



Institute
and Faculty
of Actuaries

IFoA GIRO Conference 2024

18–20 November, ICC, Birmingham



Institute
and Faculty
of Actuaries

Climate Scorpion – the sting is in the tail

Georgina Bedenham, Oliver Bettis

IFoA GIRO Conference 2024

Introductions

Georgina Bedenham



- IFoA Biodiversity Working Party member since 2020
- Author: *Climate Scorpion, The importance of biodiversity risks: Link to zoonotic diseases*
- Actuary at Government Actuary's Department (GAD)
- Specialising in disaster risk financing in low-middle income countries
- Nature Lead and member of GAD's Climate and Nature Group

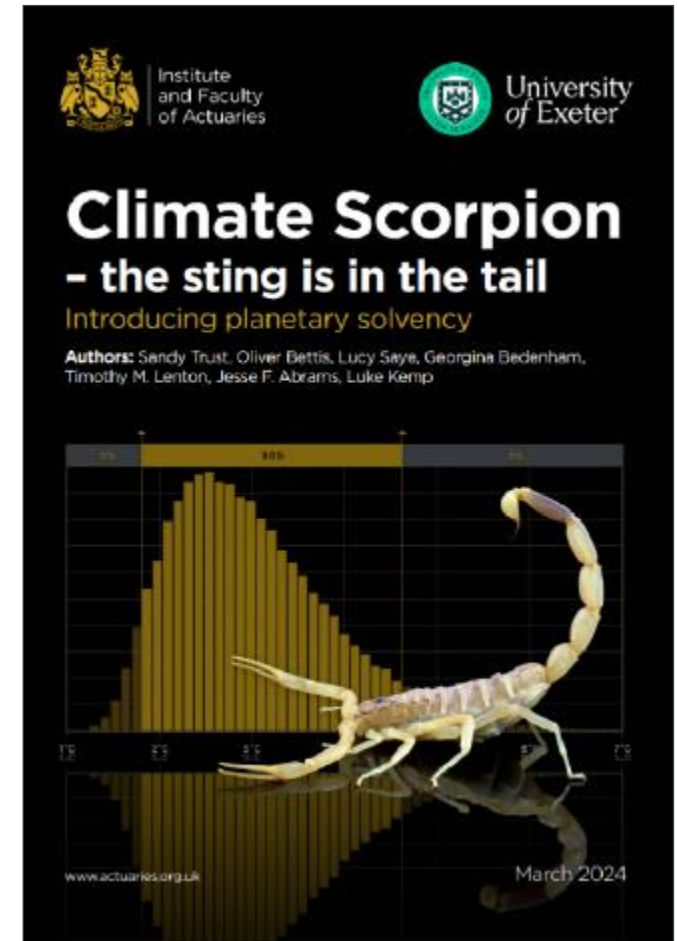
Oliver Bettis



- Inaugural Sustainability Board Chair 2014
- Author: *Climate Scorpion, The risk of climate ruin*
- Current Council Member
- Current Regulatory Board Member
- Co-chair Economics MIG
- ESG Actuary for Great Lakes Insurance (Munich Re Group)

Standby - incoming Climate Scorpion

- The Actuarial Approach to Climate Risk.
- IFOA Collaboration with Earth System Scientists.
- Shifting Distributions.
- Life in the Tail.
- The Sting – Equilibrium Climate Sensitivity and Tipping Points
- Realistic Risk Assessment, more Tipping Points
- Planetary Solvency



An Actuarial Approach to Climate Risk

“We need to have a best guess about the worst-case and make policy on that basis...”

IFOA collaboration with Earth System scientists

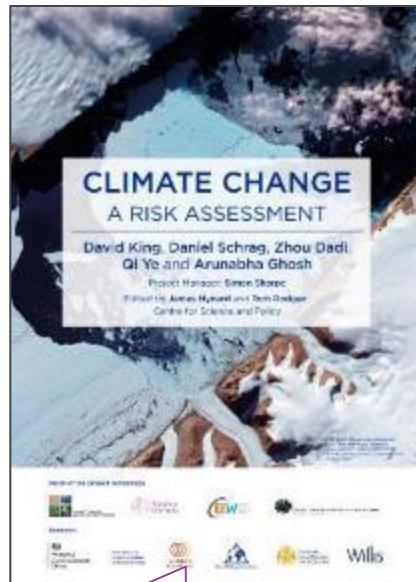
2015

2022

2023

2024

Today

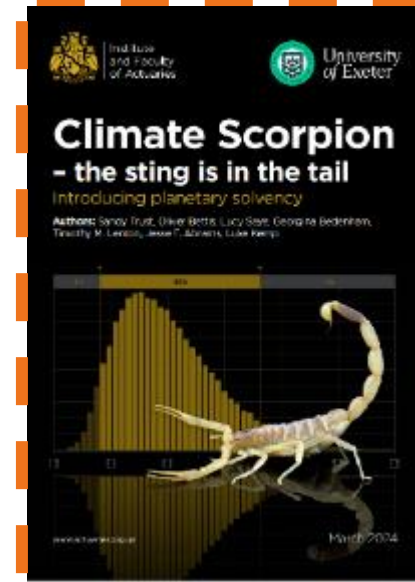


First global risk assessment of climate change, UK led with US, China and India. IFOA participated with input in particular from David Hare (then President) and Trevor Maynard (Lloyds of London).



Climate change is a risk management problem— one of the most important goals of climate change policy should be to limit the probability of a very bad outcome to an acceptably small value.

Many climate-scenario models in financial services are significantly underestimating climate risk...Real-world impacts of climate change are largely excluded from the damage functions of public reference climate-change economic models.



The Earth's climate may be more sensitive than we thought...time for Planetary Solvency

But why do we need actuaries to work with scientists?

Science

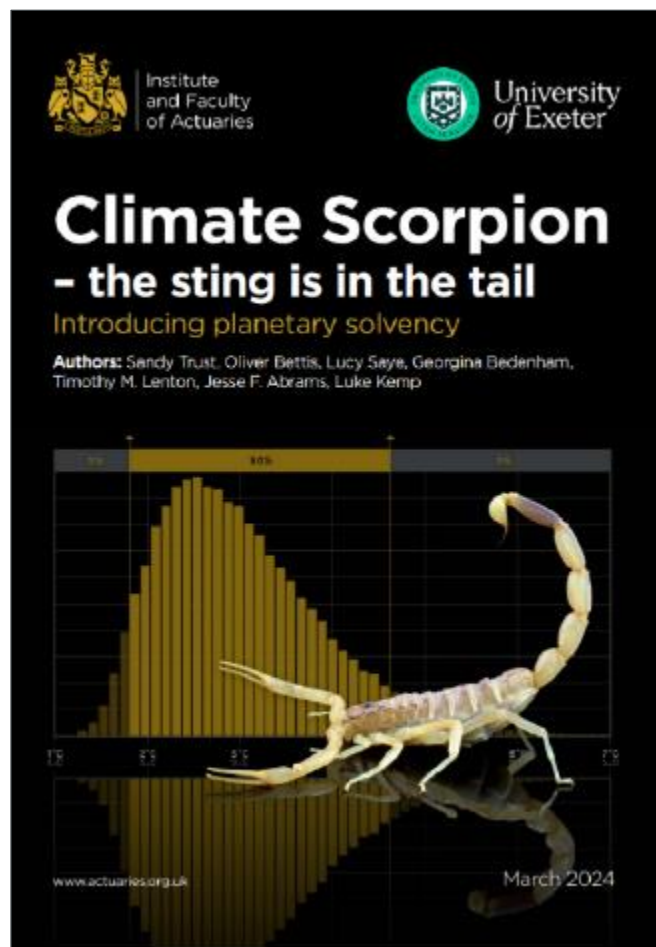
- We should not say there is an iceberg until we are fully confident there is one present
- Concerned with making predictions
- Which informs economists
- Which informs policy



Risk

- There could be an iceberg, so we should typically steer well clear of it
- Concerned with ‘what is the worst that could happen’
- This is no-one’s job...
- Could the actuarial profession play a role?

Climate Scorpion – Key Findings



1.

The rate of global warming accelerated in 2023, there is early indication this is not temporary.

2.

Life in the tail - increased warming is now driving more severe impacts across the planet .

3.

An overshoot of the 1.5°C temperature threshold is likely.

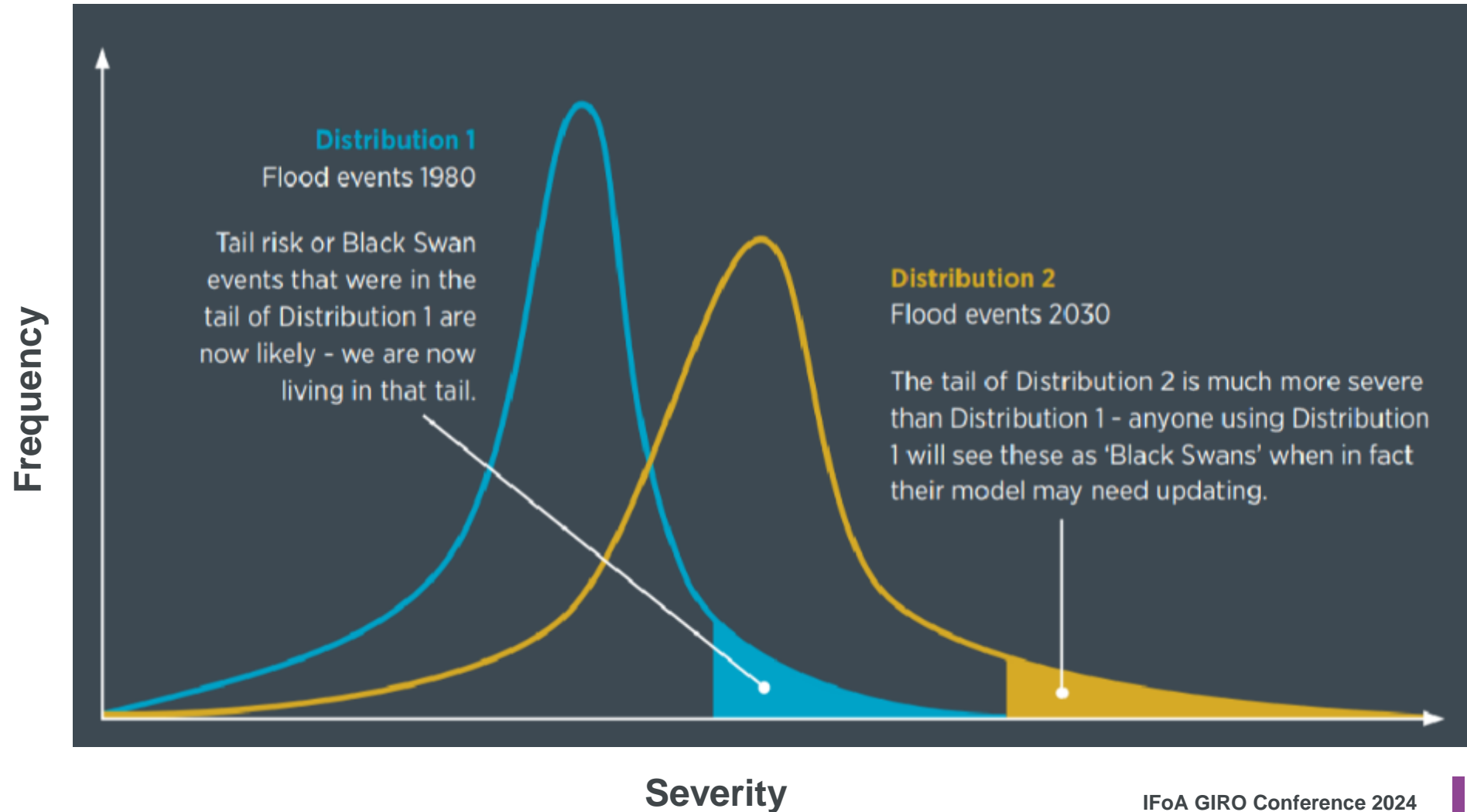
4.

The sting in the tail of the Earth's climate sensitivity.

5.

Warming above 1.5°C is dangerous, increasing the risk of triggering multiple climate tipping points.

Tail risk and shifting distributions



Distributions illustrative, not based on flood data

Earth's climate may be more sensitive than we thought

A planetary cooking experiment with global consequences...

1. Greenhouse gas levels are the hand on the temperature setting



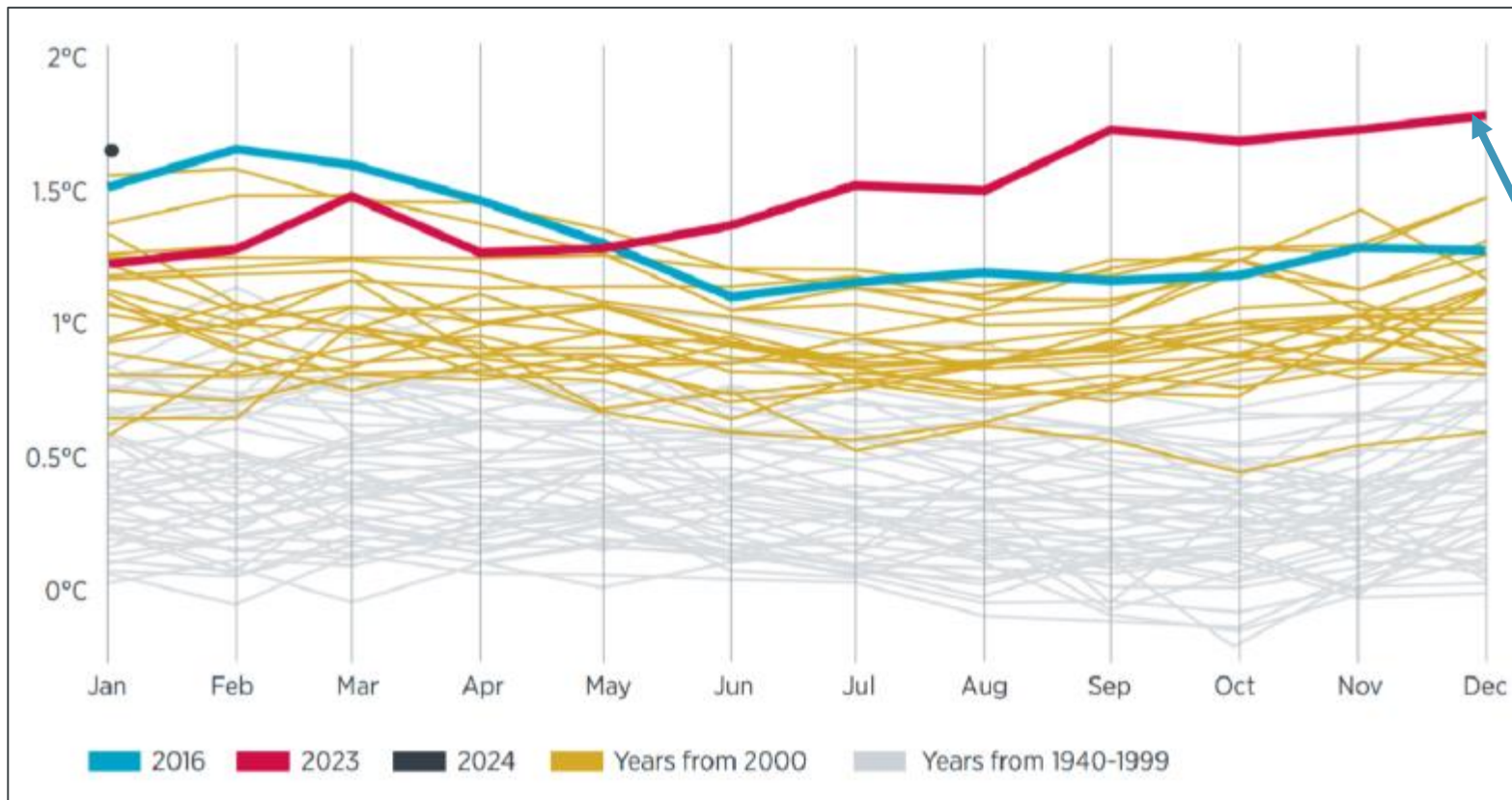
2. Earth's Energy Imbalance is the current

3. Equilibrium Climate Sensitivity (ECS) is the temperature gauge

4. Carbon budgets are the timer

The rate of global warming accelerated in 2023

Global Surface Air Temperature Anomalies



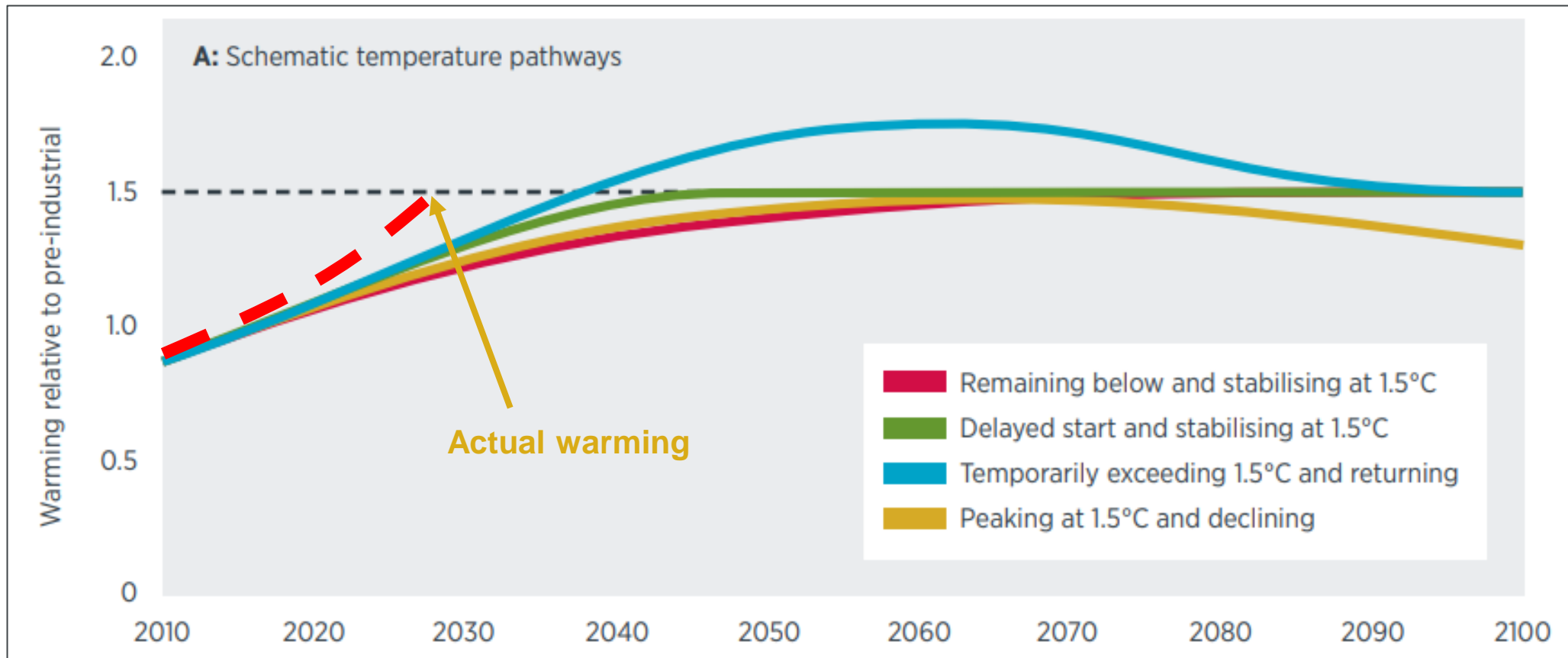
The last 9 months (to February) have consistently set temperature records for hottest month on record. Sea surface temperatures have set daily records for over a year.

2023 temperatures are shown by the red line. Notice the jump up in temperature over the 2nd half of 2023, with temperatures near the 1.75°C mark.

Source: IFoA analysis, Data ERA5 1940-2024, Reference period: 1850-1900, Source: climate.copernicus.eu

Increasing the chance of overshoot

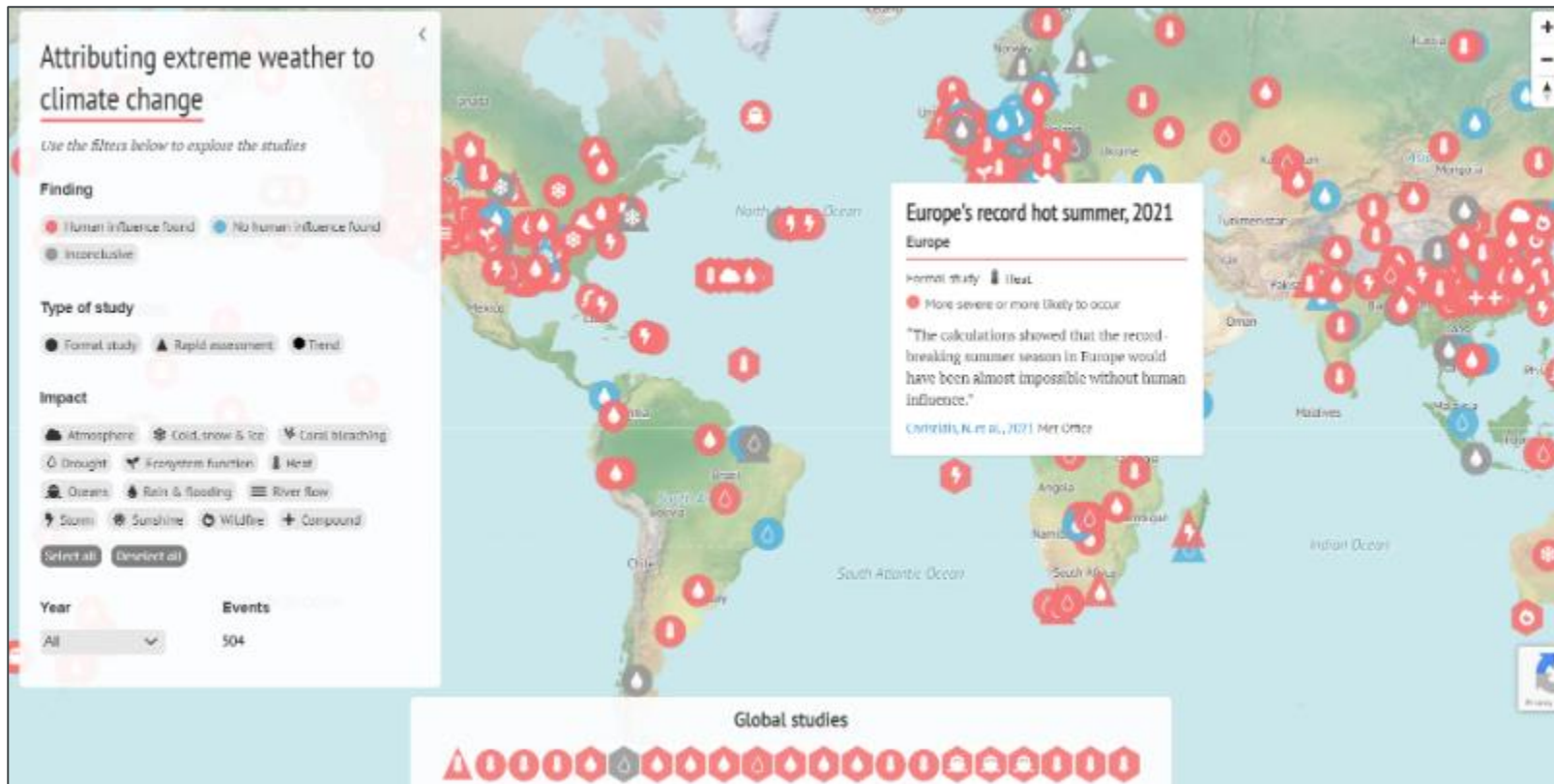
IPCC Schematic of Temperature Pathways



Source: IPCC

Life in the tail – more stings and more painful

Global attribution map of extreme weather events to climate change

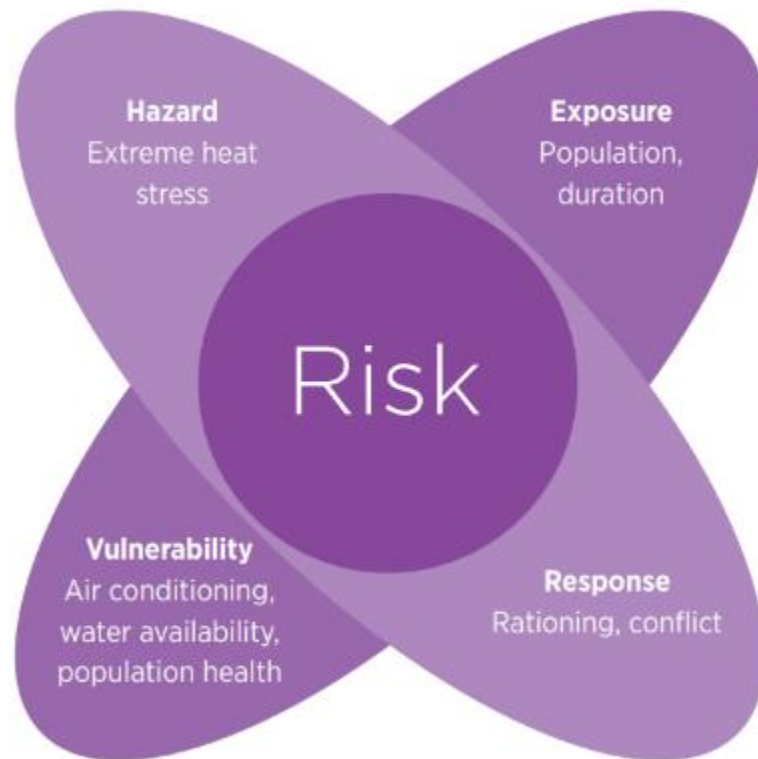


- Increase of record-breaking events across the globe, impacting billions of people.
- Increasing frequency and magnitude as the planet warms further.
- Economic impacts trending towards trillions

Source: Carbon Brief Mapped: How climate change affects extreme weather around the world (carbonbrief.org)

Systemic risk assessment

The hazard, exposure, vulnerability, response model for risk assessment



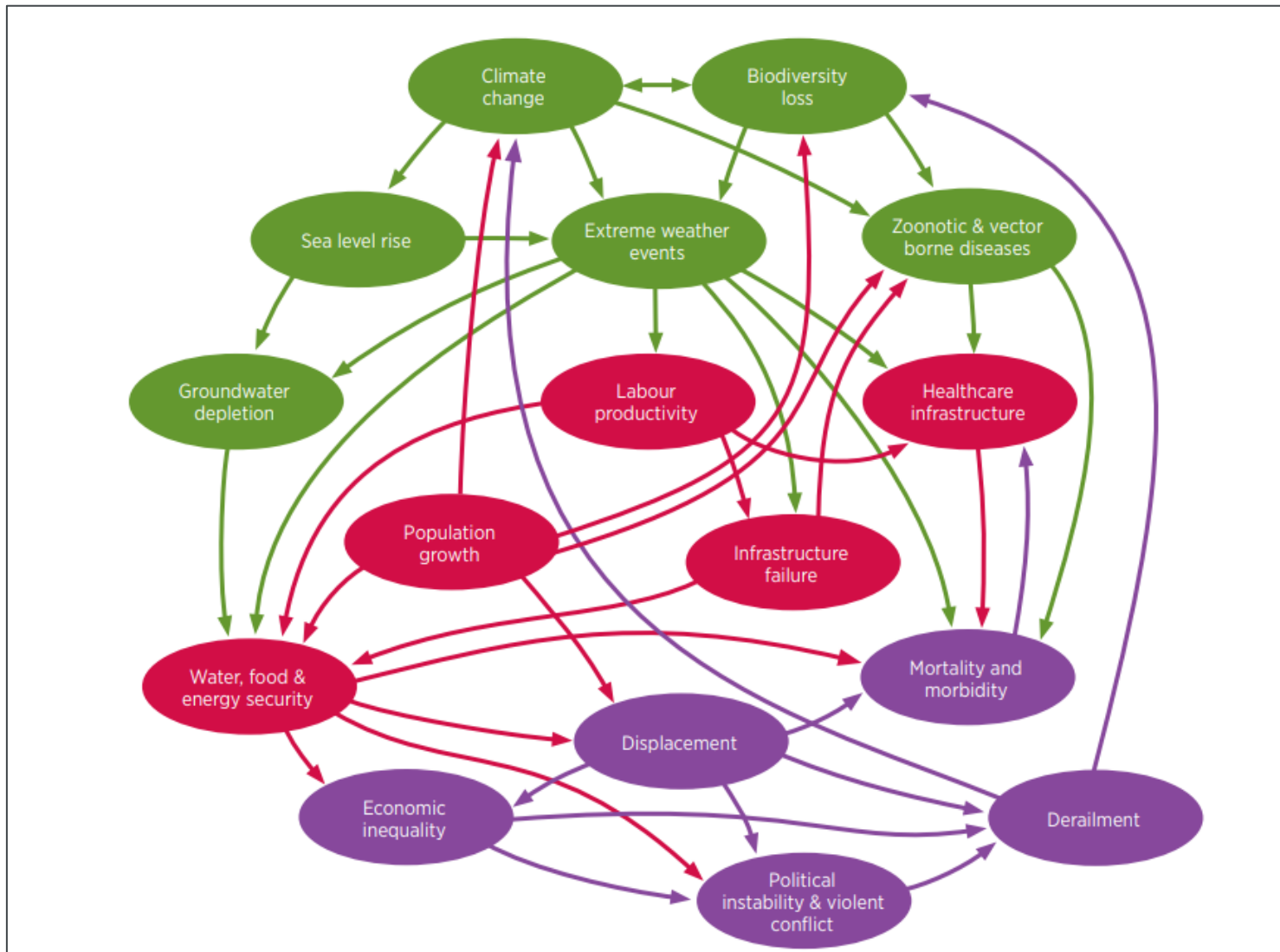
Emerging infectious diseases

Food insecurity

Water security

Extreme heat stress

Climate change as a driver for interconnected risks



● Environmental ● Social risks ● Economic risks

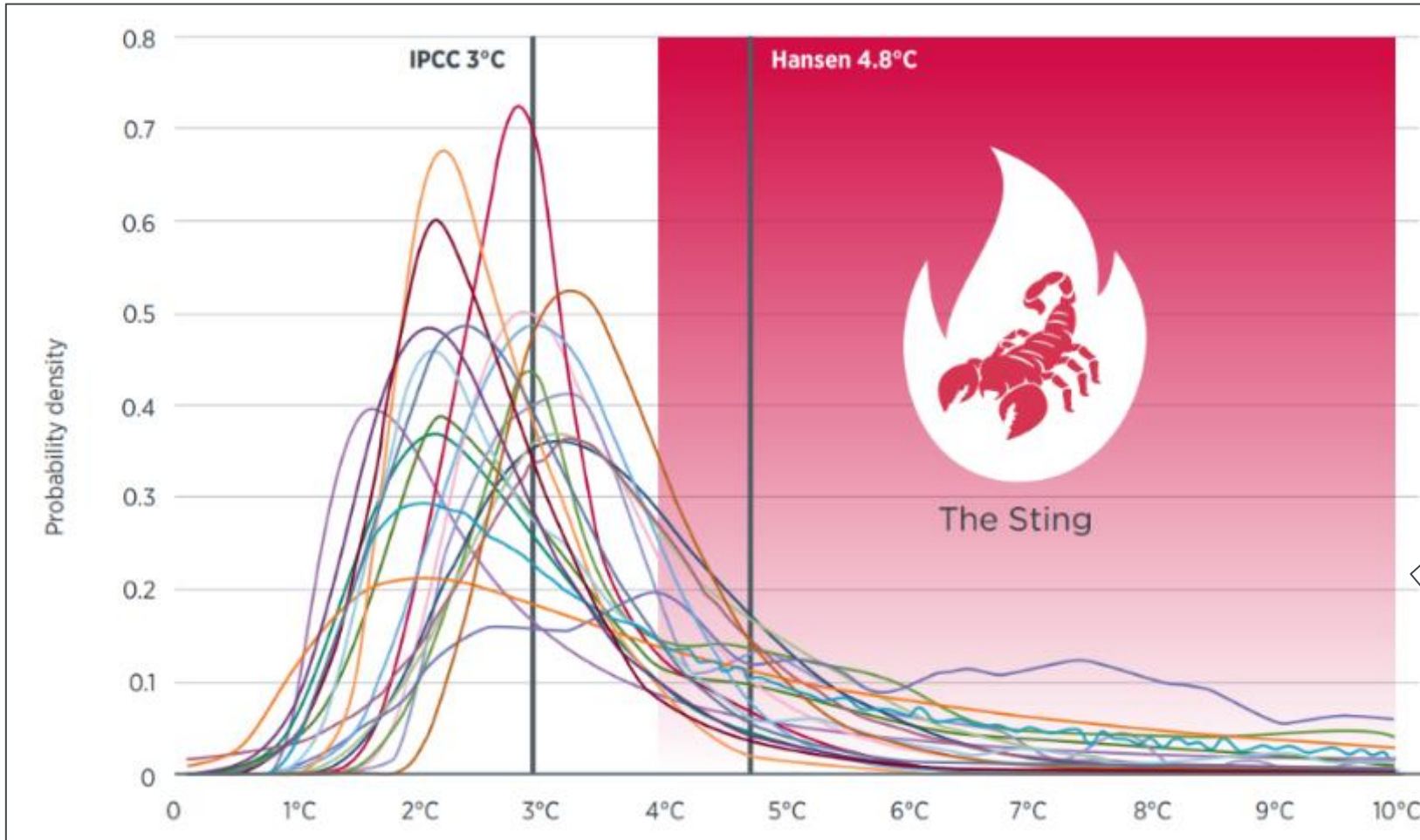
Source: Lucy Saye

Complex, compounding, cascading – characteristics of interconnected risks.

Failure to consider interconnections leads to underestimation of risk and societal impacts.

Derailment risk – response to increasingly chaotic conditions could divert focus from environmental action.

The sting in the tail of climate sensitivity



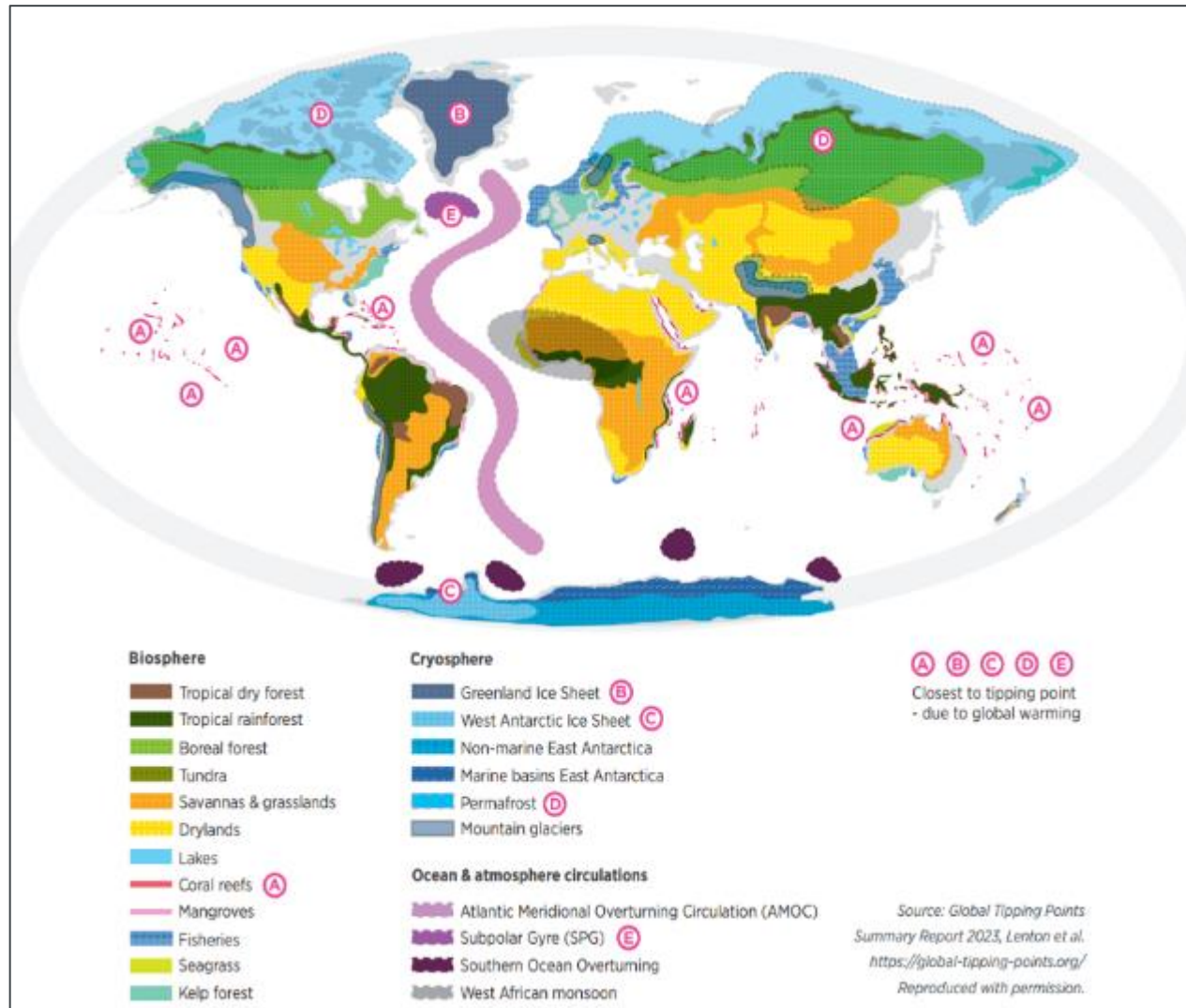
ECS has a long tail to higher temperatures. This is due to uncertainties in the magnitude of feedbacks, such as aerosol cooling, cloud formation and break-up. Because of this uncertainty, estimates vary substantially.

Under the latest IPCC estimates there is an 18% chance of ECS being greater than 4.5°C.

...a higher probability than the chance of failure in the game of Russian Roulette.

Source: Climate Scorpion – the sting is the tail

Overshoot of 1.5°C increases climate tipping point risk

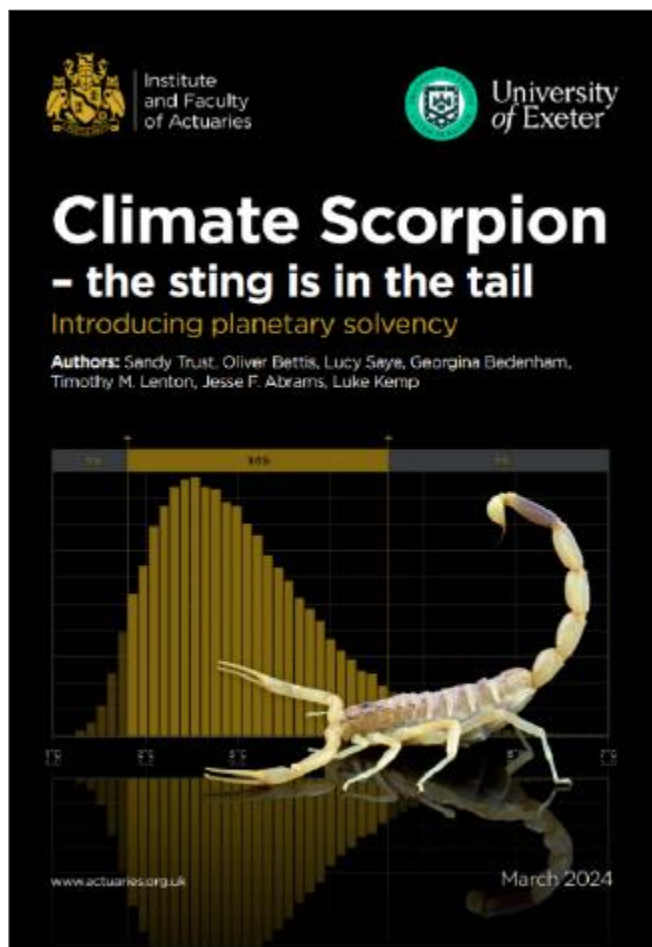


Source: Global Tipping Points

“It re-emphasizes how important it is to treat 1.5°C as a physical limit and not a political target, recognizing the risk from tipping points.”

Four of these are showing scientific evidence of now being at risk already at 1.5°C, really putting humanity’s future at risk.” Professor Johan Rockstrom

Climate Scorpion – Recommendations



1.

Carry out a realistic risk assessment of climate change as a matter of urgency, and act on it.

2.

Educate and take action to accelerate positive tipping points in the economic system.

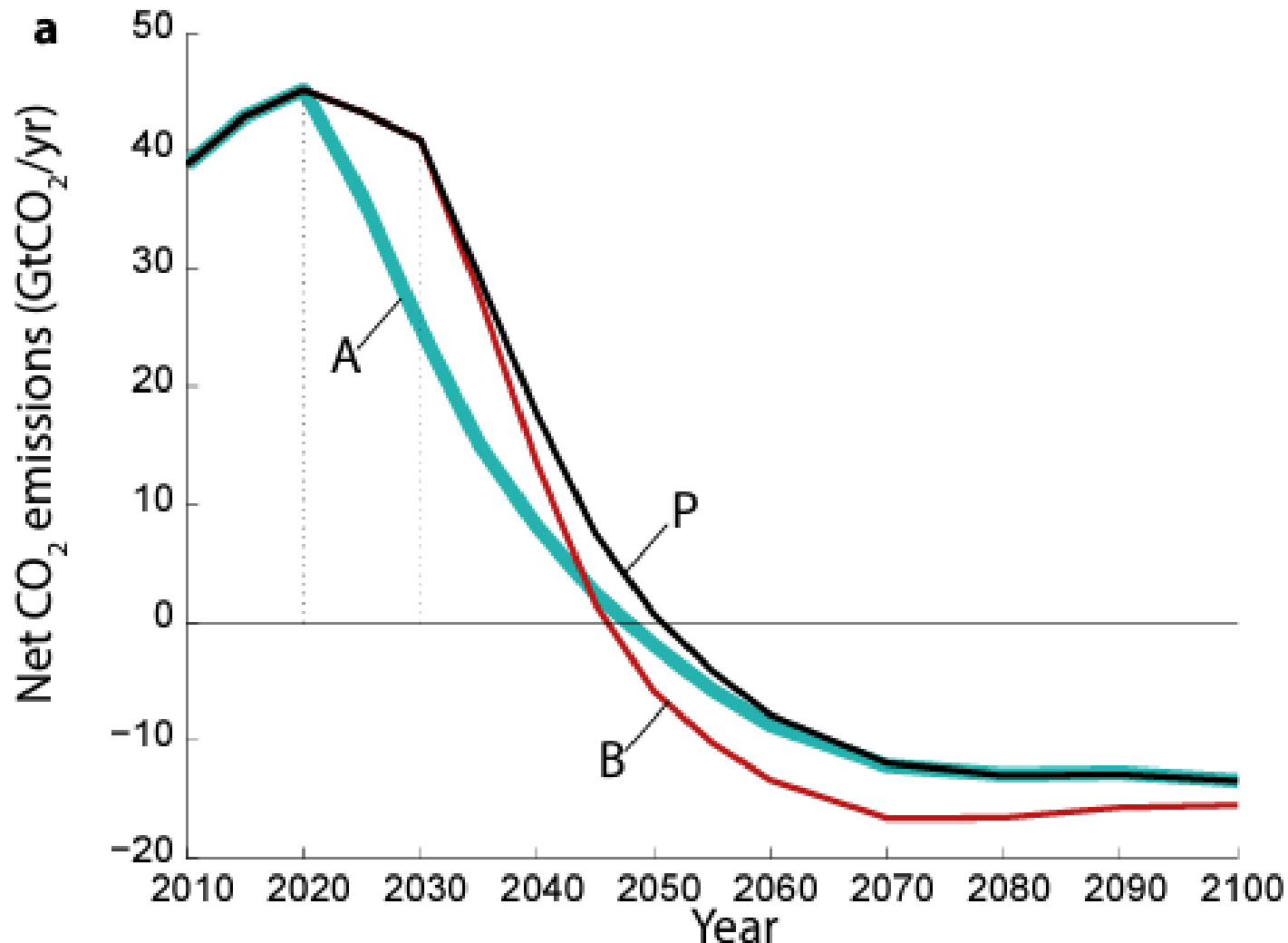
3.

Develop a Planetary Solvency framework to support long term policy decisions.

4.

Financial services institutions should review net zero approaches and related assumptions.

A need to review net zero budgets and approaches

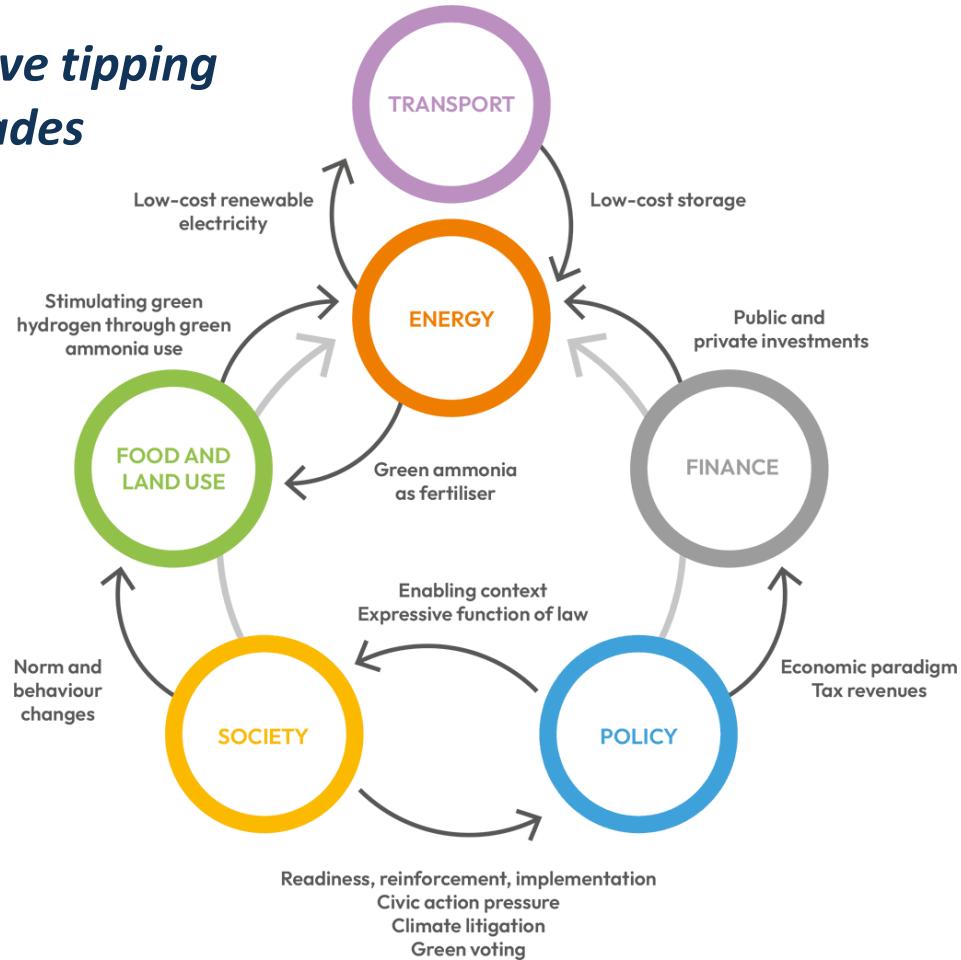


Possible implications for financial services firms:

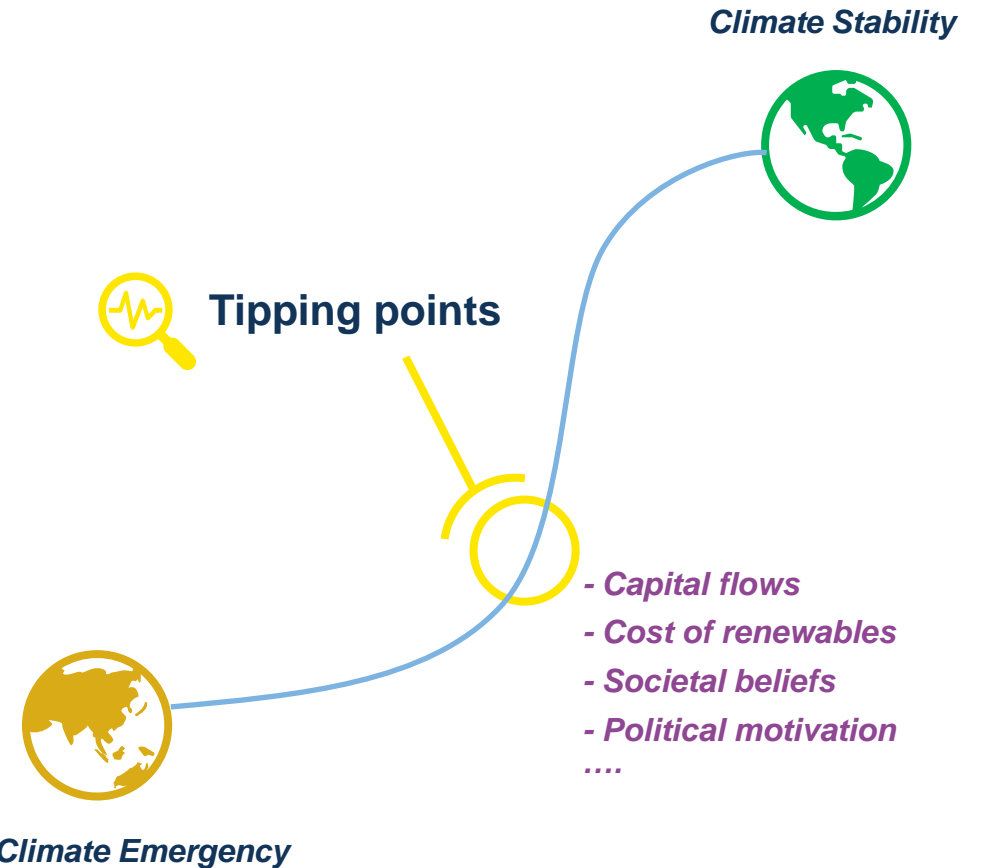
- A need to re-visit carbon budgets and related assumptions;
- Consider moving away from temperature commitments to focus on supporting real world decarbonization;
- Consider how to support policy action to accelerate positive tipping points?

Education and action on positive tipping points

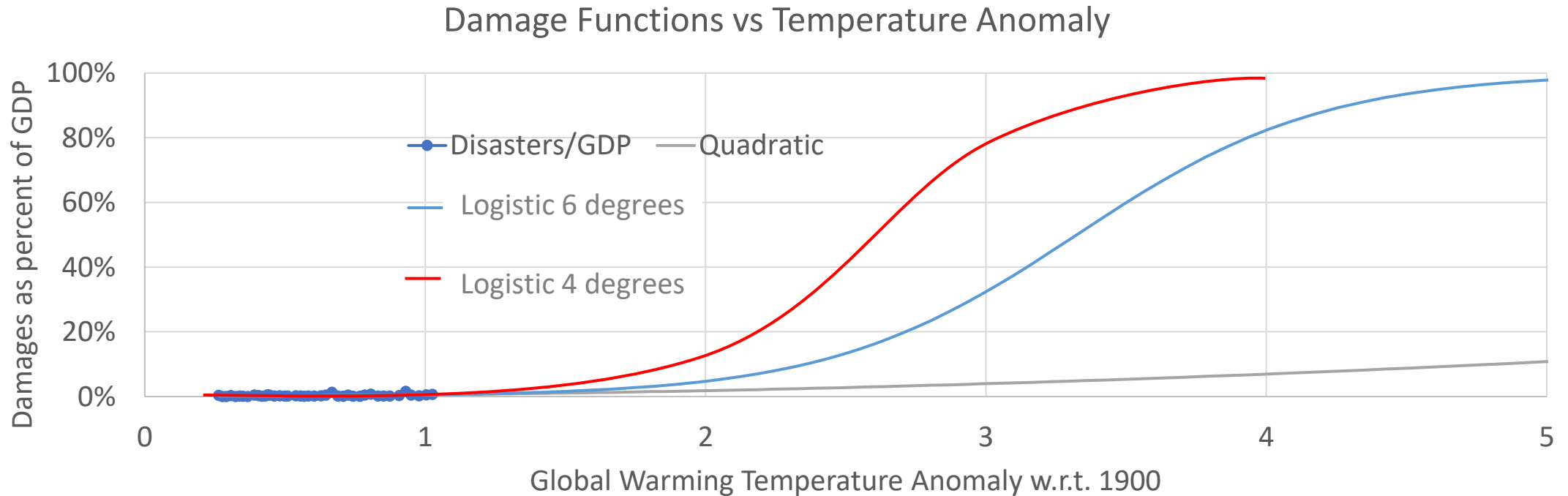
Positive tipping cascades



Source: Global Tipping Points

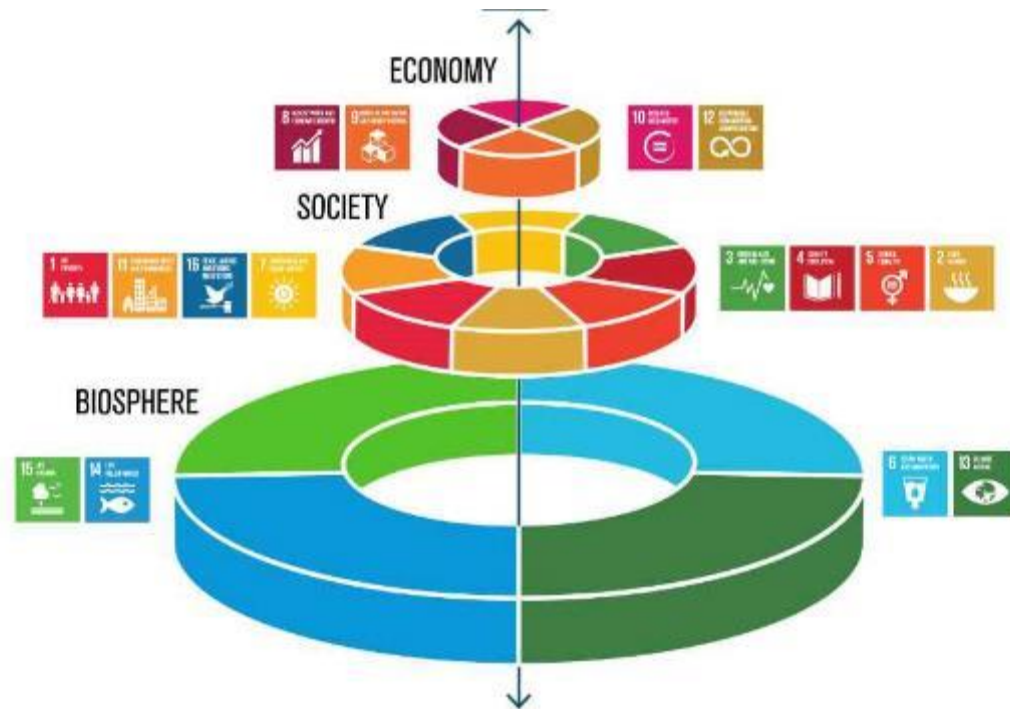


Something a little more realistic?



Source: Carbon Tracker, Keen et al, IFoA analysis.

The Earth System is the foundation for our civilisation

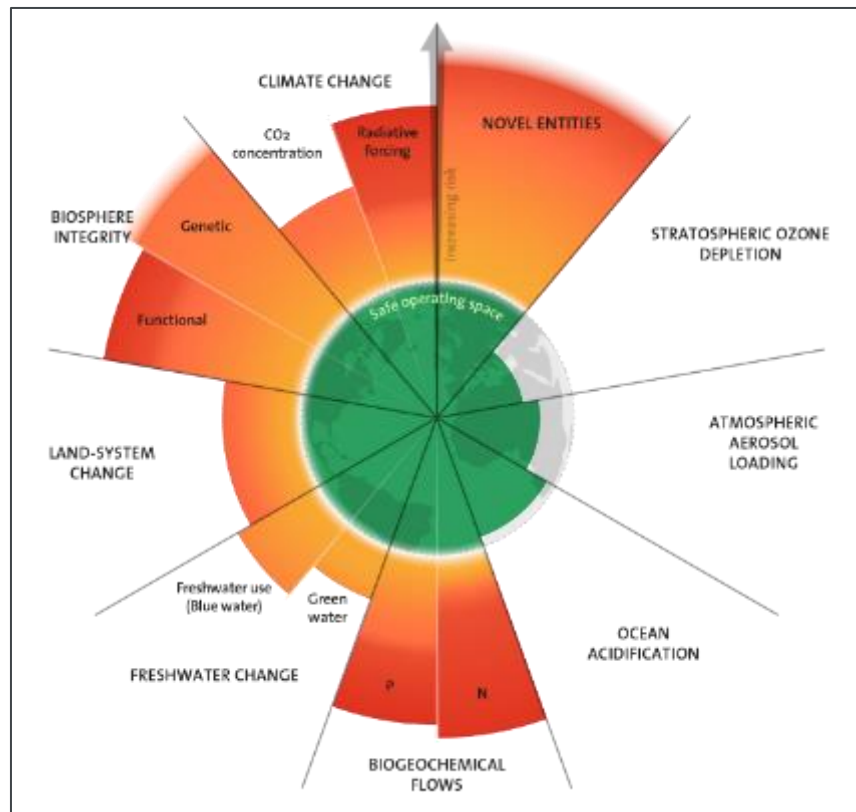


Source: Stockholm Resilience Centre

- Human society and economy rest on a stable biosphere
- The biosphere provides food, water, air, energy and raw materials to us
- Human activity is now threatening the stability of that foundation
- Risking our ability to maintain our global society and economy
- As a species we risk becoming insolvent on a planetary scale

Planetary solvency protects citizens from the ruin of their environment – and hence civilisation

Planetary boundaries – solvency limits

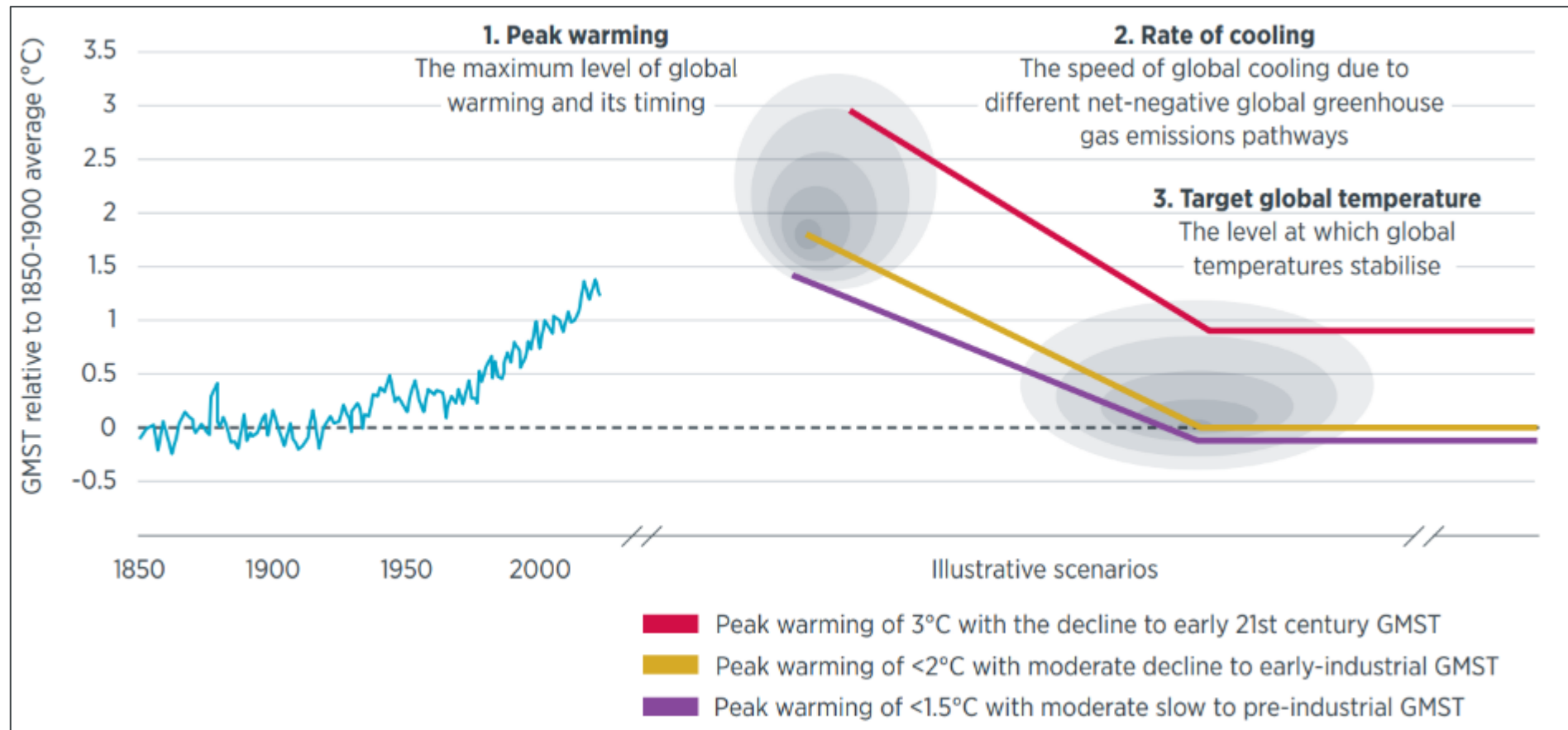


Source: Stockholm Resilience Centre

Applying an actuarial approach

- Develop risk likelihood and impacts
- What biosphere risk drivers would cause societal collapse/extinction/GDP collapse?
- How close are we to that on current trajectories?
- What action do we need to take to avoid these outcomes?
- Nature, climate, society

Planetary solvency – long term climate objectives



Source: Preparing for a post-net-zero world | A D King et al (nature.com)

Term	Definition
Latent risk	Risk that is dormant under one set of conditions but becomes active under another set of conditions
Risk cascade	Chains of risk occurring when an adverse impact triggers a set of linked risks
Systemic risk	The potential for individual disruptions or failures to cascade into a system-wide failure.
Extreme climate change	Mean global surface temperature rise of 3 °C or more above preindustrial levels by 2100
Extreme nature risk	Significant breakdown of majority of ecosystem services by 2100.
Extinction risk	The probability of human extinction within a given timeframe.
Extinction threat	A plausible and significant contributor to total extinction risk
Societal fragility	The potential for smaller damages to spiral into global catastrophic or extinction risk due to societal vulnerabilities, risk cascades, and maladaptive responses.
Societal collapse	Significant socio-political fragmentation and/or state failure with rapid, enduring, and significant loss of capital, and systems identity; this can lead to large-scale increases in mortality and morbidity
Global catastrophic risk	The probability of a loss of 25% of the global population and the severe disruption of global critical systems (such as food) within a given timeframe (years or decades).
Global catastrophic threat	A plausible and significant contributor to global catastrophic risk; the potential for climate change to be a global catastrophic threat can be referred to as “catastrophic climate change”
Global decimation risk	The probability of a loss of 10% (or more) of global population and the severe disruption of global critical systems (such as food) within a given timeframe (years or decades).
Global decimation threat	A plausible and significant contributor to global decimation risk.
Endgame territory	Levels of global warming and societal fragility that are judged sufficiently probable to constitute climate change and/or nature impacts as an extinction threat.
Worst-case warming	The highest empirically and theoretically plausible level of global warming
Worst-case nature	Significant breakdown of multiple ecosystems damaging biosphere integrity leading to mass extinction event and breakdown of ecosystem services.

Output: Risk Impact and Likelihood Matrix

RATING	Financial Impact	Non-Financial Impact			
	GDP losses	Human mortality	Climate	Nature	Societal
EXTREME	≥50%	≥50% > 4 billion deaths	3C or more by 2100 Multiple climate tipping points triggered, tipping cascade.	Breakdown of several critical ecosystem services and Earth systems. High level of extinction of higher order life on Earth.	Significant socio-political fragmentation worldwide and/or state failure with rapid, enduring, and significant loss of capital, and systems identity. Frequent large scale mortality events.
CATASTROPHIC	≥25%	≥25% >2 billion deaths	2C or more by 2100 High number of climate tipping points triggered, partial tipping cascade.	Breakdown of some critical ecosystem services and Earth systems. Major extinction events in multiple geographies. Ocean circulation severely impacted.	Severe socio-political fragmentation in many regions, low lying regions lost. Heat and water stress drive involuntary mass migration of billions. Catastrophic mortality events from disease, nutrition, thirst and conflict.
DECIMATION	≥10% >\$10 trillion annual losses	≥10% > 800 million deaths	Global warming limited to 2C by 2100 Several climate tipping points triggered.	Severe reduction in several critical ecosystem services. Major extinction events in some geographies. Frequent global food and water crises.	Severe socio-political fragmentation in regions exposed to climate and/or nature impacts. Failure of vulnerable states and mass mortality events in impacted areas.
SEVERE	≥5% >\$5 trillion annual losses	≥5% > 400 million deaths	Global warming limited to 1.5C by 2100 following overshoot Some proximate climate tipping points triggered	Some impacts to critical ecosystem services. Ongoing species extinction. Regular global food and water crises.	Some socio-political fragmentation in most vulnerable states, where adaptation has been limited. Fragile states exposed to climate risks see mass migration and mortality events from heat, water stress and weather events.
LIMITED	≥1% >\$1 trillion annual losses	≥1% > 8 million deaths	Global warming below 1.5C by 2100, with limited overshoot Climate tipping points largely avoided	Mass extinction avoided and ecosystem services largely functional. Occasional global food crisis and widespread water crises.	Ongoing significant climate impacts with many hundreds of billion dollar + loss events annually and associated mortality and socio-political stress.

LIKELIHOOD The likelihood of the risk occurring over a certain timeframe	EXTREMELY UNLIKELY	HIGHLY UNLIKELY	UNLIKELY	POSSIBLE	LIKELY	HIGHLY LIKELY
	<1%	1-10%	10-40%	40-60%	60-90%	≥90%

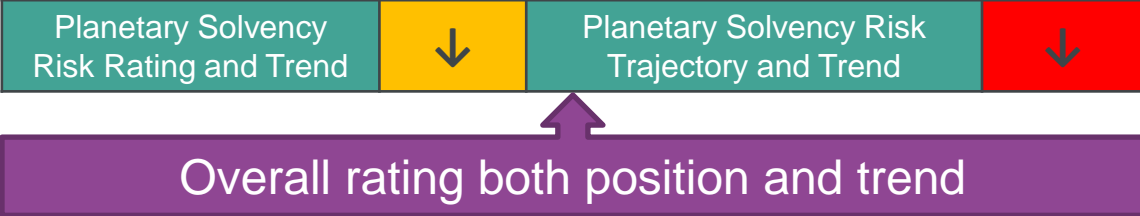
Source: *Climate Endgame* 2022 by Luke Kemp, Chi Xu, Joanna Depledge, Tim Lenton

IFoA GIRO Conference 2024
18 – 20 November, ICC, Birmingham



Institute and Faculty of Actuaries

Planetary Solvency Explanation



The y-axis shows risk impacts, described in the impact & likelihood matrix

Green and yellow – safe zone

The green and yellow areas are the safe zone – keeping risks in here gives a good chance that our society can carry on.

The x-axis shows how likely each risk is assessed to be, also described in the impact & likelihood matrix

Extinction	Yellow	Orange	Orange	Red	Red	Red
Extreme	Yellow	Yellow	Orange	Orange	Red (2)	Red (1)
Catastrophic	Green	Yellow	Orange	Orange	Orange (2)	Red (1)
Decimation	Green	Yellow	Yellow	Orange	Orange (3)	Orange
Severe	Green	Green	Yellow	Yellow	Yellow (3)	Yellow (2)
Limited	Green	Green	Green	Green	Yellow (3)	Yellow (2)
SCALE	Extremely Unlikely	Highly Unlikely	Unlikely	Possible	Likely	Highly Likely

Red and amber – death zone

The red and amber areas of the chart are **outside risk appetite** – if risks are allowed to develop into these areas increasingly serious impacts are expected and the challenge of bringing risks back within appetite is exponentially increased due to tipping points.

- Risk Trajectory
- Risk Position

Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.