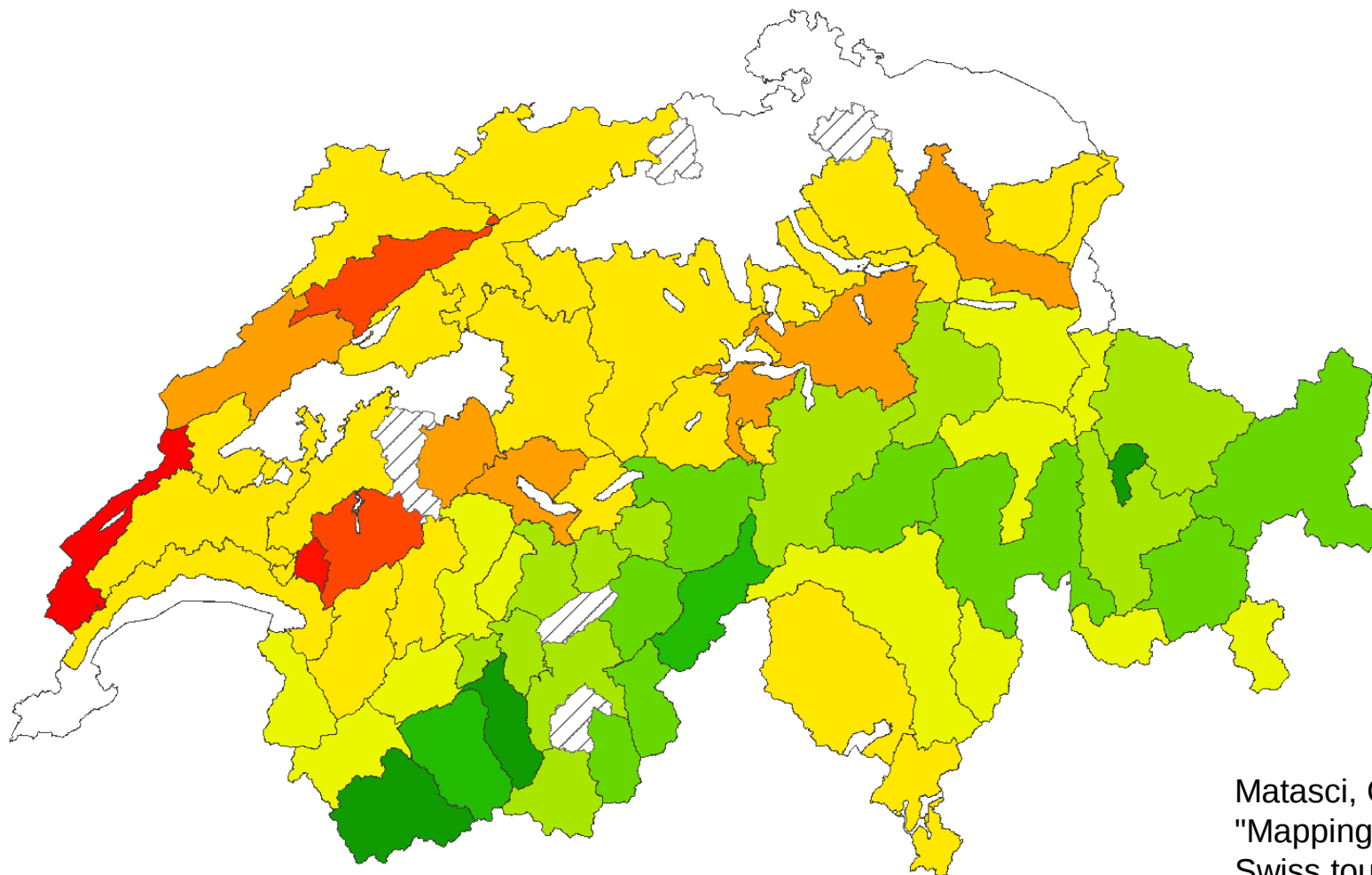
Alternative view: vulnerability includes exposure

Swiss tourism experts and stakeholders were surveyed about the most important determinants of vulnerability



Matasci, Cecilia and Philippe Thalmann, "Mapping vulnerability to climate change of Swiss tourism", manuscript, 2012

Vulnerability to snow pack reduction



Matasci, Cecilia and Philippe Thalmann,
"Mapping vulnerability to climate change of
Swiss tourism", manuscript, 2012

Representation of vulnerability at the 030-2050 horizon to snow pack reduction. The redder the region, the more vulnerable it is; the greener the region, the more it will presumably benefit from the impact. Hatched areas indicate regions with a lack of data, white areas are regions with null vulnerability.

IPCC AR5 WGII

Chapter 1	Point of Departure
Chapter 2	Foundations for Decision Making
Chapter 3	Freshwater Resources
Chapter 4	Terrestrial and Inland Water Systems
Chapter 5	Coastal Systems and Low-Lying Areas
Chapter 6	Ocean Systems
Chapter 7	Food Security and Food Production Systems
Chapter 8	Urban Areas
Chapter 9	Rural Areas
Chapter 10	Key Economic Sectors and Services
Chapter 11	Human Health: Impacts, Adaptation, and Co-Benefits
Chapter 12	Human Security
Chapter 13	Livelihoods and Poverty
Chapter 14	Adaptation Needs and Options
Chapter 15	Adaptation Planning and Implementation
Chapter 16	Adaptation Opportunities, Constraints, and Limits
Chapter 17	Economics of Adaptation
Chapter 18	Detection and Attribution of Observed Impacts
Chapter 19	Emergent Risks and Key Vulnerabilities
Chapter 20	Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development

 Part A

Part B


Chapter 21	Regional Context
Chapter 22	Africa
Chapter 23	Europe
Chapter 24	Asia
Chapter 25	Australasia
Chapter 26	North America
Chapter 27	Central and South America ..
Chapter 28	Polar Regions
Chapter 29	Small Islands
Chapter 30	The Ocean

IPCC AR5 WGII Chap. 10

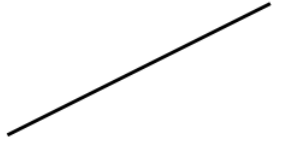
- Chapter 10 is about the impacts of climate change for the sectors energy, water, transportation, tourism, agriculture, health, finance and insurance
- Nothing much is new or surprising
- Main message: climate change is merely one of many changes that will affect most economic sectors over the next decades

Impacts for key economic sectors

"For most economic sectors, the impacts of drivers such as changes in population, age structure, income, technology, relative prices, lifestyle, regulation, and governance are projected to be large relative to the impacts of climate change (*medium evidence, high agreement*)" (SPM 31-03-2014, p.19)

Qualitative assessment of sectoral impacts

Table 10-10: Summary of findings. (extract)

Sector	CC Drivers	Sensitivity to CC	Sign	Other Drivers	Relative Impact of CC to Other Drivers
Winter tourism	Temperature Snow		Negative	Population Lifestyle Income Aging	Much less
Summer tourism	Temperature Rainfall Cloudiness		Negative for suppliers in low altitudes and latitudes Positive for suppliers in high altitudes and latitudes Neutral for tourists	Population Income Lifestyle Aging	Much less

Some areas of particular concern

- Extreme events lead to the breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services
- More frequent and/or severe weather disasters challenge the insurance system and call for complementary government insurance

Global aggregate impacts (still qualitative)

"Risks of global aggregate impacts are moderate for additional warming between 1-2°C, reflecting impacts to both Earth's biodiversity and the overall global economy (*medium confidence*)

Extensive biodiversity loss with associated loss of ecosystem goods and services results in high risks around 3°C additional warming (*high confidence*)

Aggregate economic damages accelerate with increasing temperature (*limited evidence, high agreement*) but few quantitative estimates have been completed for additional warming around 3°C or above."

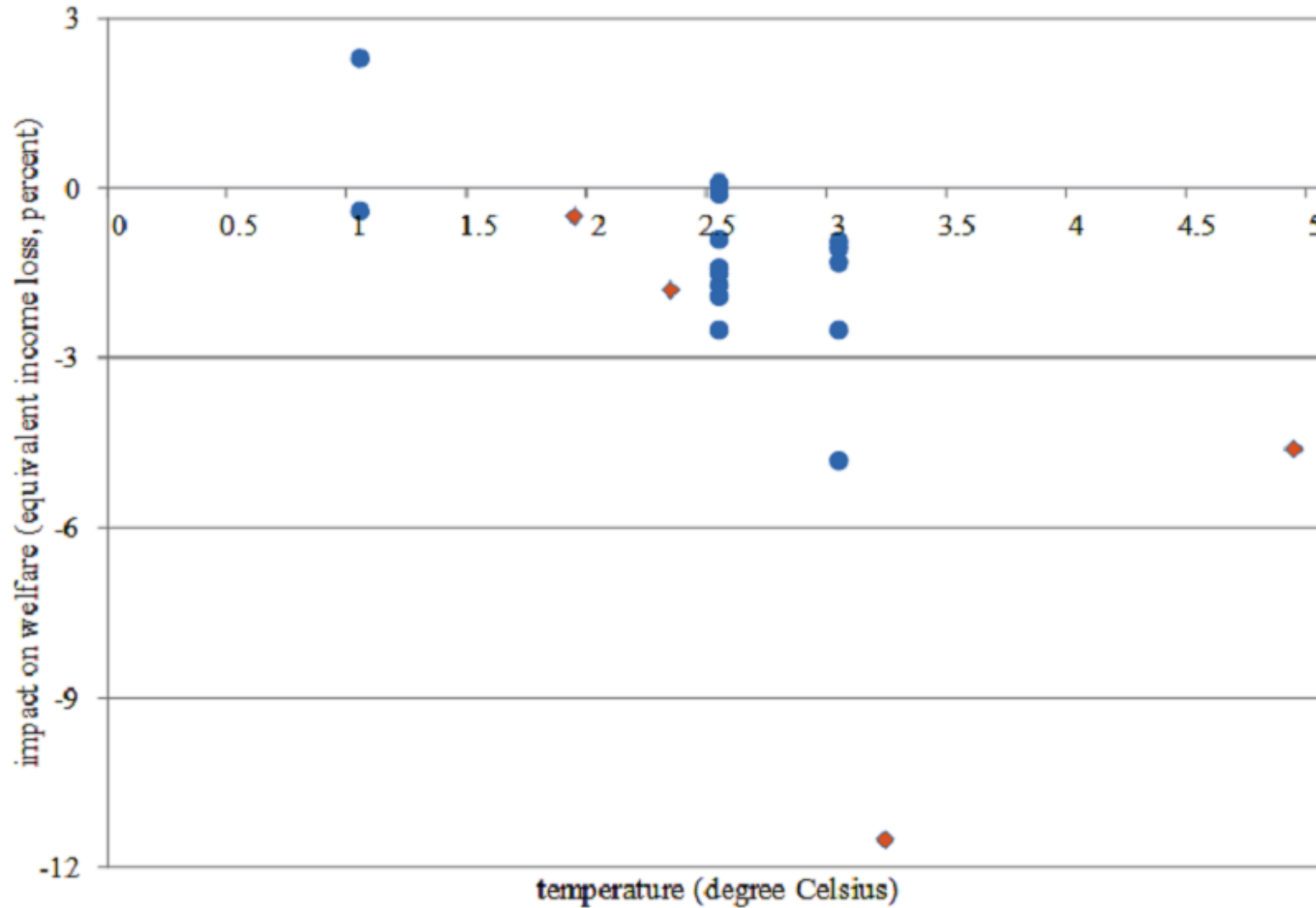
(SPM 31-03-2014, p.13)

Placing a price on impacts to increase attention



Pinterest

AR5 also enumerates the cost estimates



AR5, WGII, Chap.10

Figure 10-1: Estimates of the total impact of climate change plotted against the assumed climate change (proxied by the increase in the global mean surface air temperature); studies published since IPCC AR5 are highlighted as diamonds; see Table 10.B.1.

What do the numbers mean?

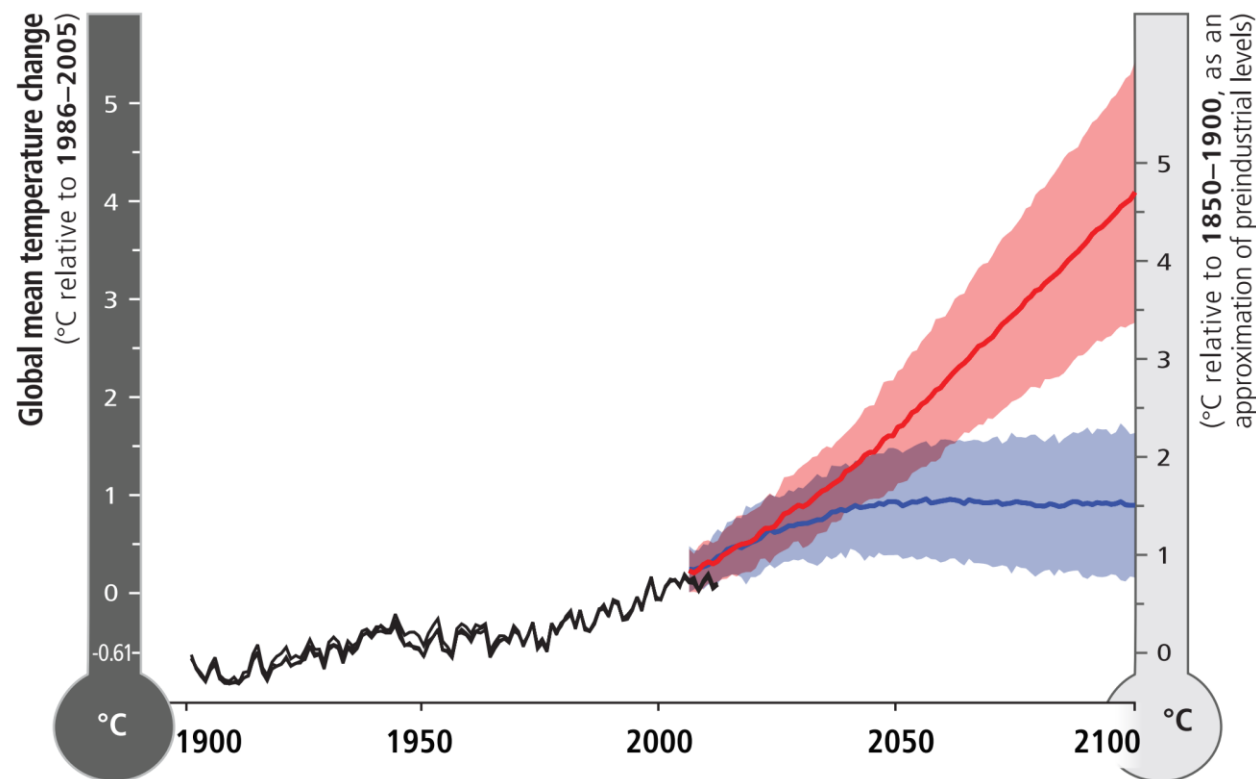
- The 2011 "Fukushima" earthquake is estimated to have caused economic losses in 2011 in the order of 210 billion USD; this is 3.5% of 2011 Japanese GDP

Lessons from AR5

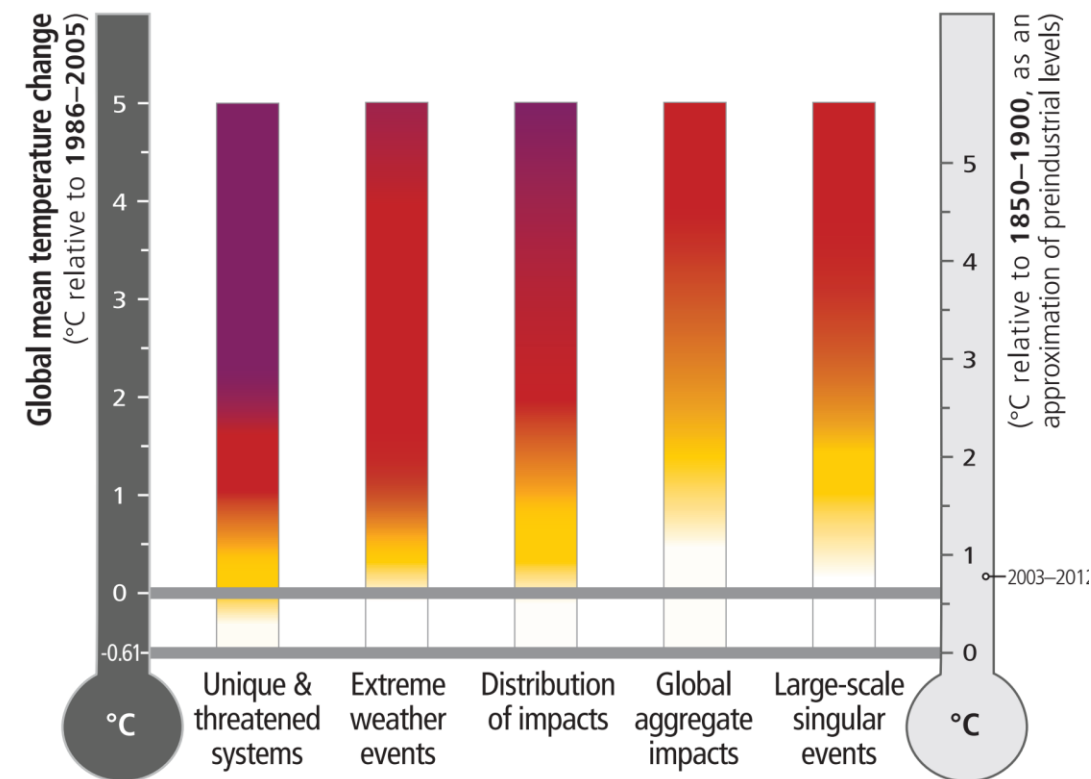
- Existing estimates are often **incomplete** (missing sectors, no catastrophic damages or tipping points, no adaptation) and depend on a large number of disputable assumptions
- Global annual economic losses for $\sim +2^{\circ}\text{C}$ are estimated between **0.2 and 2.0% of income** (*medium evidence, medium agreement*)
- Losses are more likely than not to be **greater**, rather than smaller, than this range (*limited evidence, high agreement*)
- There are large differences between and within countries
- Losses **accelerate** with greater warming (*limited evidence, high agreement*), but few quantitative estimates have been completed for additional warming around 3°C or above

(SPM 31-03-2014, p.19)

Overall, global aggregate impacts are not the main concern



- Observed
- RCP8.5 (a high-emission scenario)
- Overlap
- RCP2.6 (a low-emission mitigation scenario)



Level of additional risk due to climate change

Undetectable Moderate High Very high

Key messages of IPCC AR5

- For most economic sectors, climate change is not a central concern for the next few decades
- There is still great uncertainty about climate-change induced losses, particularly beyond +2.5°C
- Below that level, these losses are not large (<3% of incomes)
- No clear evidence yet of climate-change induced increases in insured losses, but the forecasts are gloomy
- The scientific community is still far from a consensus on the social cost of carbon

IPCC "1.5° Special report"

- Impacts increase markedly from +1.5° to +2°
- In particular, the heat extremes in inhabited areas are much stronger
- More extreme precipitations in most regions and massive droughts in some areas
- Rough estimate: +0.5° means 50% stronger impacts

Winners... or cheaters?

"An increase of two or three degrees wouldn't be so bad for a northern country like Russia. We could spend less on fur coats, and the grain harvest would go up."

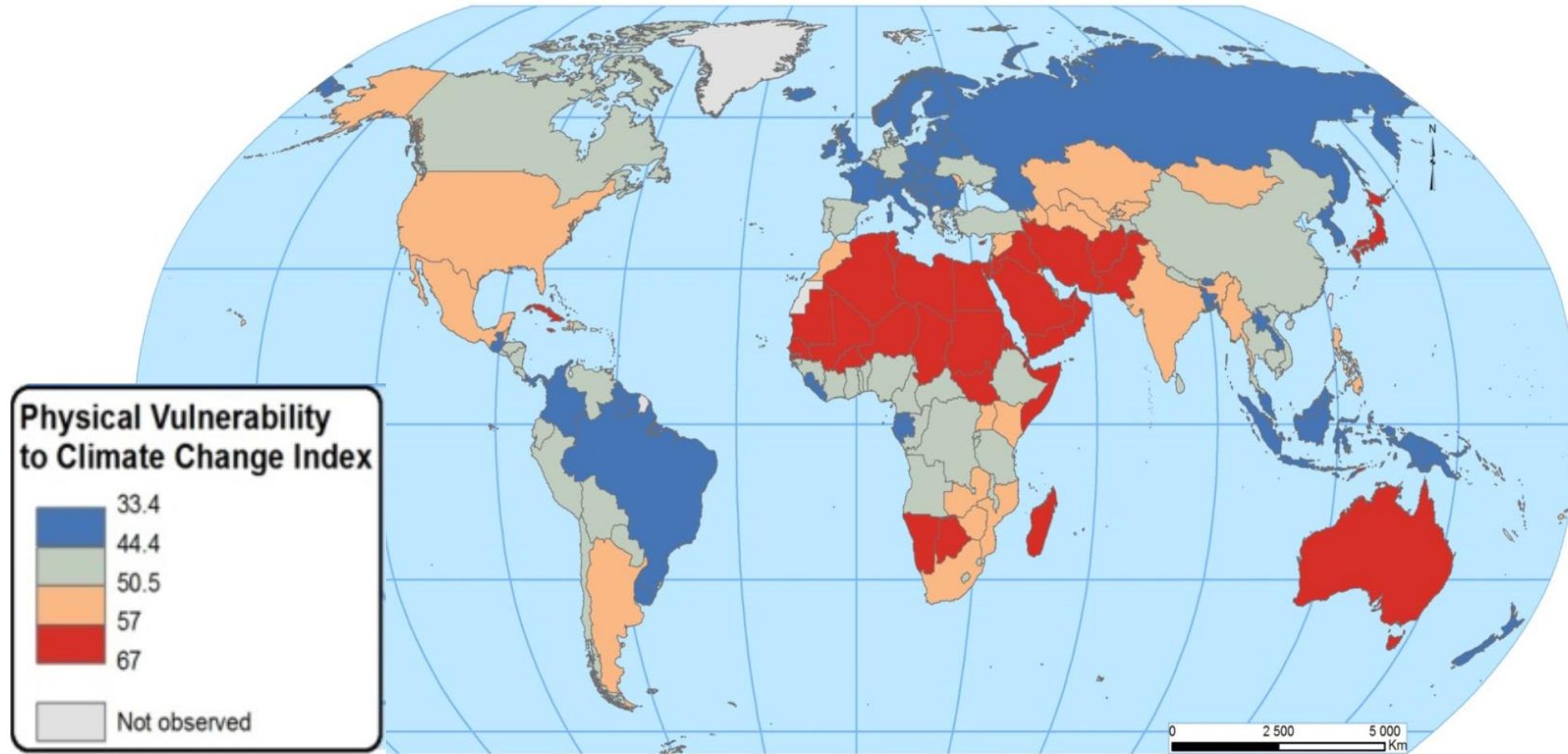
Vladimir Putin, President of the Russian Federation, addressing a conference on climate change in Moscow on 3 October 2003

"Climate change brings in more favorable conditions and improves the economic potential of this region"

Vladimir Putin speaking about the Arctic, which contributes 10% of Russia's GDP, at the Arctic Forum in Arkhangelsk on 30 March 2017



In fact, all countries are vulnerable to CC



M. Closset, S. Feindouno, P. Guillaumont, C. Simonet. A Physical Vulnerability to Climate Change Index: Which are the most vulnerable developing countries?. Ferdi Working paper P213. 2017. <hal-01719925v2>

The index assesses each country's vulnerability to rising sea level, droughts, extreme temperatures and precipitations, and storms. The score ranges from 0 to 100.

A few more general things we know about climate change impacts

- Poor countries are particularly threatened (fairness, global climate fund)

view: <https://twitter.com/TheEconomist/status/1051462010045652994>)

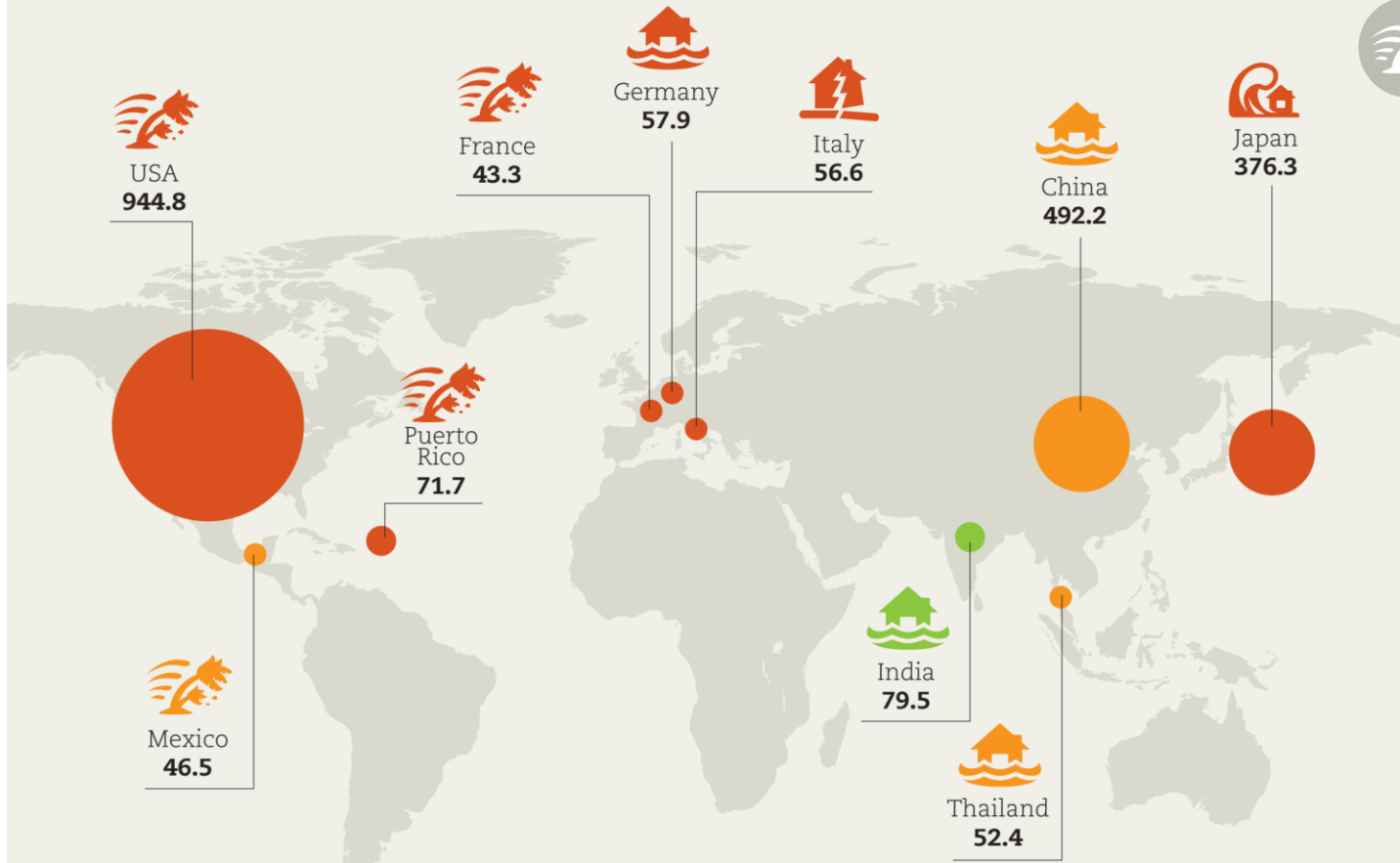
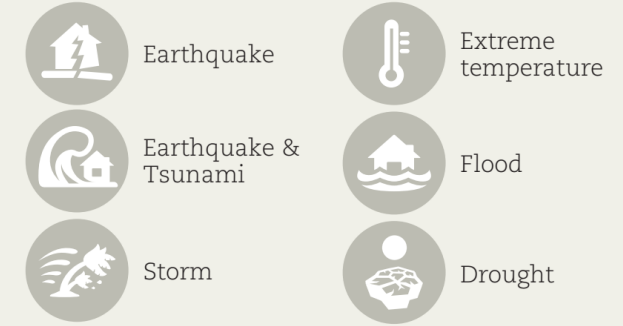
- Economic losses could be larger in rich countries
- Financial markets do not price climate-related risks adequately

In US\$, losses are largest in rich countries

Top 10 countries/territories in terms of absolute losses
(billion US\$) 1998-2017

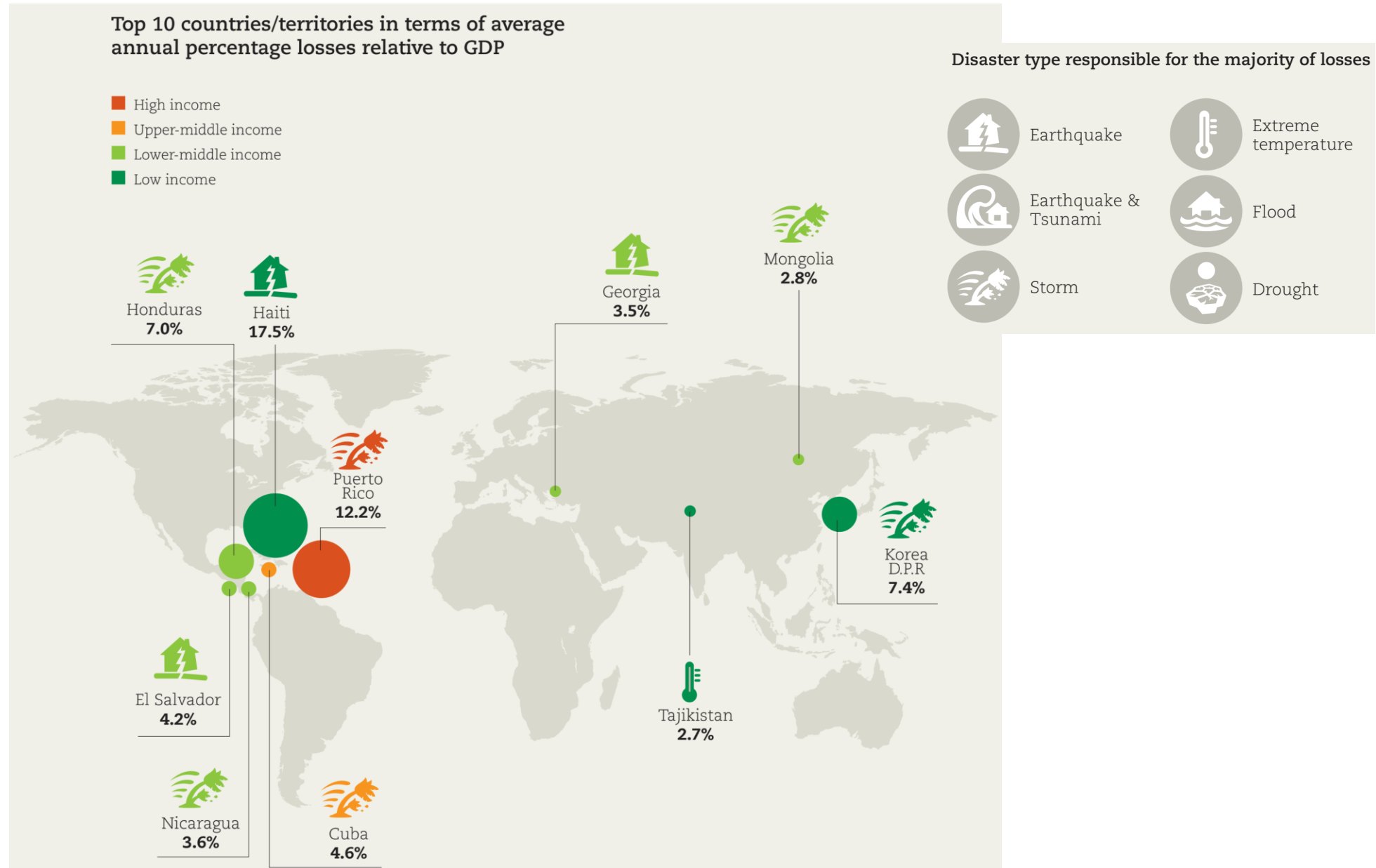
- High income
- Upper-middle income
- Lower-middle income
- Low income

Disaster type responsible for the majority of losses



United Nations
Office for Disaster
Risk Reduction
(UNISDR),
"Economic losses,
poverty & disasters:
1998-2017", 2018

In %GDP, losses are largest in poor countries



United Nations
Office for Disaster
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