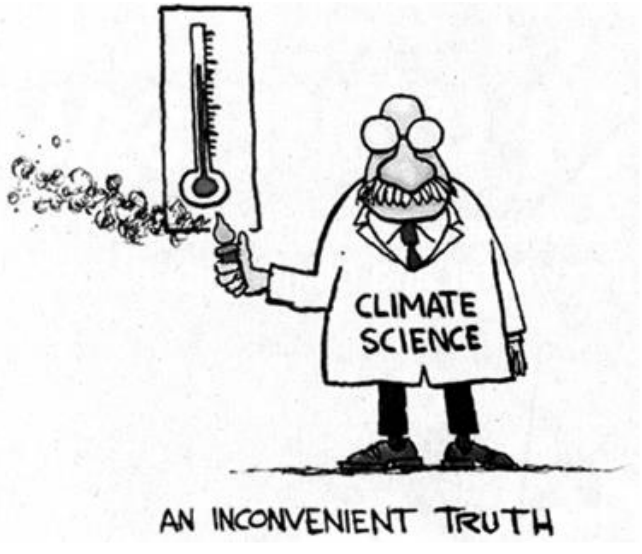
# Climate.now with built environment focus

*5 credits*

**25.4.2024: Introdcution and Environmental State of the World**


UNIVERSITY OF ICELAND
FACULTY OF CIVIL AND
ENVIRONMENTAL ENGINEERING

# Welcome

- Climate.now course with the emphasis on the built environment
- Course staff:
  - Jukka Heinonen, Professor, University of Iceland / Adjunct, Aalto University, heinonen@hi.is
  - Áróra Árnadóttir, Adjunct, University of Iceland / CEO, Green Building Council Iceland, arora@hi.is
  - Ali Amiri, Postdoctoral Researcher, Aalto University, ali.amiri@aalto.fi
- Visiting lecturers
- Course languages: Finnish / English

# Course outline

- 5 (2+3) credits: 2 from completing the online climate.now course, 3 from the built environment focus component
- Lectures once a week on Thursdays except for Tuesday May 7th (replaces Thursday May 9th)
  - 14:15-15:45
  - In-person and online lectures
    - May 7th and 23rd online, the rest in person
    - Link to the online lectures: Click here to join the meeting
  - Non-mandatory, but highly encouraged, 10% of the overall course grade
- Weekly assignment (5x)
- Project report

# Schedule

| Lecture | Topic | Where | Lecturer | Assignment paper |
|---|---|---|---|---|
| **25.4.** | Introduction - environmental state of the world | L01 | Jukka Heinonen | - |
| **2.5.** | Density and low-carbon illusion | L01 | Jukka Heinonen | Heinonen et al. (2013) Situated lifestyles I: How lifestyles change along with the level of urbanization and what are the greenhouse gas implications, a study of Finland, Environ. Res. Lett., 8 (2), 025003. |
| **7.5.** | Carbon budgets, construction materials and emissions | Online | Áróra Árnadóttir | Müller et al. (2013) Carbon Emissions of Infrastructure Development, Environmental Science & Technology 2013 47 (20), 11739-11746 |
| **16.5.** | Building LCA and green building certificates | L01 | Ali Amiri | Amiri, A.; Emami, N.; Ottelin, J.; Sorvari, J.; Marteinsson, B.; Heinonen, J.; Junnila, S. (2021): Embodied emissions of buildings - A forgotten factor in green building certificates, Energy & Buildings, 241, 110962. |
| **23.5.** | Circular construction | Online | Katarzyna Anna Jagozinska | Joensuu, T.; Edelman, H.; Saari, A. (2020): Circular economy practices in the built environment, Journal of Cleaner Production, 276 (10), 124215. |
| **30.5.** | Carbon storing potential of the built environment | L01 | Ali Amiri | Churkina et al. (2020) Buildings as a global carbon sink, Nature Sustainability, 3, 269–276 |

# Climate.now online course

- Take the online climate.now course e.g. at:
  - https://studies.helsinki.fi/kurssit/toteutus/otm-7ba13077-981a-4178-b9f4-34e50b7bf67c/ATM386
  - Deliver to heinonen@hi.is the certificate of successful completion
  - Deadline May 24th
  - Highly encouraged to take the online course early during the course to make it as useful as possible
- 2 credits / 40% of the course, pass/fail
  - No impact on the course grade beyond pass/fail
  - Do not include the online course separately in your study transcript!

# Weekly assignments

- Related to the topic of the next lecture, DL before each lecture
- Instructions: Read carefully the assignment article, and answer briefly the following questions:
  1. What were the main results of the paper?
  2. How are these results relevant to climate mitigation in the built environment?
- 300-400 words
- Return to MyCourses (or if problems with that, deliver by email to heinonen@hi.is) before the next lecture
- Papers can be found from MyCourses
- Graded with pass/fail, **feedback only if the grade is fail**
  - **If you get a fail, you get feedback and a chance to resubmit for 50% of the points**
  - **Don't use AI to produce your answer…**
- **Can be written in Finnish, but highly encouraged to write in English**

# Final report

Choose a topic based on your own interests and write an essay following the four rules below.

1) The built environment is in a central role somehow
2) Focus on something that would radically improve the climate profile in comparison to the current typical option AND would be an important improvement
3) Use at least 10 academic sources using a proper academic referencing style
   - Use e.g. http://scholar.google.com to find relevant academic articles
4) 2000-3000 words in an essay format
5) **Focus on justifying why what you suggest would radically improve the climate-sustainability of the built environment!**

- Deadline June 1st 23:59
- Graded with 0-40 points
- Can be written in Finnish, but highly encouraged to write in English

# Grading

1) Completion of the climate.now online course mandatory requirement but has no impact on the grade beyond pass/fail
2) Lecture participation 10%: 10 points available, each lecture 2 points (5/6 enough for maximum)
3) Assignments: pass/fail, 10% each (0/10 points, 50 available overall), 3/5 must be passed
4) Final report 40% (0-40 points), 15 points minimum to pass

Late delivery of assignments or the final report reduce the points by 25% per day.

# Grading

- 0-50 points = 0
- 51-60 = 1
- 61-70 = 2
- 71-80 = 3
- 81-90 = 4
- 91-100 = 5

# Time-budget

5 credits, ~140 hours of work

1) climate.now online course 56 hours
2) Lectures 6x1.5 = 9 hours
3) weekly assignments 5x5 = 25 hours
4) final report 50 hours

Notice that quite a lot of time has been reserved for the final report. It is the only item graded with points (not pass/fail), so no free points are available.

# Environmental State of the World

# Environmental State of the World

- Planetary boundaries
- Interconnections between the major environmental problems
- Some basic issues to understand about the use and development of the built environment
  - Overshoot
  - Increasing impacts vs. tipping points (points of no return)
  - Direct vs. indirect impacts

# IPCC 6th assessment report

„Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years“

- C02 concentration the highest in the atmospehere in at least 2 million years
- Sea level rise fastest rates in at least 3000 years
- Arctic sea ice area lowest level in at least 1000 years
- Glaciers retreat unprecendented in at least 2000 years

„Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach“ (the goal of the paris agreement)

„It is indisputable that human activities are causing climate change, making extreme climate events, inclusing heat waves, heavy rainfall, and droughts, more frequent and severe“

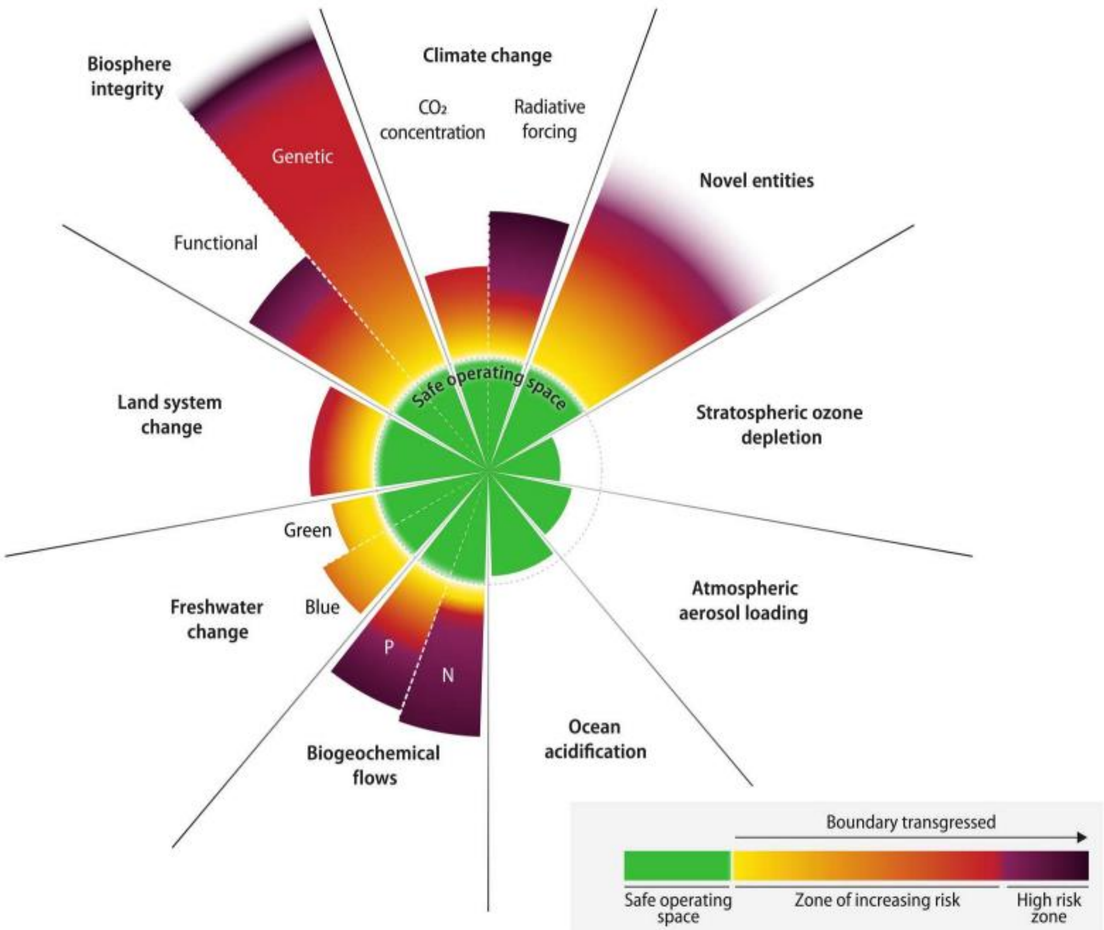
https://interactive-atlas.ipcc.ch
https://sealevel.nasa.gov/data_tools/17

# Planetary Boundaries

The Holocene

6 boundaries crossed

- Climate change
- Biodiversity loss
- Land system change
- Freshwater change
- Biochemical flows



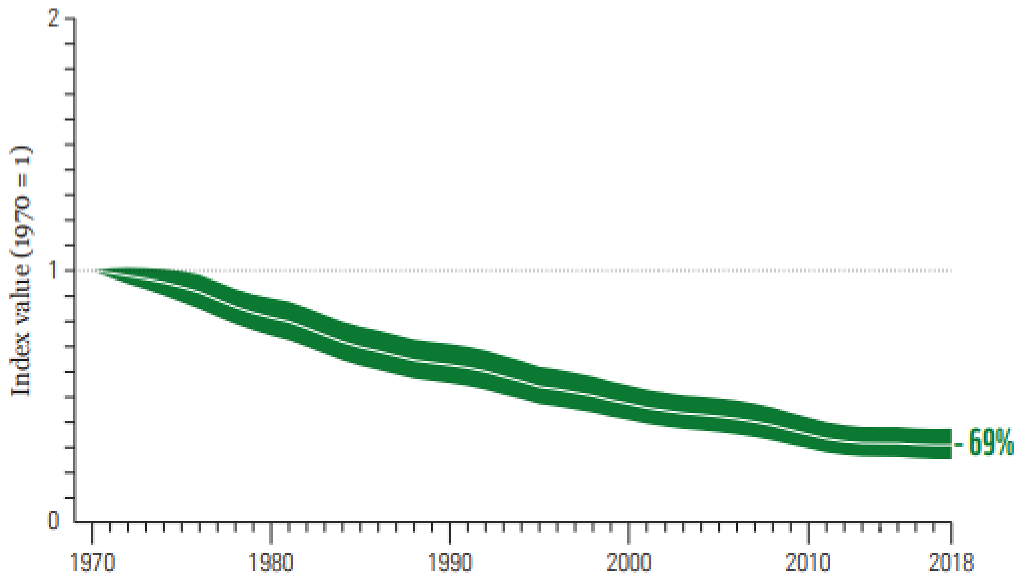

Richardson et al. 2023

# Biodiversity loss: more than extinction rates

***Figure 3: The global Living Planet Index (1970 to 2018)***
*The average change in relative abundance of 31,821 populations, representing 5,230 species monitored across the globe, was a decline of 69%. The white line shows the index values and the shaded areas represent the statistical certainty surrounding the trend (95% statistical certainty, range 63% to 75%). Source: WWF/ZSL (2022)[184].*

*Key*

- Global Living Planet Index
- Confidence limits



Valentina Marconi, Louise McRae and Robin Freeman (Zoological Society of London)

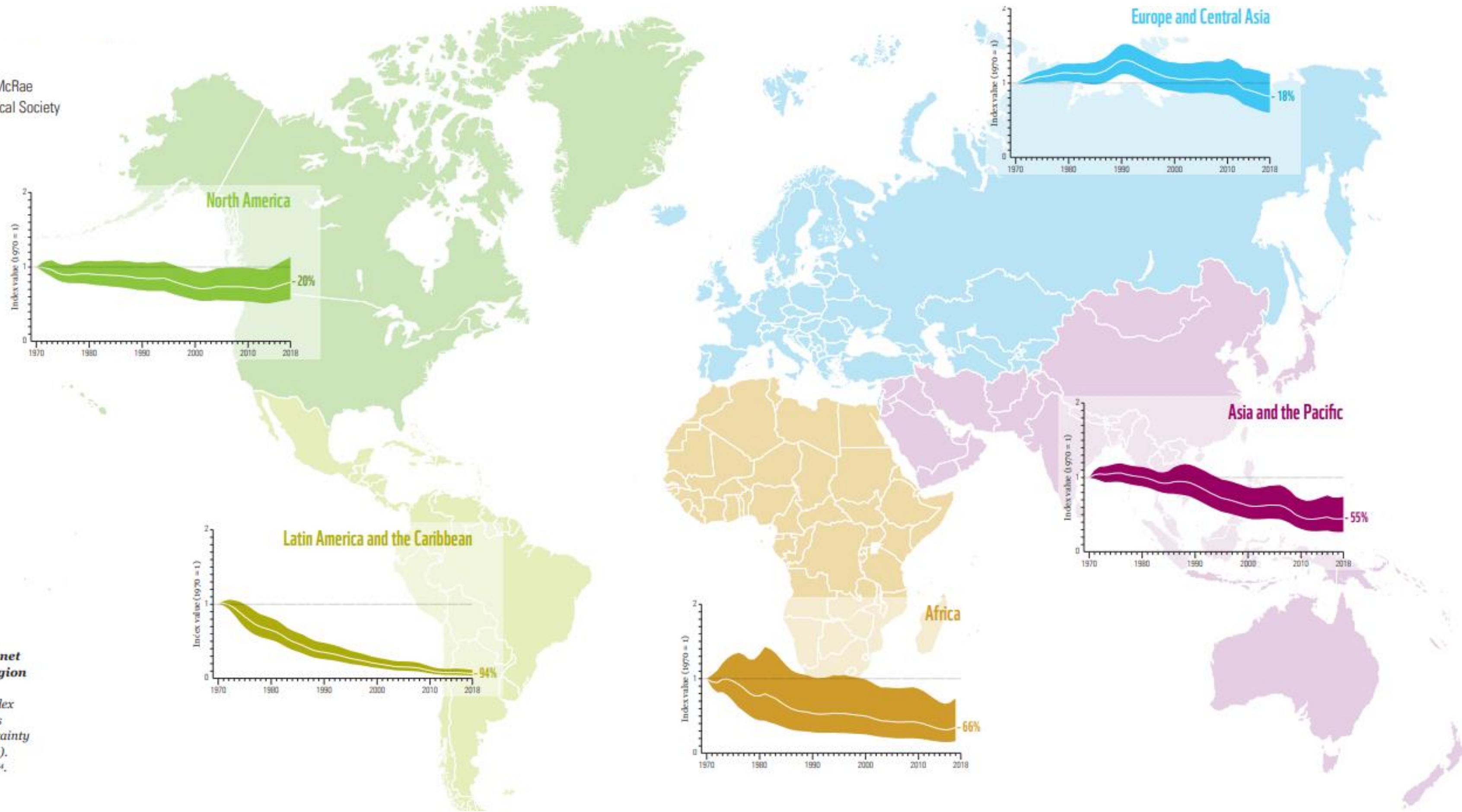
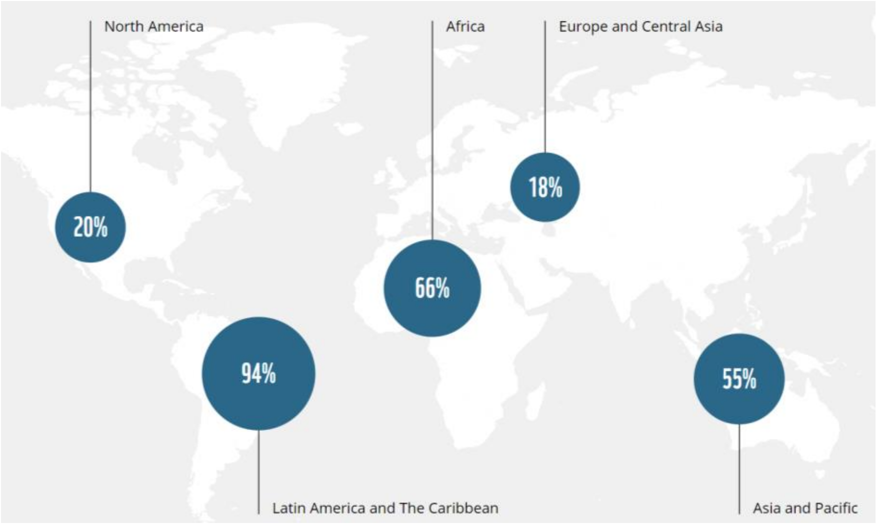


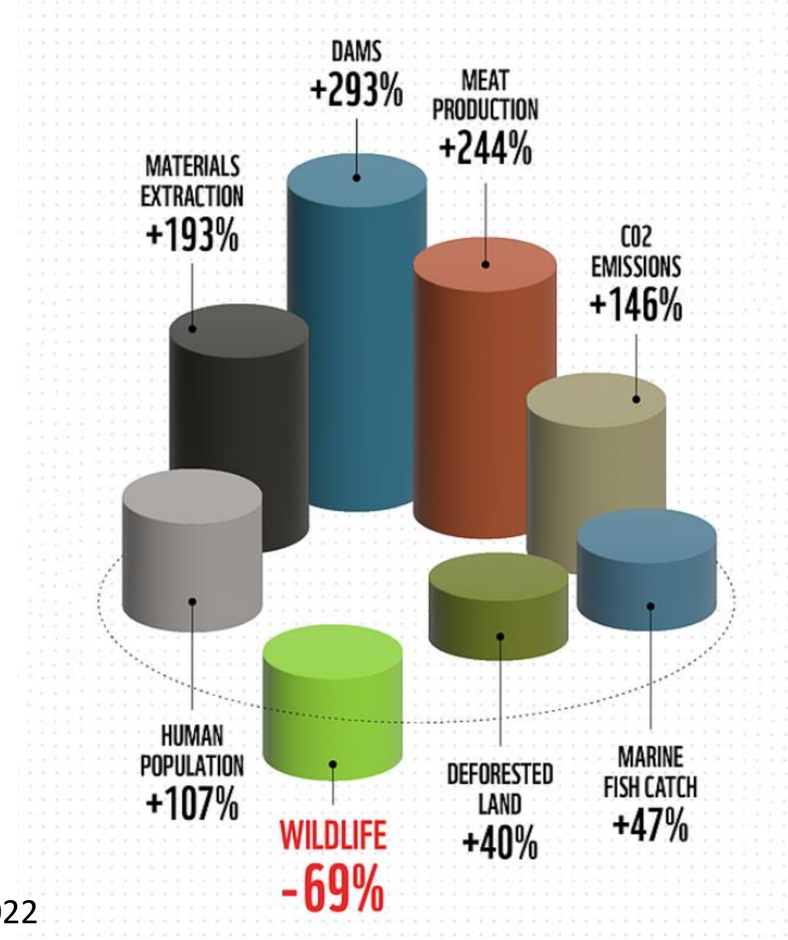

***Figure 4: The Living Planet Index for each IPBES region (1970 to 2018)***
*The white line shows the index values and the shaded areas represent the statistical certainty surrounding the trend (95%). Source: WWF/ZSL (2022)[184].*



WWF Living Planet report 2022

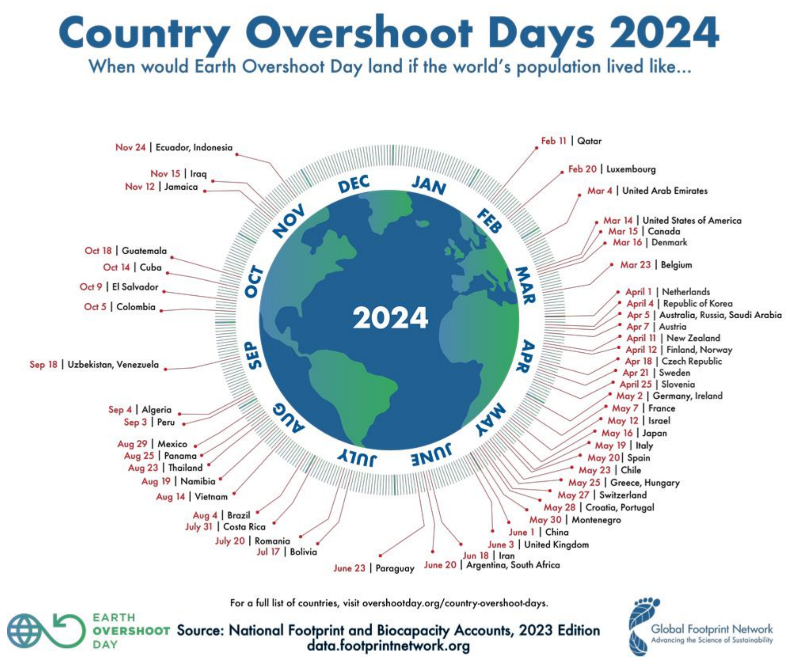
# Biodiversity decline 2022

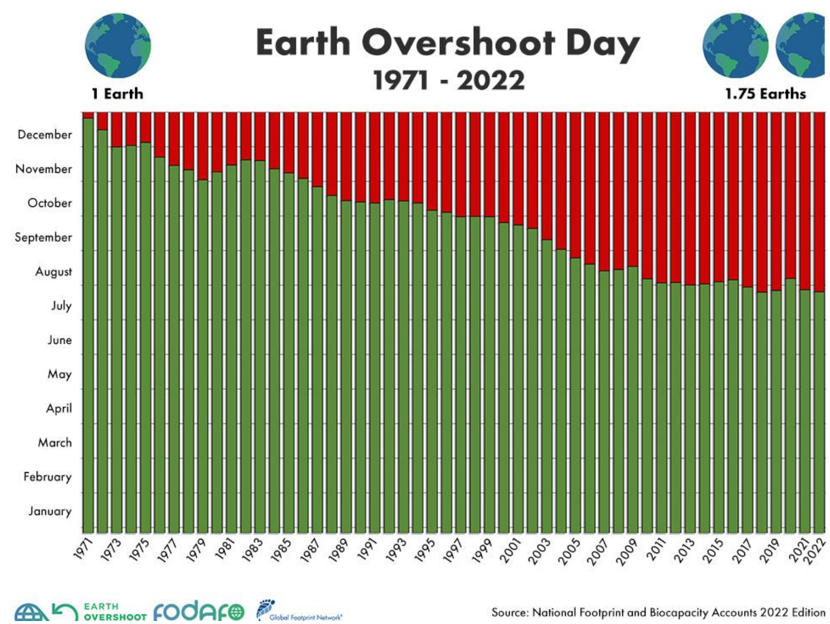



Living Planet Report, WWF 2022

# Planet Earth Overshoot Day 2024 lands in July-August



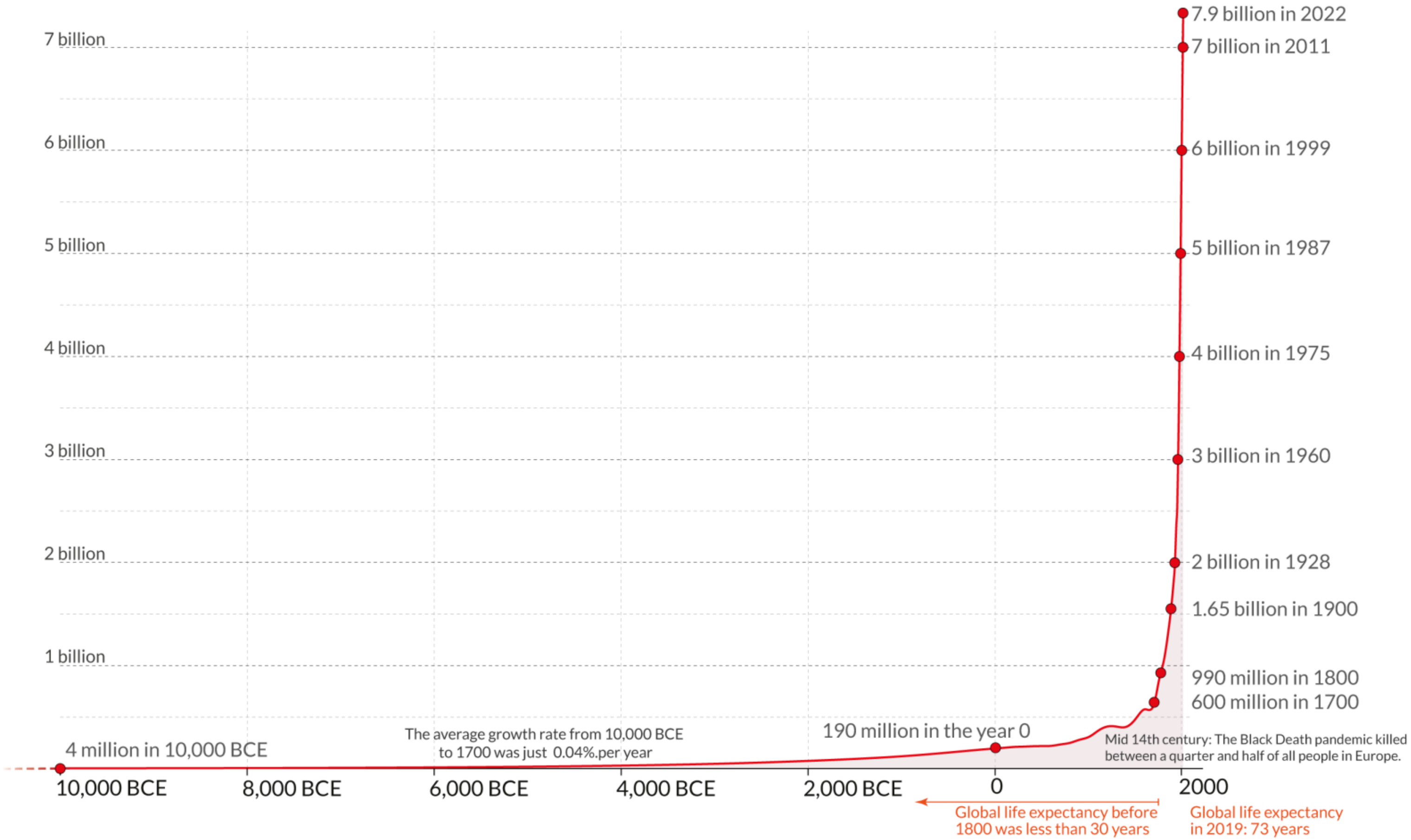

https://www.footprintnetwork.org/our-work/earth-overshoot-day/

## KEY ISSUES WHICH CAUSE THE SITUATION AND NEED TO BE OVERCOME ONE WAY OR ANOTHER

Our World in Data

# The size of the world population over the last 12.000 years

Demographers expect rapid population growth to end by the end of the 21st century. The UN demographers expect a population of about 11 billion in 2100.




Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations. On OurWorldinData.org you can download the annual data.
This is a visualization from OurWorldinData.org.

## Regional and national Ecological Footprints

A regional assessment of humanity's Ecological Footprint in 1961 and 2010 (Figure 22) shows that the global supply of and demand for renewable resources have changed over the past half-century – largely due to population growth.

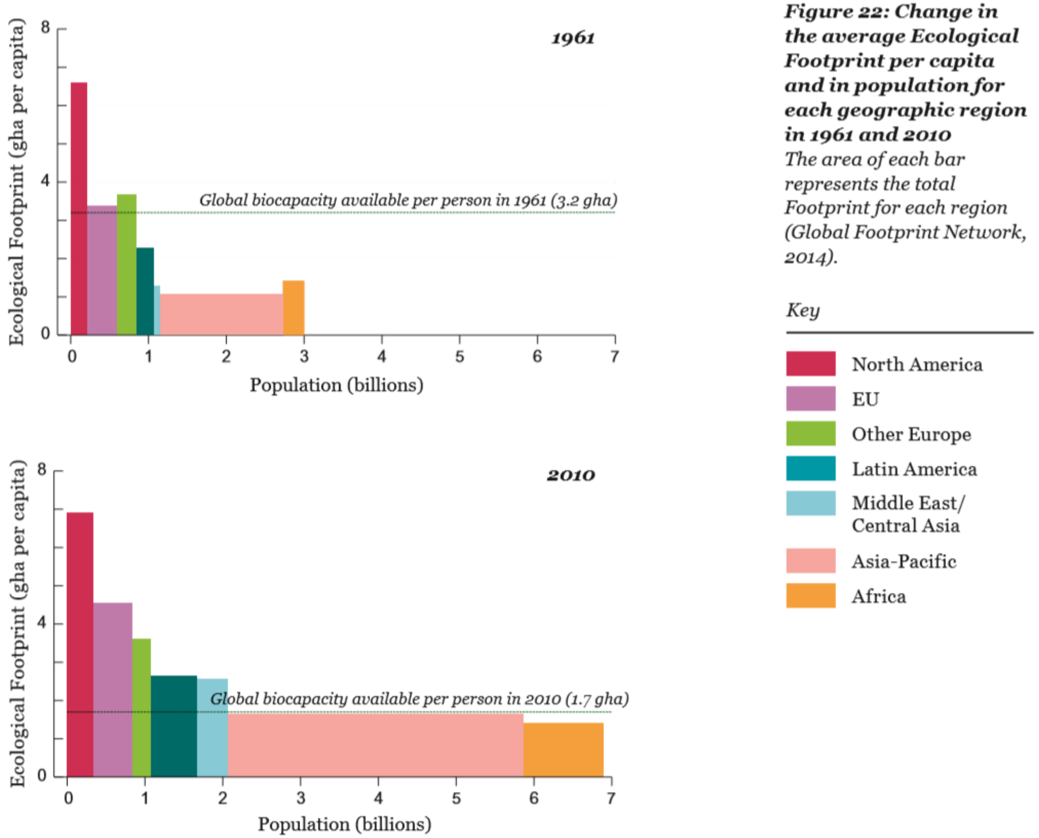



***Figure 22: Change in the average Ecological Footprint per capita and in population for each geographic region in 1961 and 2010***
*The area of each bar represents the total Footprint for each region (Global Footprint Network, 2014).*


Figure: Seppo Leinonen, www.seppo.net

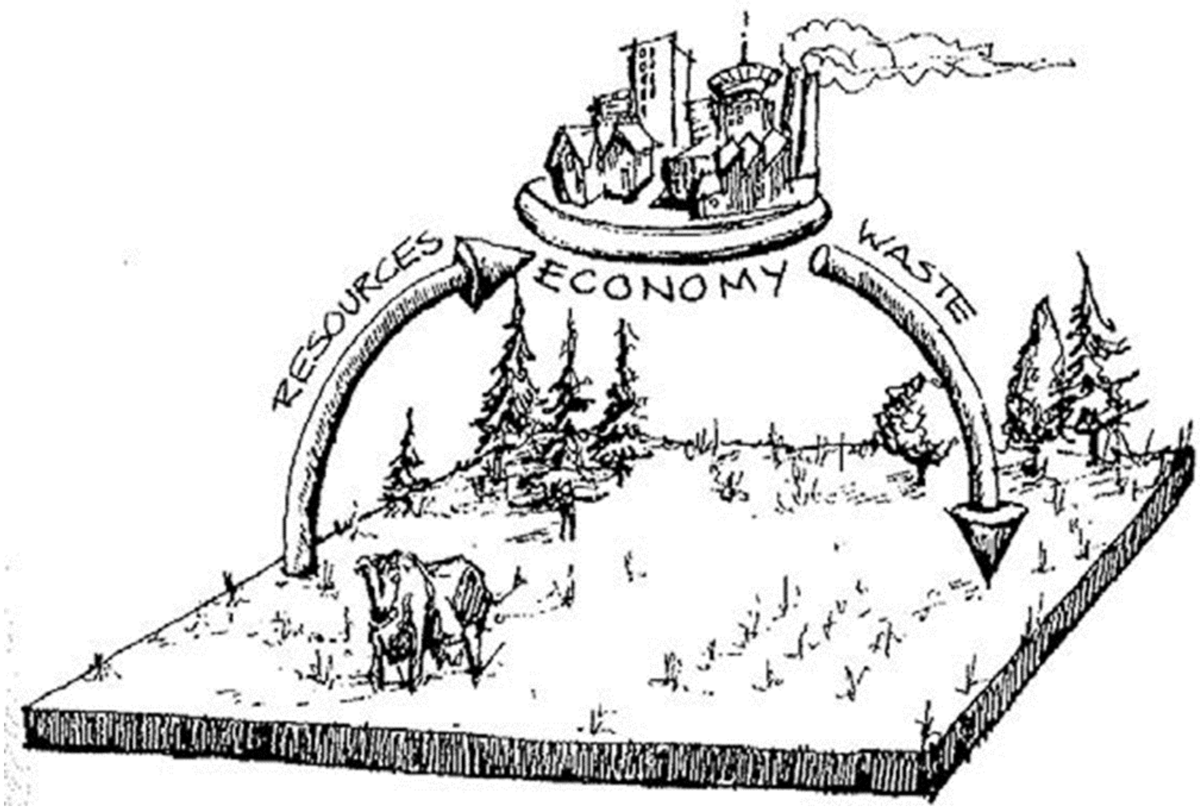


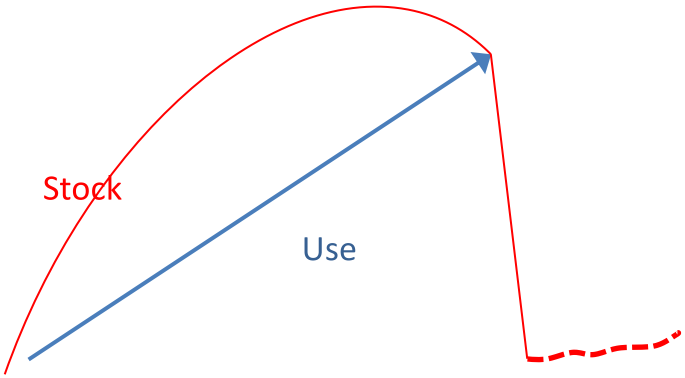

**Figure: William Rees & Mathis Wackernagel (1996) Urban Ecological footprints: Why cities cannot be sustainable – and why they are a key to sustainability**

**AND OF COURSE, UNDERLYING EVERYTHING IS OUR RELIANCE ON NON-RENEWABLE RESOURCES, PARTICULARLY FOSSIL FUELS, BUT ALSO CEMENT AND OTHER RESOURCED USED FOR DEVELOPING THE BUILT ENVIRONMENT**

# Tipping points

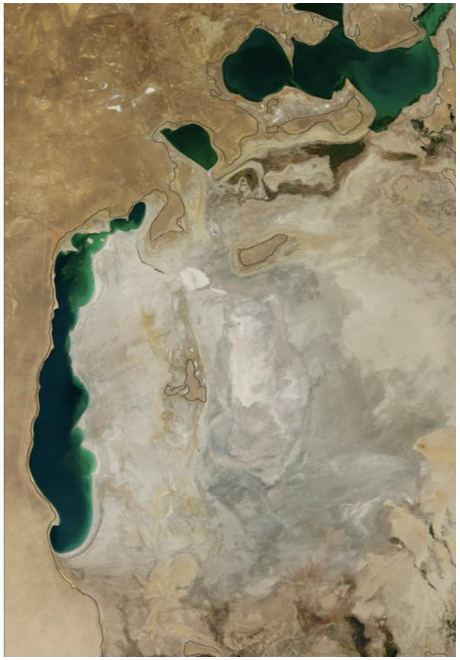
= points of no return (or at least no quick return)

- Plenty of well-known small scale examples
- Can happen for the whole globe / global ecosystem
- Are we currently approaching a global tipping point – or have we exceeded one?



# Tipping point anatomy

Lake Aral
1989



Lake Aral
2014

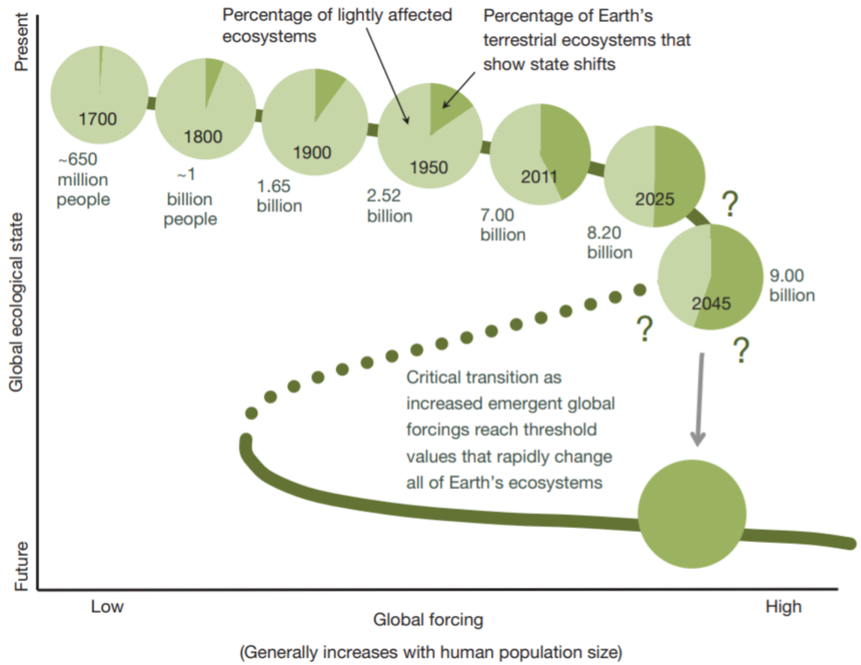
# Tipping point anatomy

Amazon rainforest

# Tipping point anatomy

Agincourt Reef Australia

# A planetary state shift

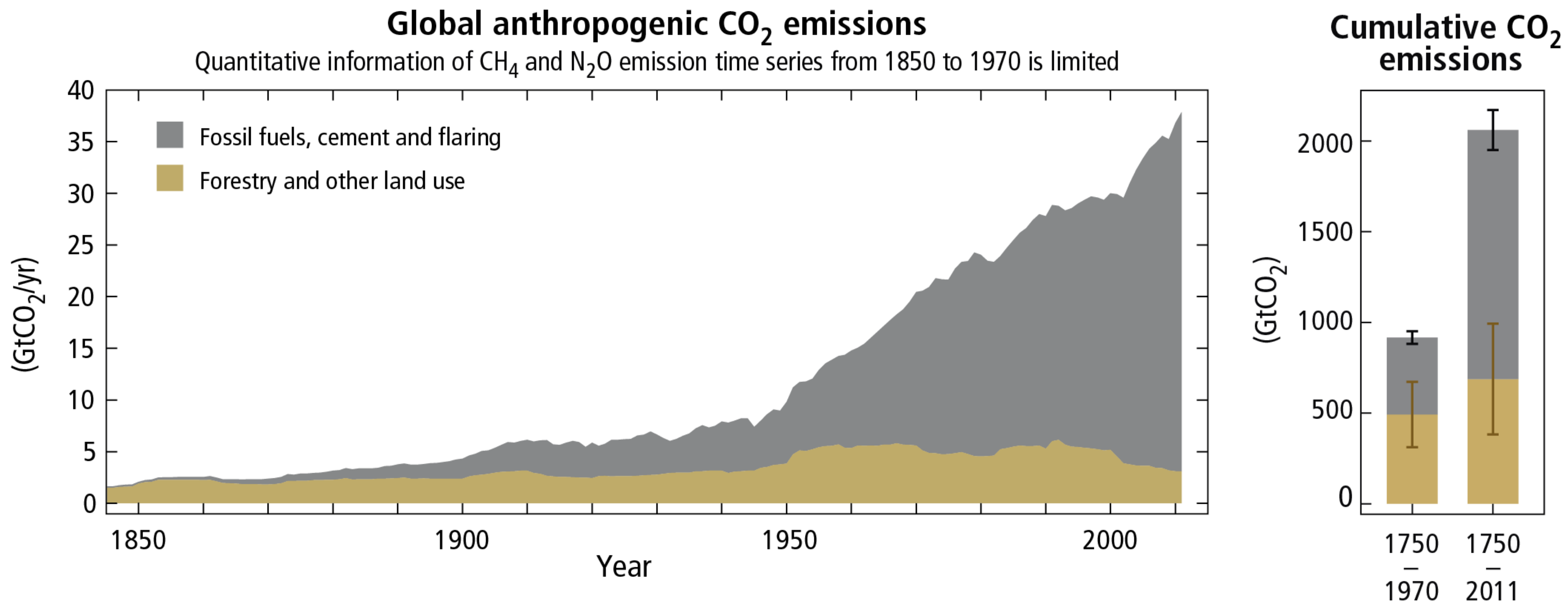



Barnosky et al. (2012). Approaching a State Shift in Earth‘s Biosphere. *Nature*, 486.

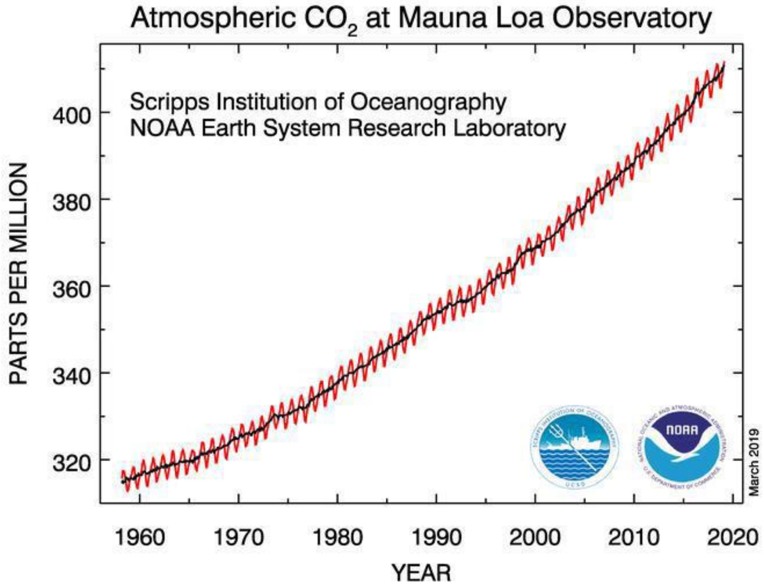
# Potential global tipping point mechanisms

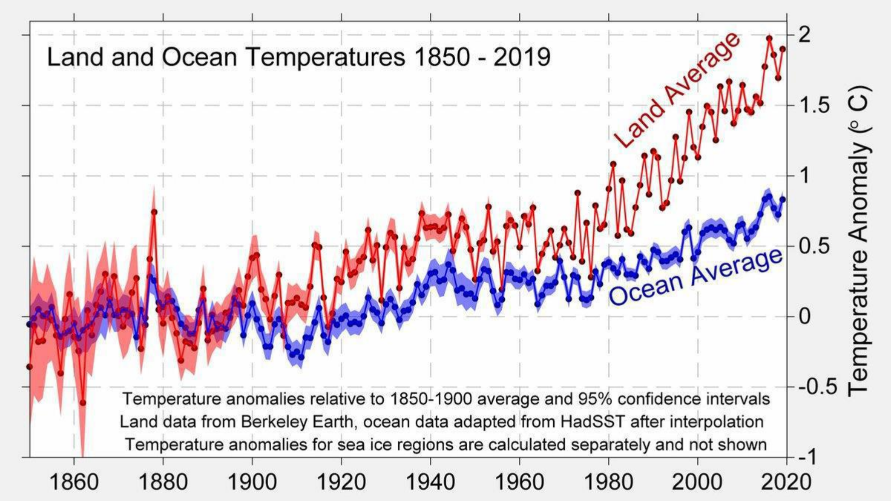
- **Permafrost melting**
  - Warming climate leads to permafrost melting causing huge natural gas emissions
  - Natural gas is a much stronger greenhouse gas (GHG) than carbon dioxide
  - Warming accelerates even if emissions don’t increase, and potentially even if they decrease
- **Glacier melting**
  - Melting glaciers become darker and darker and reflect less radiation, which accelerates melting
- **Darkening of water surfaces**
  - Eutrophication leads to darkening of water surfaces with the same result than with glacier melting
- **Ocean acidification**
  - Oceans have so far absorbed an important share of the anthoropogenic GHGs, but along with acidifcation caused by the same GHGs, they can absorb less and less
- **Several other such mechanisms**

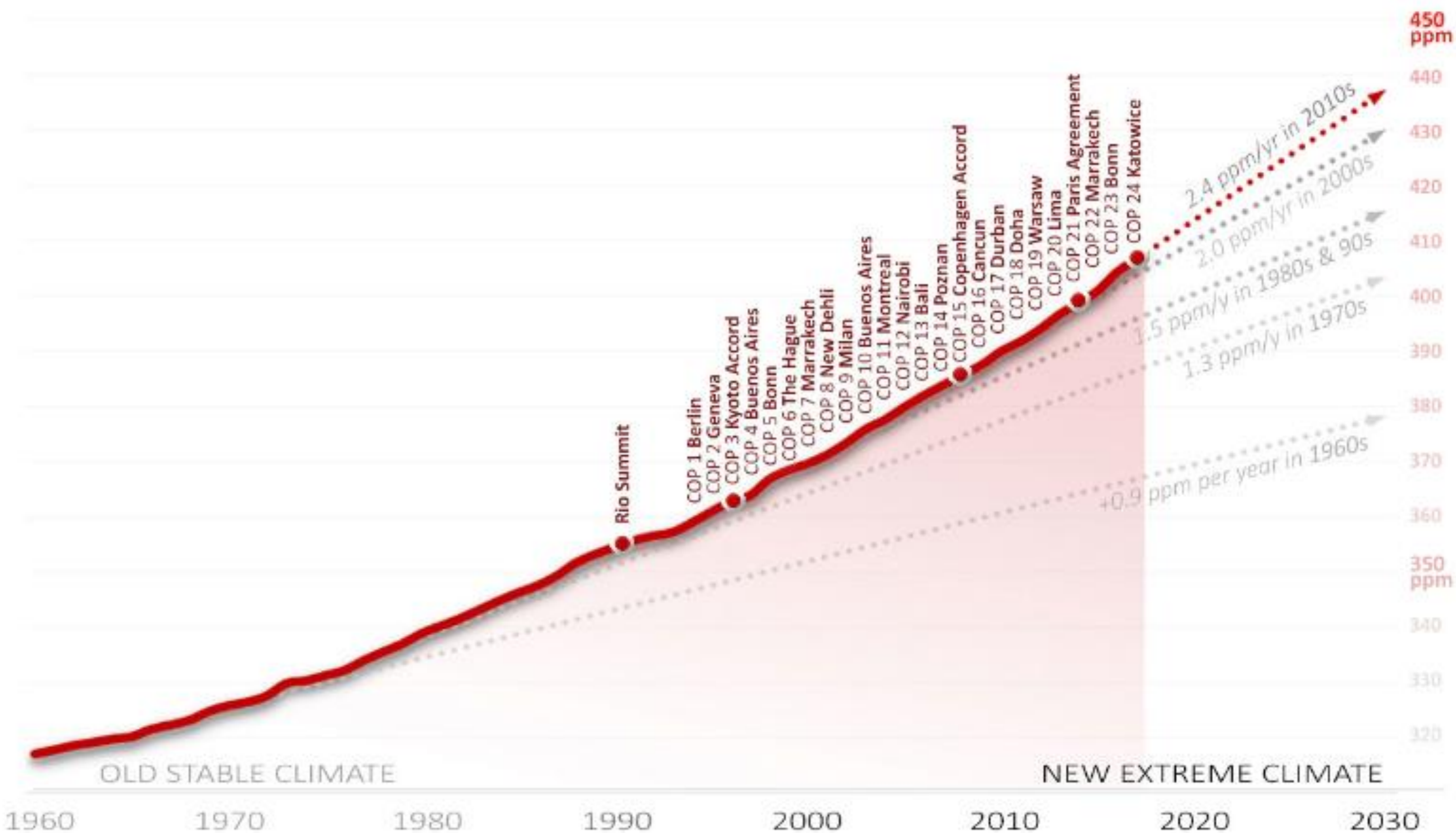
# CO2 emissions



# $CO_2$ ppm & temperature increases

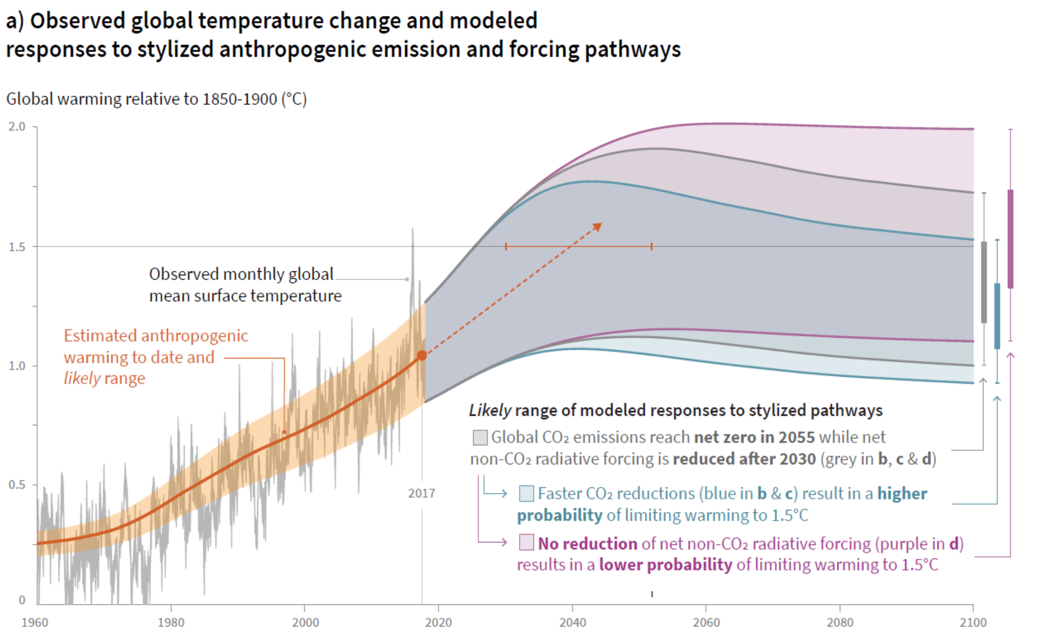




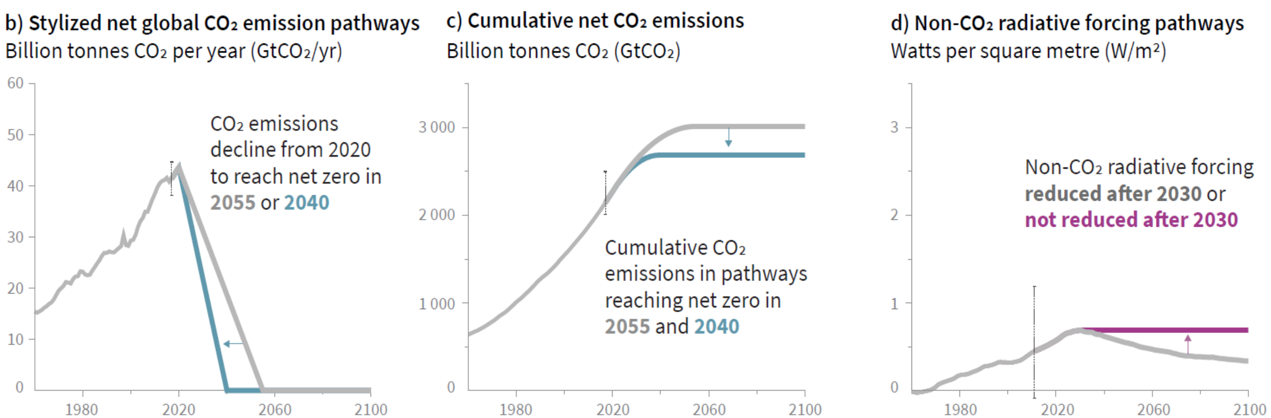

**CO2** IN OUR ATMOSPHERE

# Climate change




IPCC 2018

# Climate change



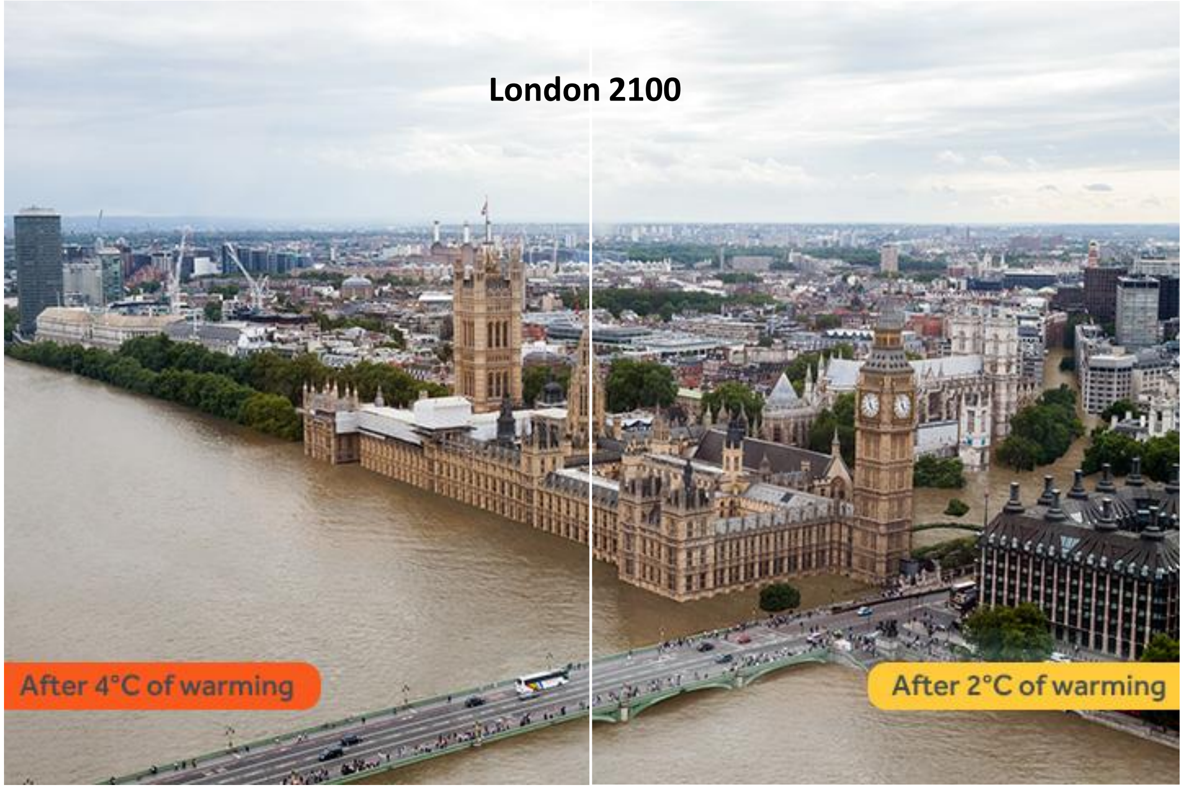

Faster immediate $CO_2$ emission reductions limit cumulative $CO_2$ emissions shown in panel **(c)**.

Maximum temperature rise is determined by cumulative net $CO_2$ emissions and net non-$CO_2$ radiative forcing due to methane, nitrous oxide, aerosols and other anthropogenic forcing agents.

IPCC 2018

# Some consequences of climate change

- Sea level rise up to tens of meters (over a long time)
  - Disappearing agricultural areas
  - Drowning major cities
- Large-scale desertification
  - Relocation of billions of people
- Accelerating biodiversity loss
  - Collapses of global ecosystems
- Freshwater shortages
  - Conflicts and wars over water reserves




http://www.climatecentral.org

**Thank you!**

**heinonen@hi.is**