Sustainability through an engineering lens

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Learning objectives

- Understand key concepts in sustainability
  - Holocene
  - Climate change
  - Great acceleration
  - Anthropocene
  - Planetary boundaries
  - SDGs
  - Shifting base-line syndrome
  - SSPs
  - Re-wiring the economy

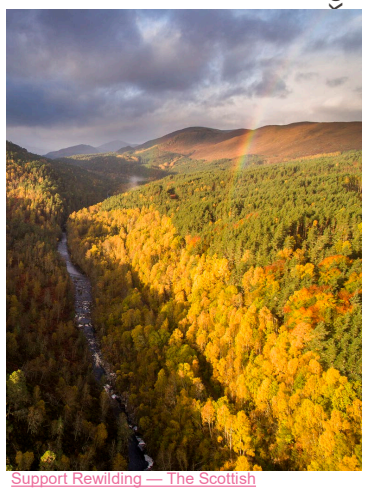
Now is the most exhilarating time to be an innovator.

2050: what is your vision?

AP to set up solar-wind hybrid project with battery back-up – The Leading Solar Magazine In India (eqmagpro.com)

Daily Mail Online

EV World Record: Mercedes Benz Vision EQXX Travels 1,000 Km On A Single Charge (forbes.com)



Support Rewilding — The Scottish Rewilding Alliance

ZEROe on the Rise at Airbus - CAFE Foundation Blog

[기업소개] 수소연료탱크 제조사 '일진다이아' : 네이버 블로그 (naver.com)

Child Fun Outdoors - Free photo on Pixabay

4 NetZero Energy Lessons | NetZero Buildings

People Group Many - Free photo on Pixabay

Sustainability can be defined as:

"Avoiding the depletion of our natural resources in order to maintain a balanced ecosystem and preserve natural capital *while* meeting the needs (wants?) of the present without compromising the ability of future generations to meet their own needs".

slido

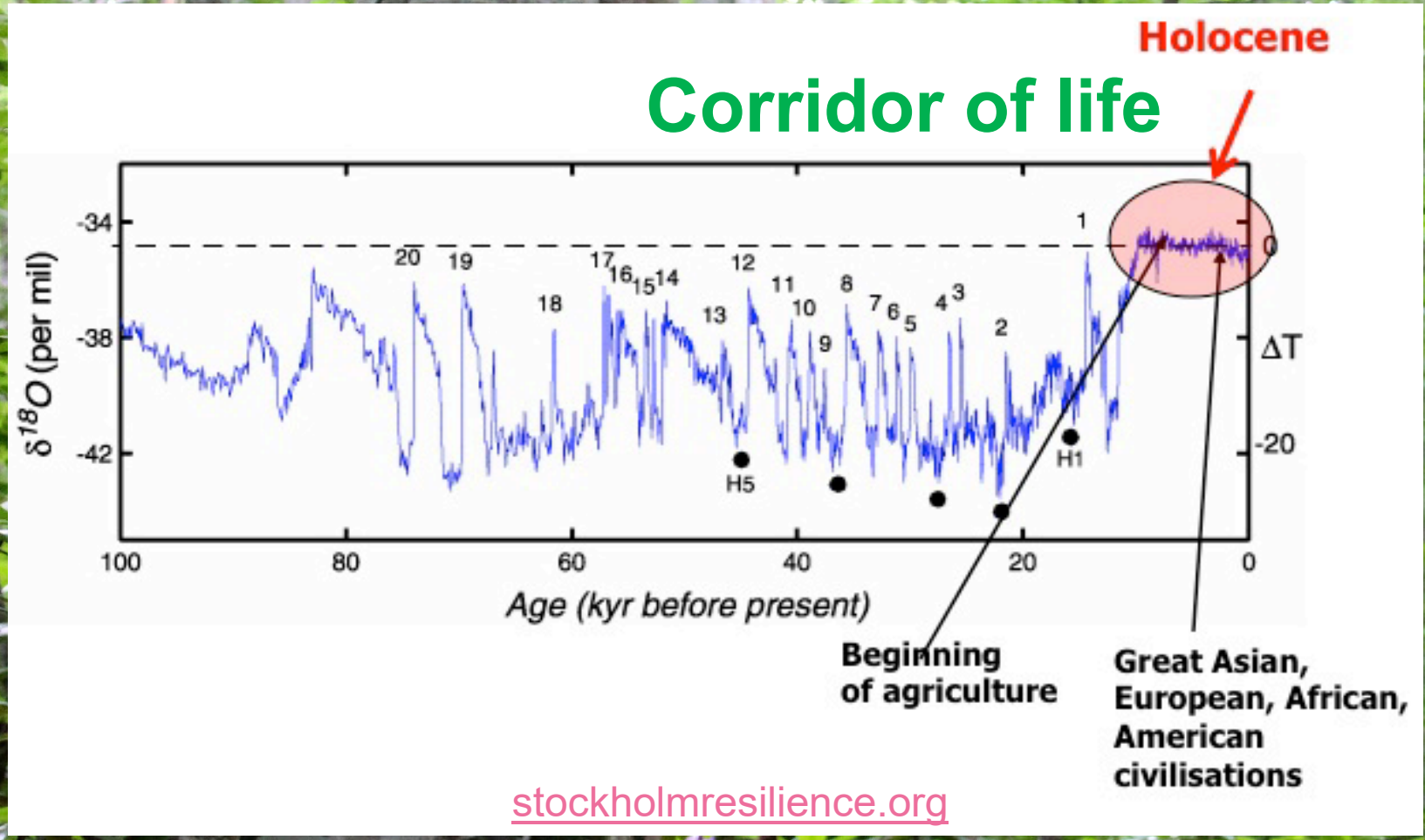
Please download and install the Slido app on all computers you use

To what extent do you consider materials products and supply chains are sustainable?

ⓘ Start presenting to display the poll results on this slide.

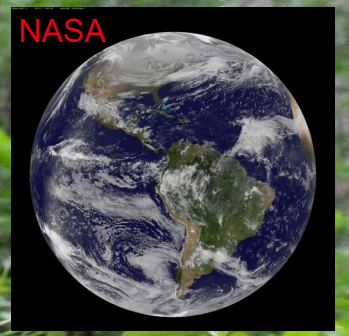
Holocene

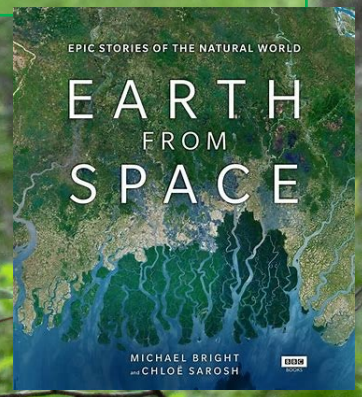
the stable geological epoch in the earth history that has lead to our blue and green planet



stockholmresilience.org

- Relatively stable Holocene climate during the past ca. 10,000 years
- Record from Greenland Ice Sheet, proxy for atmospheric temperature over Greenland





Virgin Forests: WWF Saving the Last Remaining in Europe, Part 1 | WWF (panda.org)

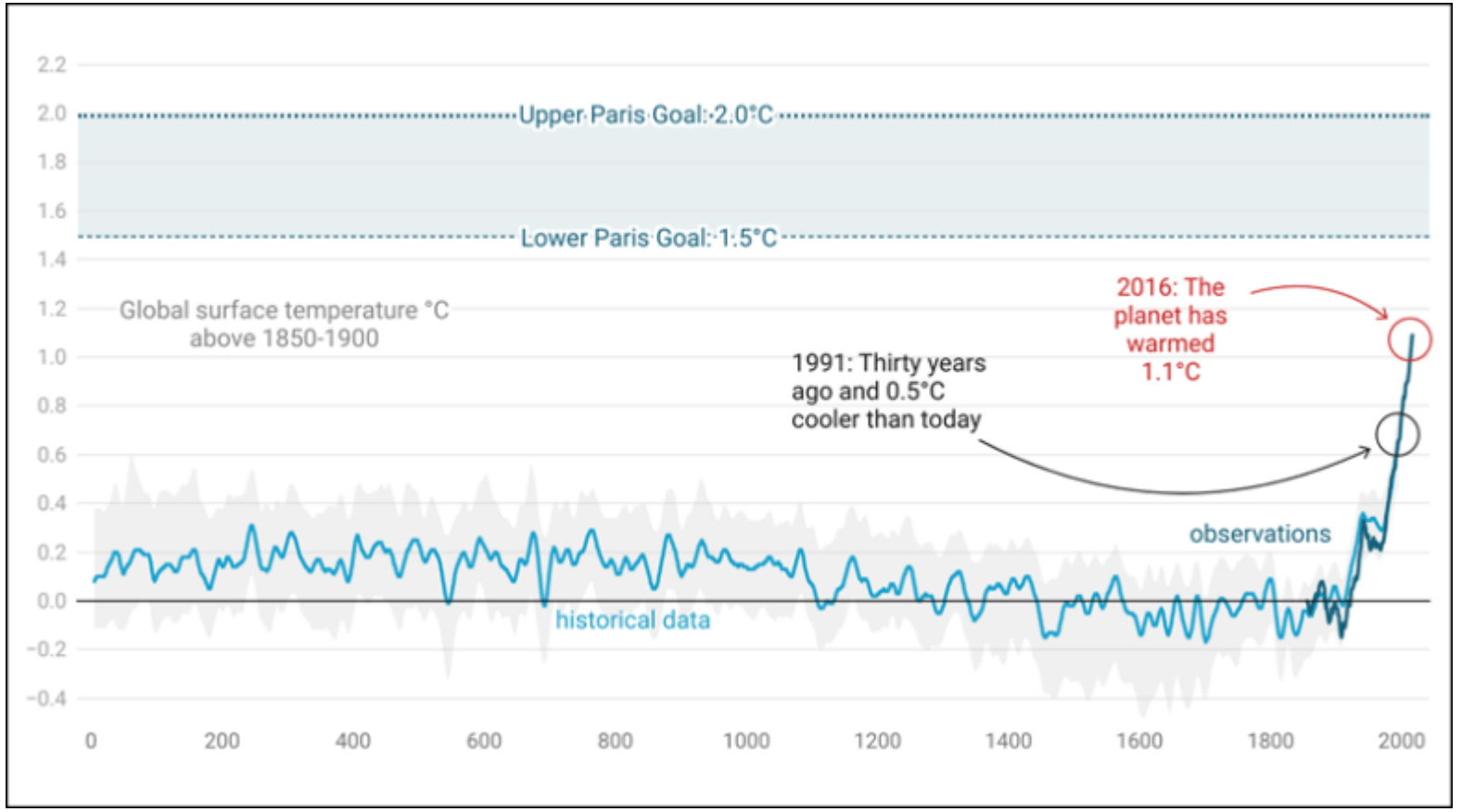
Fire side chat

- What flows in our economy?
  - Energy
  - Mass
  - CO_2e
  - $
  - People
  - Information
- Need a systemic approach

Global warming thus far

- Past 2,000 years, global surface temperatures stayed relatively constant until an unprecedented rate of warming began in the mid-20th century.
- Historical data came from paleoclimate archives, and recent observations are direct measurements.

- Shading shows 5% and 95% confidence intervals for historical measurements. Credit: Jenessa Duncombe. Source: *IPCC* [2021]



2024 was +1.6°C vs. pre-industrial

Global Climate Highlights 2024 | Copernicus

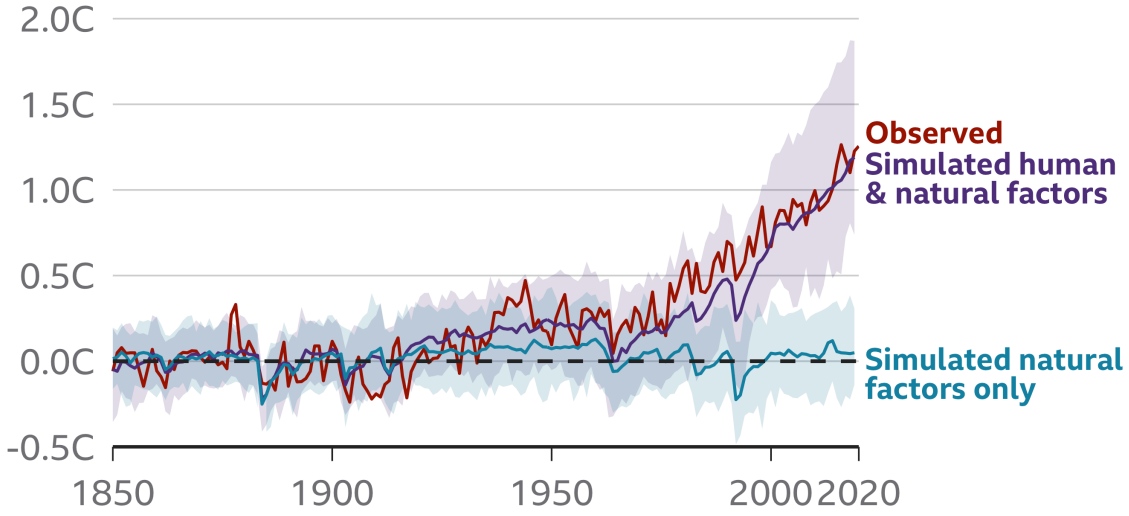
What Five Graphs from the U.N. Climate Report Reveal About Our Path to Halting Climate Change - Eos

Our planet is getting warmer, CO2e driven

- Unequivocal warming through human activity

Human influence has warmed the climate

Change in average global temperature relative to 1850-1900, showing observed temperatures and computer simulations



Note: Shaded areas show possible range for simulated scenarios

Source: IPCC, 2021: Summary for Policymakers

BBC

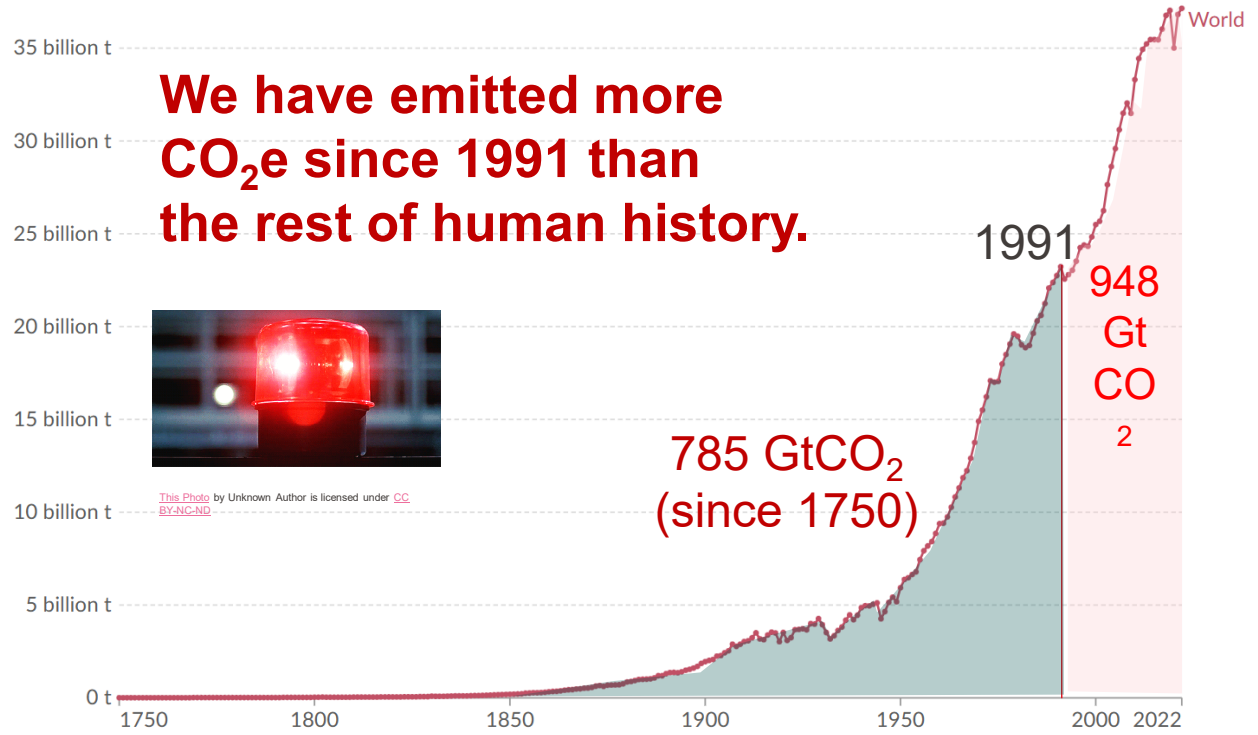
IPCC_AR6_SYR_SPM.pdf

Climate change: UN warning over nations' climate plans - BBC News

Annual CO_2 emissions

Carbon dioxide (CO_2) emissions from fossil fuels and industry[1]. Land-use change is not included.

Our World in Data



Data source: Global Carbon Budget (2023)

OurWorldInData.org/co2-and-greenhouse-gas-emissions | CC BY

1. Fossil emissions: Fossil emissions measure the quantity of carbon dioxide (CO_2) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO_2 includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

CO_2 emissions - Our World in Data

Our gift, our home

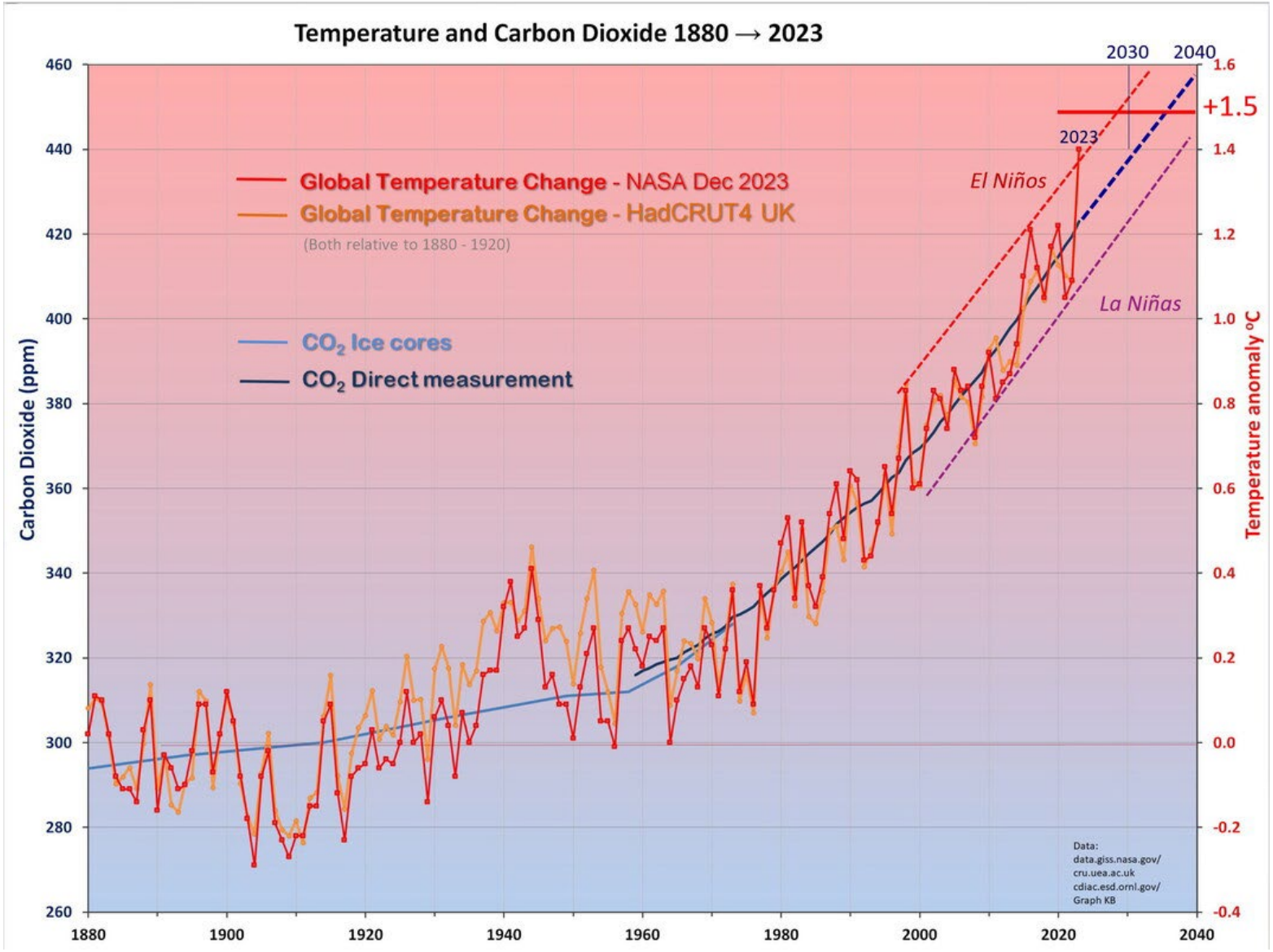
1968 Apollo 8 (NASA) Earthrise, Dec. 24th 1968

- Bill Anders said, "We came all this way to discover the Moon. And what we really did discover is Earth."

- Unique, as far as we know, in the Universe

See the Apollo 8 "Earthrise" in a Whole New Way - Universe Today

Temperature and CO2e correlate



Climate Science (cs4s.net)

Arrhenius 1896

ARRHENIUS EQUATION

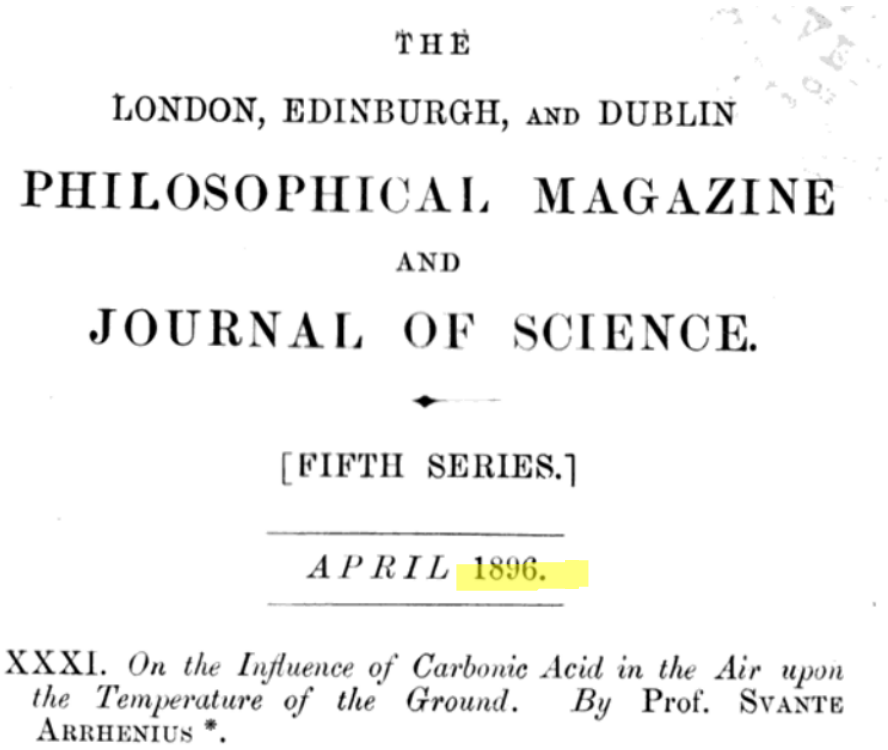
$$k = A e^{\frac{-E_a}{RT}}$$

On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground

Svante Arrhenius

Philosophical Magazine and Journal of Science
Series 5, Volume 41, April 1896, pages 237-276.

Arrhenius's paper is the first to quantify the contribution of carbon dioxide to the greenhouse effect (Sections I-IV) and to speculate about whether variations in the atmospheric concentration of carbon dioxide have contributed to long-term variations in climate (Section V). Throughout this paper, Arrhenius refers to carbon dioxide as "carbonic acid" in accordance with the convention at the time he was writing.



THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

APRIL 1896.

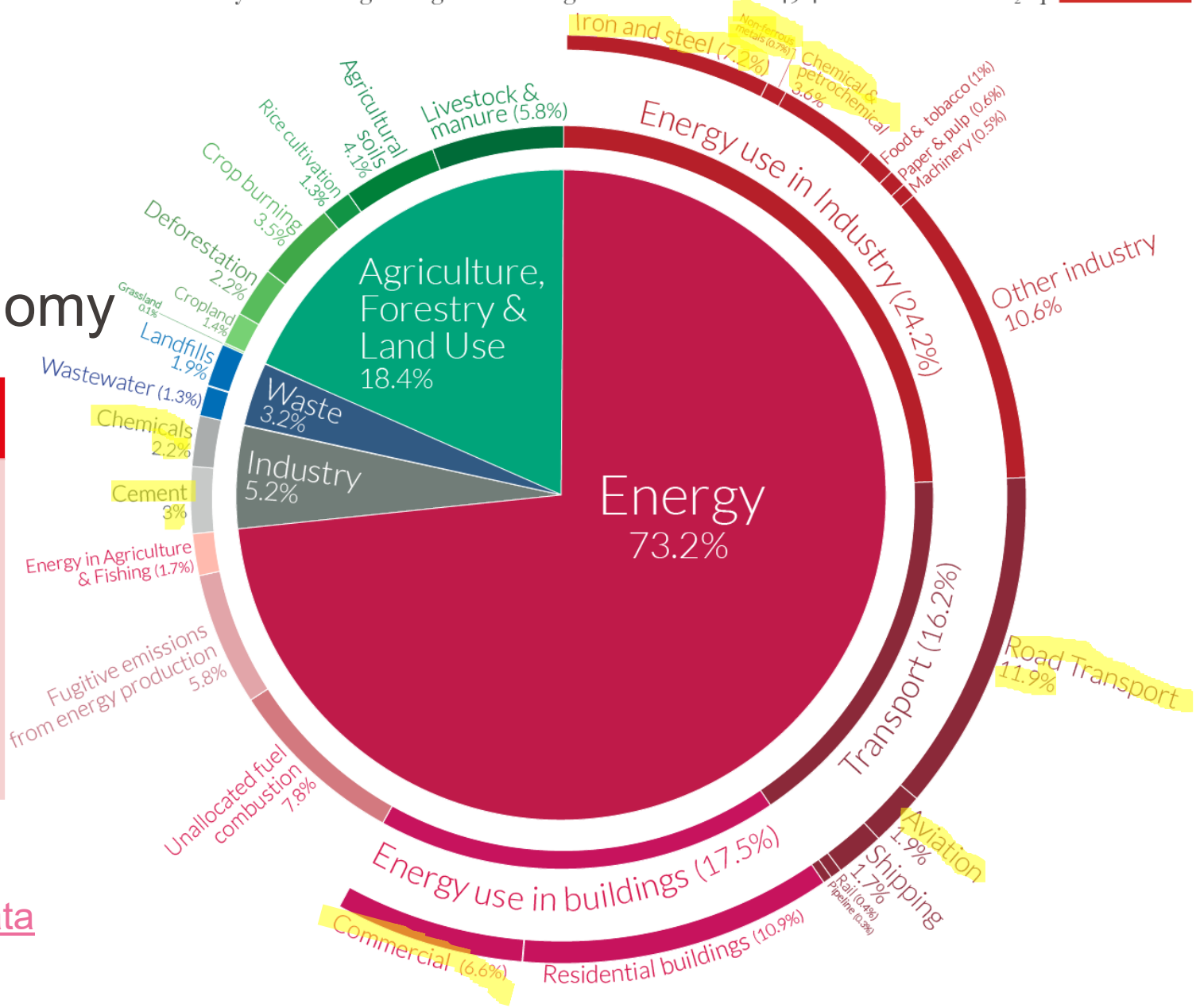
XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* By Prof. SVANTE ARRHENIUS *.

On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground (rsc.org)

Major GHG contributors

- Engineered products touch many categories of the economy

Transport 16%	Chemicals 5.8%	Materials 20%
• Road 12% • Aviation 1.9% • Shipping 1.7%	• 2.2% manufacturing • 3.6% powering chemical industry	• Steel 7% • Plastic 3% • Aluminum 0.5% • Cement 3-5% • Coal/energy mining 3-4% • Other metals 1%

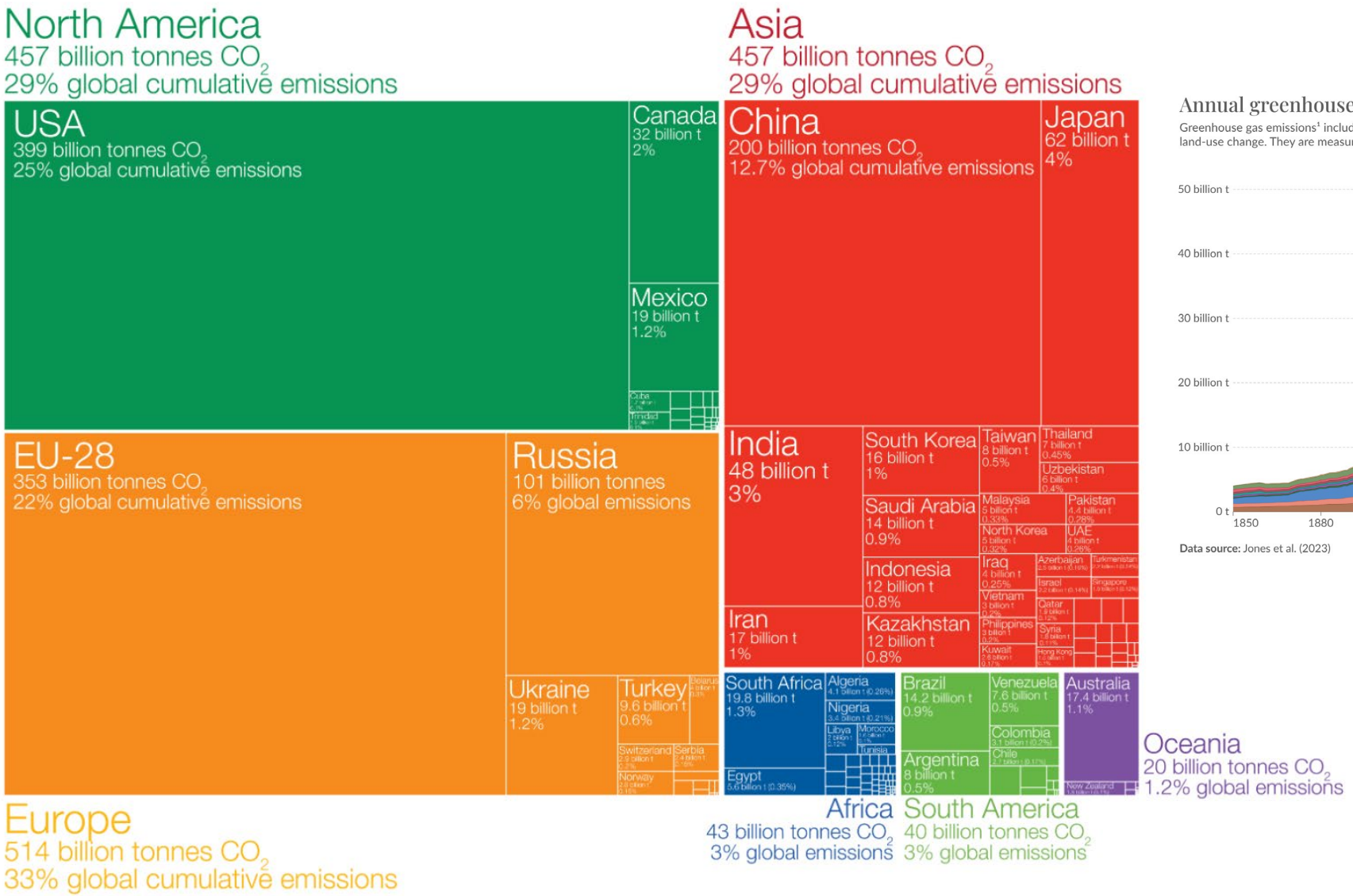


Emissions by sector - Our World in Data

Who has contributed most to global CO_2 emissions?

Cumulative carbon dioxide (CO_2) emissions over the period from 1751 to 2017. Figures are based on production-based emissions which measure CO_2 produced domestically from fossil fuel combustion and cement, and do not correct for emissions embedded in trade (i.e. consumption-based). Emissions from international travel are not included.

Our World in Data



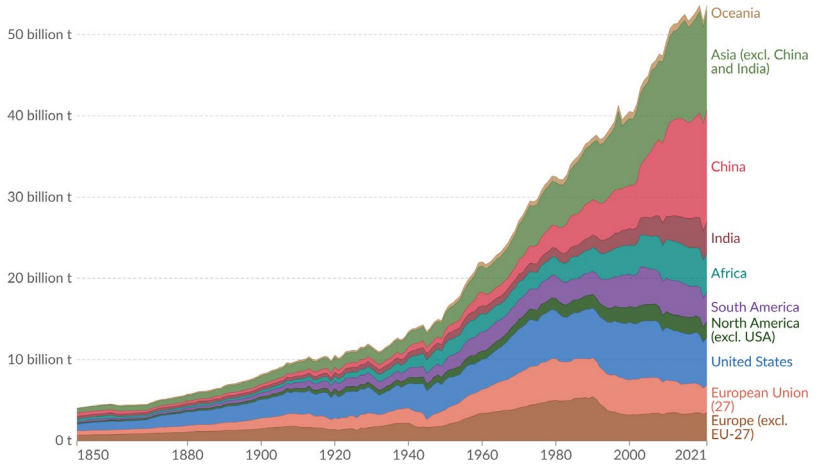
Figures for the 28 countries in the European Union have been grouped as the 'EU-28' since international targets and negotiations are typically set as a collaborative target between EU countries. Values may not sum to 100% due to rounding.

Data source: Calculated by Our World in Data based on data from the Global Carbon Project (GCP) and Carbon Dioxide Analysis Center (CDIAC).
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

Annual greenhouse gas emissions by world region, 1850 to 2021

Our World in Data

Greenhouse gas emissions[1] include carbon dioxide, methane and nitrous oxide from all sources, including land-use change. They are measured in tonnes of carbon dioxide-equivalents[2] over a 100-year timescale.



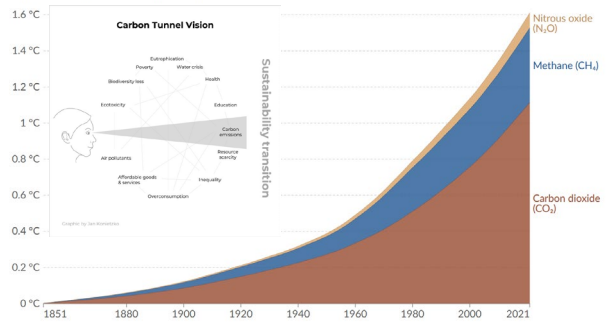
Data source: Jones et al. (2023)

OurWorldInData.org/co2-and-greenhouse-gas-emissions | CC BY

Contribution to global mean surface temperature rise by gas, World, 1851 to 2021

Our World in Data

The global mean surface temperature change as a result of a country or region's cumulative emissions of three gases – carbon dioxide, methane, and nitrous oxide.

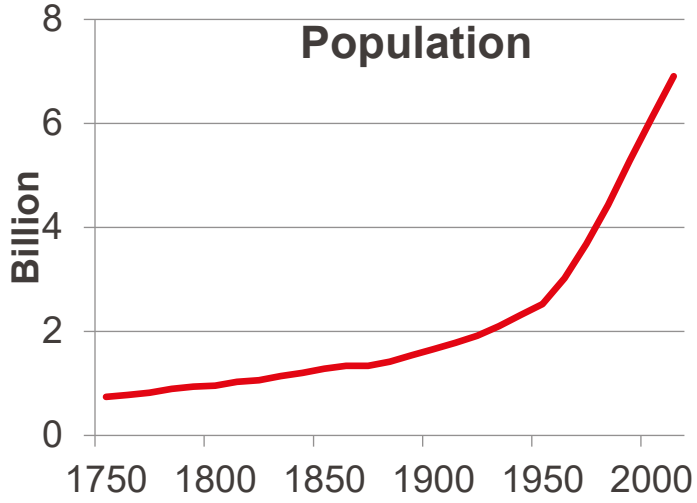


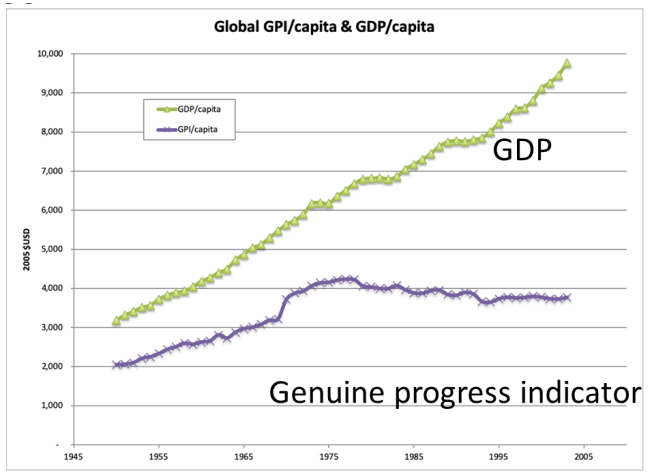
Data source: Jones et al. (2023)

OurWorldInData.org/co2-and-greenhouse-gas-emissions | CC BY

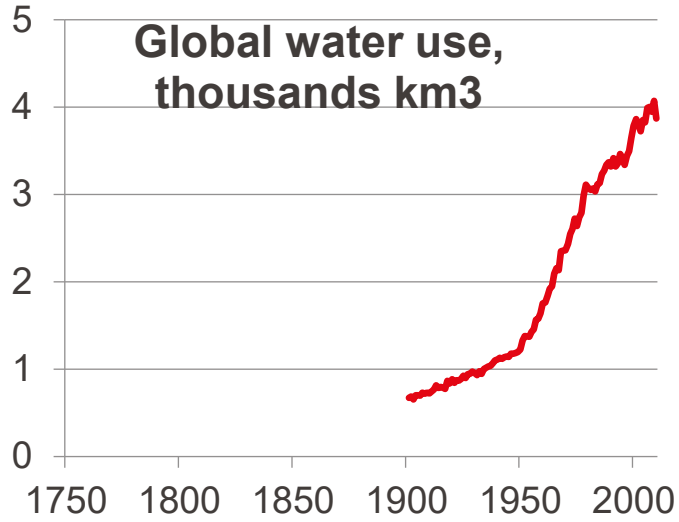
Note: This does not include cooling impacts from sulphur dioxide and aerosols, so the net warming can be lower.

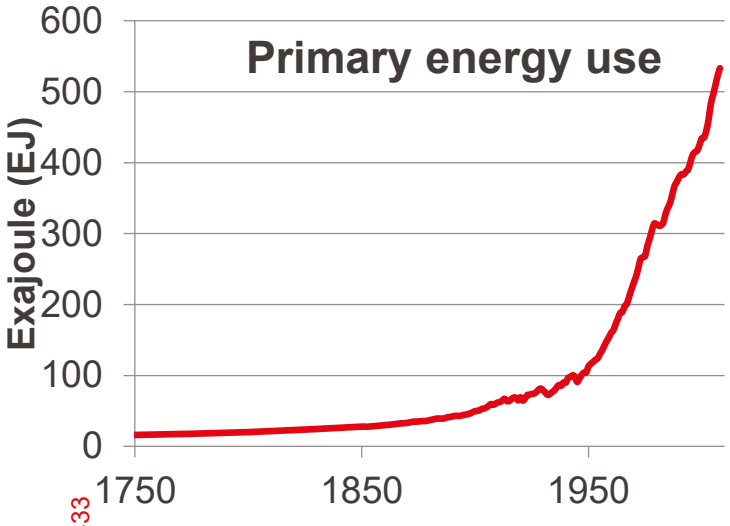
The great acceleration: Socio-economic trends (6 of 12)

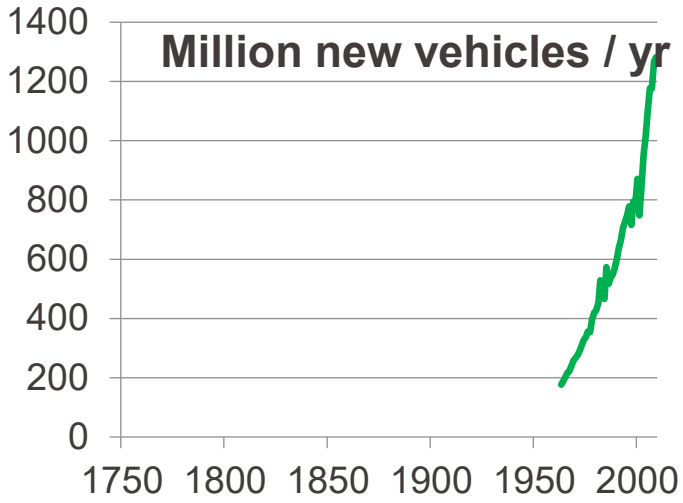


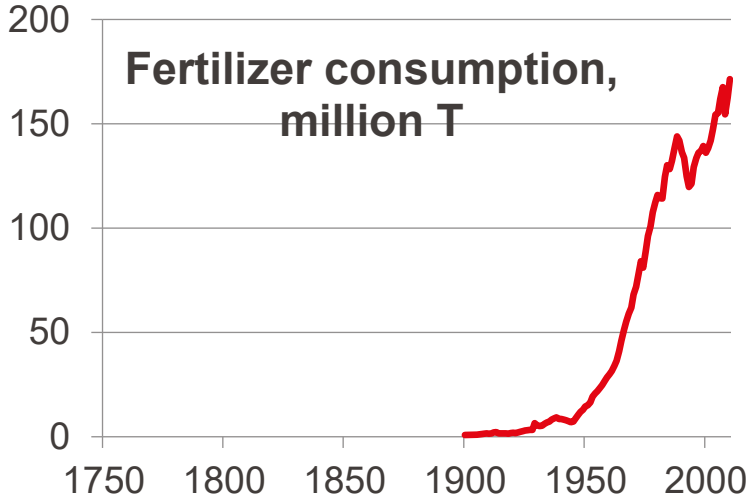


Since 1978, Genuine Progress has been falling even while GDP continues to increase. Credit: Kubiszewski et al., Beyond GDP: Measuring and achieving global genuine progress





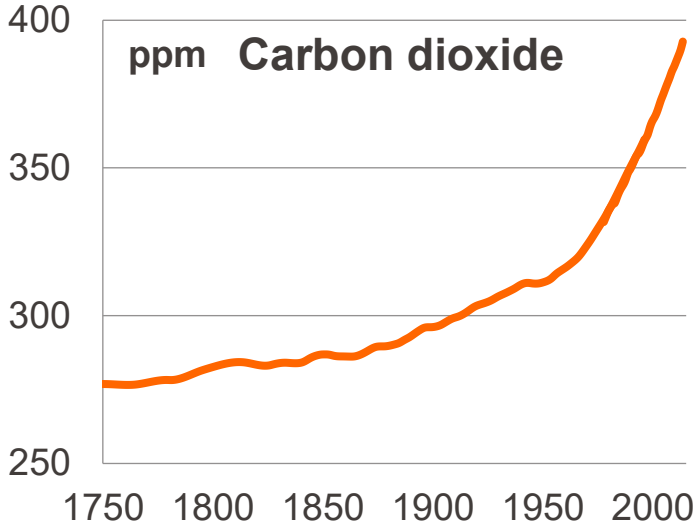


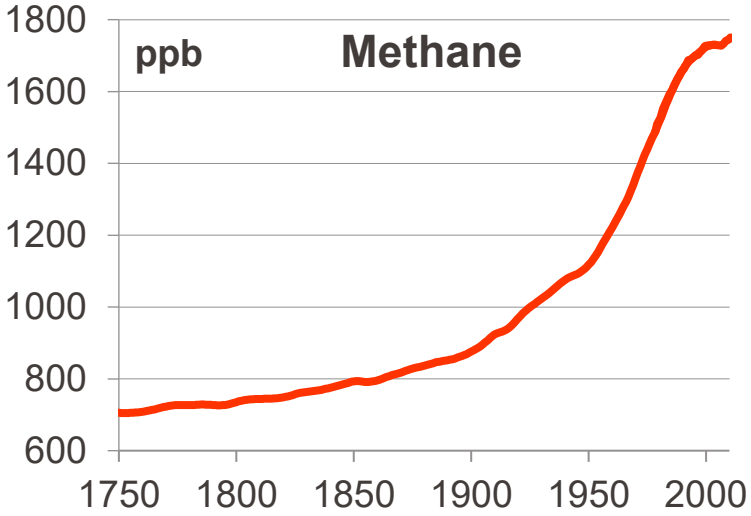


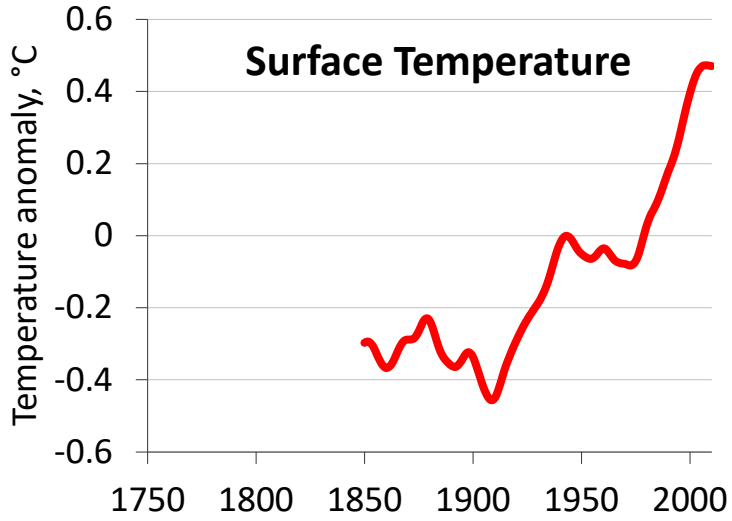
IGBPGreatAccelerationdatacollection.xlsx (live.com)

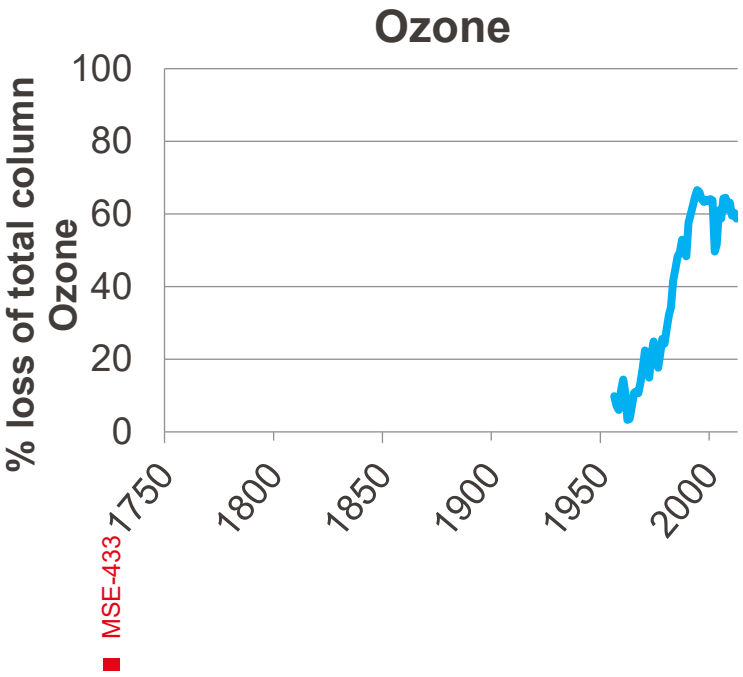
GPI = GDP (value of all goods and services produced) minus the environmental and social costs

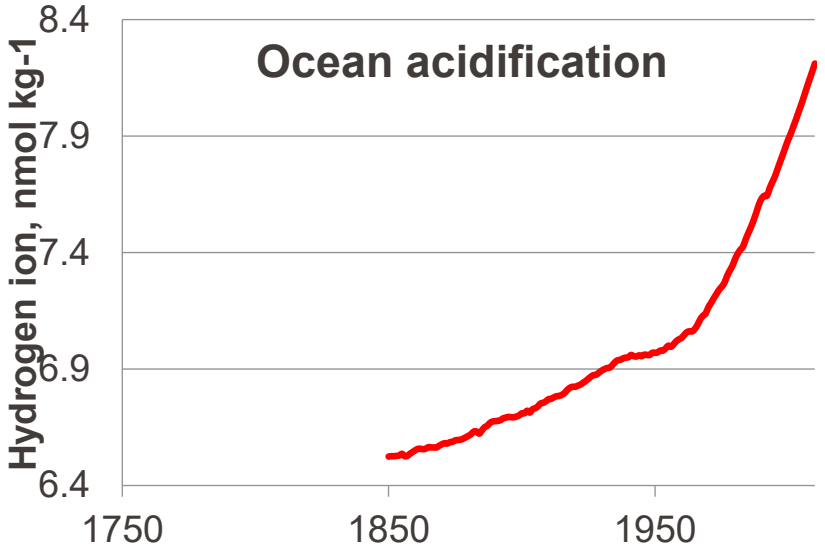
The great acceleration: Earth System trends (6 of 12)

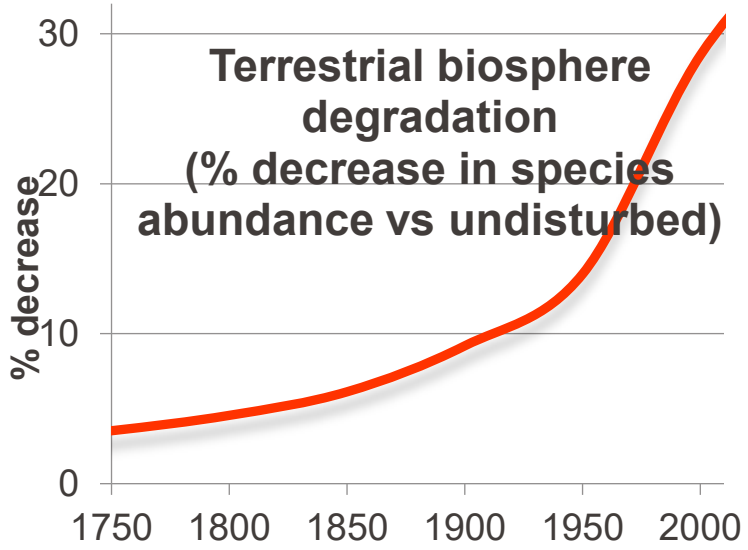












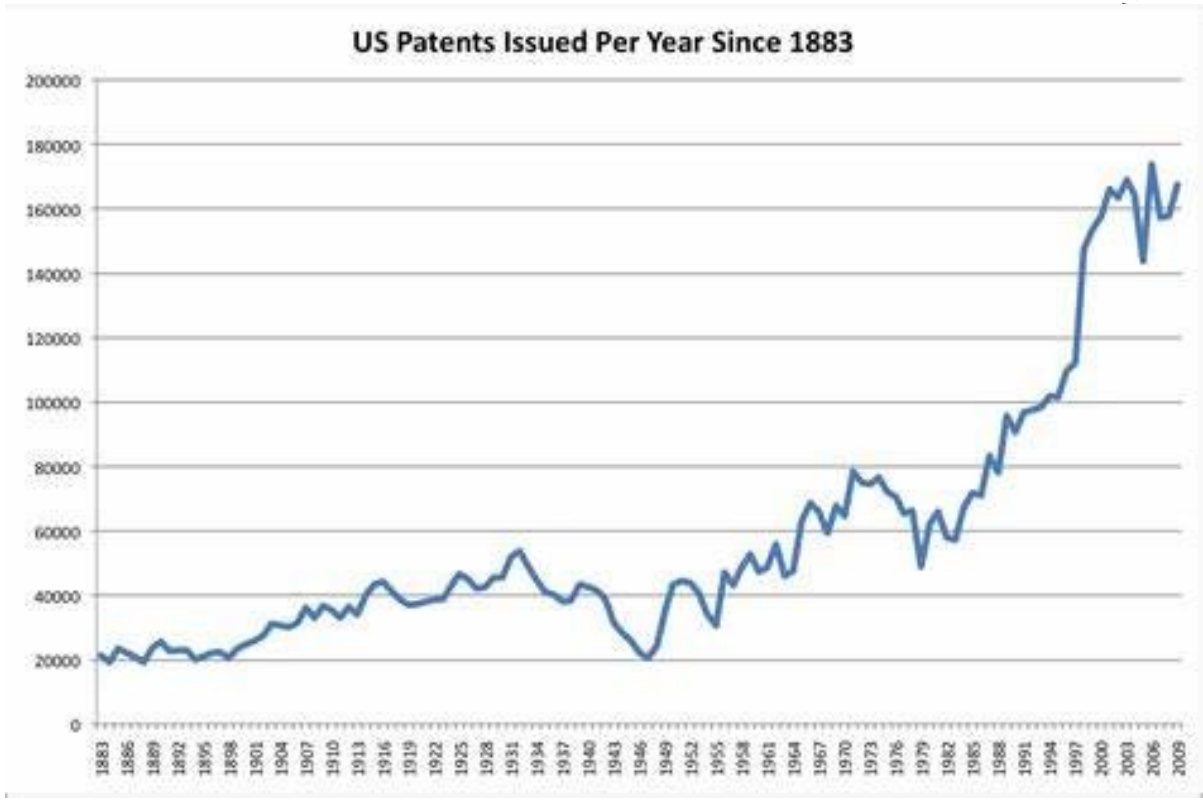
IGBPGreatAccelerationdatacollection.xlsx (live.com)

Continued advancing … but in a sustainable way

- Find a way to capture the amazing advances we have made as a human society (health, longevity, science, technology, travel, art …)

but

- in a sustainable way ***(without taking a mortgage on future generations)***



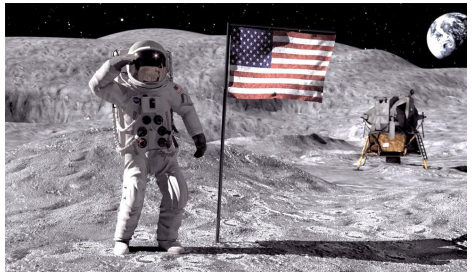
Research: part of the great acceleration

- Value our own mental and physical health
- A remapping of we how we become more advanced as a society

Anthropocene

Proposed geological epoch dating from the commencement of significant human impact on Earth's geology and ecosystems, including, but not limited to, anthropogenic climate change

- Start date range: i) Agricultural Revolution 12,000–15,000 years ago, ii) peak in radionuclides fallout from atomic bomb testing in 1950s
- September 2021: formally proposed to International Commission on Stratigraphy (ICS) locating markers to the time period coinciding with the Great Acceleration, and the Atomic Age.
- Ratification rejected yet being opposed



maxresdefault.jpg (1280×720) (ytimg.com)

surgery-header.jpg (1100×385) (utmb.edu)

Anthropocene - Wikipedia

Terraforming: Largest Mines in the World (911metallurgist.com)

The Diavik diamond mine, Canada (Rio Tinto)

2.4 million

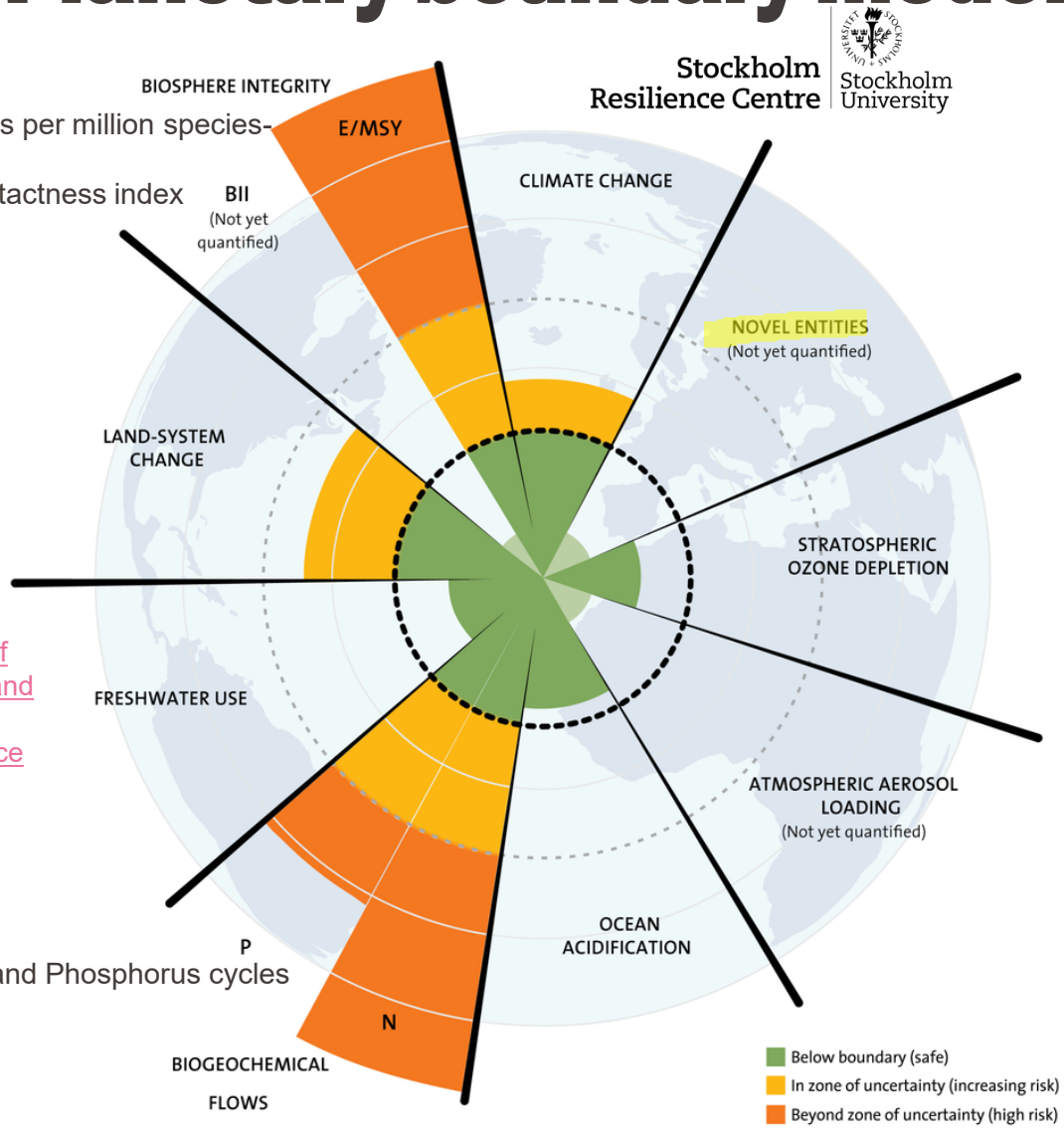
A 1991 study by the International Physicians for the Prevention of Nuclear War (IPPNW) predicted that some **2.4 million** people would eventually die from cancer as a result of atmospheric testing globally.

75 YEARS LATER, NUCLEAR WEAPONS STILL KILL | Geneva Centr...
www.gcsp.ch/global-insights/75-years-later-nuclear-weapons-still-kill

Trinity was the code name of the first detonation of a nuclear device. It was conducted by the United States Army at 5:29 a.m. on July 16, 1945, as part of the Manhattan Project.

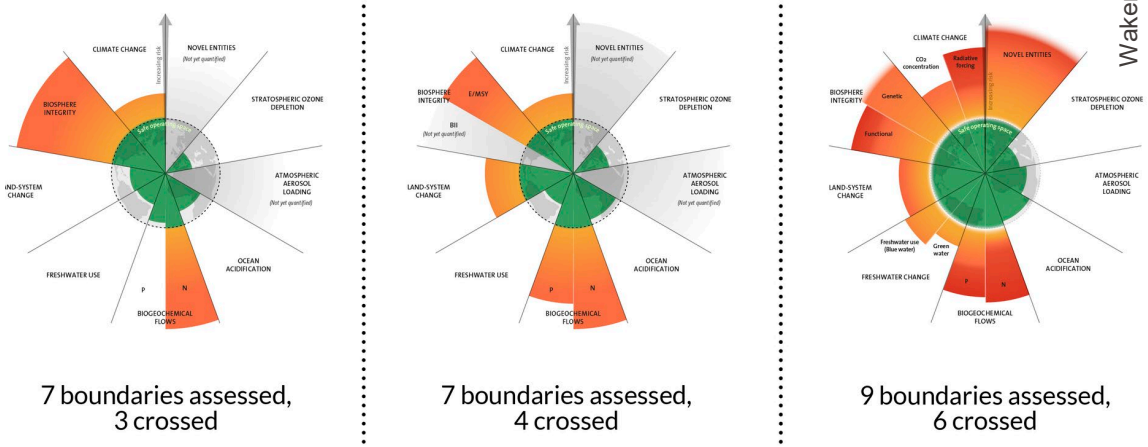
Planetary boundary model

E/MSY = extinctions per million species-years
BII = biodiversity intactness index



Nitrogen and Phosphorus cycles

Steffen et. al, 16 January 2015, Science



7 boundaries assessed, 3 crossed

7 boundaries assessed, 4 crossed

9 boundaries assessed, 6 crossed

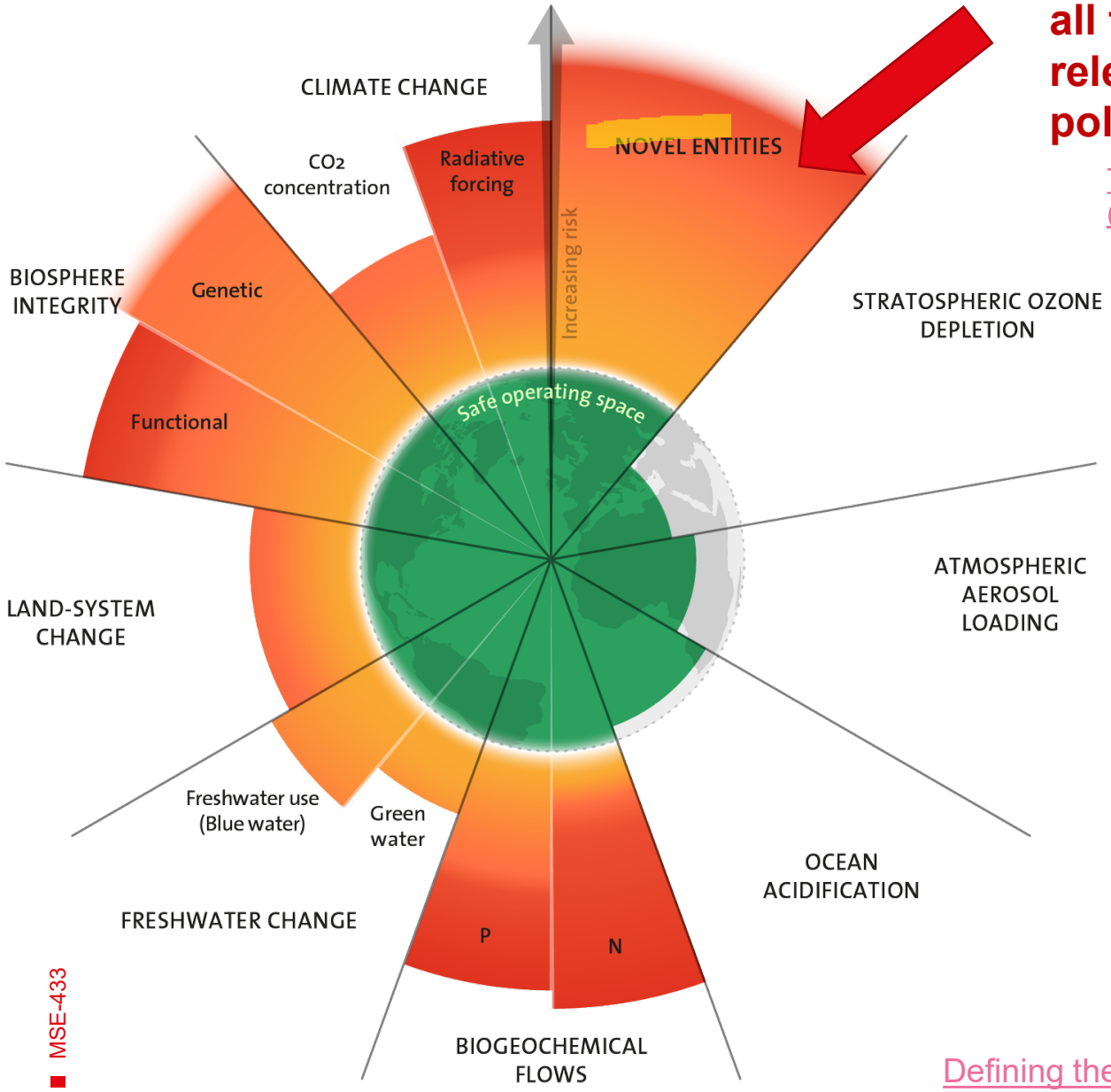
PB over time. 2009, 2015, 2023.jpg | Powered by Box

The tipping points of climate change — and where we stand - Stockholm Resilience Centre

Let the environment guide our development | Johan Rockstrom - YouTube

Planetary boundaries - Stockholm Resilience Centre

2023 Planetary boundary model

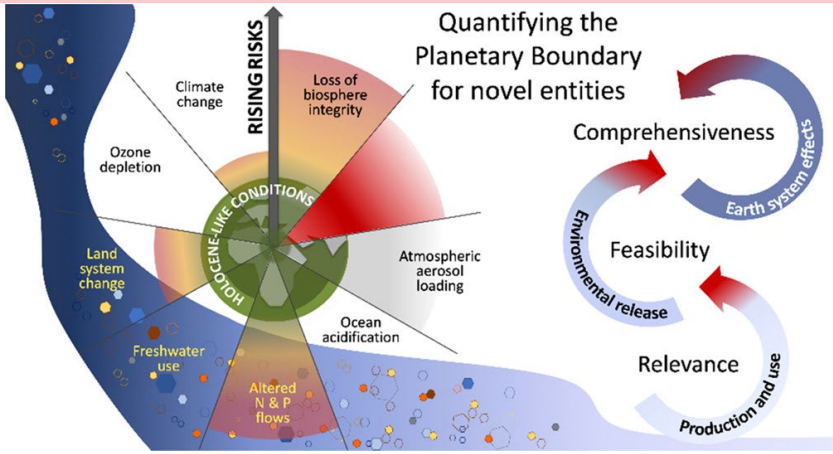


all toxic and long-lived substances that humans release into the environment, persistent organic pollutants, e.g. perfluorooctanoic acid (1950-2020!)

The Lawyer Who Became DuPont's Worst Nightmare - The New York Times (nytimes.com)

For chemical to pose threat to earth system, 3 conditions:

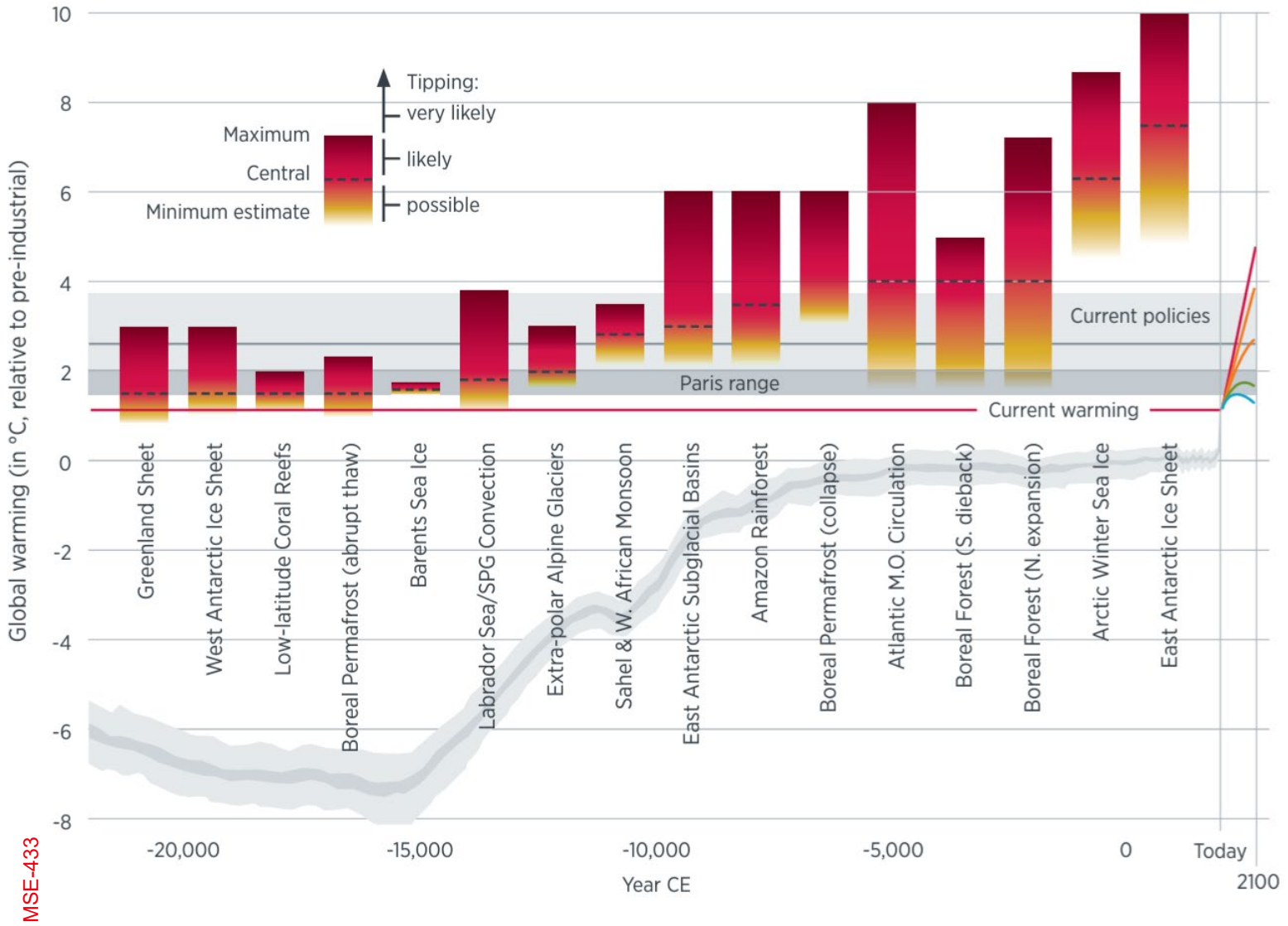
i) **disruptive effect on a vital earth system process;**
ii) **disruptive effect is not discovered until it is a problem at the global scale**
iii) **effect is not readily reversible**



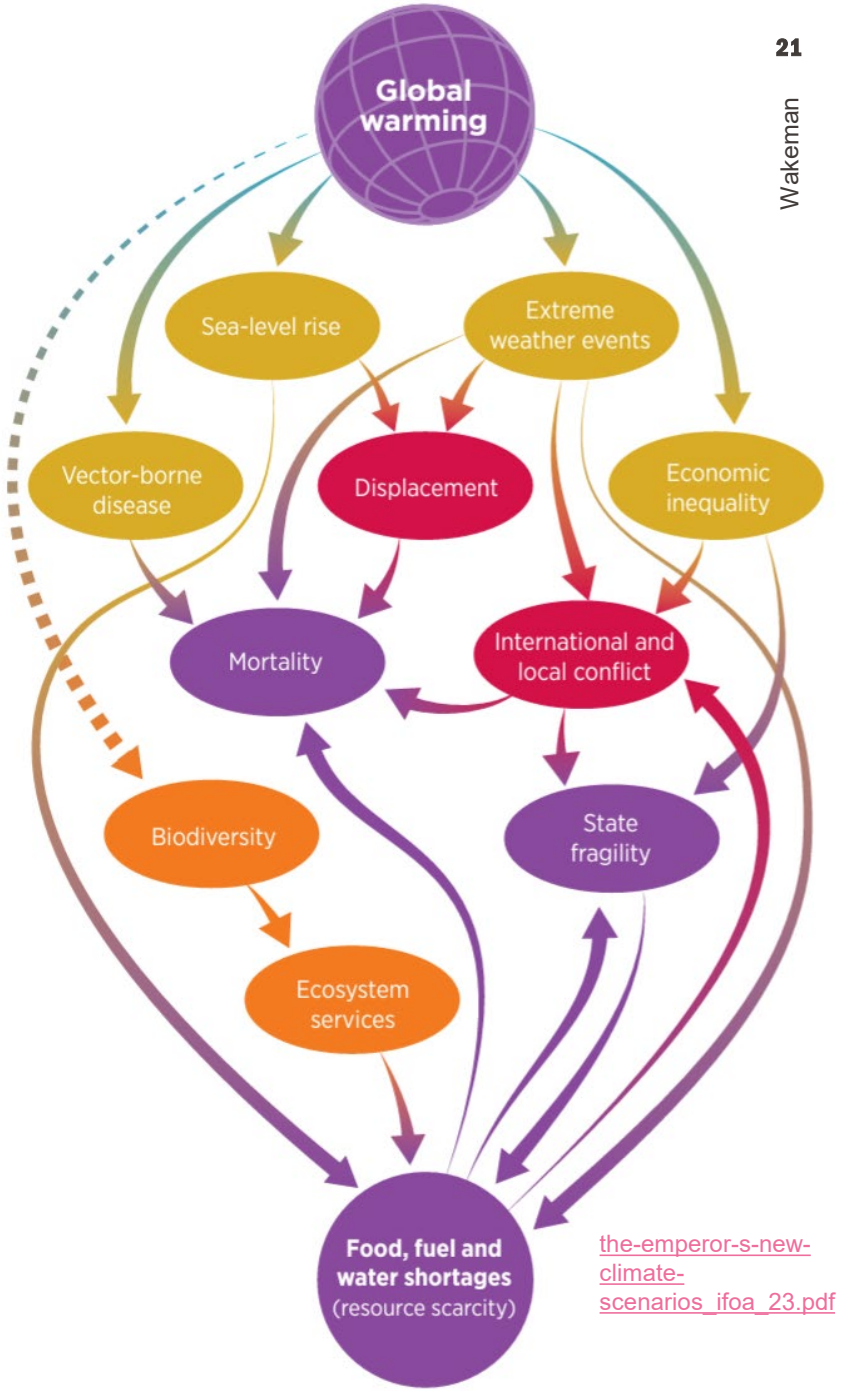
Defining the risk presented by novel entities: How plastic and chemicals affect Earth system integrity - Ikhapp

Climate tipping points

Figure 4: The likelihood of tipping points being triggered for different global warming temperatures



Source: McKay et al, Exceeding 1.5°C global warming could trigger multiple climate tipping points, 2022. Reproduced with permission.



Wakeman

the-emperor-s-new-climate-scenarios_ifoa_23.pdf

Earth overshoot day

- Date humanity's resource consumption for year exceeds Earth's capacity to regenerate those resources that year.
- "Overshoot" represents level by which human population exceeds sustainable amount of resources
- Day in which humanity enters environmental **deficit spending**

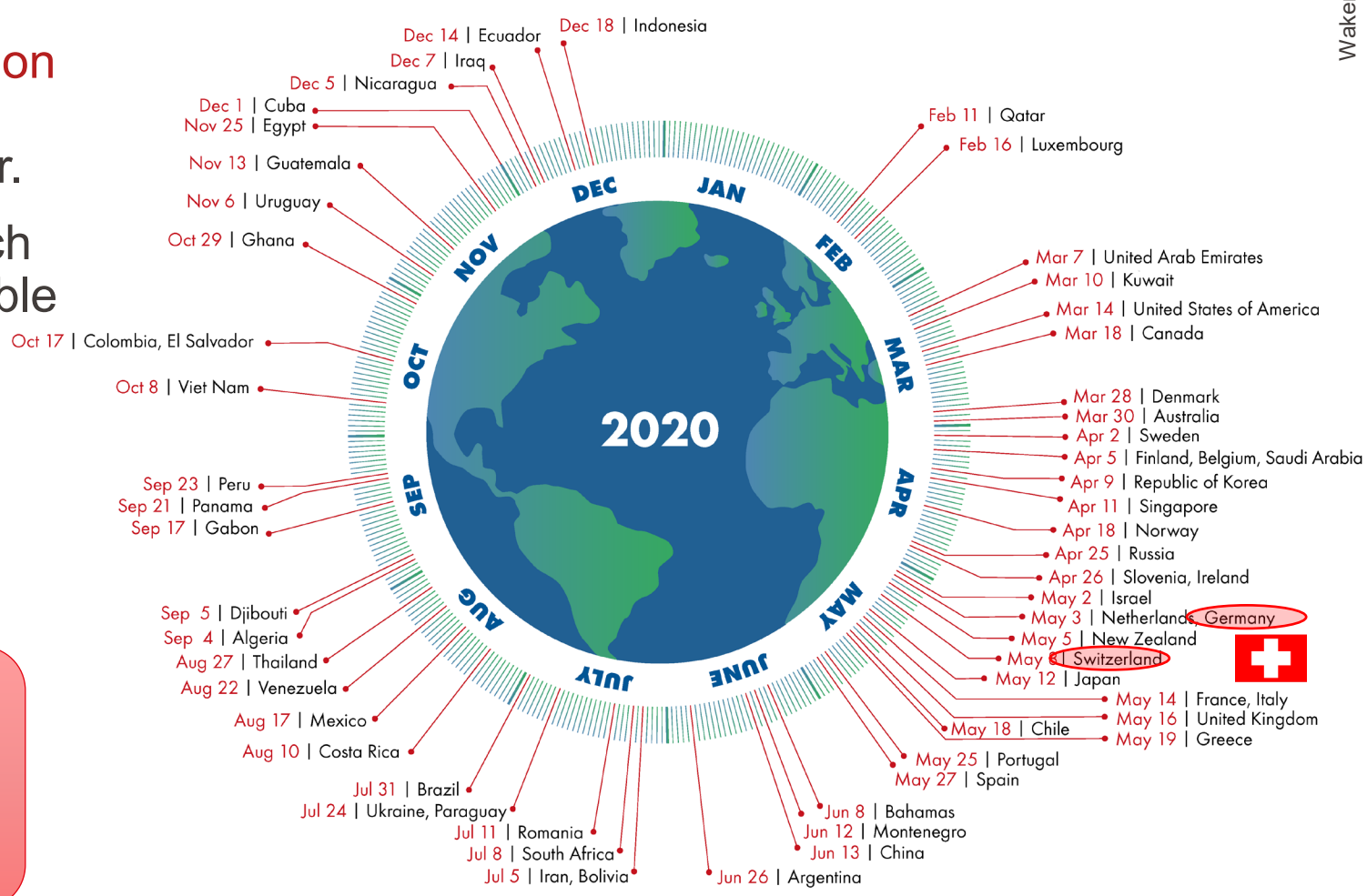
EOD = $\frac{\textbf{world biocapacity}}{\textbf{world ecological footprint}}$

world biocapacity
(the amount of natural resources generated by Earth that year)

world ecological footprint
(humanity's consumption of Earth's natural resources for that year), and multiplying by 365, the number of days in a year.

Country Overshoot Days 2020

When would Earth Overshoot Day land if the world's population lived like...

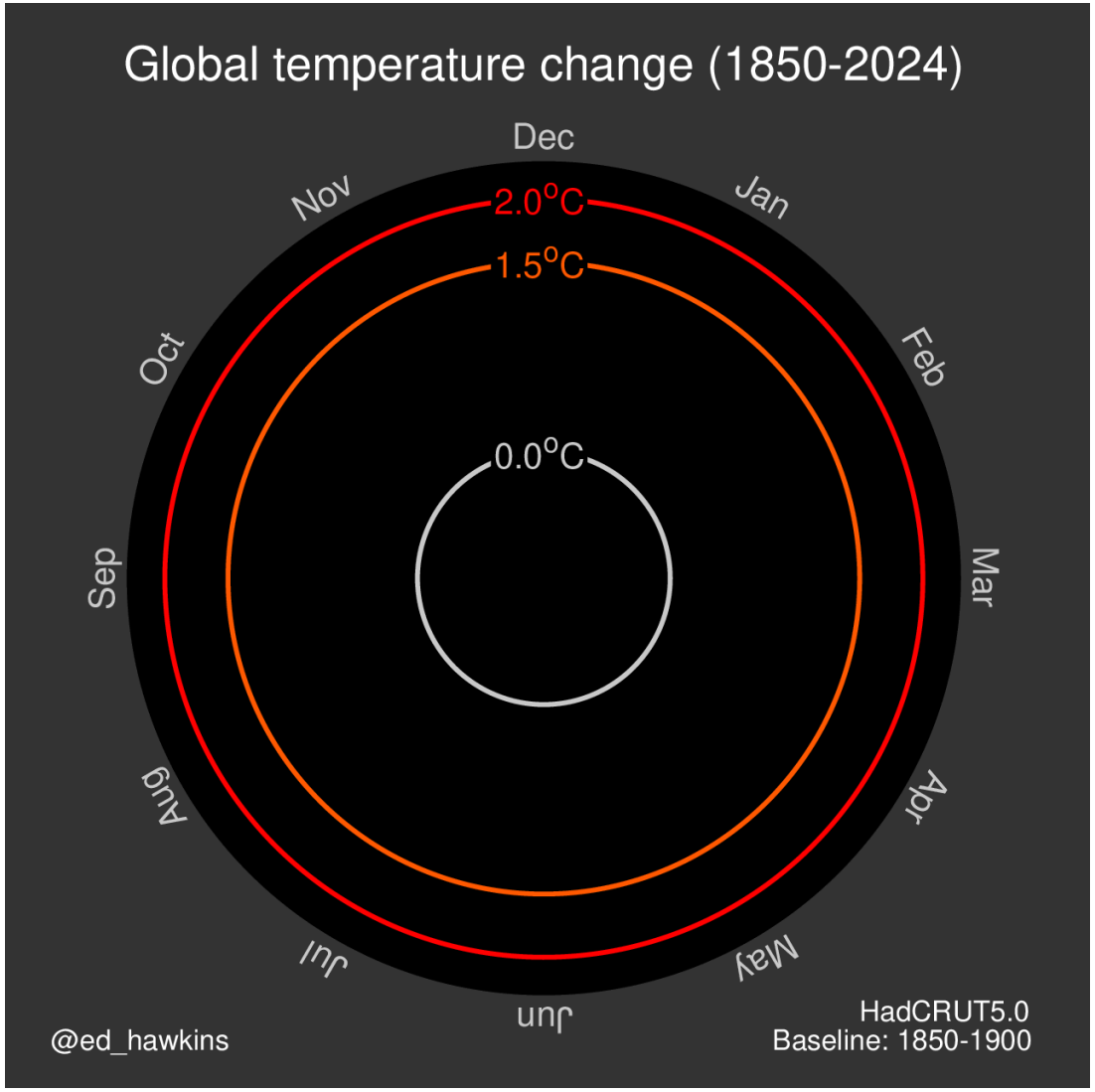


EARTH OVERSHOOT DAY

Source: Global Footprint Network National Footprint and Biocapacity Accounts 2019

Global Footprint Network
Advancing the Science of Sustainability

[Earth Overshoot Day 2020 – Dynaversity]



global_temperature_spiral_2024_large.gif (1280×1280)

BBC

Home News Sport Business Innovation Culture Arts Travel Earth Video Live

World's first year-long breach of key 1.5C warming limit

8 February 2024

Share Save

Mark Poynting
BBC News climate reporter

Chile has seen forest fires in several regions in February, including La Araucanía (pictured)

For the first time, global warming has exceeded 1.5C across an entire year, according to the EU's climate service.

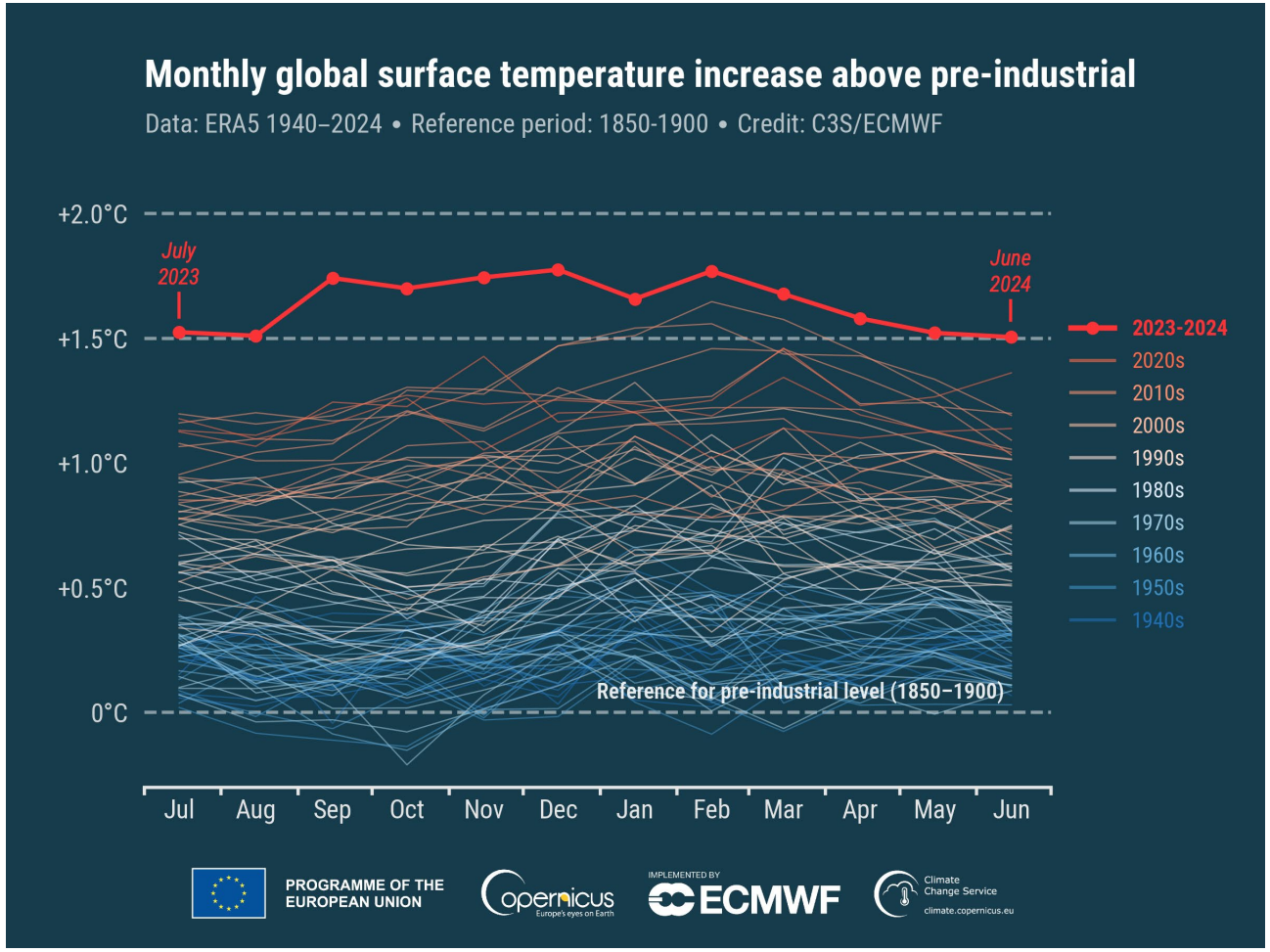
World leaders promised in 2015 to try to limit the long-term temperature rise to 1.5C, which is seen as crucial to help avoid the most damaging impacts.

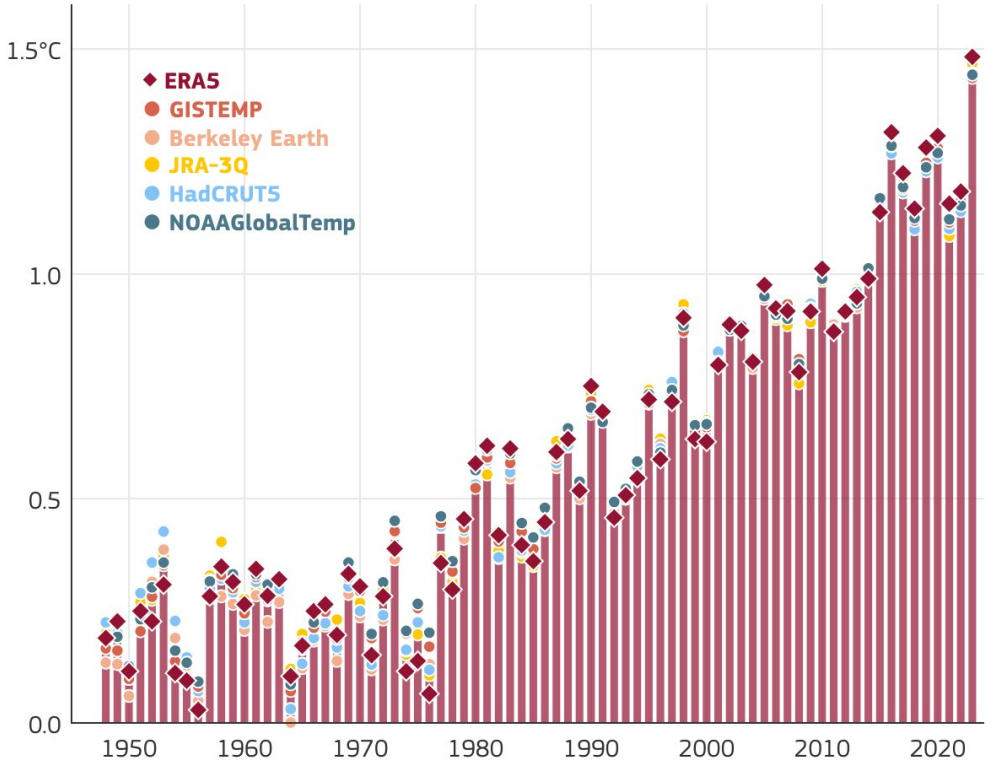
This first year-long breach doesn't break that landmark Paris agreement, but it does bring the world closer to doing so in the long-term.

Urgent action to cut carbon emissions can still slow warming, scientists say.

"This far exceeds anything that is acceptable," Prof Sir Bob Watson, a former chair of the UN's climate body, told the BBC Radio 4's Today Programme.

July 2023 – June 2024 above 1.5ºC

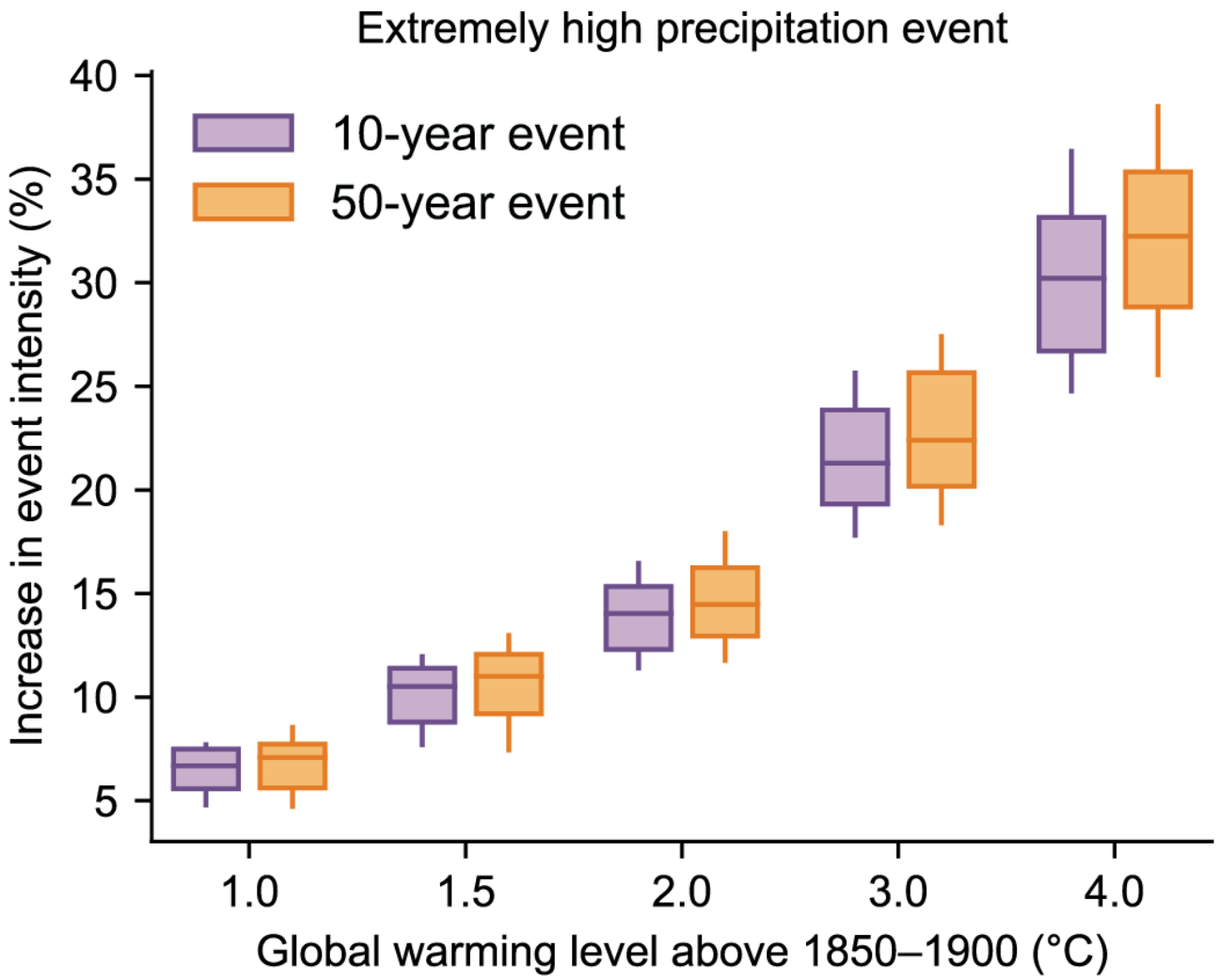




Why do we keep talking about 1.5°C and 2°C above the pre-industrial era? | Copernicus

If warming continues at today's pace, we expect to reach the 1.5°C threshold in the early 2030s.

Warming raises precipitation events



ipcc.ch / IPCC_AR...hapter11

11

Weather and Climate Extreme Events in a Changing Climate

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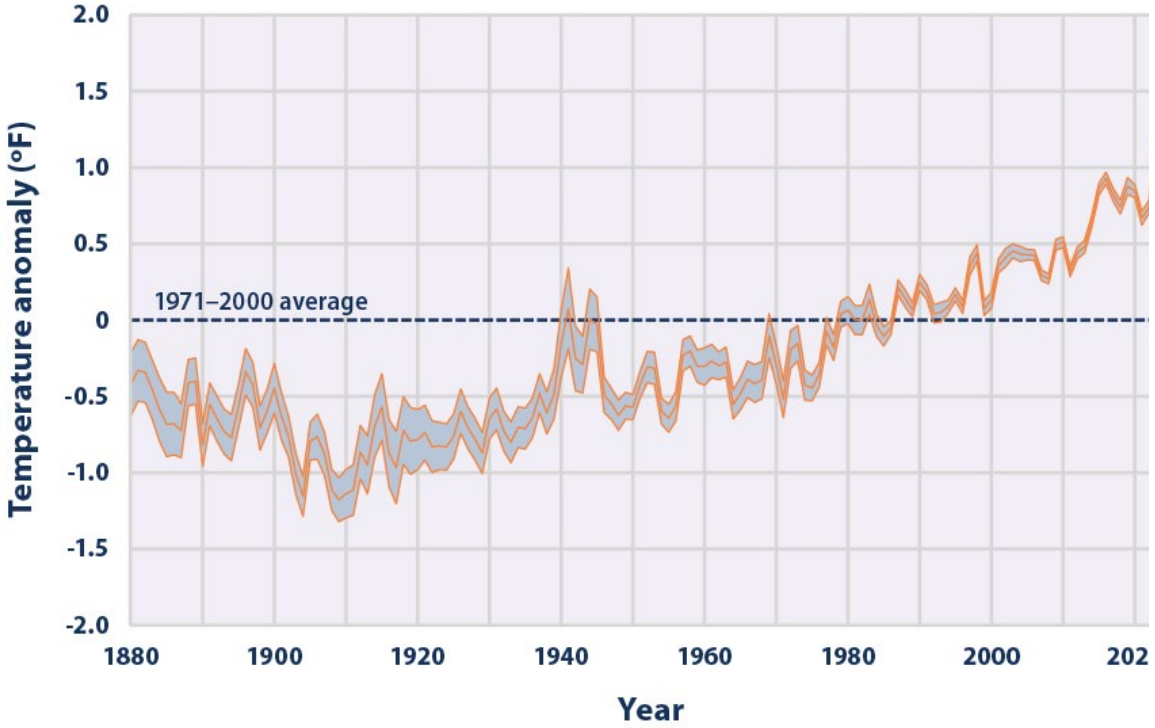
Chapter 11: Weather and Climate Extreme Events in a Changing Climate | Climate Change 2021: The Physical Science Basis

Ocean warming

About ninety percent of global warming is occurring in the ocean.

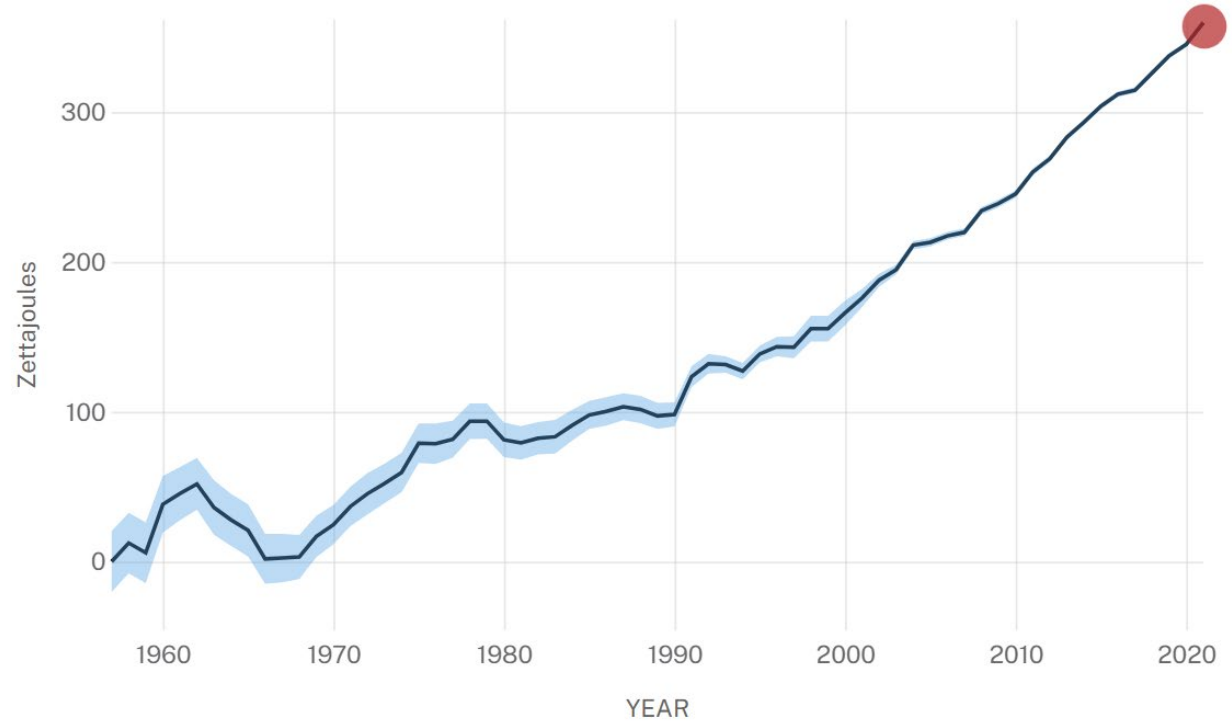


Climate Change Indicators: Sea Surface Temperature | US EPA

The effects of ocean warming include sea level rise due to thermal expansion, coral bleaching, accelerated melting of Earth's major ice sheets, intensified hurricanes*, and changes in ocean health and biochemistry.

OCEAN HEAT CONTENT CHANGES SINCE 1955 (NOAA)

Data source: Observations from various ocean measurement devices, including conductivity-temperature-depth instruments (CTDs), Argo profiling floats, and eXpendable BathyThermographs (XBTs). Credit: NOAA/NCEI World Ocean Database



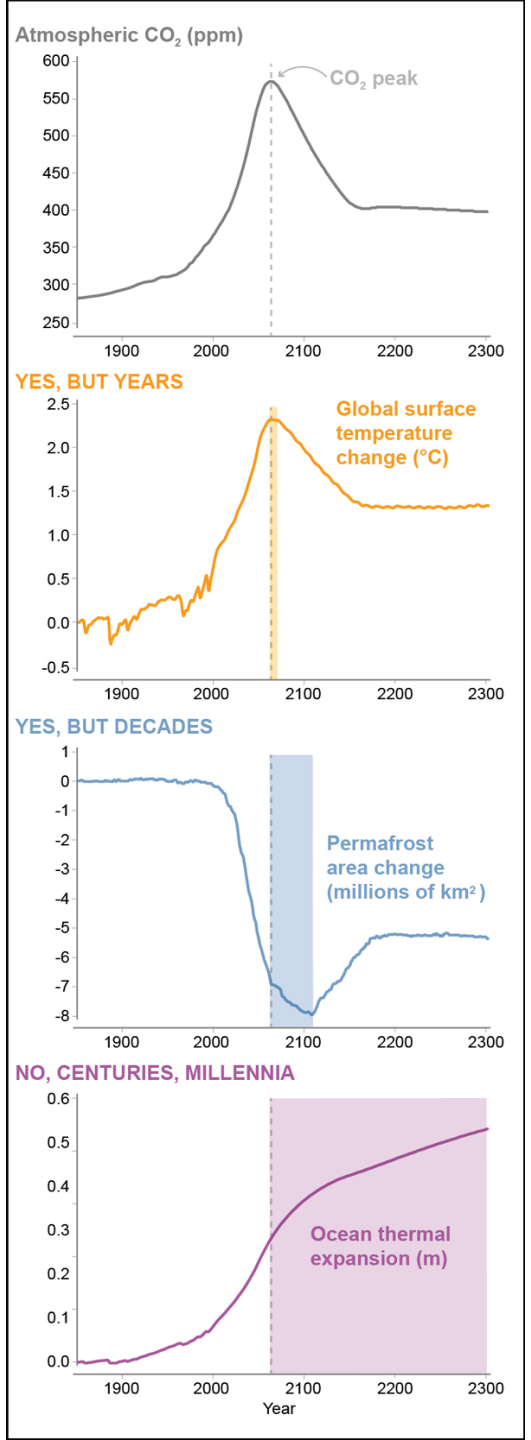
Ocean Warming | Vital Signs – Climate Change: Vital Signs of the Planet

Time lines of reversal

- Global surface temperature: years
- Permafrost: decades
- Ocean expansion: millennia

Reversal outside of pricing and economics (Significant non-trivial externalities not considered by economics)

Carbon dioxide stays in atmosphere for centuries to millennia, but carbon removal accelerates the natural cycle to store excess carbon in soil, plants, or water.



A simplified computer model shows how long Earth systems take (years to centuries) to rebound following peak CO_2 emissions (vertical gray dashed lines in each plot). Credit: *IPCC* [2021], FAQ 5.3

new-ipcc-2021-figure-5.png (600×1669) (wp.com)

Mark Carney, ex governor of the bank of England

- climate change is the **"Tragedy of the Horizon"**
- The catastrophic effects of climate change will be felt (well) beyond the traditional horizons of most (financial) actors

Climate change is already causing

- More frequent and intense extreme weather events (heatwaves, droughts, floods, storms)
- Rising sea levels threatening coastal communities
- Biodiversity loss and ecosystem collapse
- Threats to food and water security
- Health impacts from air pollution and disease spread

- **Worsening trajectory UNLESS we change**

Climate change is causing and will cause

- **Unequal impacts**
  - Climate change disproportionately harms:
    - Low-income countries with fewer resources to adapt
    - Indigenous communities losing traditional lands and livelihoods
    - The global poor facing food insecurity and displacement
    - Future generations inheriting a degraded planet

- **Over-consumption impacts**
  - Especially in wealthy countries, drives emissions through:
    - Resource extraction and manufacturing
    - Transportation of goods
    - Waste generation and disposal
    - Detrimental to our health

Transformation

- **Systemic transformation**
  - Addressing the climate crisis requires fundamental changes to:
    - Energy systems
    - Transportation infrastructure
    - Food production and distribution
    - Urban planning and building design
    - Economic models and incentives

- **Individual action**
  - While systemic change is crucial, individual choices also matter:
    - Reducing personal carbon footprints
    - Making sustainable consumer choices

Flight, fight, or freeze

- Aim is to help you fight
- Not freeze in data overload
- Not run away and ignore the issue

peter rabbit GIF (giphy.com)

Ten photographs that made the world wake up to climate change

By Nell Lewis, CNN

7 minute read · Updated 4:43 AM EDT, Thu March 30, 2023

Ten photographs that made the world wake up to climate change | CNN

Waterfalls pour off a Nordaustlandet ice cap in Svalbard, Norway, during an unusually warm summer in 2014.
Courtesy of Paul Nicklen

An emaciated polar bear staggers on the search for food. The photograph, taken in 2017, received widespread attention, sparking a conversation around climate change.
Courtesy of Cristina Mittermeier

Ten photographs that made the world wake up to climate change | CNN

A kangaroo jumps past a burning house in Lake Conjola, Australia in December 2019. That season's bushfires were among the worst the country had ever seen, with nearly three billion animals killed or displaced.

Matthew Abbott/The New York Times

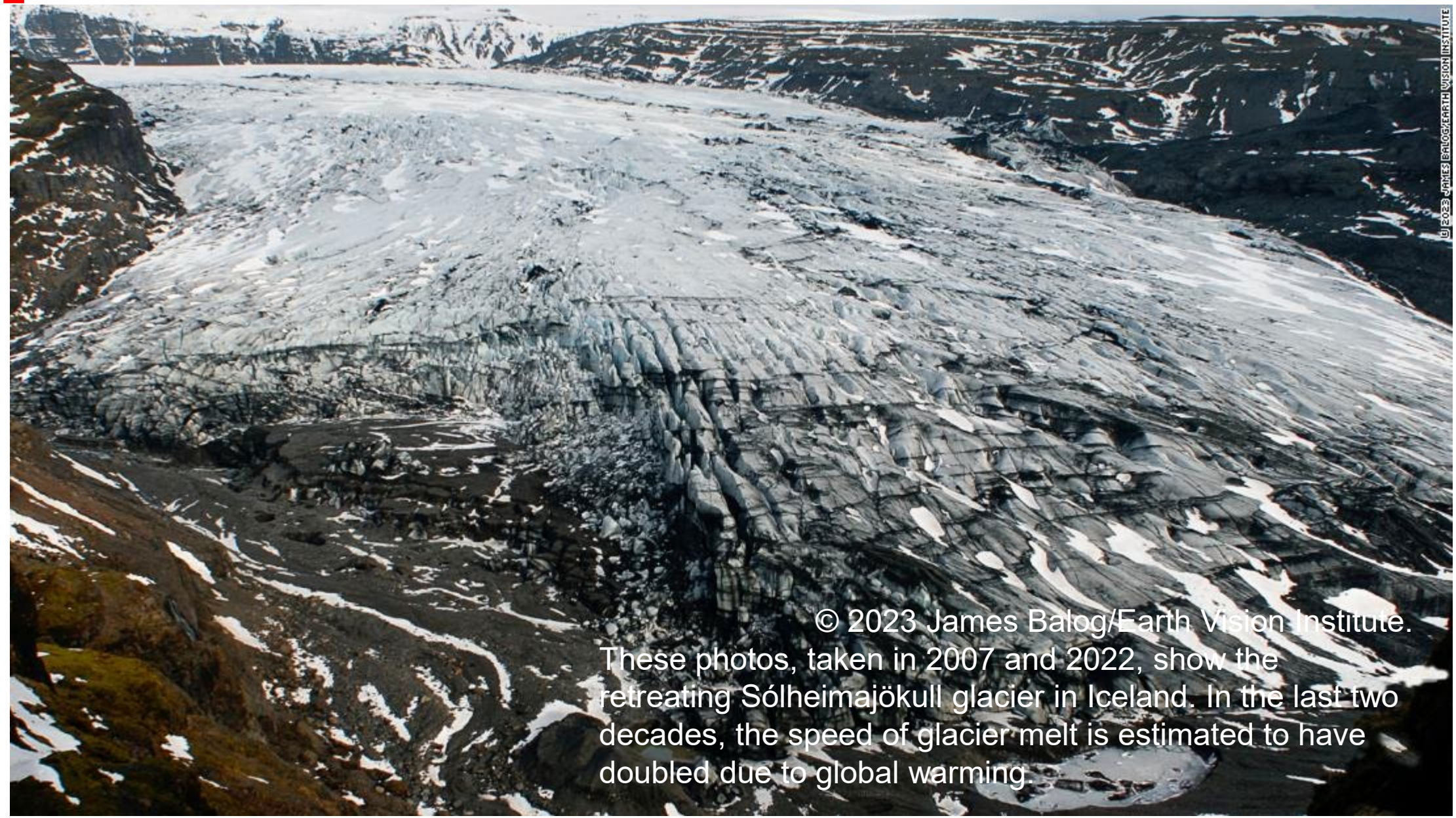
The bodies of six giraffes lie on the outskirts of Eyrib village in Sabuli wildlife conservancy, Kenya, in 2021. A prolonged drought in the northeast of the country and the wider Horn of Africa has created food and water shortages for both animals and local communities.

Ed Ram/Getty Images

Ten photographs that made the world wake up to climate change | CNN

Villagers stand on a remnant of a road in Bhola Island, Bangladesh, in 2005. The area, at the mouth of the Ganges delta, is still suffering from accelerated erosion due to sea level rise.

Ten photographs that made the world wake up to climate change | CNN



© 2023 James Balog/Earth Vision Institute.
These photos, taken in 2007 and 2022, show the retreating Sólheimajökull glacier in Iceland. In the last two decades, the speed of glacier melt is estimated to have doubled due to global warming.

Ten photographs that made the world wake up to climate change | CNN

These photos, taken in 2007 and 2022, show the retreating Sólheimajökull glacier in Iceland. In the last two decades, the speed of glacier melt is estimated to have doubled due to global warming.

Ten photographs that made the world wake up to climate change | CNN

Polar bears move into an abandoned weather station in Kolyuchin, Russia. The majestic mammals are at particular risk from climate change, which is melting the Arctic sea ice that they depend on.
Dmitry Kokh

Ten photographs that made the world wake up to climate change | CNN

Alice, Stanley and their child were displaced as floods destroyed their house in Kenya in 2017. They are photographed at the Ol Pejeta Conservancy together in the same frame as Najin, one of the last two northern white rhinos in the world. It's part of photographer Nick Brandt's "The Day May Break" series that portrays people and animals impacted by environmental destruction.

Ten photographs that made the world wake up to climate change | CNN

Yet our planet is still so beautiful and worth fighting to preserve

A school of bright cardinalfish swerve to make way for a sea lion in the Galápagos. The archipelago off the coast of Ecuador is famous for its vibrant marine life and is one of the largest marine protected areas in the world.
Courtesy of Cristina Mittermeier

Ten photographs that made the world wake up to climate change | CNN

Our socio-economic model also affects us as humans

- Ecological ceiling (and boundaries)
- Social foundation (and shortfalls)
- **Need the safe and just space between these social and planetary boundaries**
- Humanity's 21st century goal

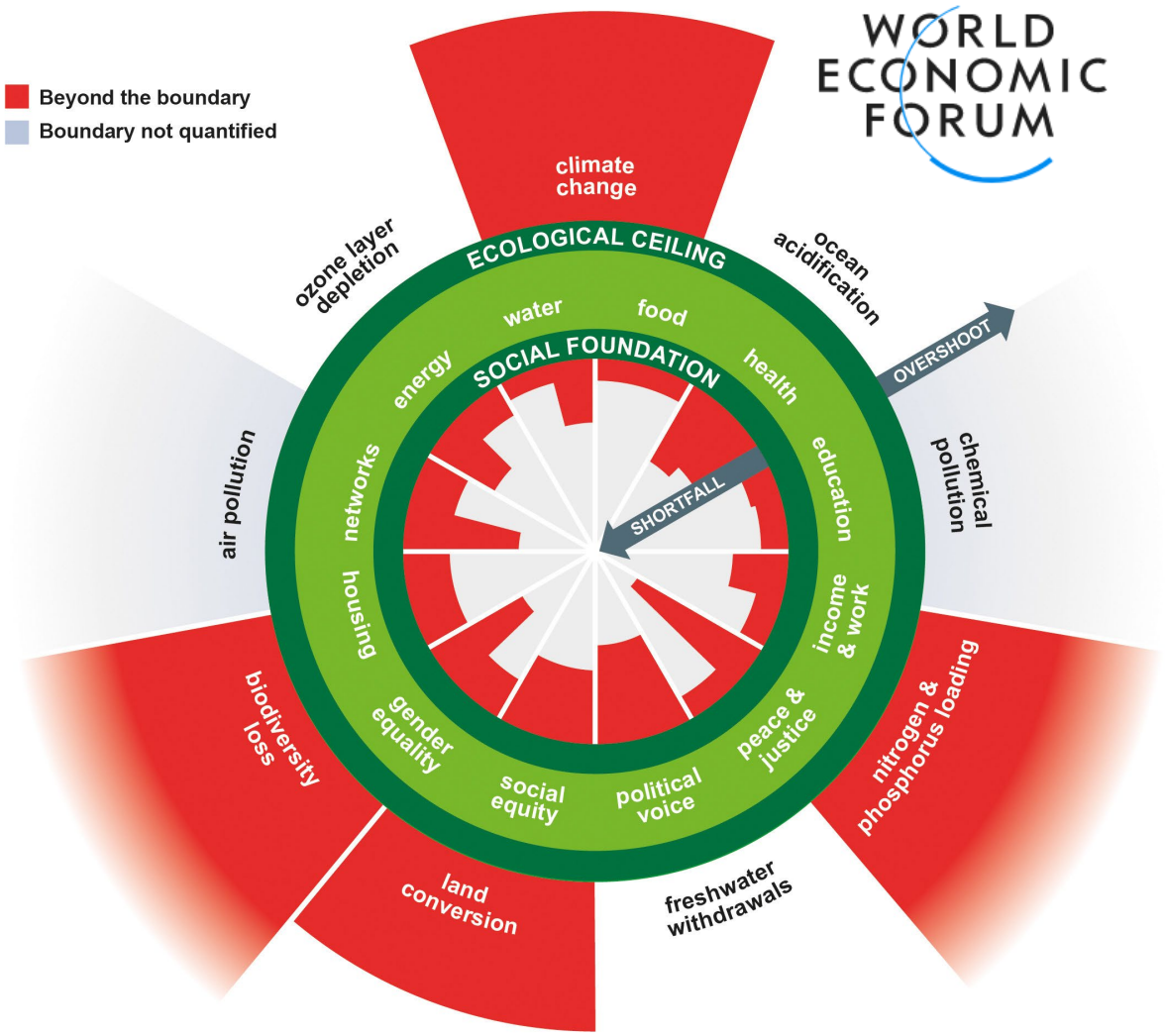


Image: Kate Raworth and Christian Guthier/The Lancet Planetary Health

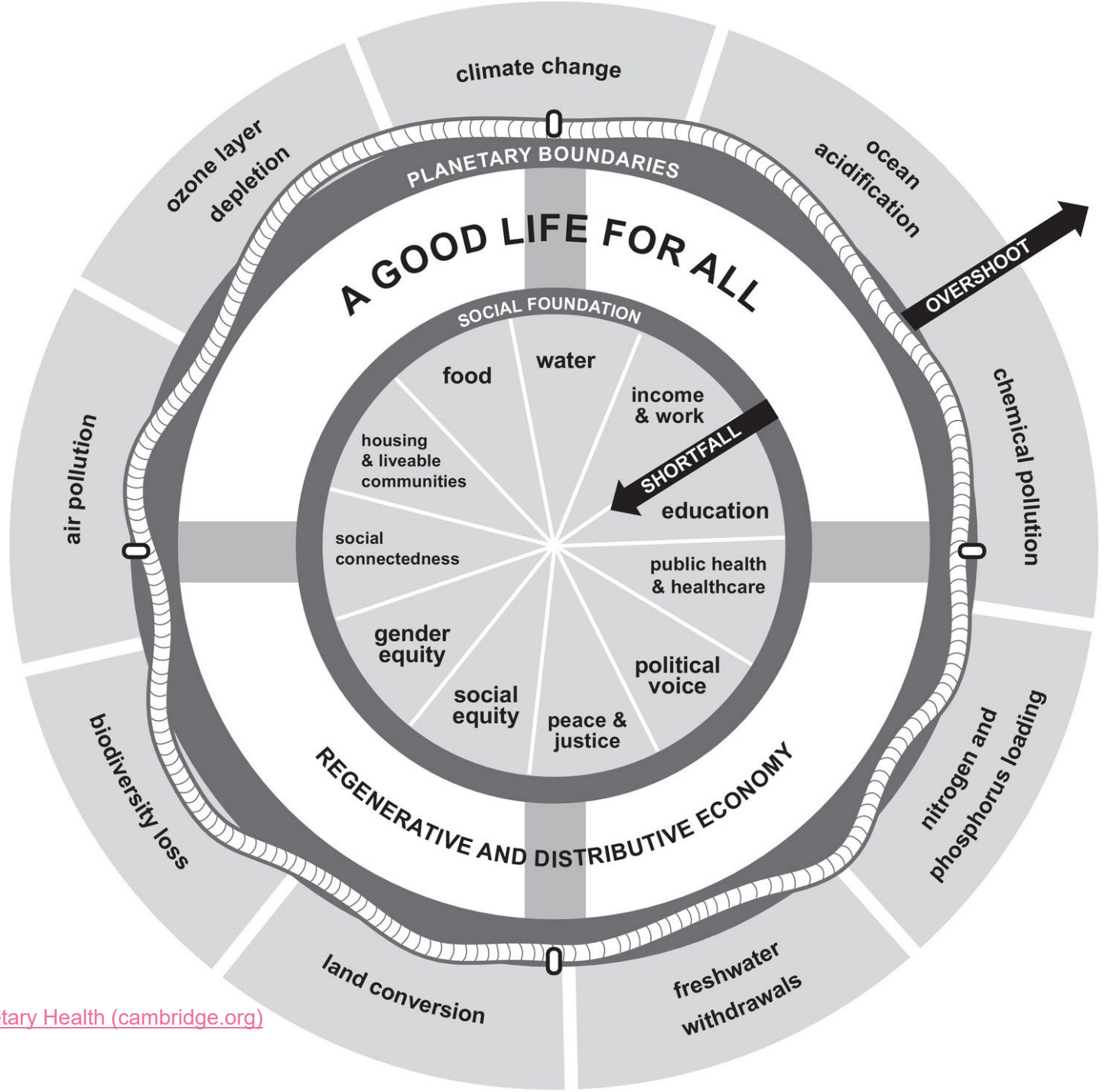
Meet the doughnut: the new economic model that could help end inequality | World Economic Forum (weforum.org)

Doughnut | Kate Raworth

Life buoy economy

- The Lifebuoy Economy, redrawn from Kate Raworth's image of the doughnut economy (www.kateraworth.com/doughnut/)

- (because doughnuts are used for gorging and contribute to obesity, while lifebuoys are used for rescue and contribute to survival!). Graphic by Emanuel Santos



Sustaining Planetary Health in the Anthropocene (Chapter 12) - Planetary Health (cambridge.org)

UN 2030 sustainable development goals

[Transforming our world: the 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs (un.org)]

[Home | Sustainable Development (un.org)]

The Doughnut economy and circularity in business models – Best For The World

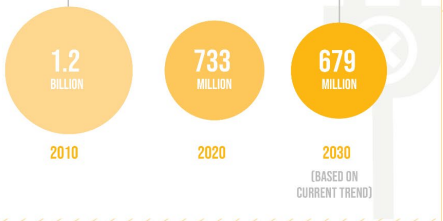
Graphics by Jerker Lokrantz/Azote

7 AFFORDABLE AND CLEAN ENERGY — ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL

IMPRESSIVE PROGRESS IN ELECTRIFICATION HAS SLOWED

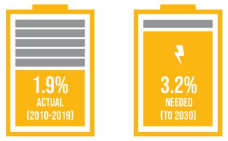
DUE TO THE CHALLENGE OF REACHING THOSE HARDEST TO REACH

NUMBER OF PEOPLE WITHOUT ELECTRICITY



PROGRESS IN ENERGY EFFICIENCY NEEDS TO SPEED UP TO ACHIEVE GLOBAL CLIMATE GOALS

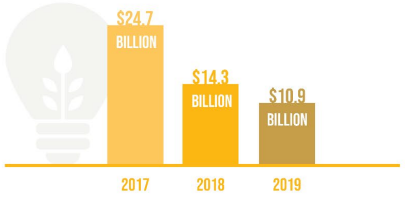
ANNUAL ENERGY-INTENSITY IMPROVEMENT RATE



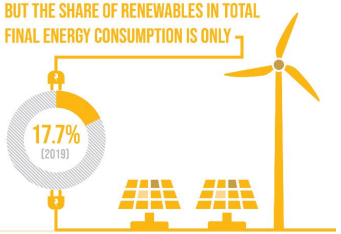
2.4 BILLION PEOPLE STILL USE INEFFICIENT AND POLLUTING COOKING SYSTEMS

(2020)

INTERNATIONAL FINANCIAL FLOWS TO DEVELOPING COUNTRIES FOR RENEWABLES DECLINED FOR A SECOND YEAR IN A ROW



TOTAL RENEWABLE ENERGY CONSUMPTION INCREASED BY A QUARTER BETWEEN 2010 AND 2019, BUT THE SHARE OF RENEWABLES IN TOTAL FINAL ENERGY CONSUMPTION IS ONLY

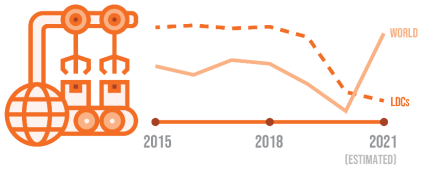


THE SUSTAINABLE DEVELOPMENT GOALS REPORT 2022: UNSTATS.UN.ORG/SDGS/REPORT/2022/

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE — BUILD RESILIENT INFRASTRUCTURE, PROMOTE INCLUSIVE AND SUSTAINABLE INDUSTRIALIZATION AND FOSTER INNOVATION

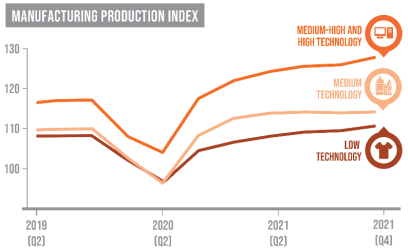
GLOBAL MANUFACTURING HAS REBOUNDED FROM THE PANDEMIC BUT LDCs ARE LEFT BEHIND

MANUFACTURING GROWTH



HIGHER-TECHNOLOGY INDUSTRIES ARE FAR MORE RESILIENT IN CRISES THAN THEIR LOWER-TECH COUNTERPARTS

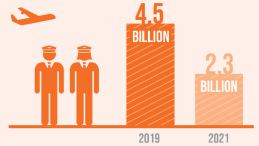
MANUFACTURING PRODUCTION INDEX



SMALL-SCALE INDUSTRIES LACK ACCESS TO FINANCIAL SUPPORT FOR RECOVERY

ONLY 1 IN 3 SMALL MANUFACTURERS ARE BENEFITING FROM A LOAN OR LINE OF CREDIT (2020-2021)

PASSENGER AIRLINE INDUSTRY IS STILL STRUGGLING TO RECOUP CATASTROPHIC LOSSES



2.3 BILLION PASSENGERS IN 2021, COMPARED WITH 4.5 BILLION IN 2019

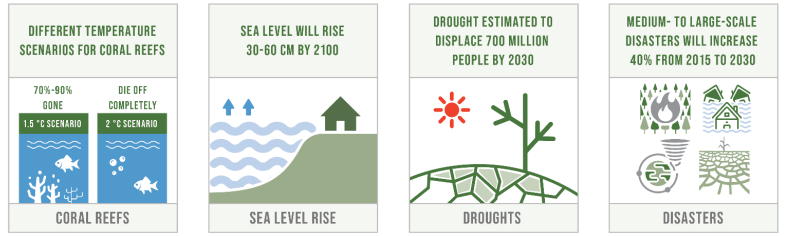
1 IN 3 MANUFACTURING JOBS ARE NEGATIVELY IMPACTED BY THE CRISIS

THE SUSTAINABLE DEVELOPMENT GOALS REPORT 2022: UNSTATS.UN.ORG/SDGS/REPORT/2022/

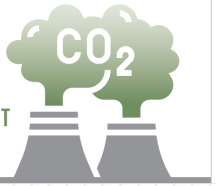
13 CLIMATE ACTION — TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

CLIMATE CHANGE IS HUMANITY'S "CODE RED" WARNING

OUR WINDOW TO AVOID CLIMATE CATASTROPHE IS CLOSING RAPIDLY



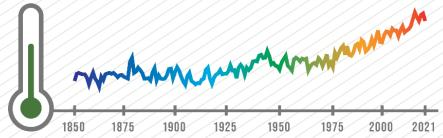
ENERGY-RELATED CO_2 EMISSIONS INCREASED 6% IN 2021 REACHING HIGHEST LEVEL EVER



CLIMATE FINANCE FALLS SHORT OF $100 BILLION YEARLY COMMITMENT

DEVELOPED COUNTRIES PROVIDED $79.6 BILLION IN CLIMATE FINANCE IN 2019

RISING GLOBAL TEMPERATURES CONTINUE UNABATED, LEADING TO MORE EXTREME WEATHER



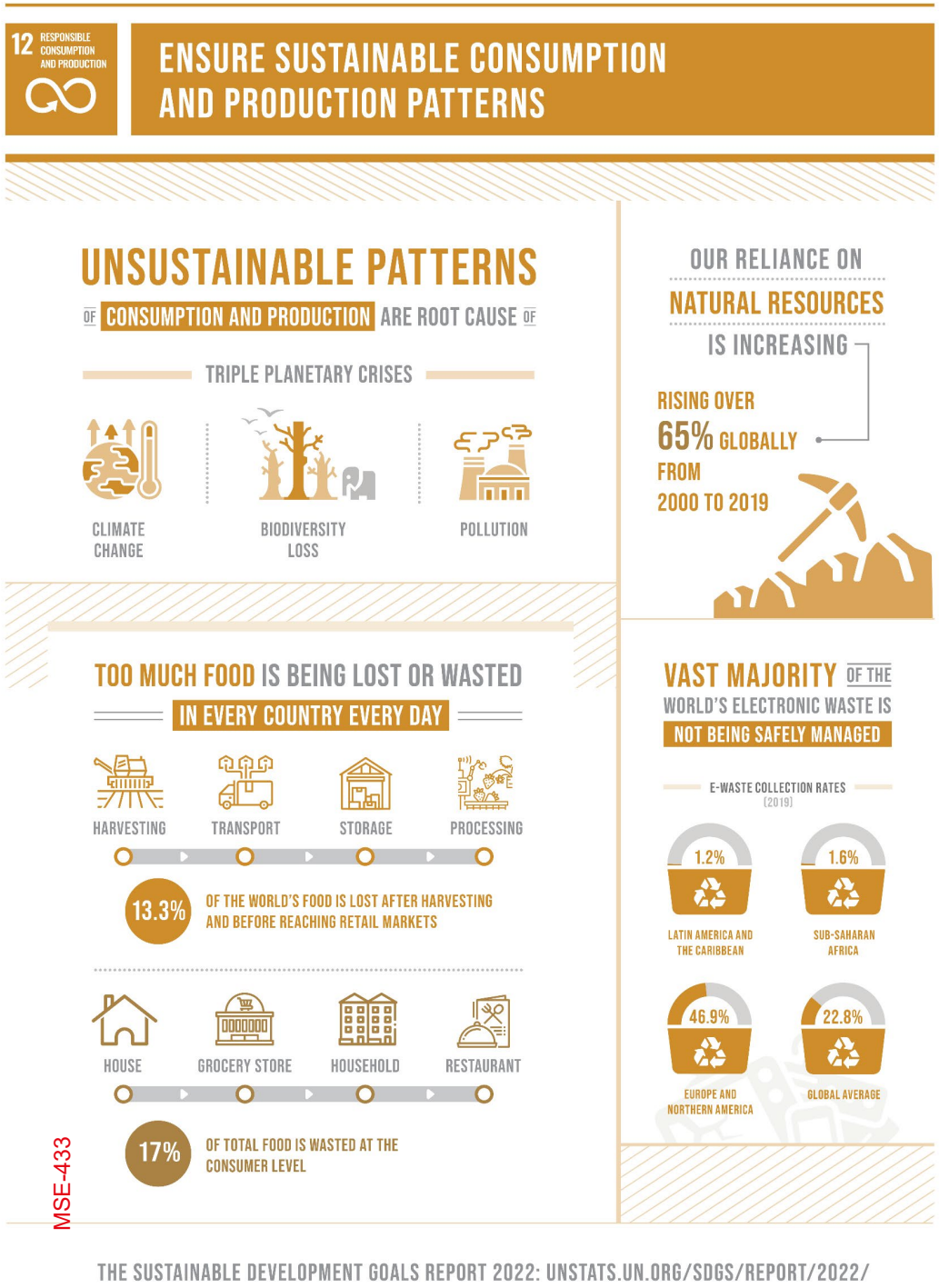
THE SUSTAINABLE DEVELOPMENT GOALS REPORT 2022: UNSTATS.UN.ORG/SDGS/REPORT/2022/

Wakeman

MSE-433

Materials, products, and supply chains contribute to many SDGs especially 6,7,9,11,13

THE 17 GOALS | Sustainable Development (un.org)



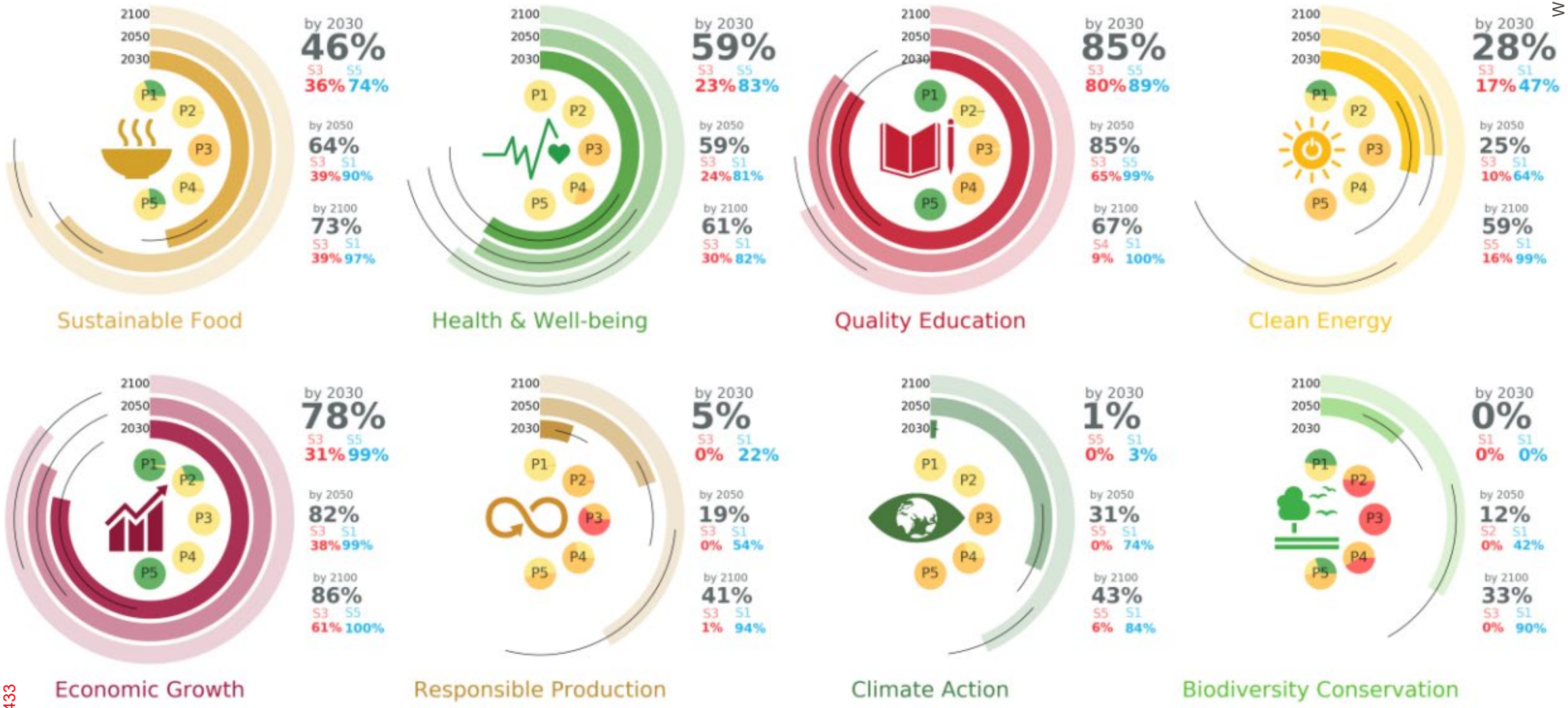
… but

- **goal 12 "Sustainable consumption and production" is a challenge for materials, products, and supply chains**
- **circular economy is a key enabler to SDG 12**

[Goal 12 | Department of Economic and Social Affairs (un.org)]

SDG progress

Countries are making incremental progress on strengthening their NDCs, but what we really need to achieve the goals of the Paris Agreement is urgent transformational change.



(15) (PDF) Global pathways to sustainable development to 2030 and beyond (researchgate.net)

state-of-ndcs-2022.pdf (wri.org)

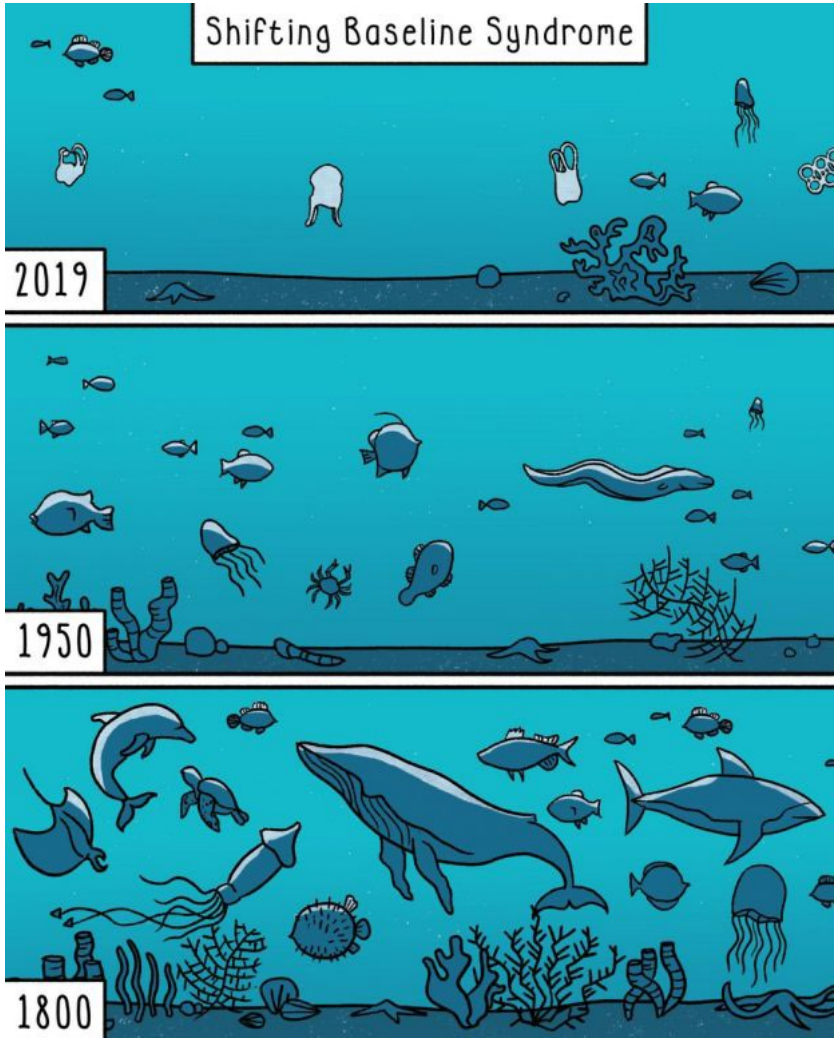
SDG Tracker: Measuring progress towards the Sustainable Development Goals - Our World in Data

Shifting baseline syndrome (Daniel Pauly in 1995)

'A gradual change in the accepted norms for the condition of the natural environment due to a lack of experience, memory and/or knowledge of its past condition'.

- In this sense, what *we consider to be a healthy environment now*, *past generations would consider to be degraded*, and what *we judge to be degraded now*, ***the next generation will consider to be healthy or 'normal'***.

- ***Without memory, knowledge, or experience of past environmental conditions,*** current generations cannot perceive how much their environment has changed (because they are comparing it to their own 'normal' baseline and not to historical baselines).



Wakeman

shifting-baselines-620x775.jpg (620×775) (uvic.ca)

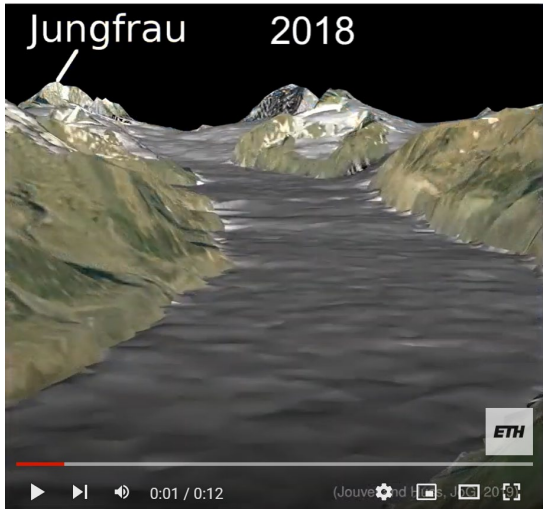
Are You Suffering From Shifting Baseline Syndrome? | Earth.Org - Past | Present | Future

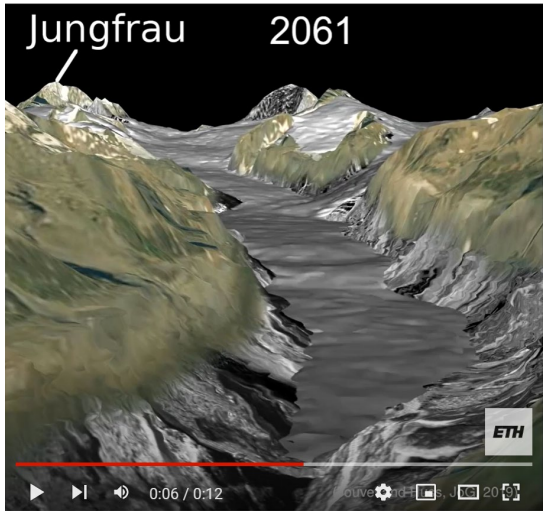
Activation

- Ask your parents and grandparents, where still alive, about changes to
  - Climate
  - Insects
  - Birds

Shifting baseline syndrome (Daniel Pauly in 1995)

Shifting baseline syndrome (Daniel Pauly in 1995)





Swiss Alps lost as much ice in 2 years as it did between

The volume of ice lost in the last two years is equivalent to ice lost between 1960 and 1990.

Sejal Sharma

Published: Sep 29, 2023 04:26 AM EST

Schlechte Aussichten für den Aletschgletscher | ETH Zürich

Sicht von Eggishorn / View from Eggishorn - YouTube

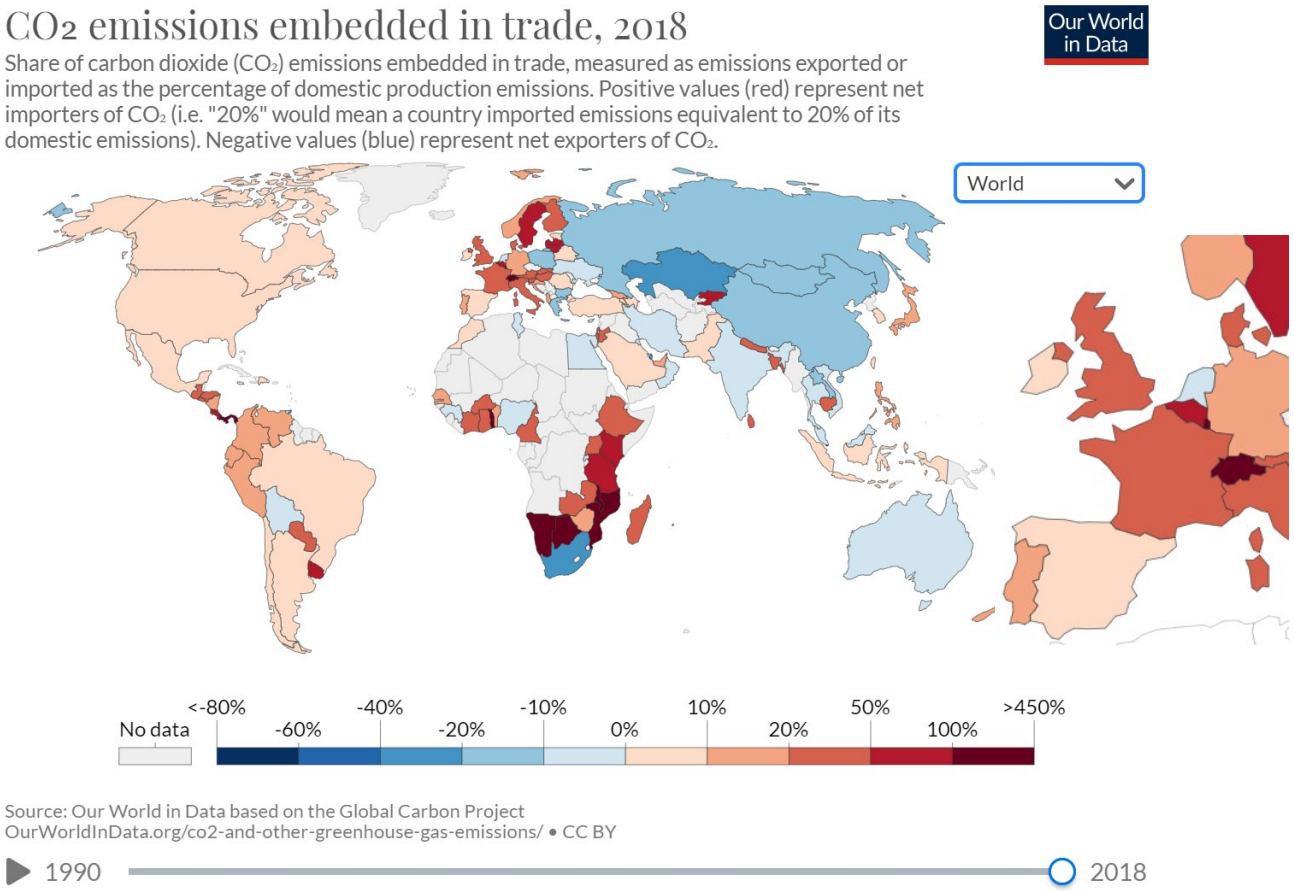
The world is changed,
I feel it in the water,
I feel it in the earth,
I smell it in the air;
much that once was is lost;
for none now live who remember it

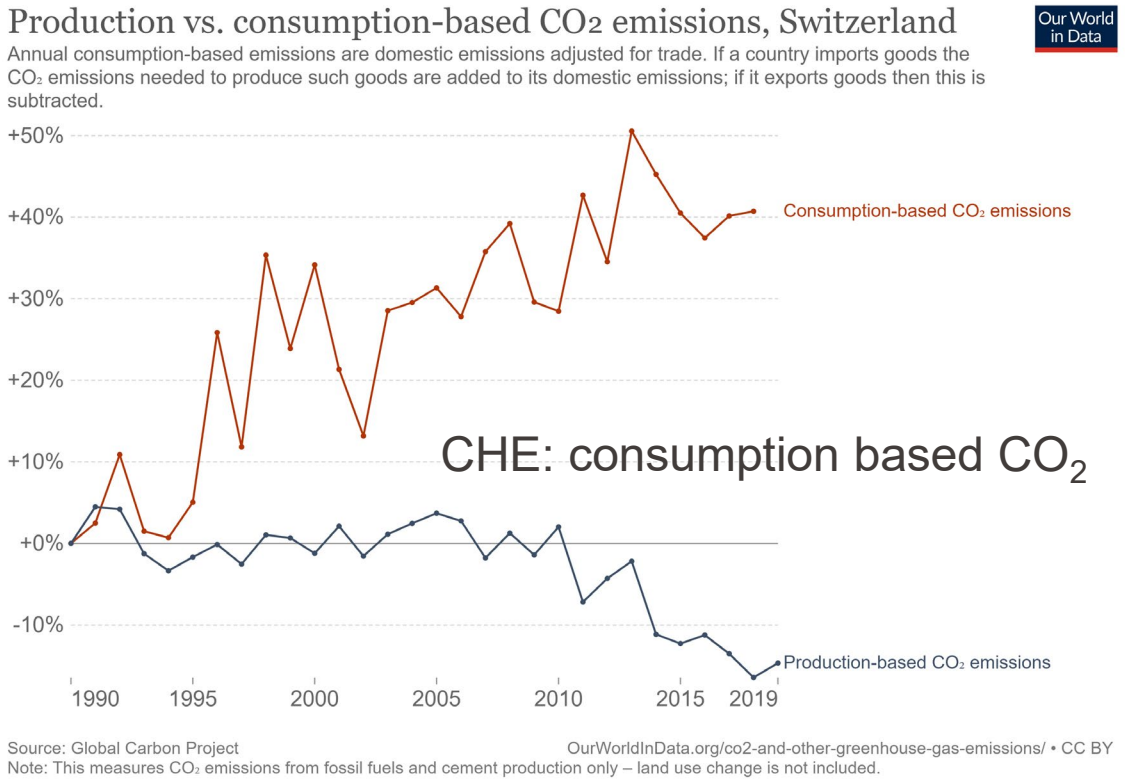
30sec

https://youtu.be/qj139dE7tFI

Key issues for Switzerland

- Net importers of CO_2
- High standard of living & wealth drive consumption based CO_2 emissions





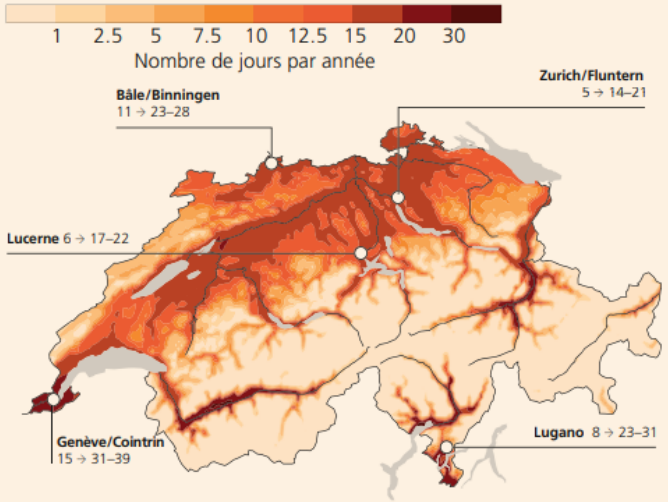
Climat: Holcim et Lonza, les plus gros pollueurs en Suisse - rts.ch - Suisse

How do CO2 emissions compare when we adjust for trade? - Our World in Data

Switzerland forecast to 2085

Évolution du nombre de journées tropicales

Évolution attendue du nombre de jours avec des températures supérieures à 30 degrés Celsius vers 2060 par rapport à 1981–2010 (moyenne sur 30 ans) sans mesures de protection du climat. Les valeurs correspondent à la période de référence 1981–2010 et les changements possibles vers 2060.

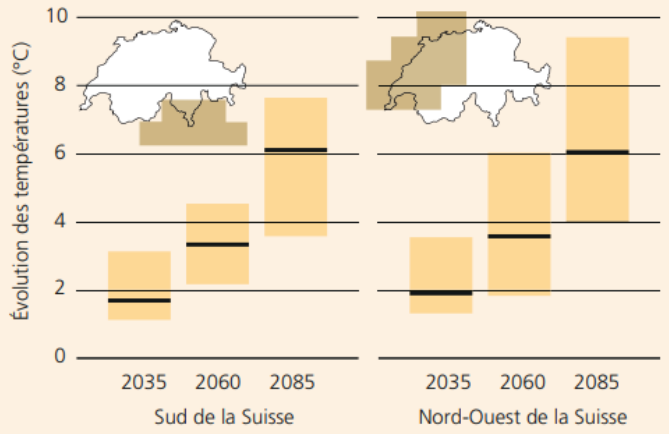


Évolution des températures maximales annuelles

Évolution moyenne vers 2035, 2060 et 2085 par rapport à la période de référence 1981–2010 (moyenne sur 30 ans) sans mesures de protection de climat.

Valeur attendue (valeur médiane de l'ensemble des simulations)

Valeurs possibles (plage des valeurs possibles sur l'ensemble des simulations)



Plus de journées tropicales

Les régions urbaines situées à basse altitude seront particulièrement touchées par des canicules. Sur le Plateau et dans les vallées alpines, le thermomètre grimpera plus fréquemment au-dessus de la barre des 30 degrés Celsius qui caractérise une « journée tropicale ». On attend le plus grand nombre de journées tropicales supplémentaires pour les régions de Genève, du Valais et du Sud de la Suisse.

Les températures maximales augmenteront particulièrement

Les températures maximales annuelles augmenteront fortement. D'ici le milieu du siècle, le jour le plus chaud de l'année pourra atteindre jusqu'à 4 degrés Celsius de plus au Sud des Alpes et même jusqu'à 6 degrés Celsius de plus au Nord des Alpes par rapport à aujourd'hui. À Genève, par exemple, le jour le plus chaud d'une année moyenne pourrait atteindre environ les 40 degrés Celsius.

Median

+4°C Lausanne 2060

+6°C Lausanne 2085 (my Kids)

[Rapport technique CH2018 (admin.ch)]

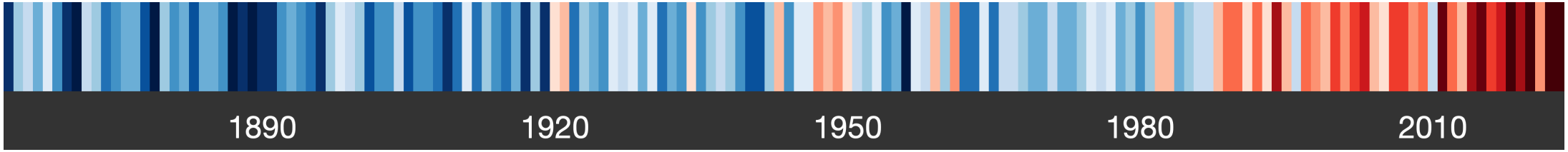
[Brochure CH2018 (admin.ch)]

SWI swissinfo.ch — Swiss perspectives in 10 languages

Swiss Alps Slammed by More Severe Flooding, Landslides

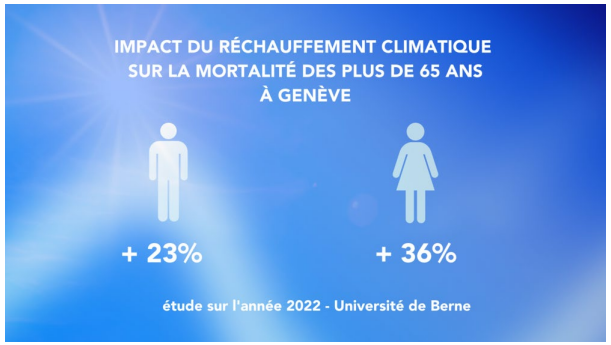
June 30, 2024 - 19:36 — 2 minutes

menu RTS Info Sport Culture



Negative externalities

#ShowYourStripes



CRISE CANICULE : PLAN D'ACTION DE LA VILLE DE GENÈVE

plan-canicule-public-juin-2024_0.pdf

La canicule plus meurtrière à Genève qu'ailleurs en Suisse

Risque d'orage violent sur Genève - lematin.ch

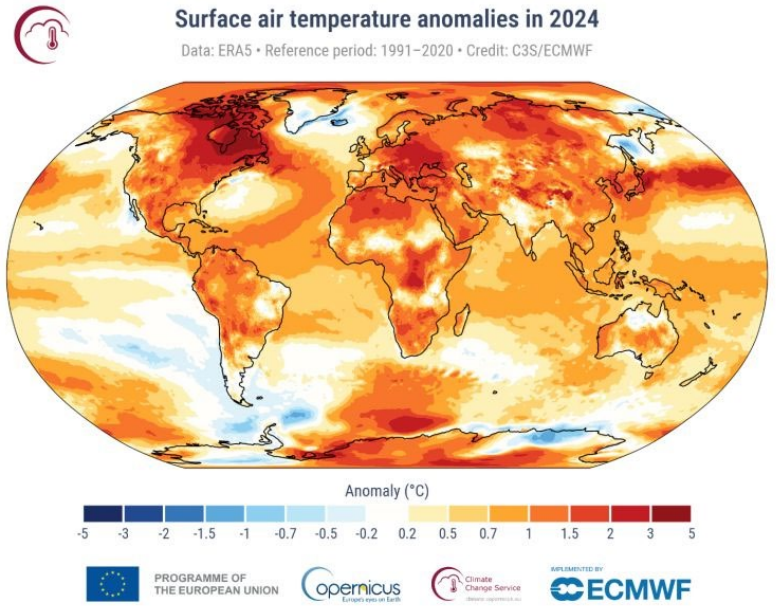


Figure 4. Surface air temperature anomalies in 2024, relative to the average for the 1991–2020 reference period. A non-linear colour scale is used to enhance the visibility of smaller anomalies and distinguish larger deviations. Data source: ERA5. Credit: C3S/ECMWF.

Genève. Des "micro-oasis" pour lutter contre la canicule en ville

The Economist

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Briefing

Jul 24th 2021 edition ›

What's the worst that could happen

Three degrees of global warming is quite plausible and truly disastrous

Rapid emission cuts can reduce the risks but not eliminate them

Three degrees of global warming is quite plausible and truly disastrous | The Economist

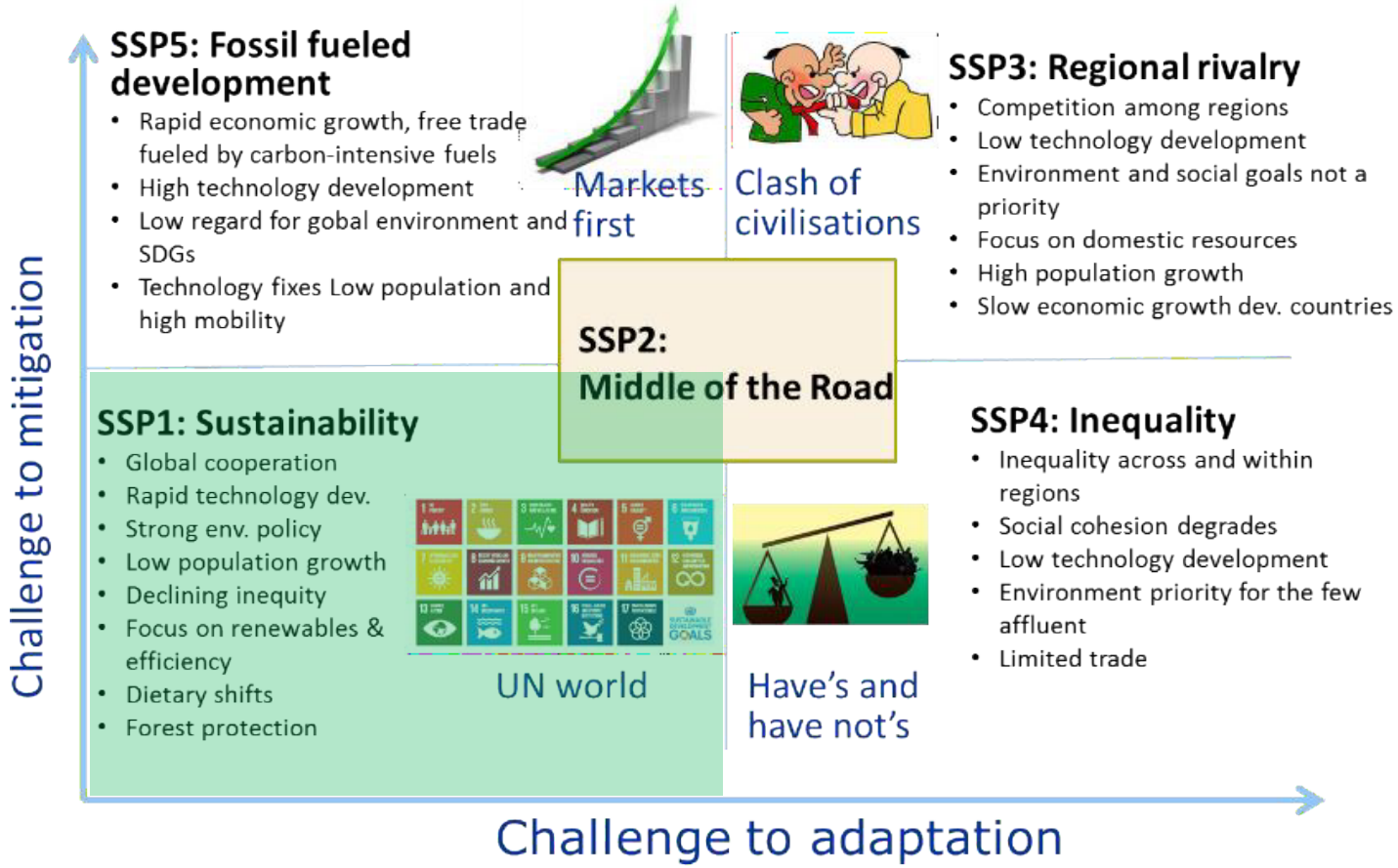
Everyday we decide tomorrow's future, one decision at a time …

- The future is not automatically predetermined
- Which pathways should we take?

Shared Socioeconomic Pathways (SSPs)

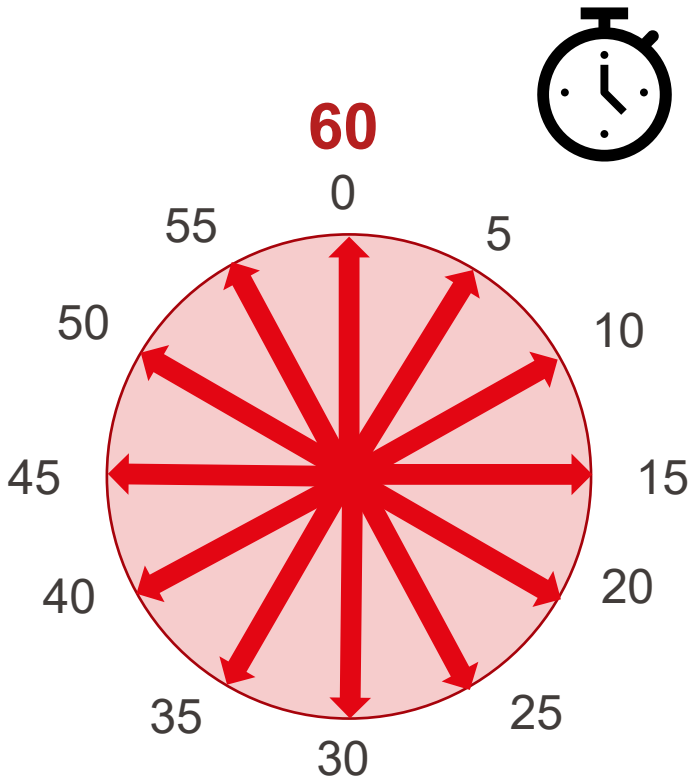
Five standard trajectories that represent possible future socioeconomic development for global or regional societies.

- **SSP1:** Sustainability
- **SSP2:** Middle of the road
- **SSP3:** Regional rivalry
- **SSP4:** Inequality
- **SSP5:** Fossil-fuel development



https://doi.org/10.1016/B978-0-12-820308-8.00003-9
SSP2_Overview.pdf

Which pathway should we take?

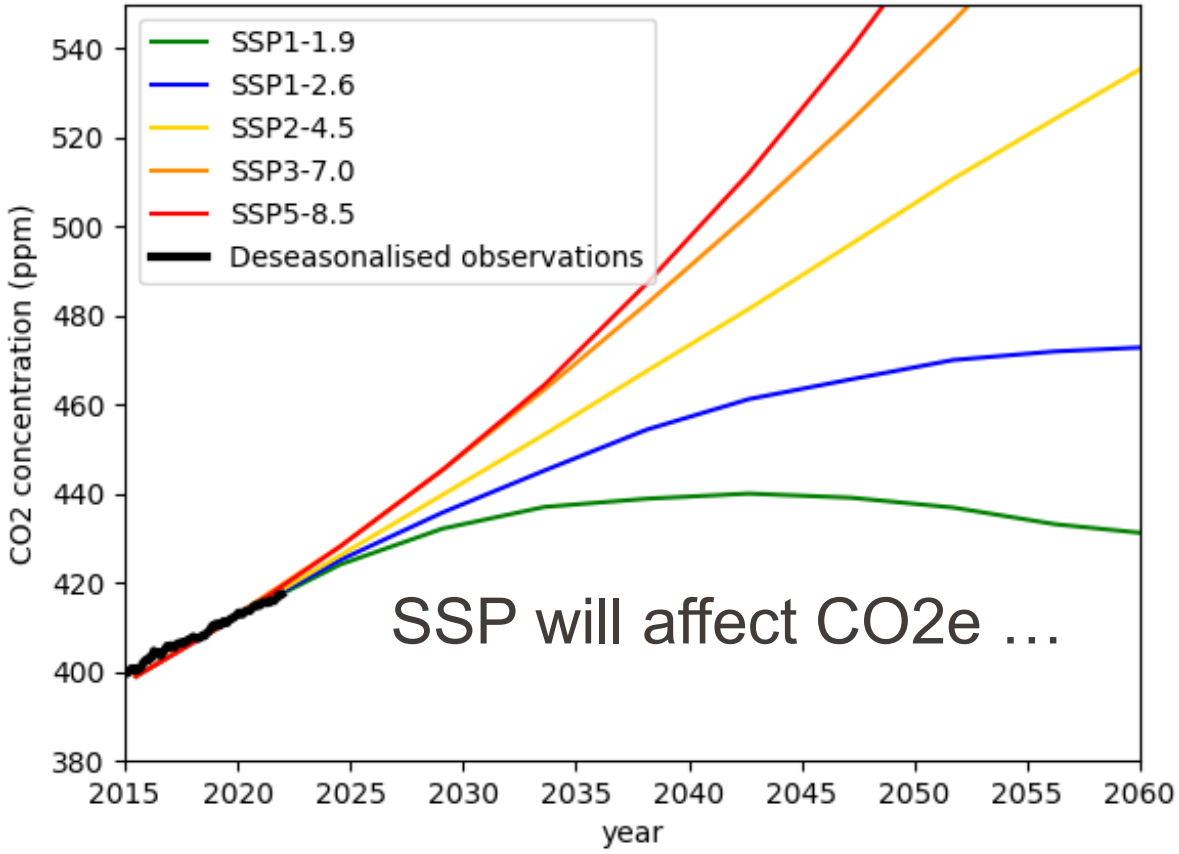


… Discuss with you neighbor

Shared Socioeconomic Pathways (SSPs)

SSP1: Sustainability

- The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects predicted environmental boundaries.
- Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being.
- Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries.
- Consumption patterns modified toward low material growth and lower resource and energy intensity.[4][12]

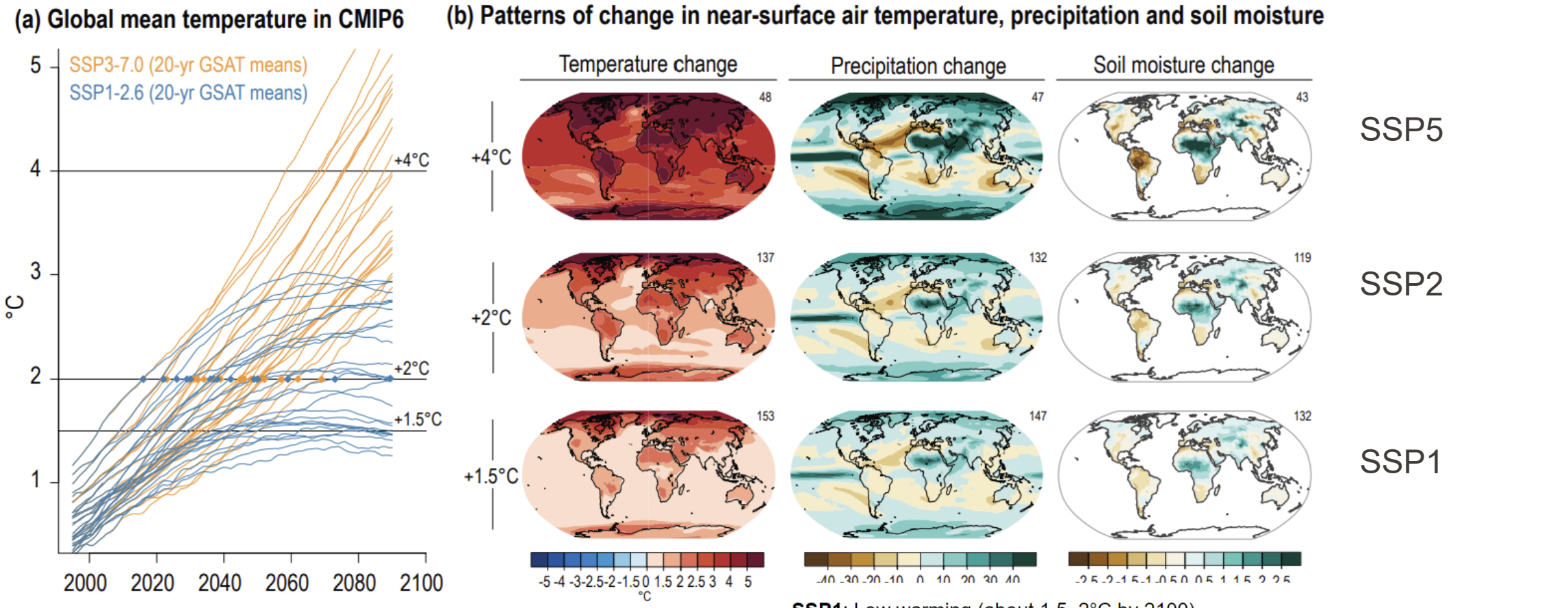


Atmospheric CO2, fossil fuel emissions, Shared Socioeconomic Pathways and the Paris Agreement. | Weather and Climate @ Reading

SSPs affect CO2e then temperatures and weather

What we choose as a society and individually affect our future

Wakeman



SSP1: Low warming (about 1.5–2°C by 2100)

SSP2: Intermediate warming (about 2.6–3°C by 2100)

SSP3: Higher warming (about 3.5–4°C by 2100)

SSP4: Intermediate warming with inequality (similar to SSP2, around 2.6–3°C by 2100)

SSP5: Very high warming (around 4–5°C by 2100)

IPCC_AR6_WGI_TS.pdf

Policy shortfalls

Despite international agreements like the Paris Accord …

- Current national policies and commitments fall far short of the emissions reductions needed to limit warming to 1.5°C or even 2°C.
- Many countries continue to expand fossil fuel production and infrastructure.
- **Urgent escalation needed.** Meeting climate goals requires:
  - **Rapidly phasing out fossil fuels**
  - **Massive scaling up of renewable energy**
  - **Transforming agricultural and land-use practices and our diet**
  - **Protecting and restoring natural carbon sinks**
  - **Implementing carbon pricing and regulations**
  - **Increasing climate finance for developing countries**
- **Without immediate, dramatic policy changes and actions, we walk ever further into undesirable SSPs for human and planetary health.**

How can we re-wire our economy?

- Starts from the principle that the economy can and should be delivering the outcomes demanded by the SDGs.
- If it doesn't, how else do governments expect to achieve them?
- The three chief actors in the economy – business, government and finance – have good reason, and many would argue responsibility, for ensuring this happens.
- It is worth working together as partners to enable this.

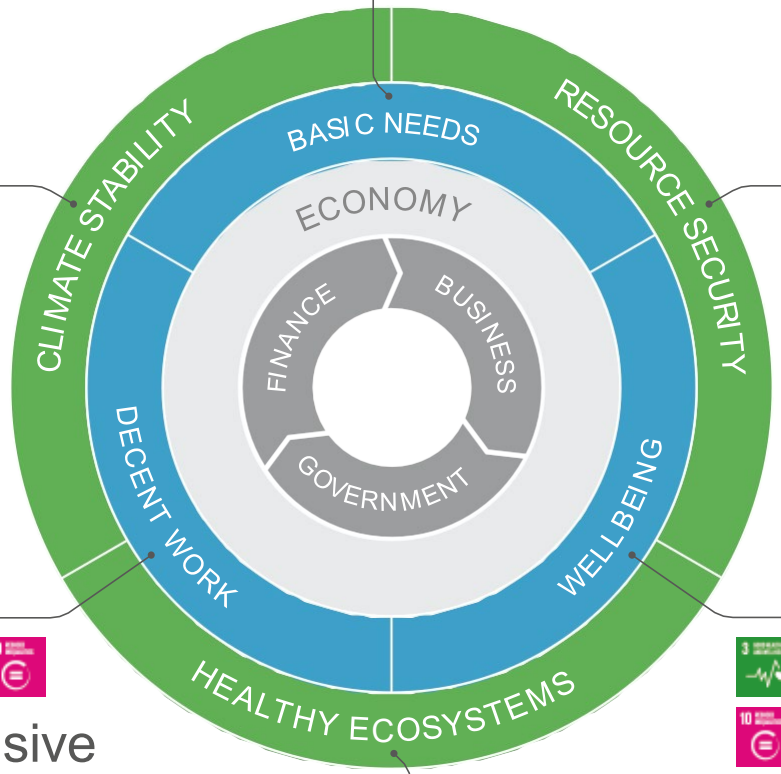
Rewiring the Economy: Ten tasks, ten years | Cambridge Institute for Sustainability Leadership (CISL)

What should the economy be delivering?

Food, water, energy, shelter, sanitation, communications, transport, credit and health for all

Limit GHG levels to stabilise global temperature rise to well below 2ºC

Preserve stocks of natural resources through efficient and circular use



Enhanced health, education, justice and equality of opportunity for all

Secure, socially inclusive jobs and working conditions for all

Maintain ecologically sound landscapes and seas for nature and people

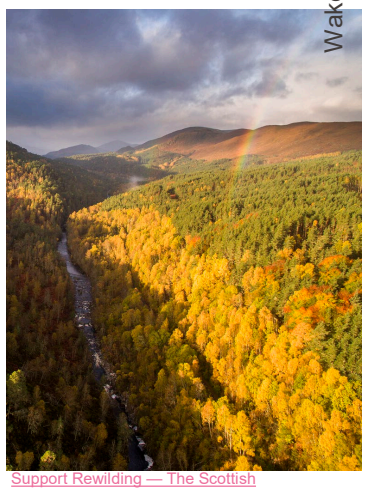
rewiring-the-economy-report.pdf

Without a vision the people perish ...

AP to set up solar-wind hybrid project with battery back-up – The Leading Solar Magazine In India (eqmagpro.com)

Daily Mail Online

EV World Record: Mercedes Benz Vision EQXX Travels 1,000 Km On A Single Charge (forbes.com)



Support Rewilding — The Scottish Rewilding Alliance

ZEROe on the Rise at Airbus - CAFE Foundation Blog

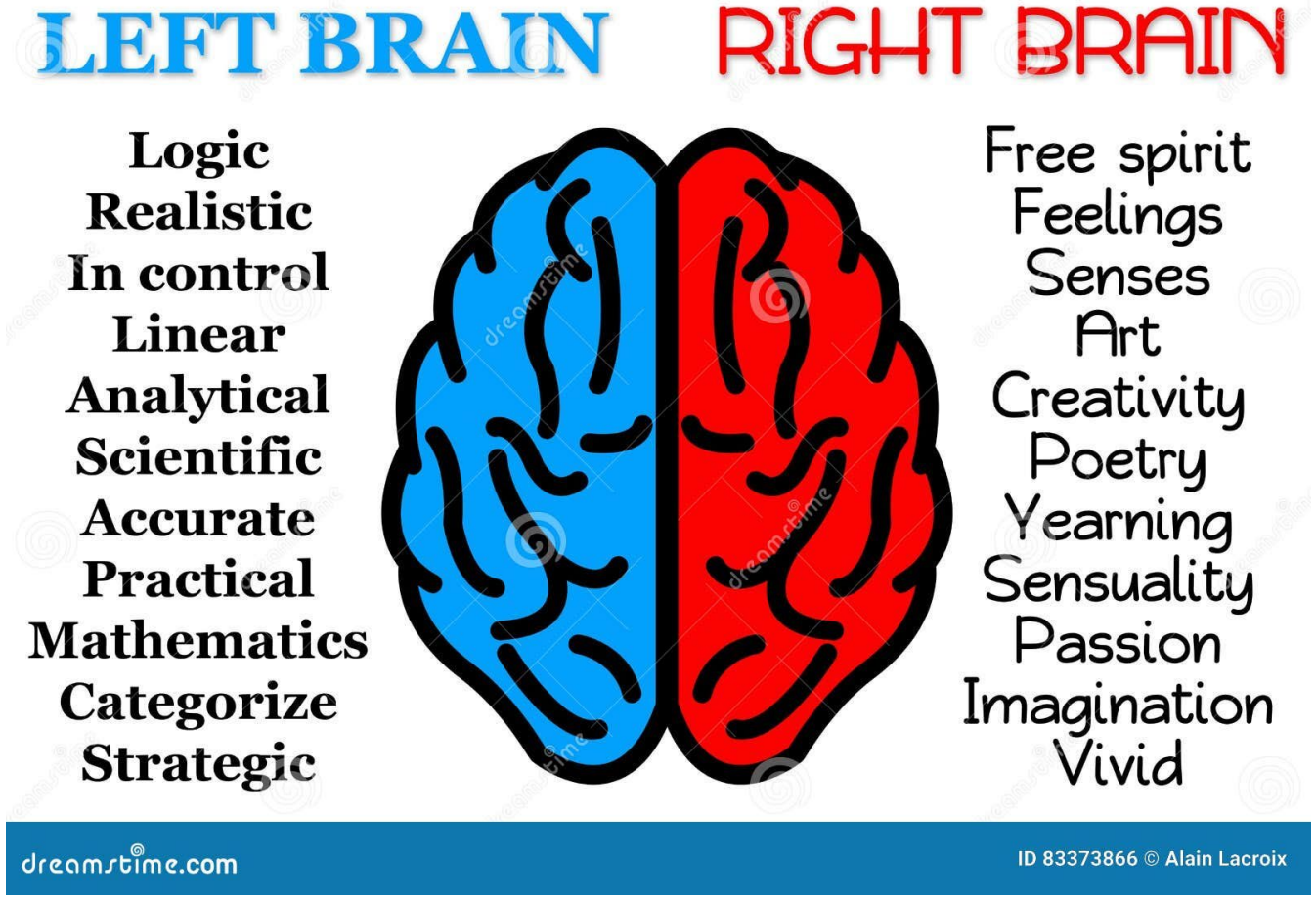
[기업소개] 수소연료탱크 제조사 '일진다이아' : 네이버 블로그 (naver.com)

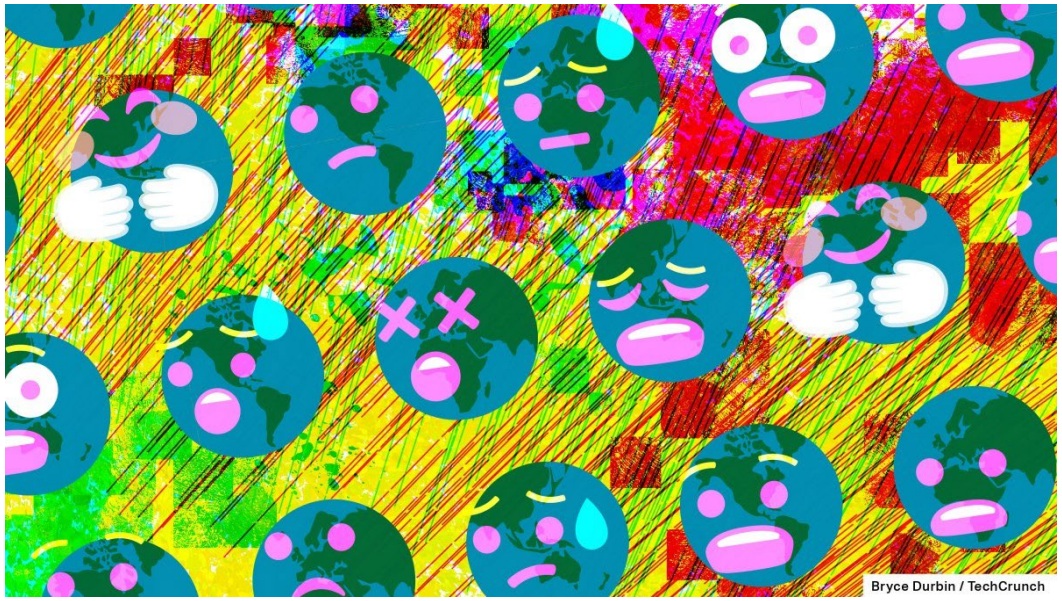
Child Fun Outdoors - Free photo on Pixabay

4 NetZero Energy Lessons | NetZero Buildings

People Group Many - Free photo on Pixabay

We need to acknowledge our emotions





slido

Please download and install the Slido app on all computers you use

What emotions have come up inside you as you listened to this lecture?

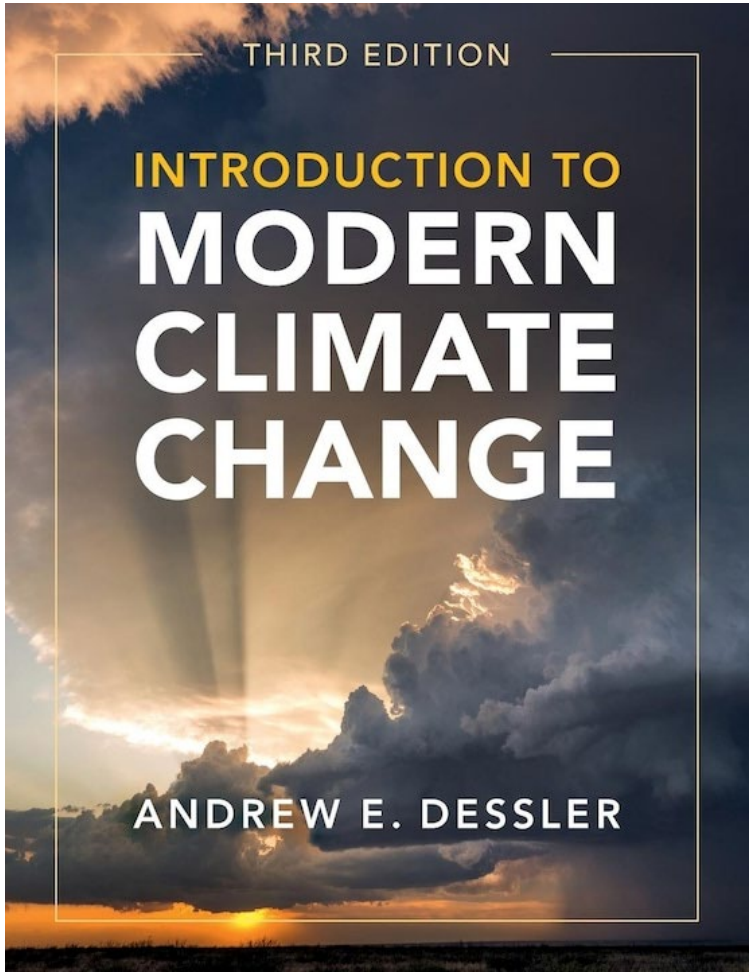
ⓘ Start presenting to display the poll results on this slide.

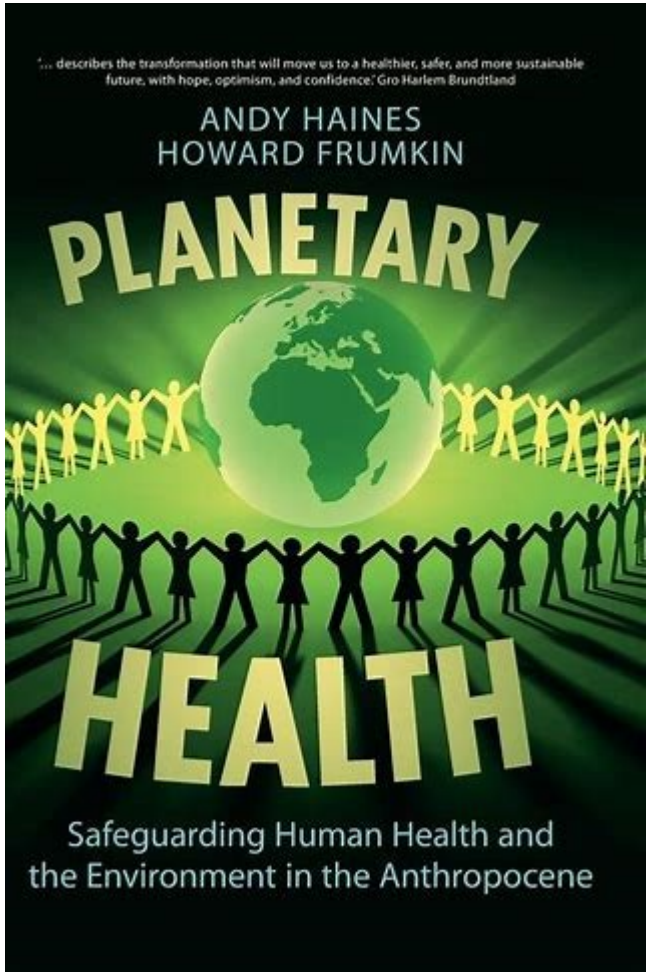
Summary

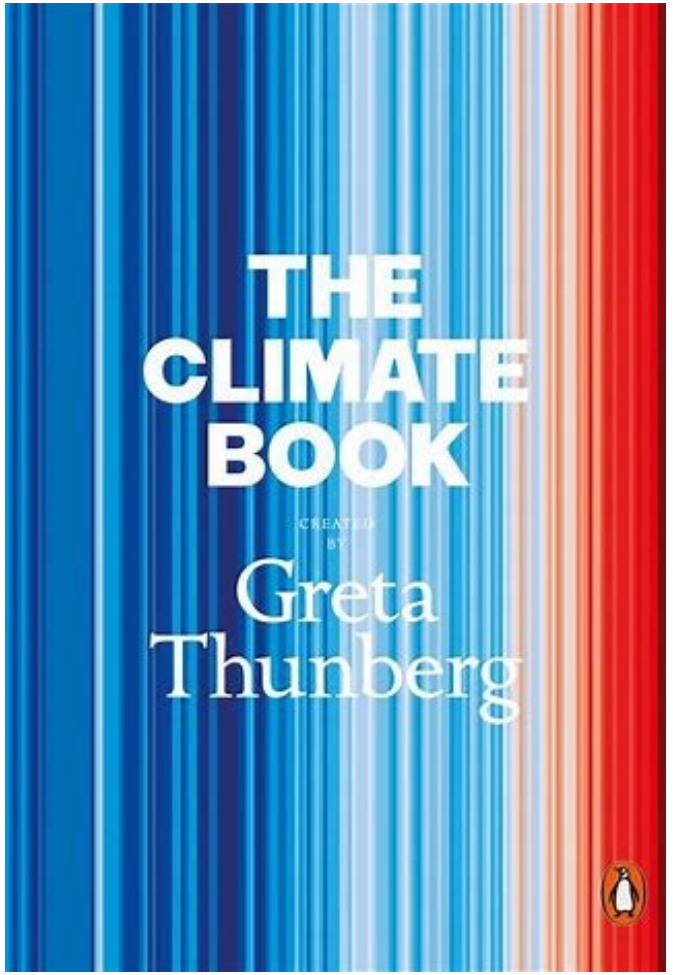
- Climate change is a reality we cannot ignore
- Compelling data and evidence around us
- Move from data analysis / paralysis to targets and action
- This benefits our health
- Will benefit the ecosystems on which we depend
- We need to re-wire the economy

Annex

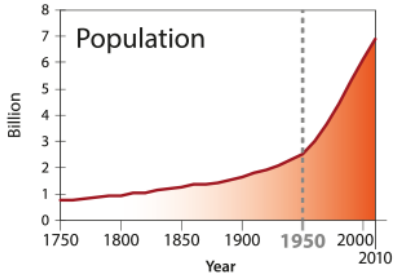
Some resources

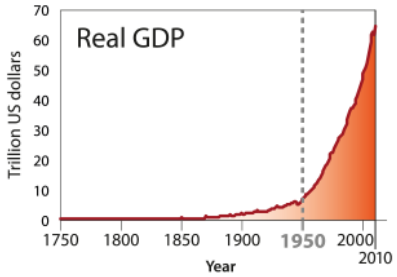


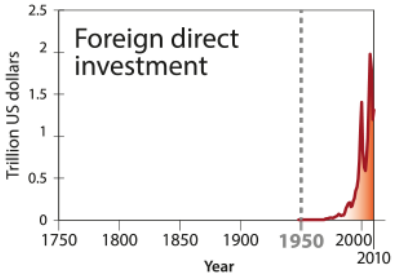


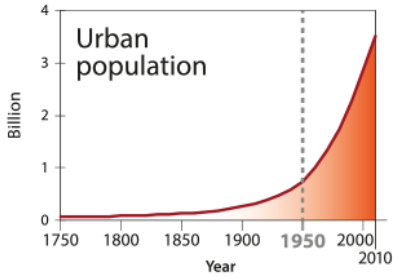


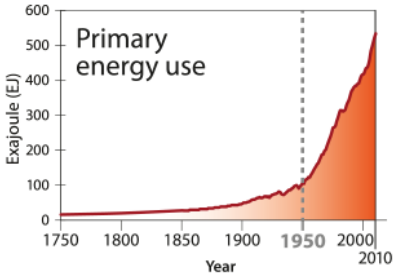
Socio-economic trends

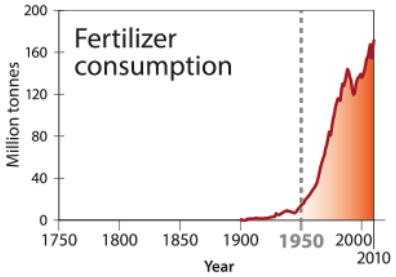


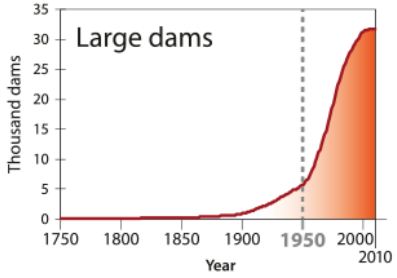


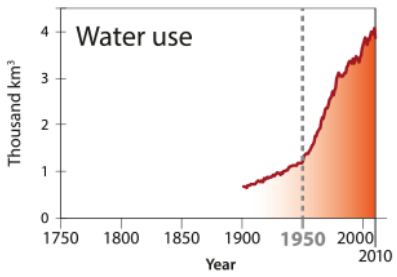


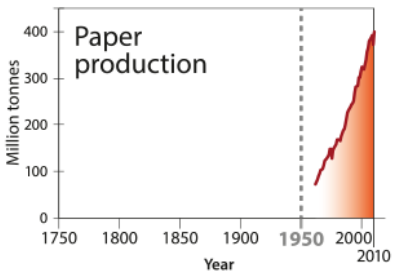


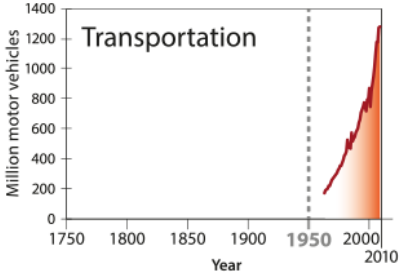


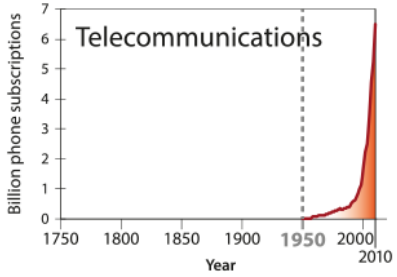


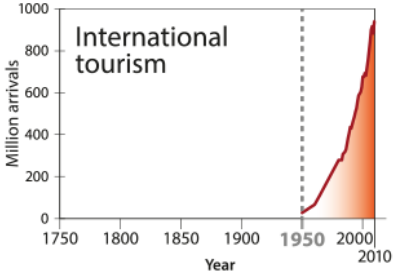




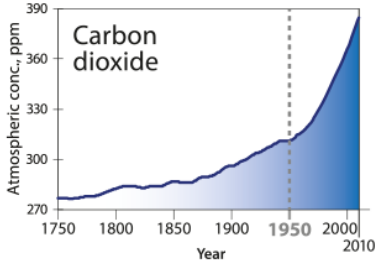


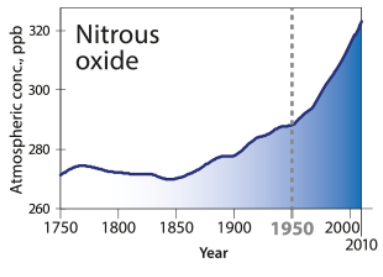


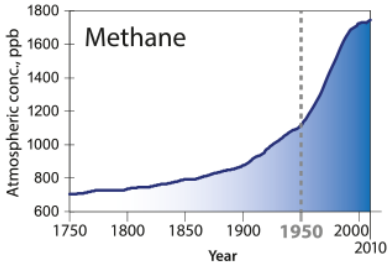


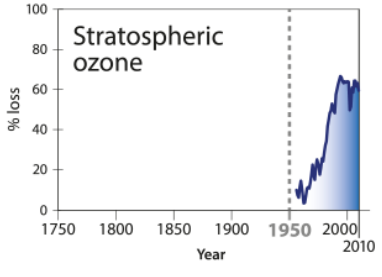


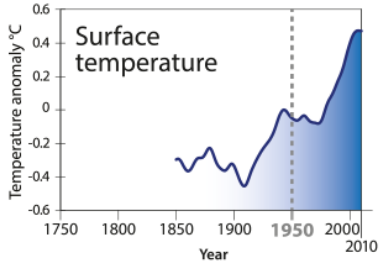
Earth system trends

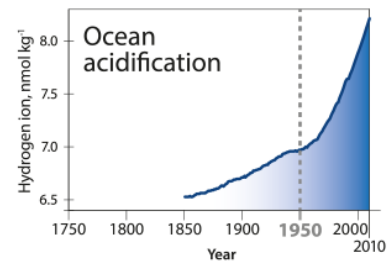


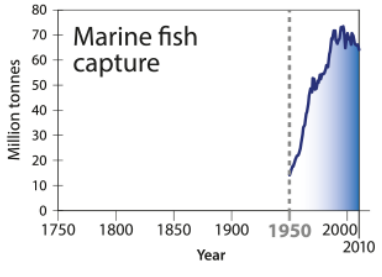


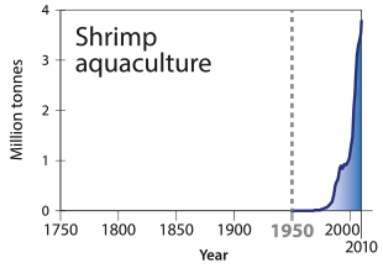


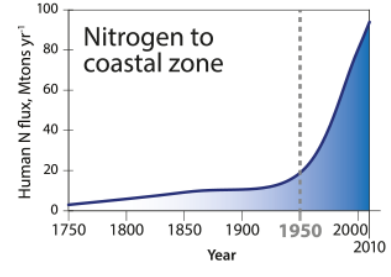


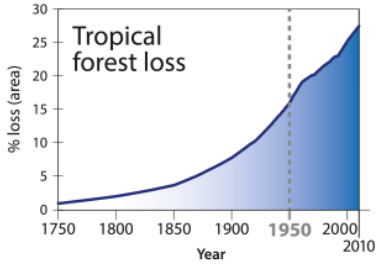


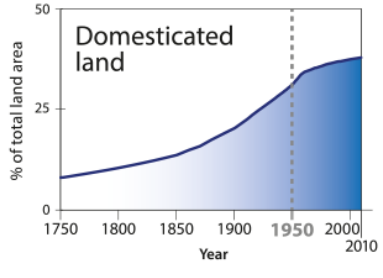


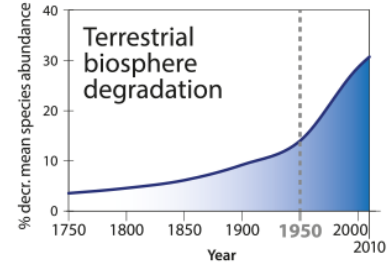




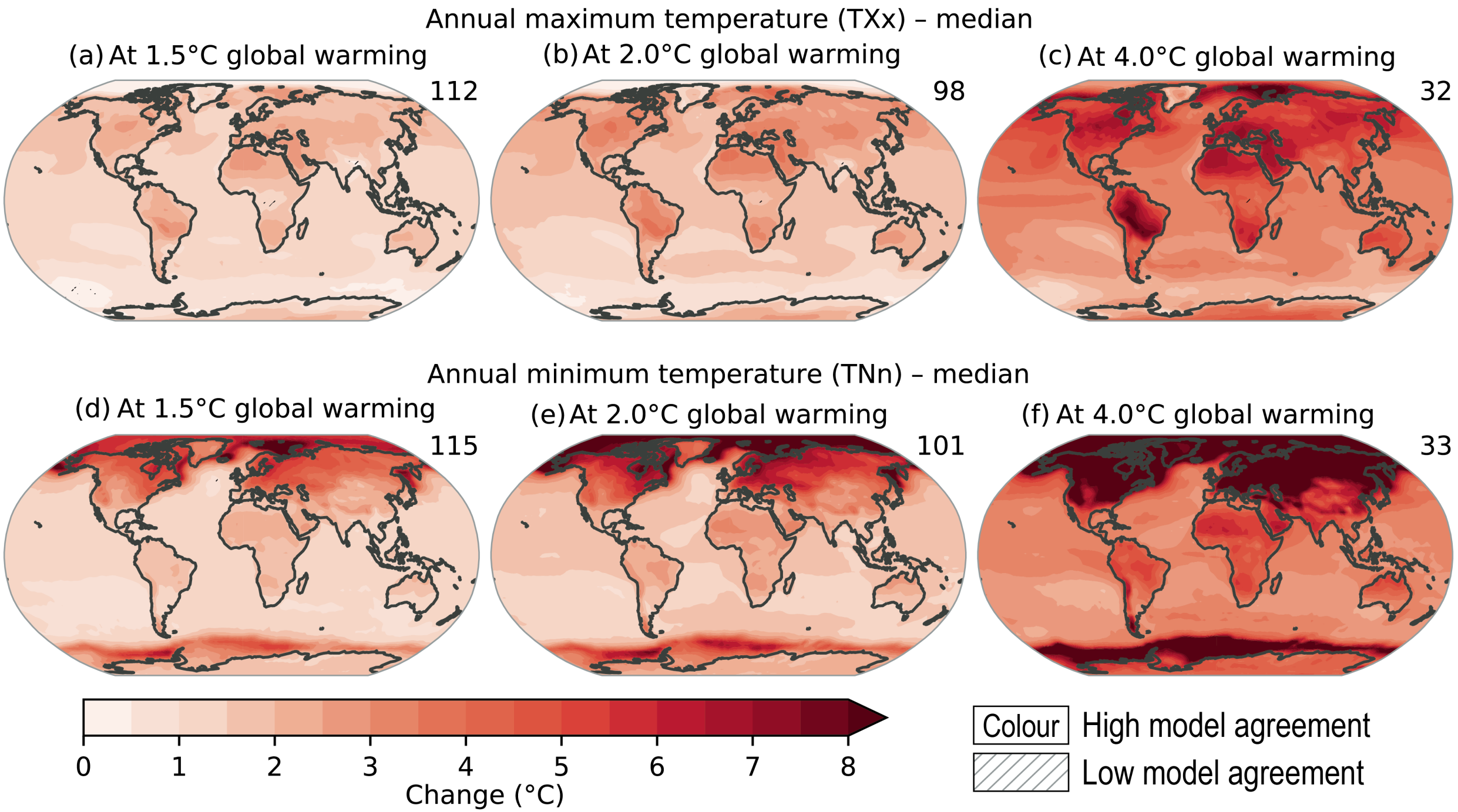




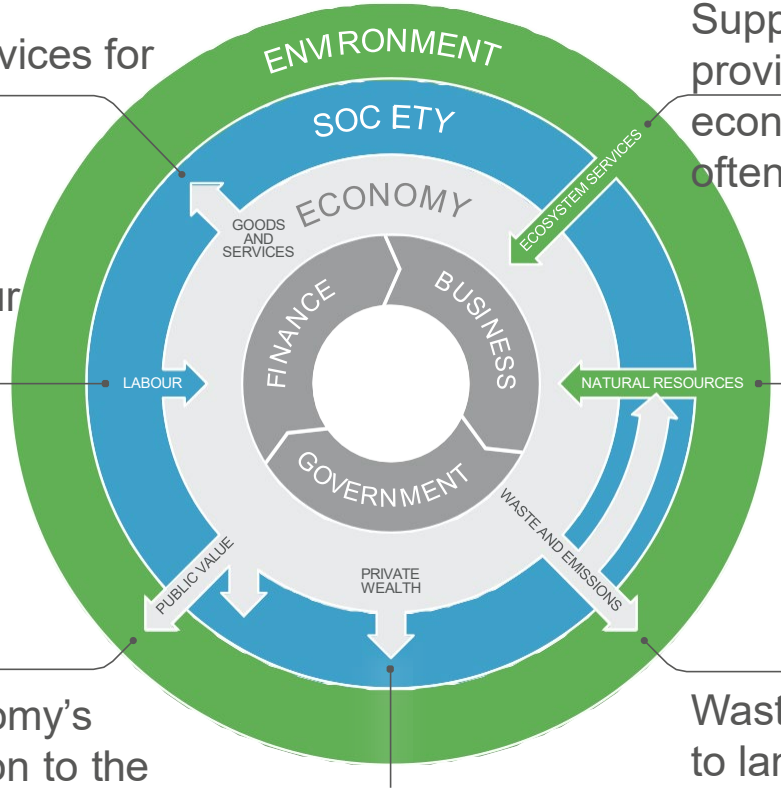




Planetary dashboard shows “Great Acceleration” in human activity since 1950 - IGBP


Annual maximum temperature (TXx) – median
(a) At 1.5°C global warming
112
(b) At 2.0°C global warming
98
(c) At 4.0°C global warming
32
Annual minimum temperature (TNn) – median
(d) At 1.5°C global warming
115
(e) At 2.0°C global warming
101
(f) At 4.0°C global warming
33
0
1
2
3
4
5
6
7
8
Change (°C)
Colour
High model agreement
Low model agreement

The economy should be delivering the outcomes demanded by the SDGs



Goods and services for humanity

Support system provided to the economy by nature, often at no cost

Skills and labour required by the economy

Materials, energy and water demanded by the economy

The economy's contribution to the public good

Wealth created by the economy through provision of labour and ownership of assets

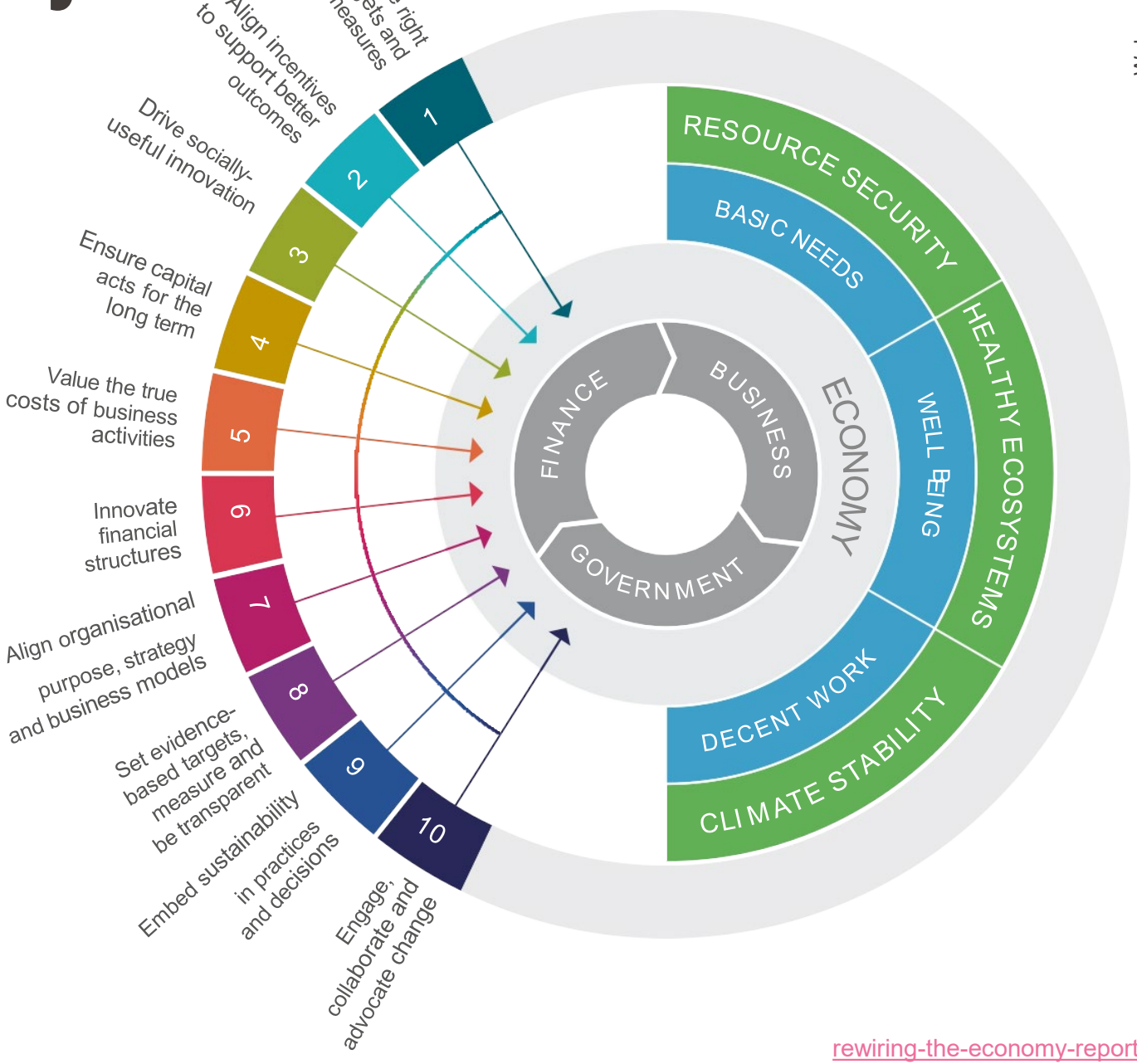
Waste and emissions to land, water and air from the economy

- The economy is dependent on inputs of labour, natural resources and ecosystems to function, in turn producing goods and services, wealth, waste and emissions as outputs.
- Some of these inflows and outflows are accounted for financially, while others – like clean air, pollination and rainfall – sit outside public or private balance sheets and are, effectively, free.
- If the draw down on these resources (the 'global commons') is not managed carefully then economic and social progress is hampered.
- Ten tasks for business, government and finance which drive up positive impacts like decent jobs and drive down negative impacts like inequality, waste and resource scarcity

rewiring-the-economy-report.pdf

Re-wiring the economy

- The economy needs re-wiring requiring significant co-operation among business, government and finance.
- Ten tasks: how these critical partners in the economy can concentrate their energies around this aim.
- Aim is to find your own place in it and the role you might play in advancing its objectives.



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