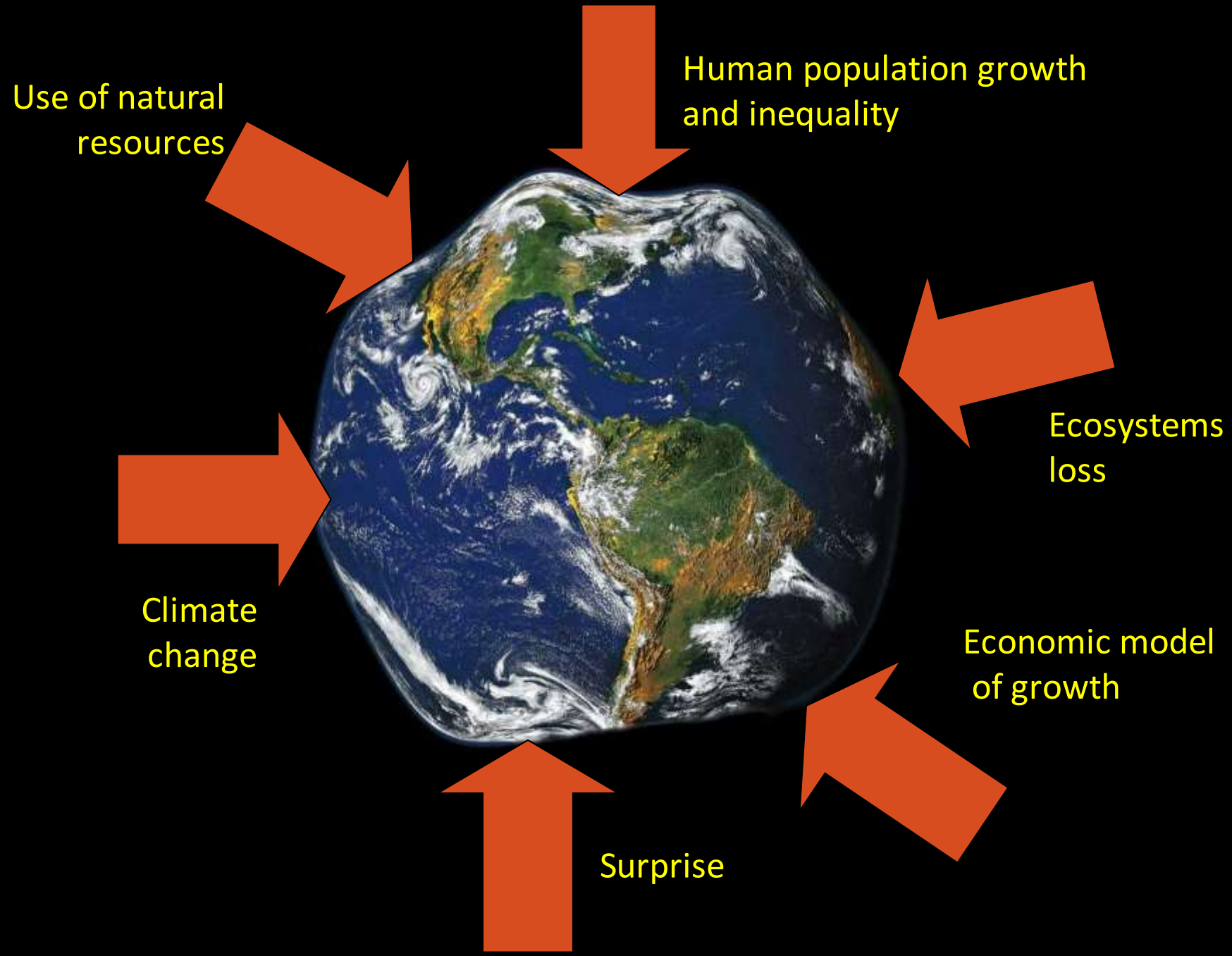
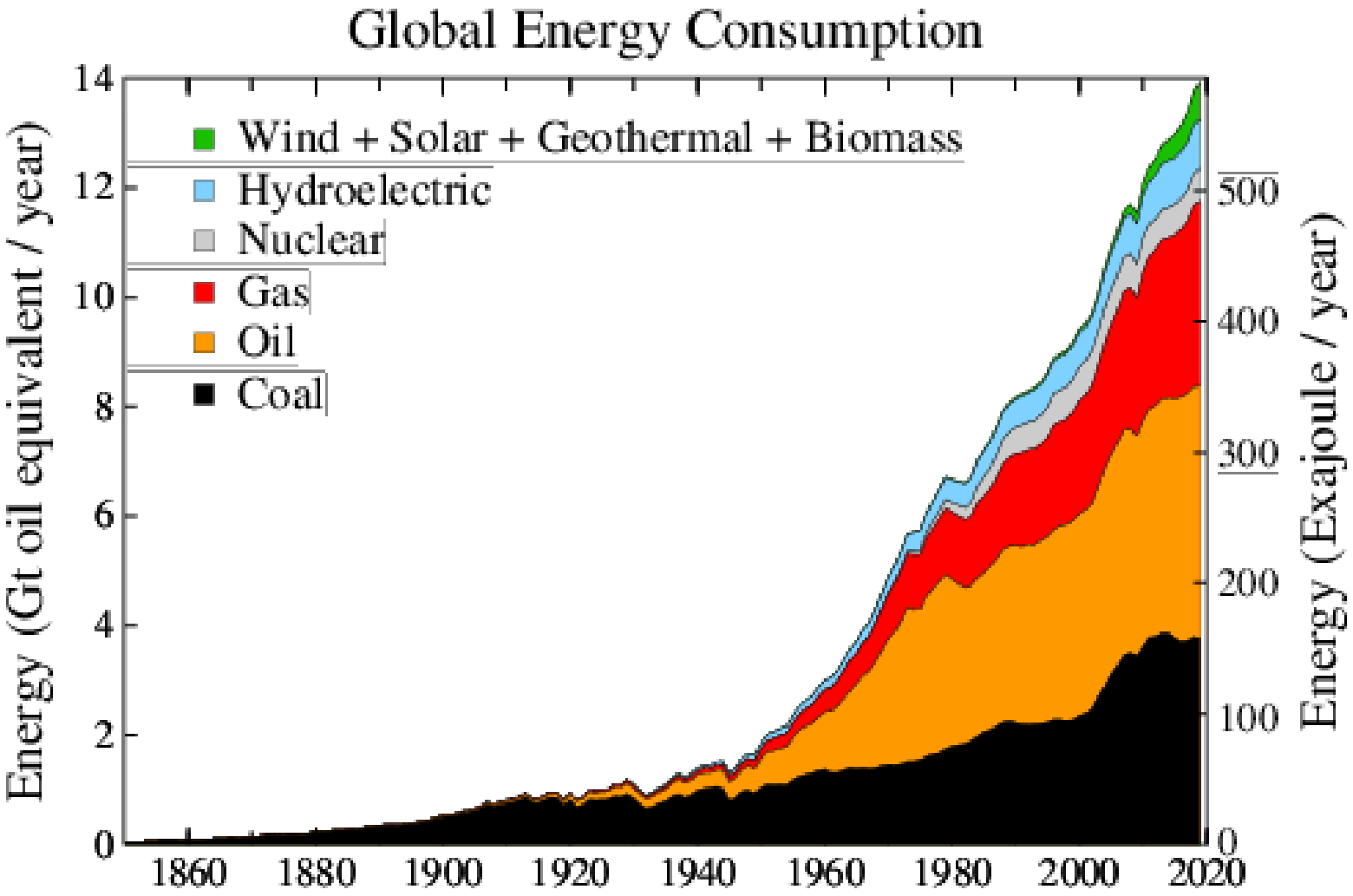
# Biofizične, ekonomske, tehnološke in družbene omejitve blaženja in prilagajanja podnebnim spremembam

Prof. Lučka Kajfež Bogataj

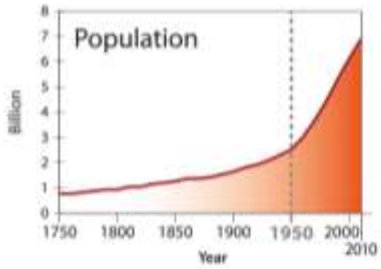

Use of natural resources
Human population growth and inequality
Ecosystems loss
Climate change
Economic model of growth
Surprise

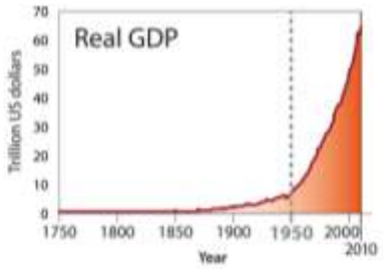
- Civilization is being threatened in ways it never has before, presenting new realities, new norms and new shocks.
- Alpine space and people are intimately connected to these startling changes: resource use, climate change, political instability, human rights, immigration and border issues, to name a few.

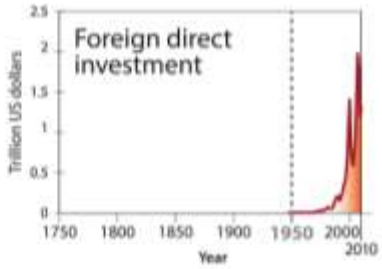
# LIFESTYLE TODAY IS HIGLY ENERGY CONSUMING

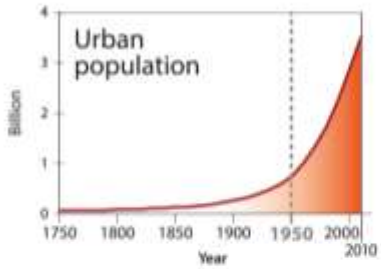


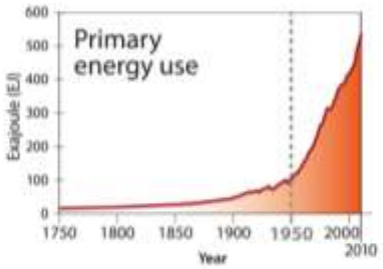
# Socio-economic trends

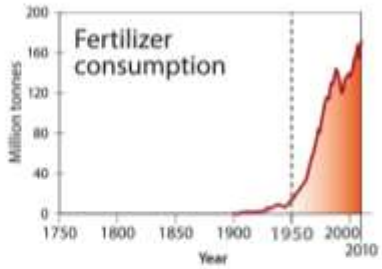


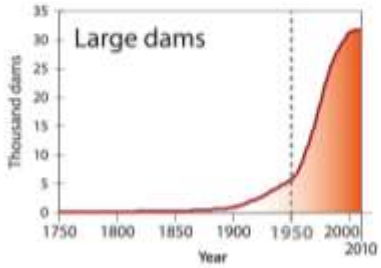



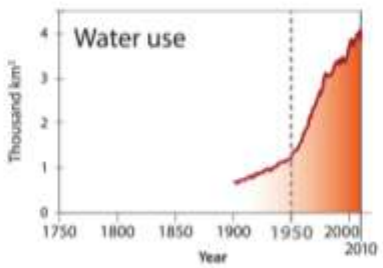



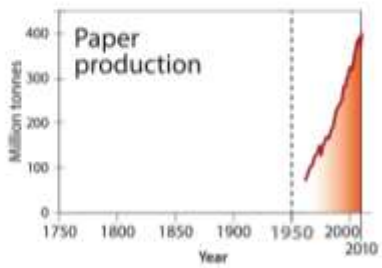



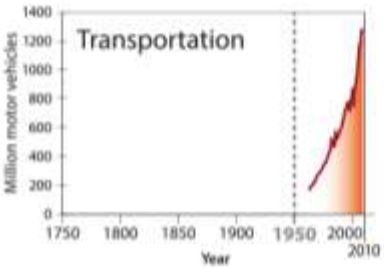



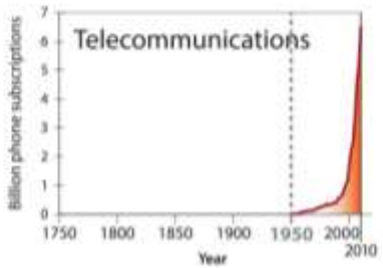



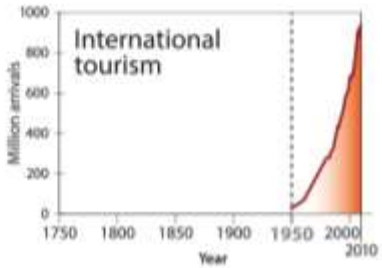



From

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# The planetary boundaries concept

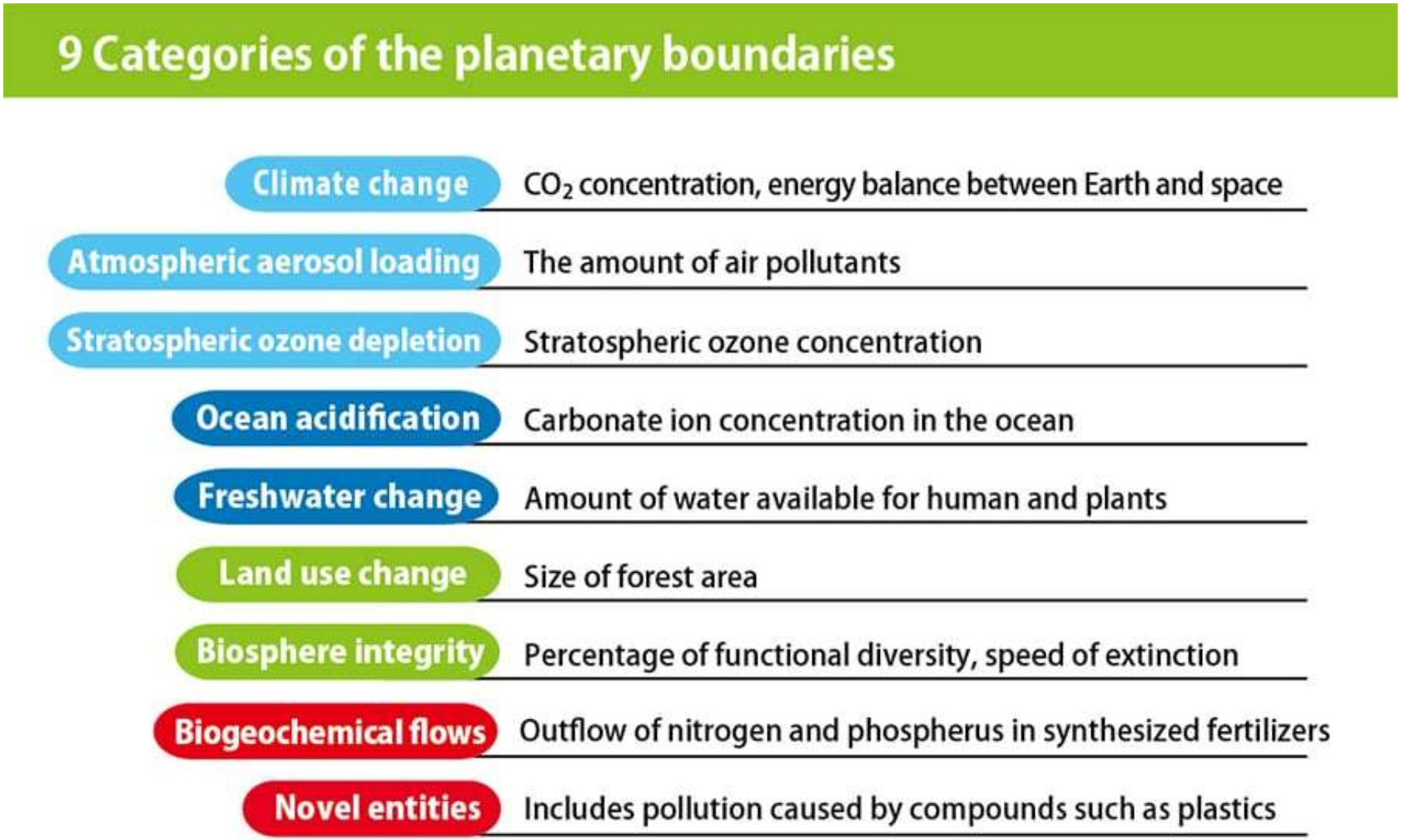
Stockholm Resilience Centre | Stockholm University

https://www.stockholmresilience.org/research/planetary-boundaries.html

# The planetary boundaries concept

The planetary boundaries signify the Earth's capacity to tolerate change and set out the science-based limits that must not be surpassed if the Earth is to remain hospitable for future generations.

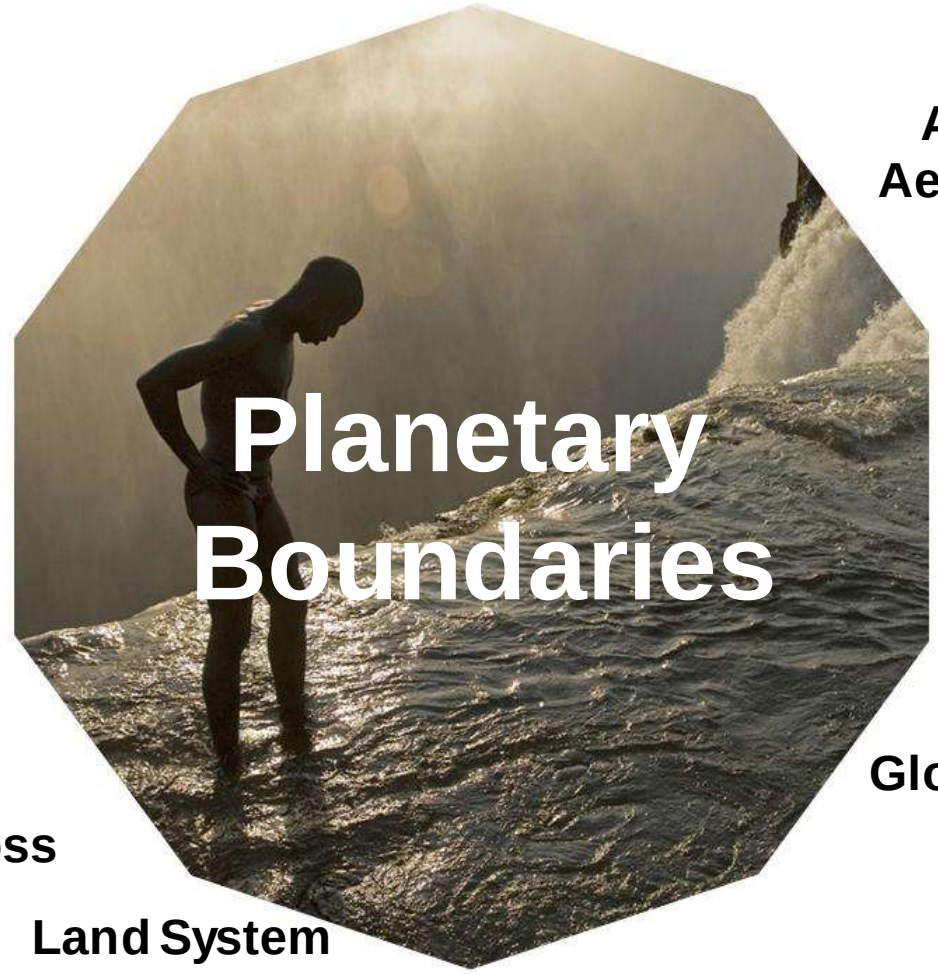
# "Planetary Boundaries" concept:
# Indicating the limits of the global environment



Climate Change

Ozone depletion

Biogeochemical loading: Global N & P Cycles




Atmospheric Aerosol Loading

Ocean acidification

Rate of Biodiversity Loss

Global Freshwater Use

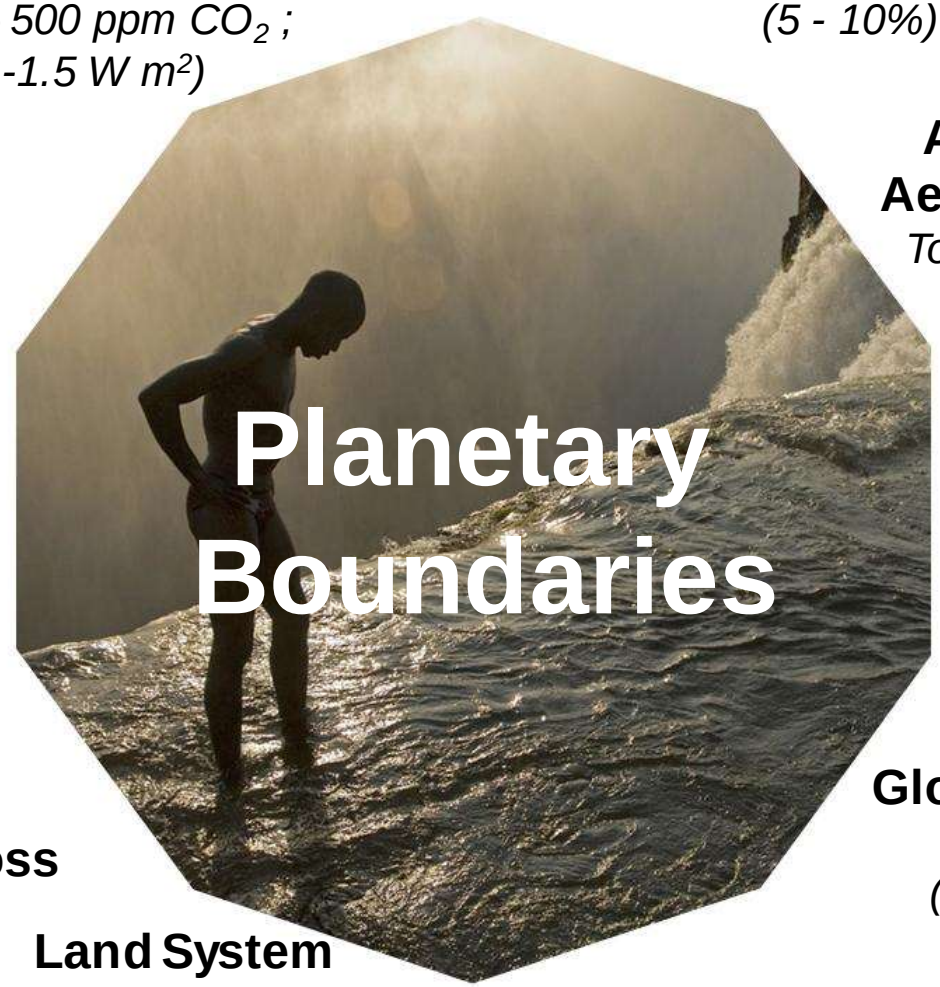
Land System Change

Chemical Pollution

**Climate Change**
*< 350 ppm $CO_2$ < 1W $m^2$*
*(350 – 500 ppm $CO_2$ ;*
*1-1.5 W $m^2$)*

**Ozone depletion**
*< 5 % of Pre-Industrial 290 DU*
*(5 - 10%)*

**Biogeochemical loading: Global N & P Cycles**
*Limit industrial fixation of $N_2$ to 35 Tg N $yr^{-1}$(25 % of natural fixation)*
*(25%-35%)*
*P < 10× natural weathering inflow to Oceans*
*(10× – 100×)*




**Atmospheric Aerosol Loading**
*To be determined*

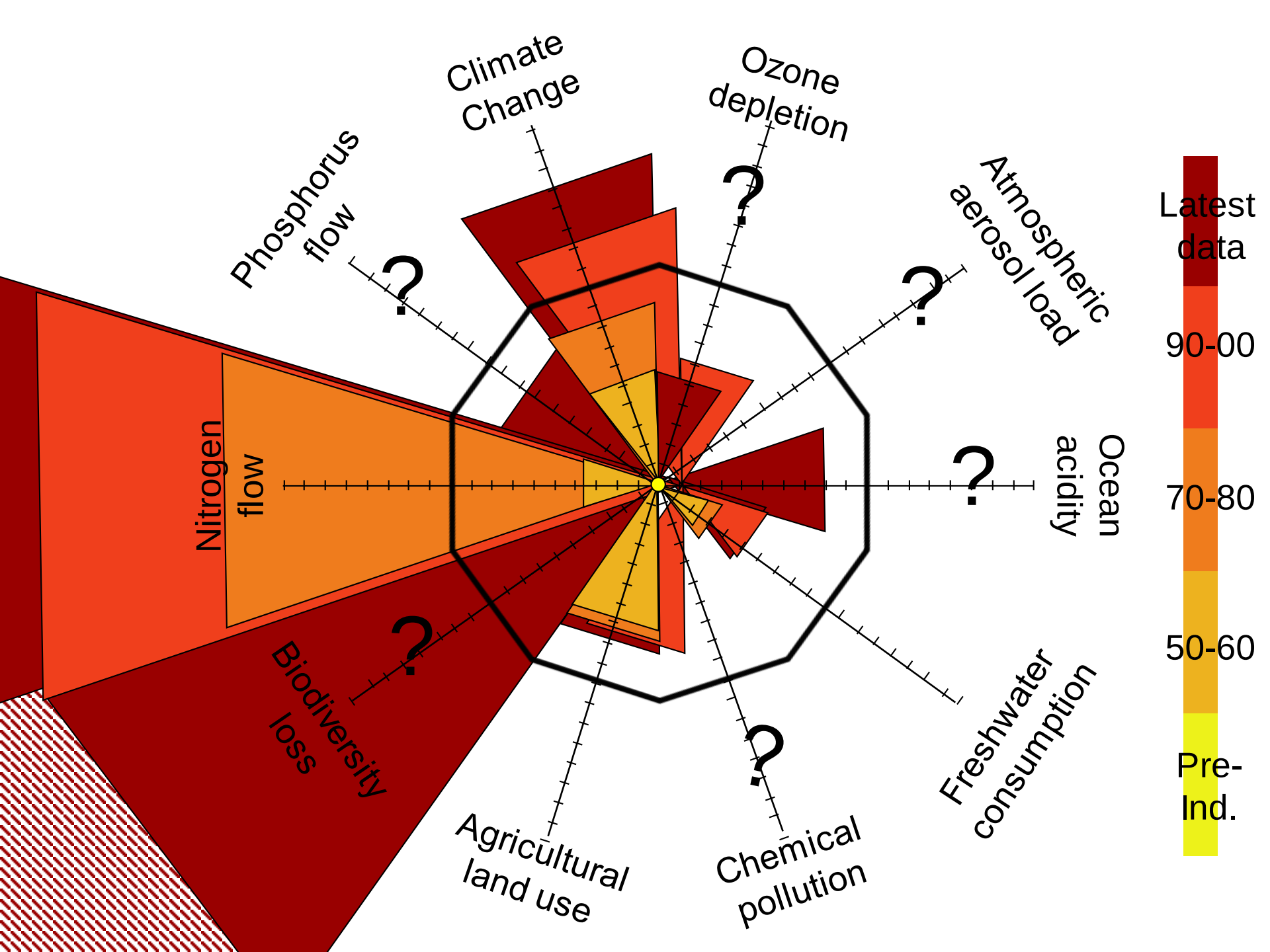
**Ocean acidification**
*Aragonite saturation ratio > 80 % above pre-industrial levels*
*(> 80% - > 70 %)*

**Rate of Biodiversity Loss**
*< 10 E/MSY*
*(< 10 - < 1000 E/MSY)*

**Global Freshwater Use**
*<4000 $km^3$/yr*
*(4000 – 6000 $km^3$/yr)*

**Land System Change**
*≤15 % of land under crops*
*(15-20%)*

**Chemical Pollution**
*Plastics, Endocrine Desruptors, Nuclear Waste Emitted globally*


Climate Change
Ozone depletion
Atmospheric aerosol load
Ocean acidity
Freshwater consumption
Chemical pollution
Agricultural land use
Biodiversity loss
Nitrogen flow
Phosphorus flow
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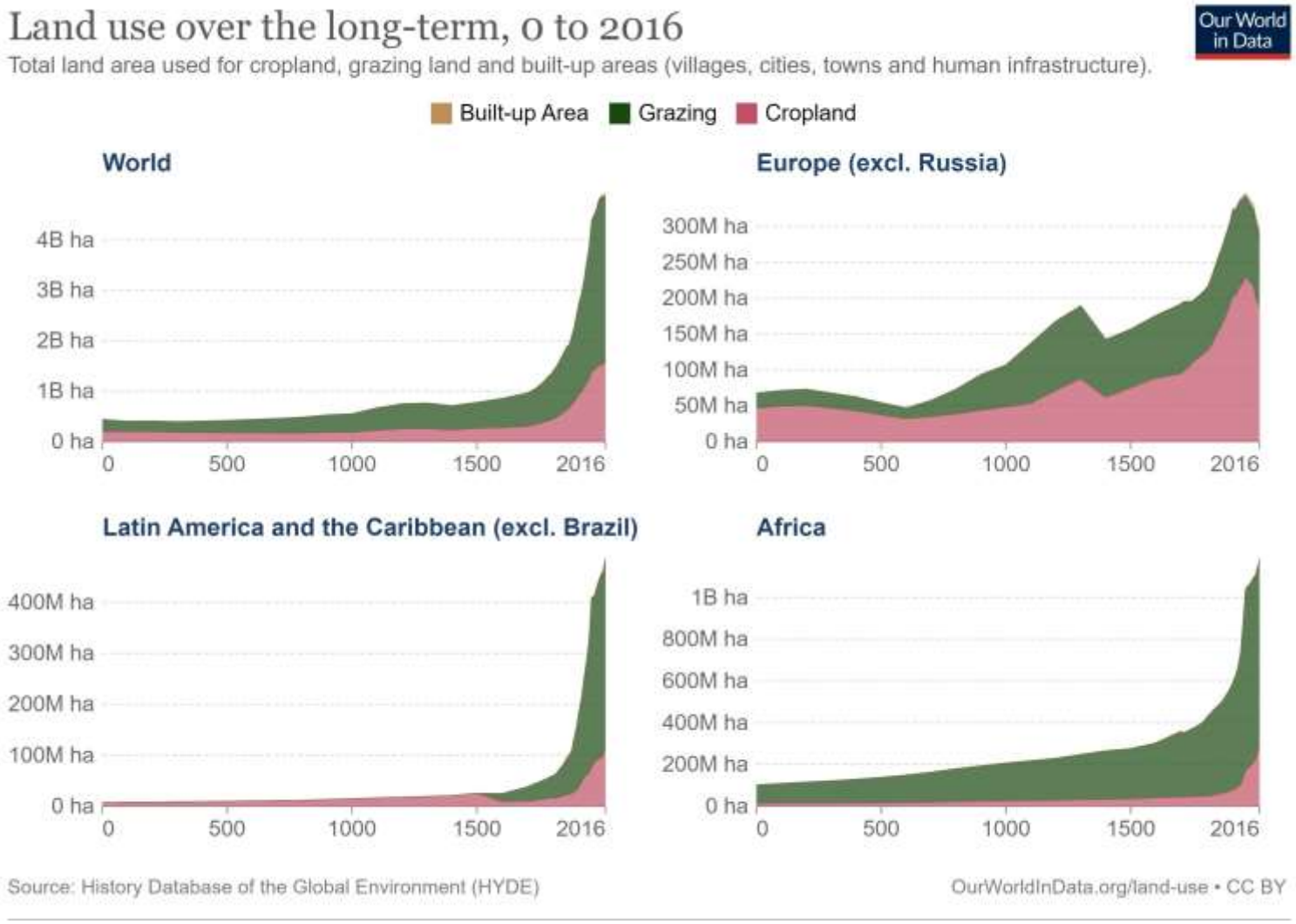
Latest data
90-00
70-80
50-60
Pre-Ind.

# 2016 Land system change boundary exceeds safe limits



# 2022 Freshwater boundary exceeds safe limits

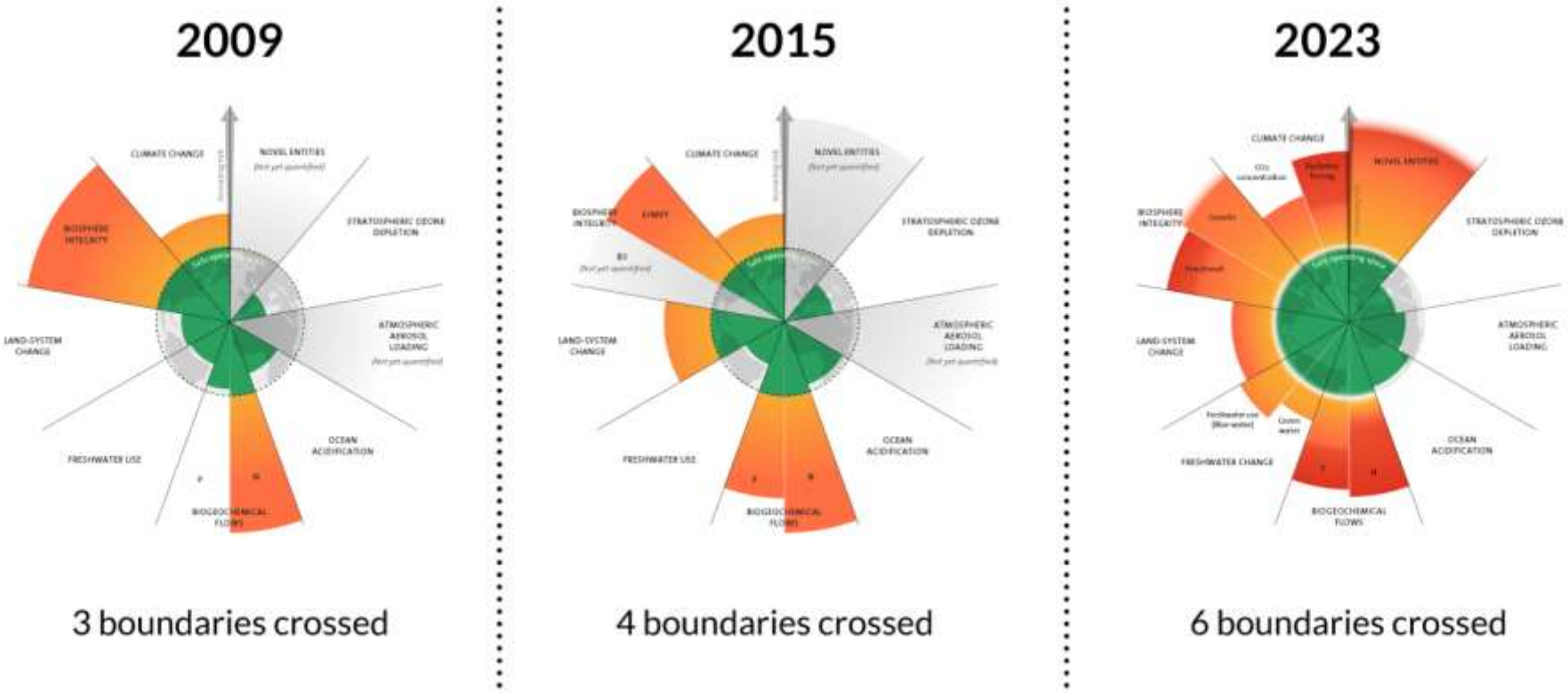
- Everywhere, from the boreal forests to the tropics, from farmlands to forests, soil moisture is changing. Abnormally wet and dry soils are increasingly commonplace.
- Profoundly changing water cycle
- Amazon at risk : large parts could switch from rainforest to savannah-like states
- We humans might be pushing green water well outside of the variability that Earth has experienced over several thousand years during the Holocene

# 2022 Chemical pollution exceeds safe limits

- 350,000 different types of manufactured chemicals on the global market.
- Plastics, pesticides, industrial chemicals, chemicals in consumer products, antibiotics and other pharmaceuticals.
- 50-fold increase in the production of chemicals since 1950. This is projected to triple again by 2050. Plastic production alone increased 79% between 2000 and 2015.
- The rate at which these pollutants are appearing in the environment far exceeds the capacity of governments to assess global and regional risks, let alone control any potential problems.

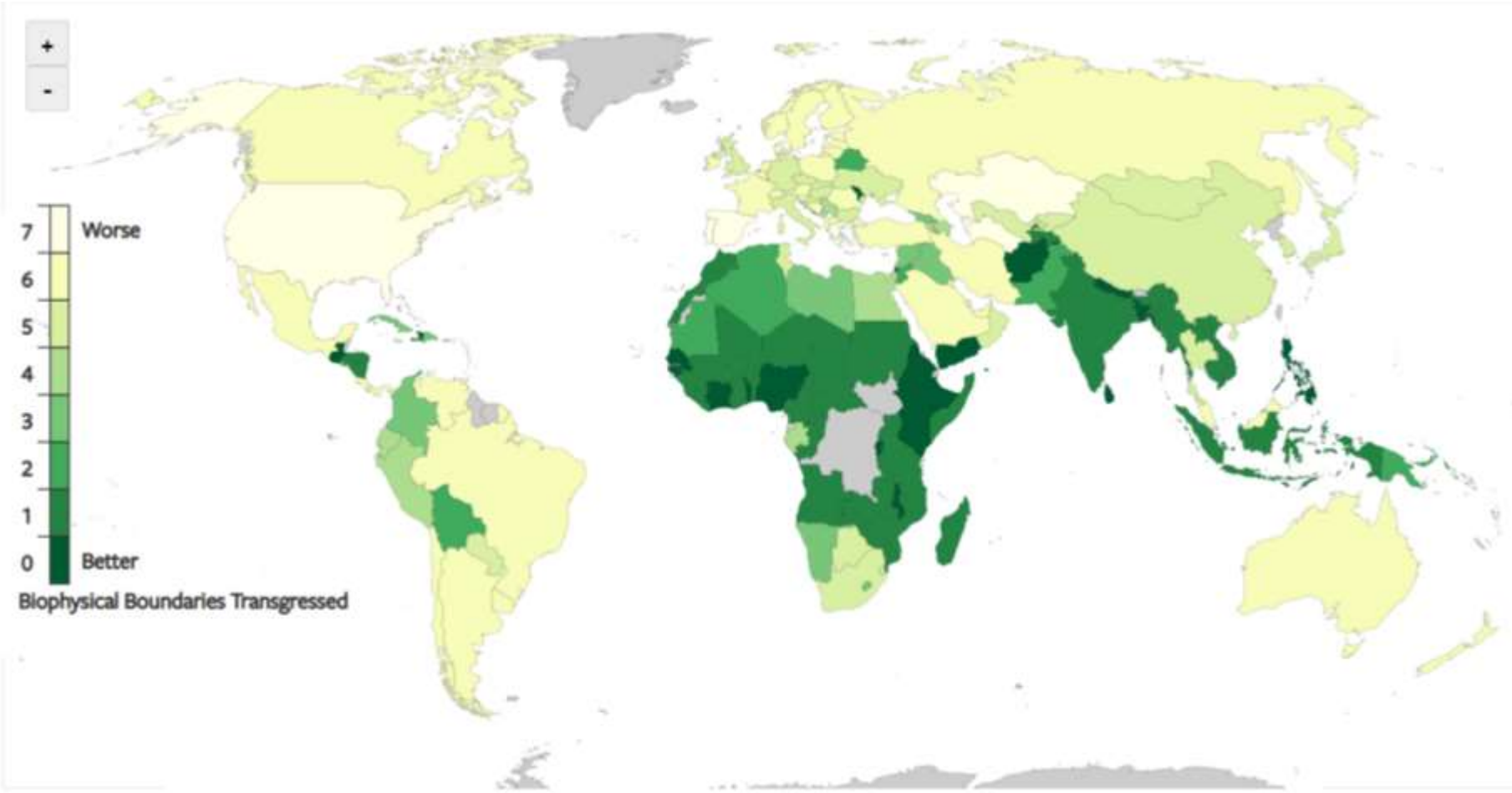
# 2023 Six boundaries are already transgressed

Climate change, biosphere integrity, biogeochemical cycles, land system change and novel entities (which includes plastic and other manmade chemicals) and green water




Richardson et al.,Sci. Adv.9,(2023)

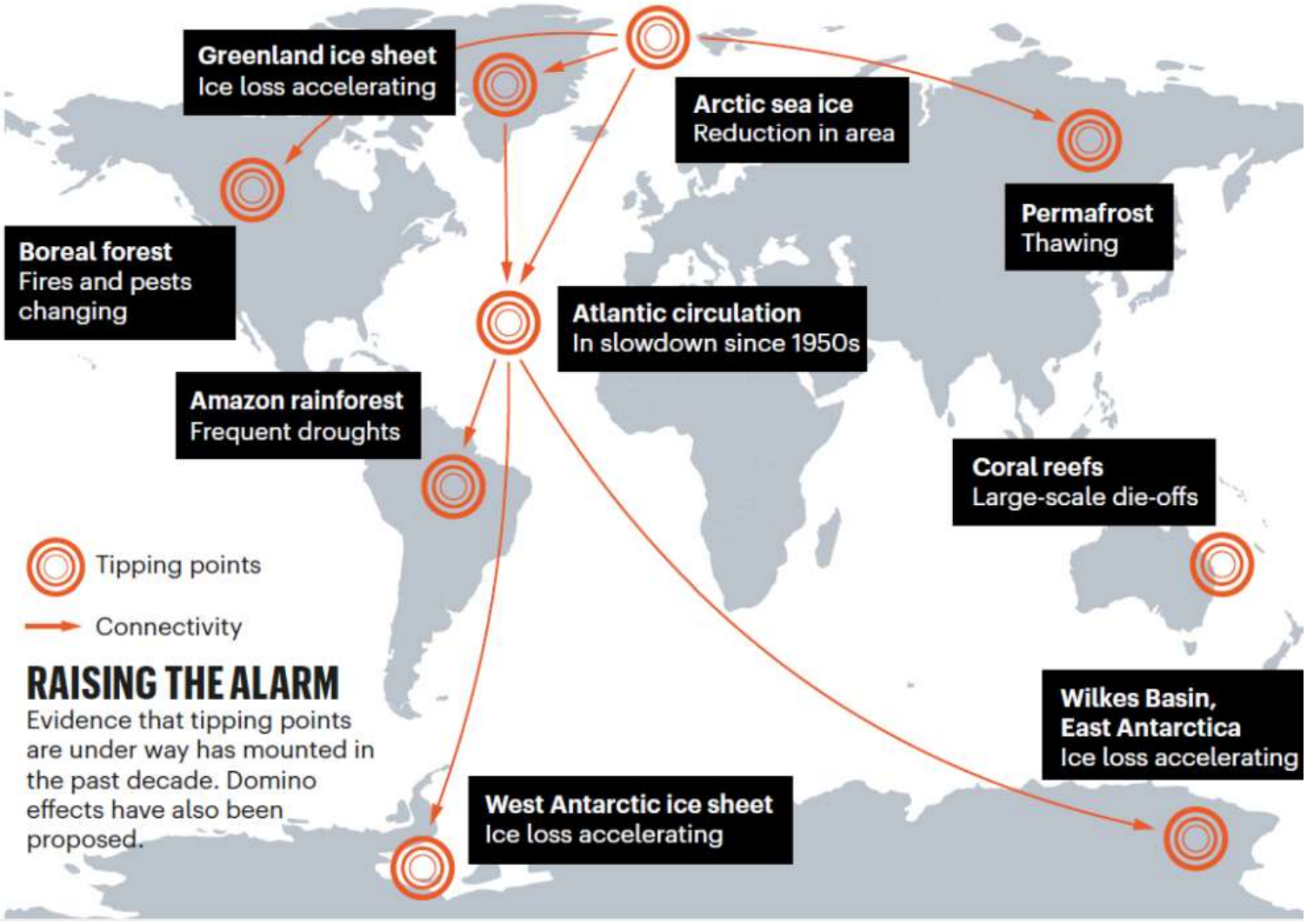
# Biophysical boundaries that different countries transgress



# Breaking 6 of 9 planetary boundaries of safety

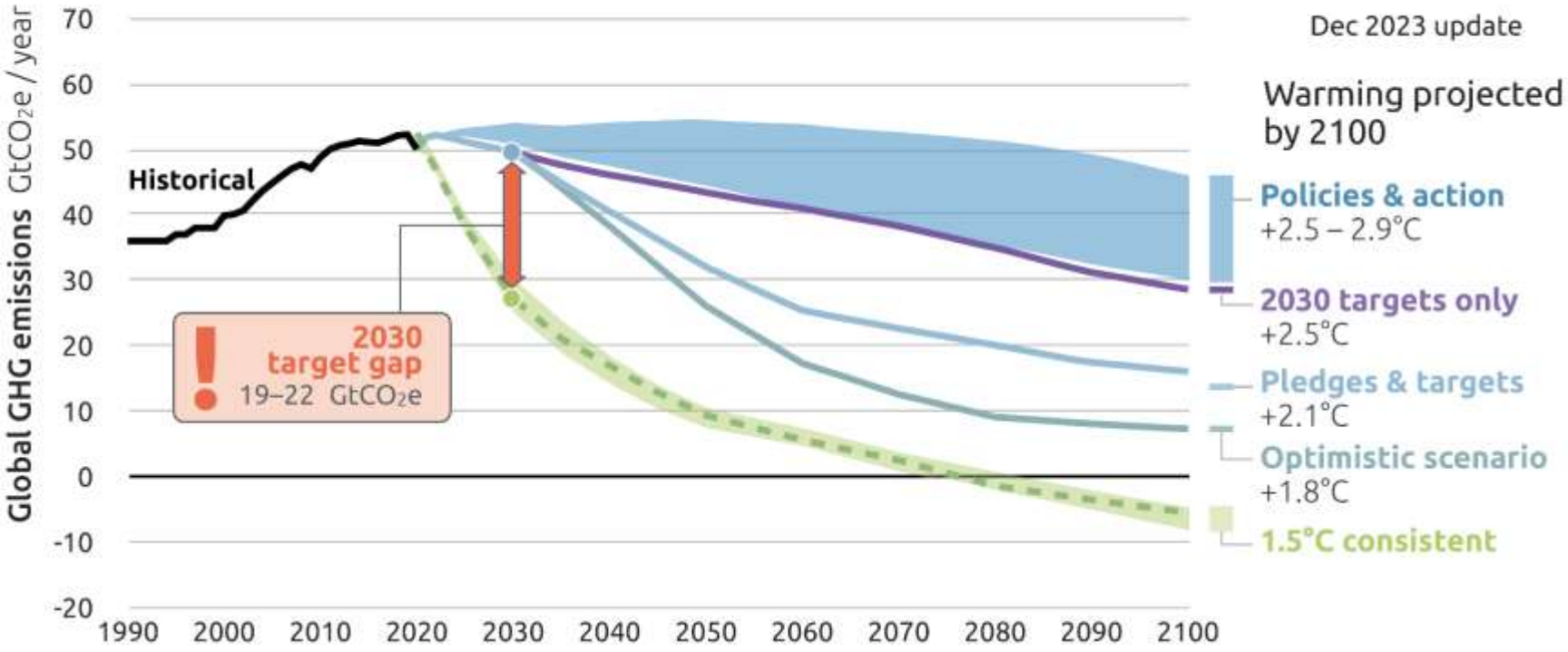
- Environmental decline is complex and unpredictable. Crossing the estimated boundaries increases the risk of triggering large-scale abrupt or irreversible environmental changes.
- This is creating new forms of risk to lives, livelihoods and the natural world -risks that in extreme cases can overwhelm societies, even entire countries.
- Without restoring a healthy and fully functional natural environment, the risks of insecurity, instability and conflict will keep rising.

# Domino effects possible



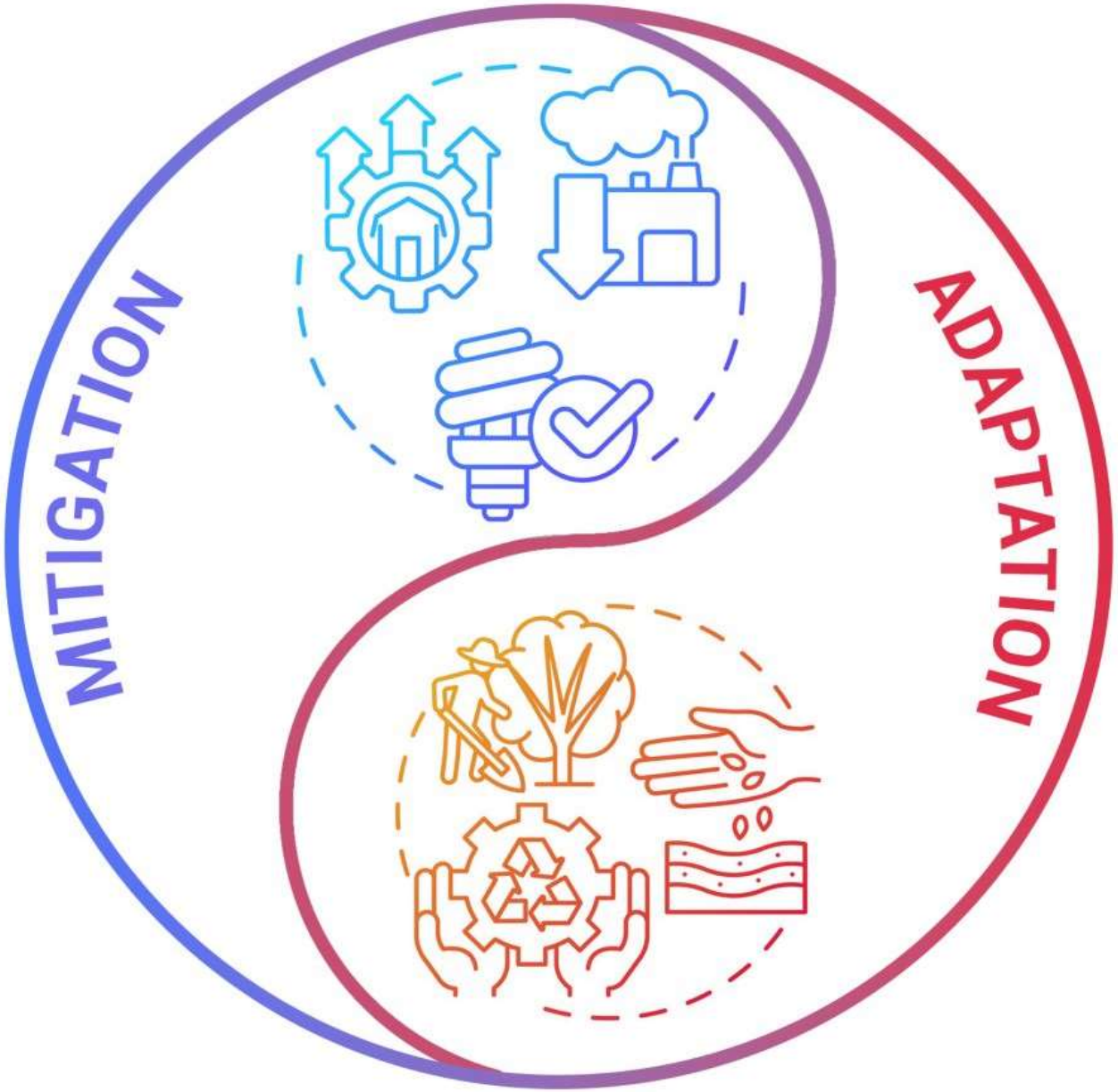
# Climate change

# Where are we after COP28 ?



# The cost of worsening climate impacts on Europe

- Climate-related extremes in Europe have cost around EUR 738 billion in damages since 1980.
- During 2020-2023, losses exceeded EUR 168 billion.
- Flood in August in 2023 in Slovenia caused direct and indirect damages that are estimated at about 16 % of the national GDP.
- A conservative estimate is that worsening climate impacts could reduce EU GDP by about 7 % by the end of the century.


MITIGATION
ADAPTATION

# Soft and hard limits to mitigation and to adaptation

- **Ecological/Physical limitations (hard limits)** Lakes, glaciers, forests and arid lands, for example can be disrupted by unexpected and drastic changes in state - an ecosystem's ability to withstand disturbance has a limit.
- **Economic limits (soft limits)** Implementing adaptation measures entails a significant financial investment. Limits to adaptation/mitigation occur when costs exceed the costs of the averted impacts.
- **Technological (hard limits)** When the technology to adapt to climate change impacts is available but not on the scale required, or when its application on the required scale is practically unfeasible.
- **Social (soft limits)** Cognitive and normative restrictions that govern how people react to climate variability and change are social limitations to climate change mitigatin/adaptation. The organization and structure of social institutions are among the most important considerations

# Climate technologies play important part in mitigating carbon emissions

**Renewables**
Solar, wind (onshore and offshore), grid innovation

**Batteries and energy storage**
Electric-vehicle batteries, long-duration energy storage

**Circular economy**
Battery recycling, chemical cellulosic recycling, heat recovery, plastics recycling

**Building technologies**
Geothermal heating, heat pumps, electric equipment

**Industrial-process innovation**
Electrification of heat sources, green steelmaking, green cement making

**Hydrogen**
Electrolyzers, fuel cells, methane pyrolysis

**Sustainable fuels**
Advanced biofuels, e-fuels

**Nature-based solutions**
Monitoring and verification for forests, peatlands, mangroves

**Carbon removal, capture, and storage**
Point-source carbon capture, direct air capture

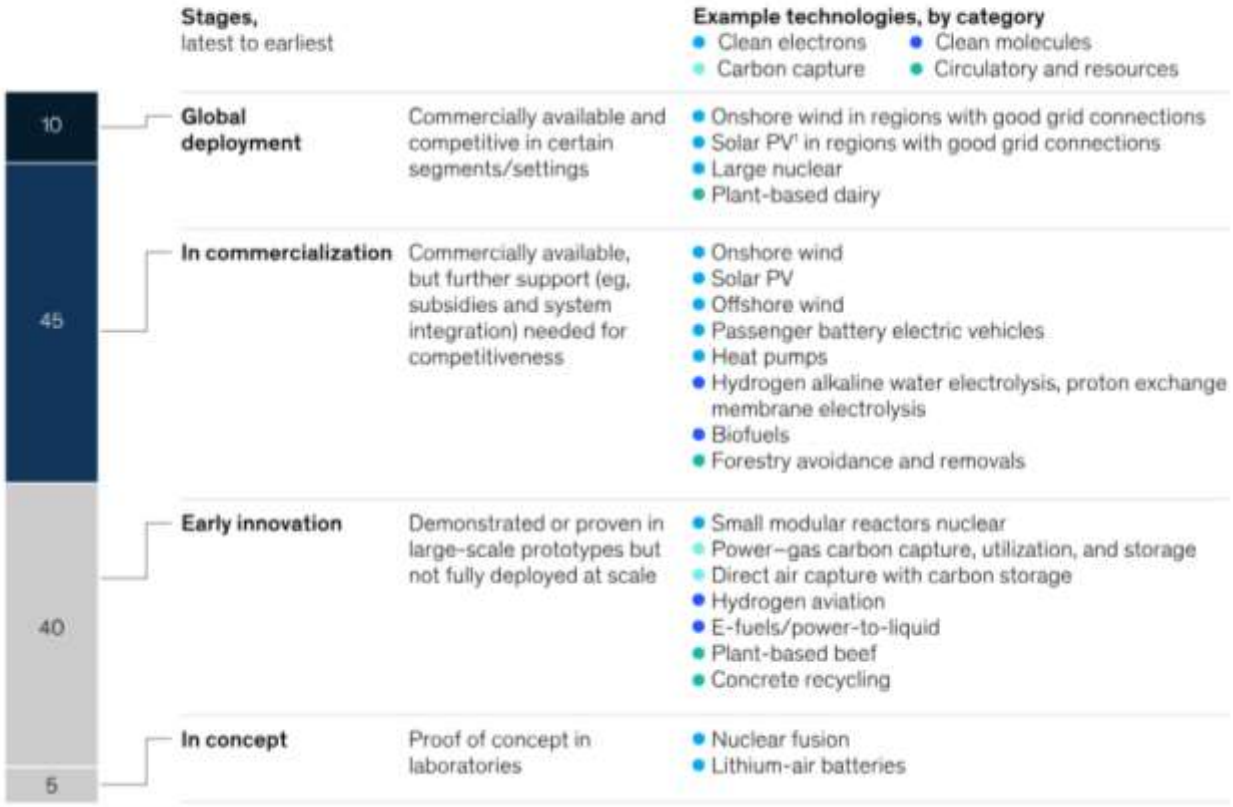
**Agriculture and food**
Precision agriculture, crop preservation, regenerative tech, alternative proteins

# Technological limits to mitigation

Many of the climate technologies needed to achieve decarbonization already exist. The challenge is scaling them to achieve technical and commercial breakthroughs.

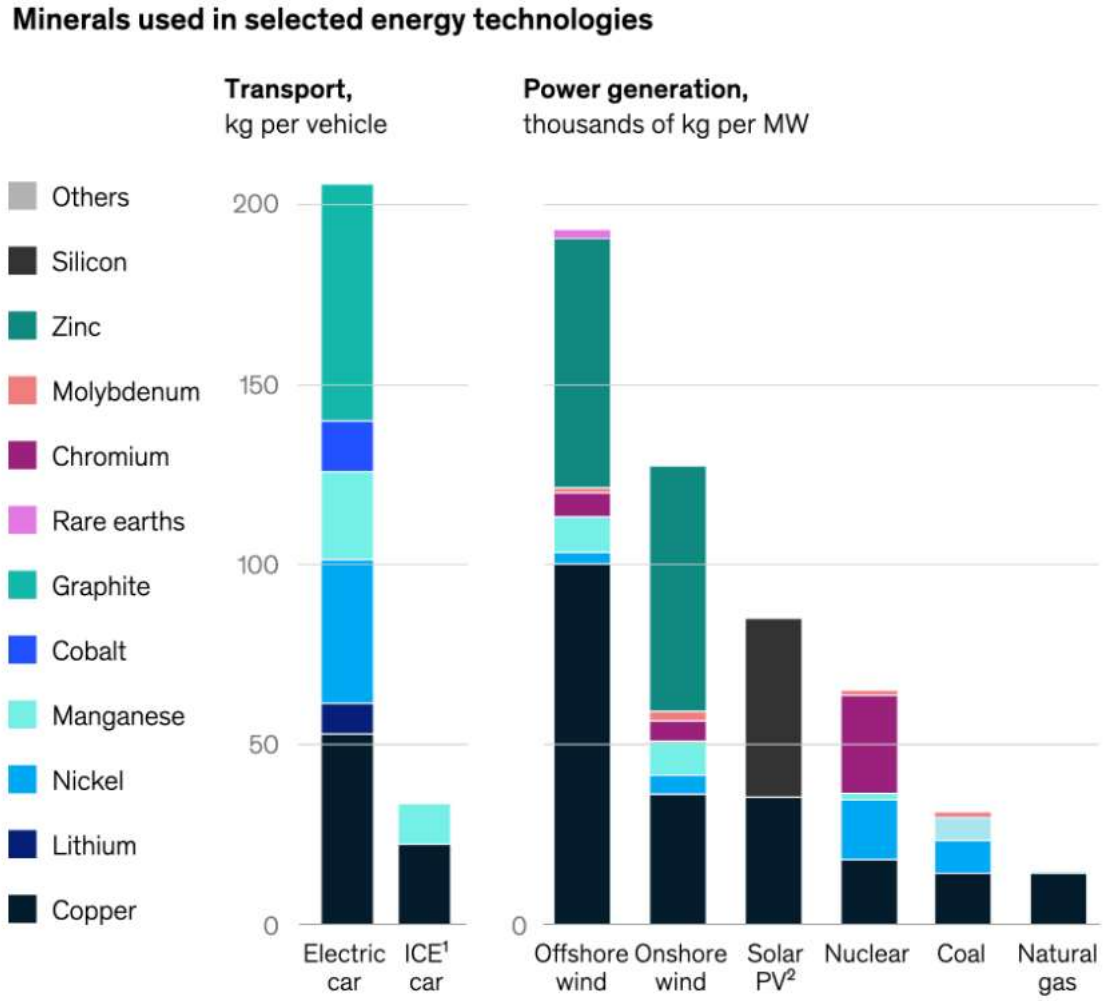
**Most high-potential climate technologies are at advanced maturity levels, but only 10 percent are commercially competitive.**

**Share of total abatement by technology in 2050,** %



# Physical limits to mitigation - greater demand for metals and minerals

low-carbon technologies often require more of these materials than conventional energy




[1]Internal combustion engine.
[2]Photovoltaic.
Source: *The role of critical minerals in clean energy transitions*, IEA, updated Mar 2022

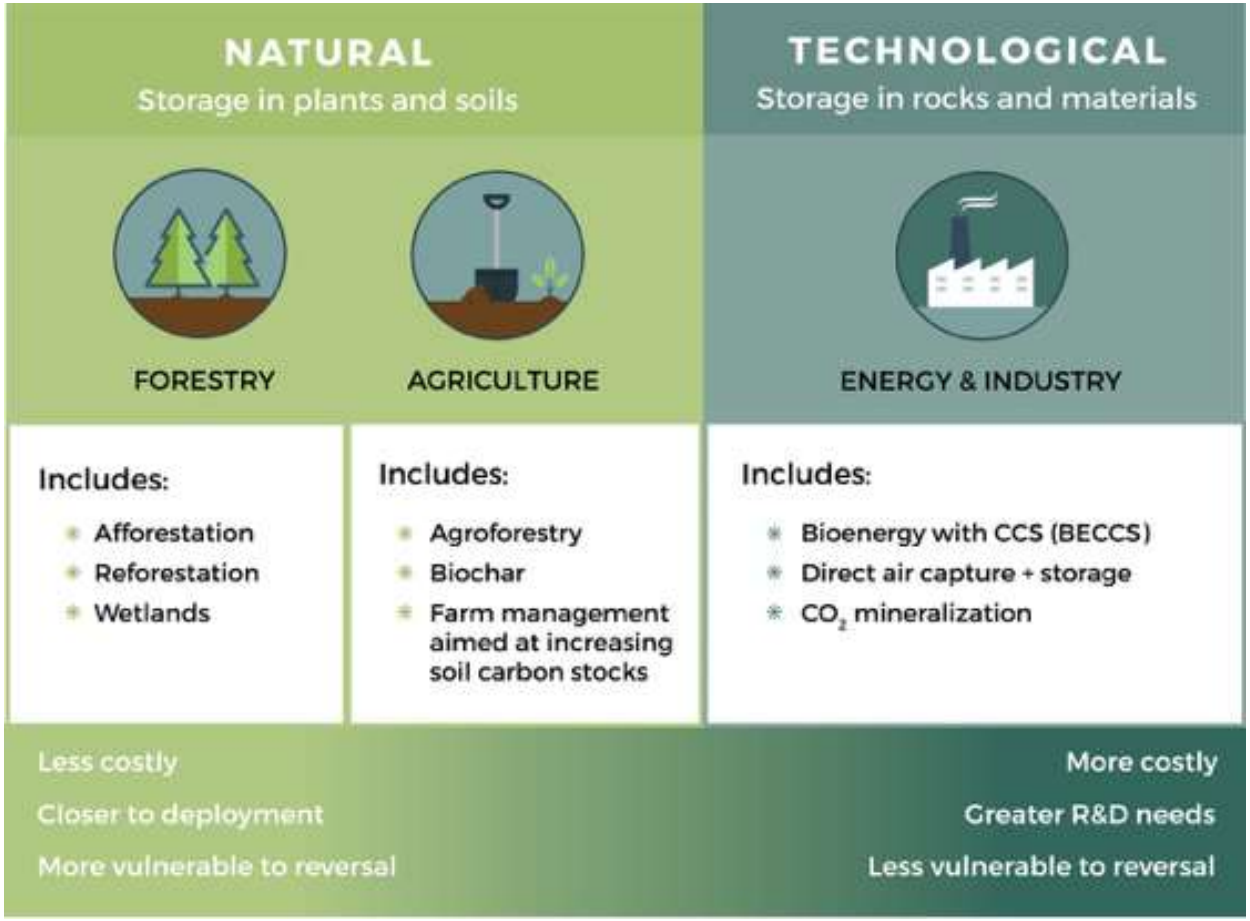
McKinsey & Company

Wind turbine blade 107 meters in length (Cherbourg, France)

Renewables are diffuse - small power per unit area

# How could ‘negative emissions’ affect land, food and wildlife?

Carbon removal techniques might require huge amounts of land




Negative emissions are a group of methods that aim to remove $CO_2$ from the atmosphere and store it in the land or ocean:

from planting trees – to the technologically advanced, such as using machines to suck $CO_2$ from the air

# Is green growth the solution?

Promoting
Economic Growth

VS

Fighting Climate
Change

But there is no such thing as green growth.
Growth is wiping the green from the Earth.

# Conclusions

- We can no longer postpone tackling difficult issues.
- We need to change the way we produce, consume and trade. The way out of climate crisis requires an Alpine area that works together.
- Need to invest in innovation and research, redesign economy and update industrial policy.

We need enlightened policies and governance, and an engaged citizenry if we are to achieve long-term sustainability.