

Our Common Future within Planetary Boundaries

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Photo: Yann Arthus-Bertrand

Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship



Stockholm
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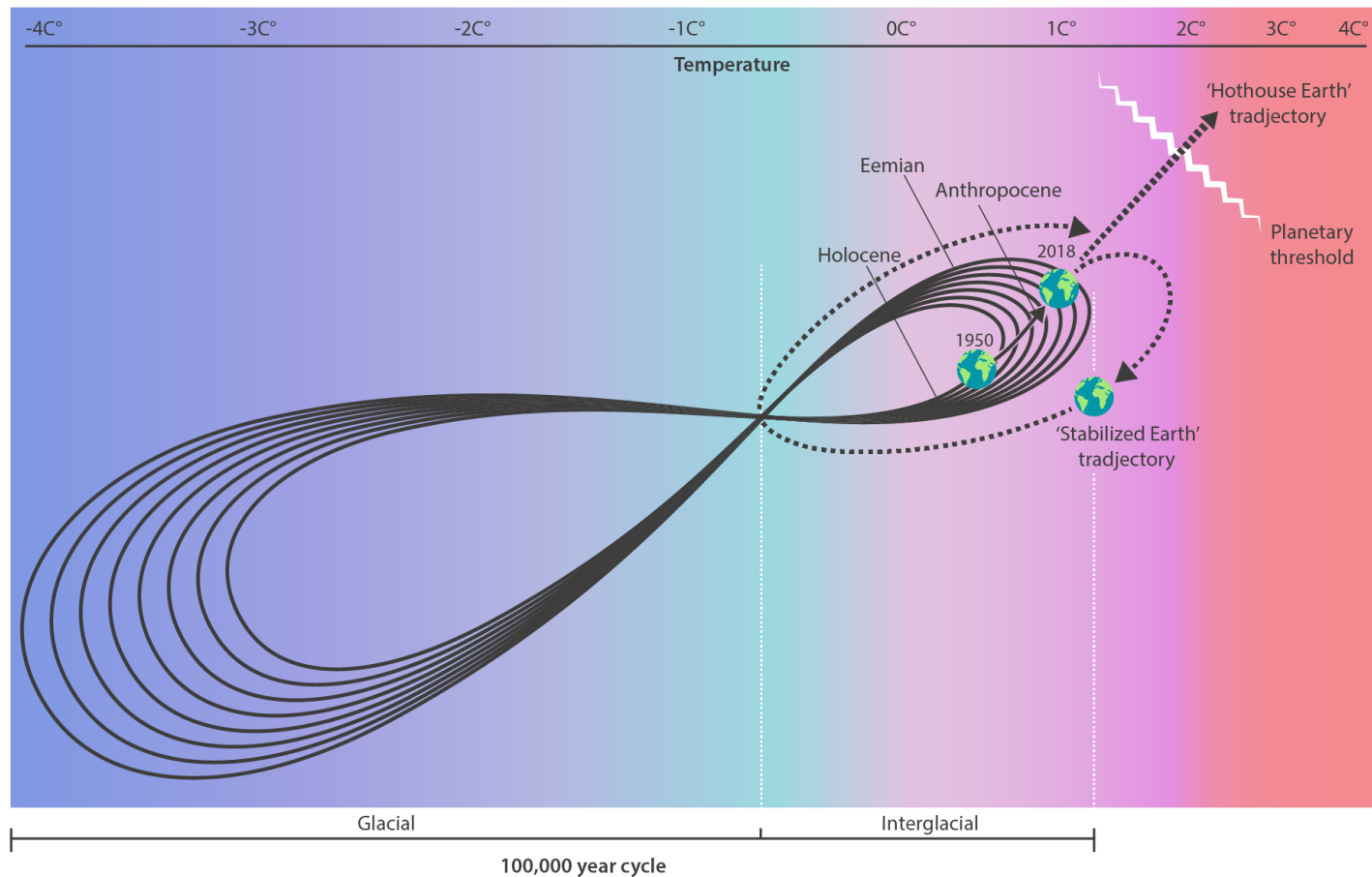




People are embedded parts of the biosphere and shape it,
from local to global scales, from the past to the future

At the same time - people are fundamentally dependent on
the capacity of the biosphere to sustain human development

Limit cycles of the earth system the last 1.2 million years and potential earth trajectories the coming 100 years



A savanna landscape under a clear blue sky. In the foreground, a herd of antelopes with spiraling horns is grazing in a field of dry, golden-brown grass. A few white birds are scattered among the antelopes. In the background, several acacia trees with flat, umbrella-like canopies are visible against the horizon.

Major Biomes on earth that regulate 'Earth Resilience'

Photos: World Wildlife Fund, breakingenergy.com, saguidedtours.com, Sierra Club Pennsylvania, Projectaware.com, Duncan Greene/Wired UK.



The Global Commons in the Anthropocene – Biomes,
Biogeochemical cycles and Biodiversity

Abrupt shifts are occurring earlier than predicted



1. Extreme events (USA 2017 Hurricane season
Maria, Irma, Harvey > 350 billion USD)

2. Thirty percent of the Great Barrier Reef has crossed an irreversible tipping point.

3. Regional ocean circulation slow down, raising questions about the Gulf Stream and Ocean conveyor belt

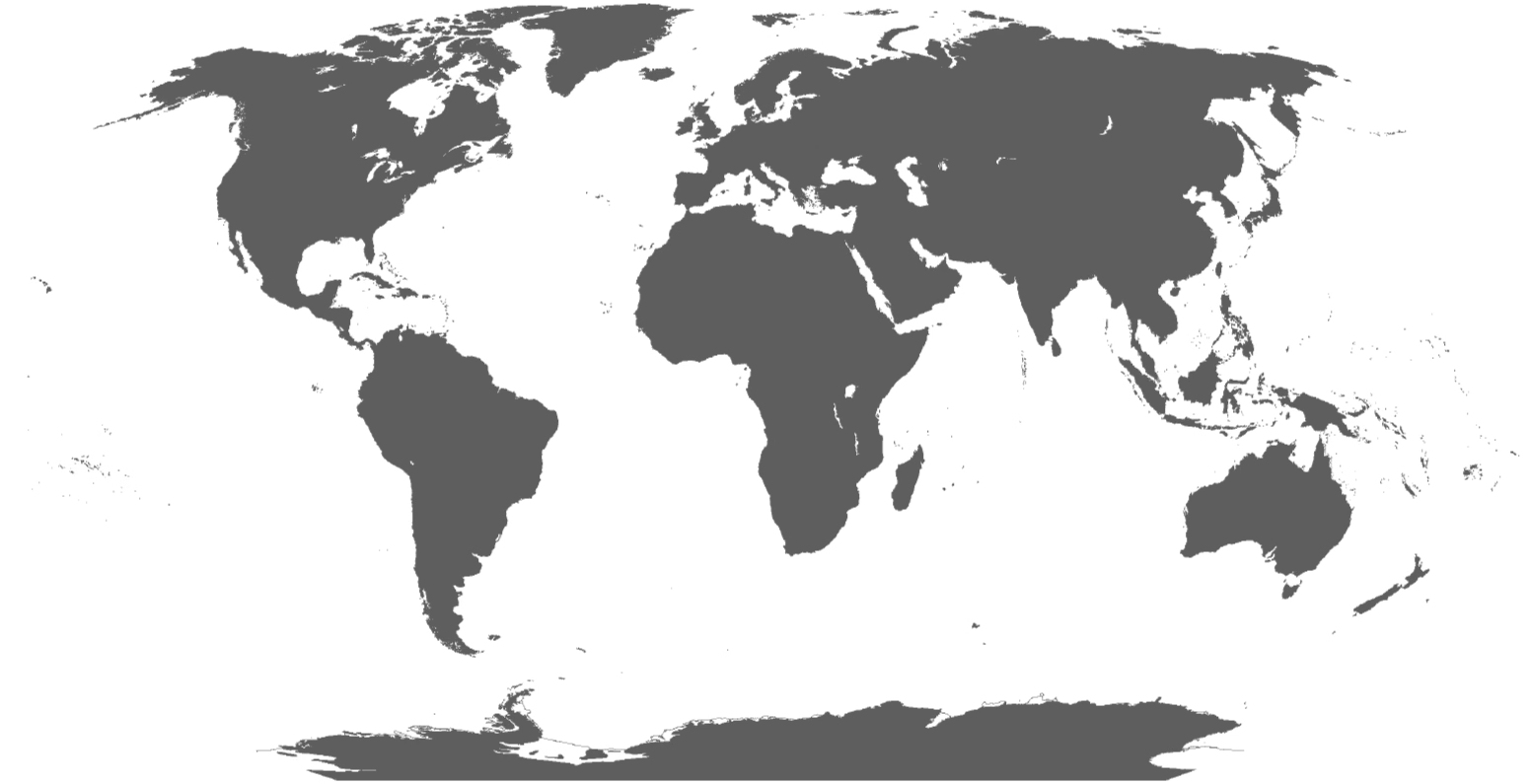
4. Rainforest tipping point at 25 % deforestation?
We are at approx 15 % today

5. Planetary Ground Zero

Arctic - 2 °C Globally = 5 °C

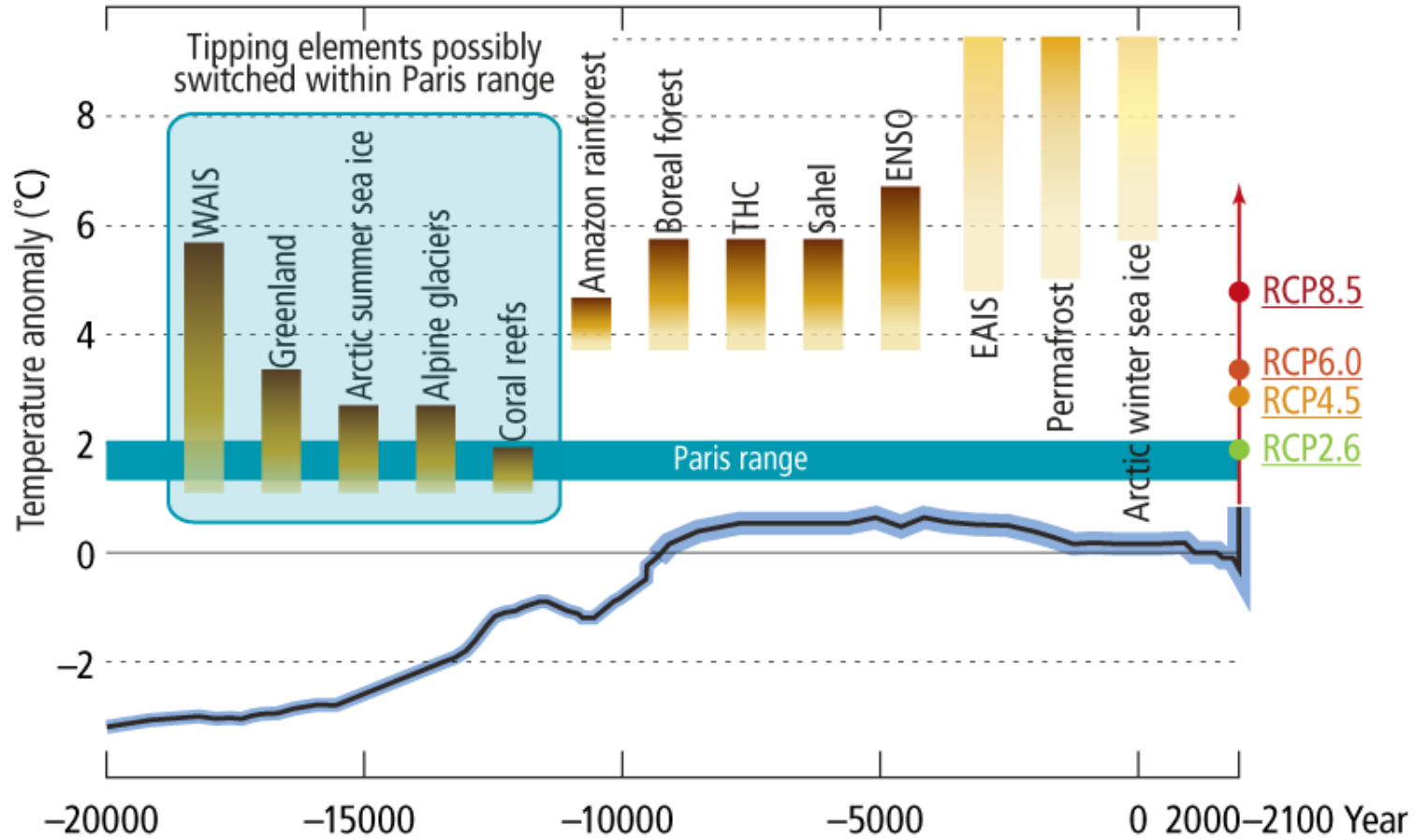
Antarctica - Melting 3 times faster than a decade ago

Global Tipping Points



Tipping Points & the Paris Agreement

Sources: Adapted from Schellnhuber et al. (2016). Nature Climate Change



The background of the slide is a composite image. On the left, a portion of the Earth is visible from space, showing the curvature of the planet and some city lights. The rest of the background is a dark blue field filled with a complex, glowing network of white and light blue lines, resembling a global communication or data network or a representation of the planet's internal systems.

Welcome to the **Anthropocene**

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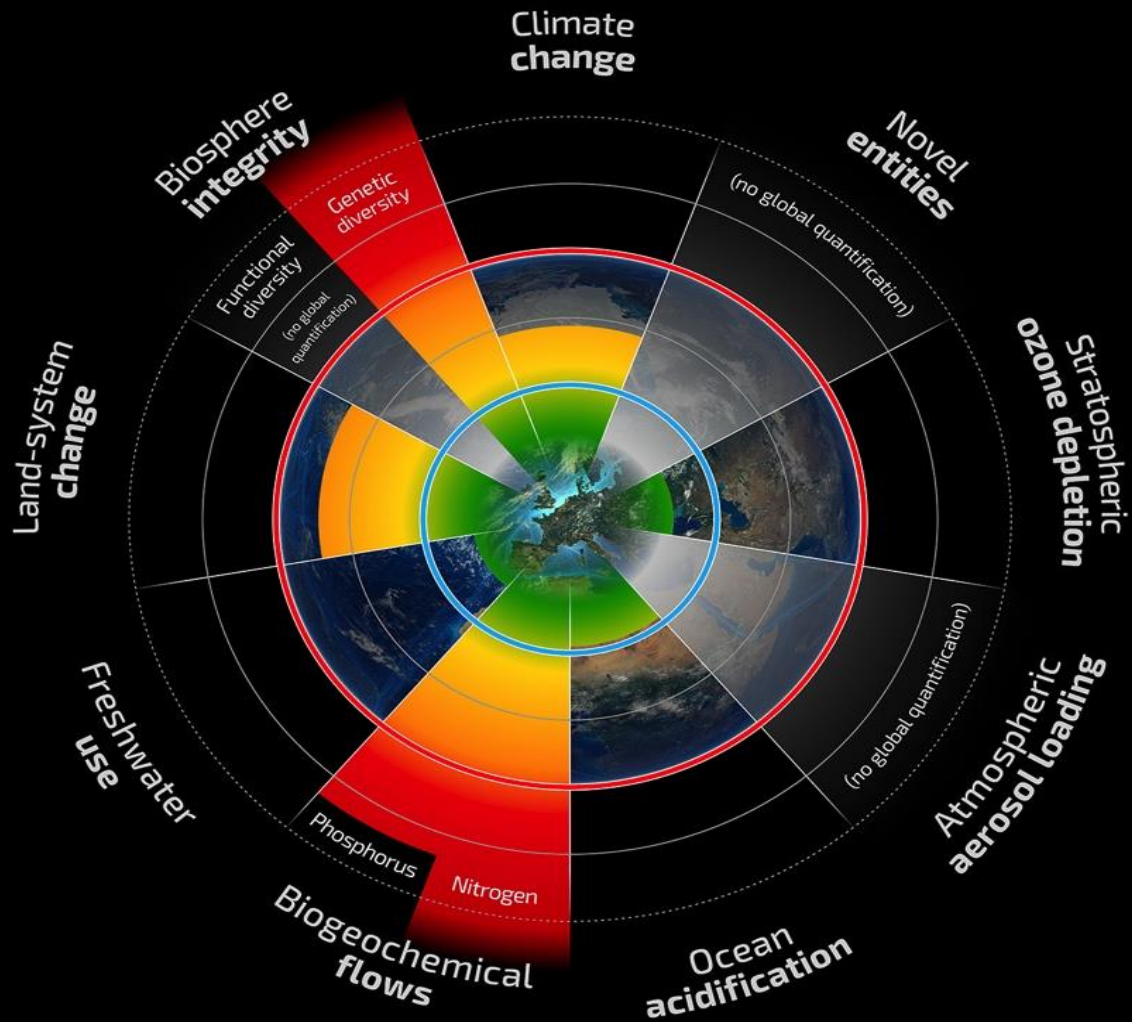
Holocene our **Garden of Eden**

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Tipping Points part of Normality

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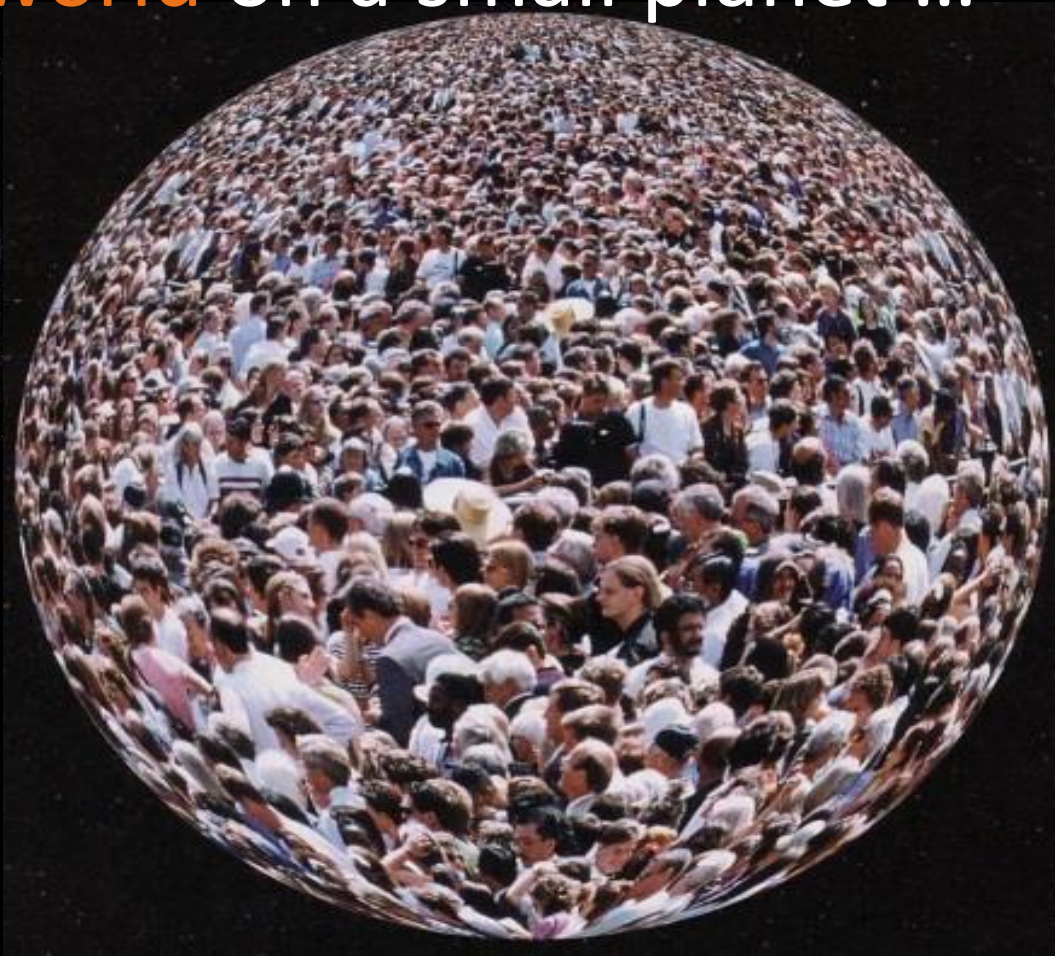
Human Prosperity within **Planetary Boundaries**

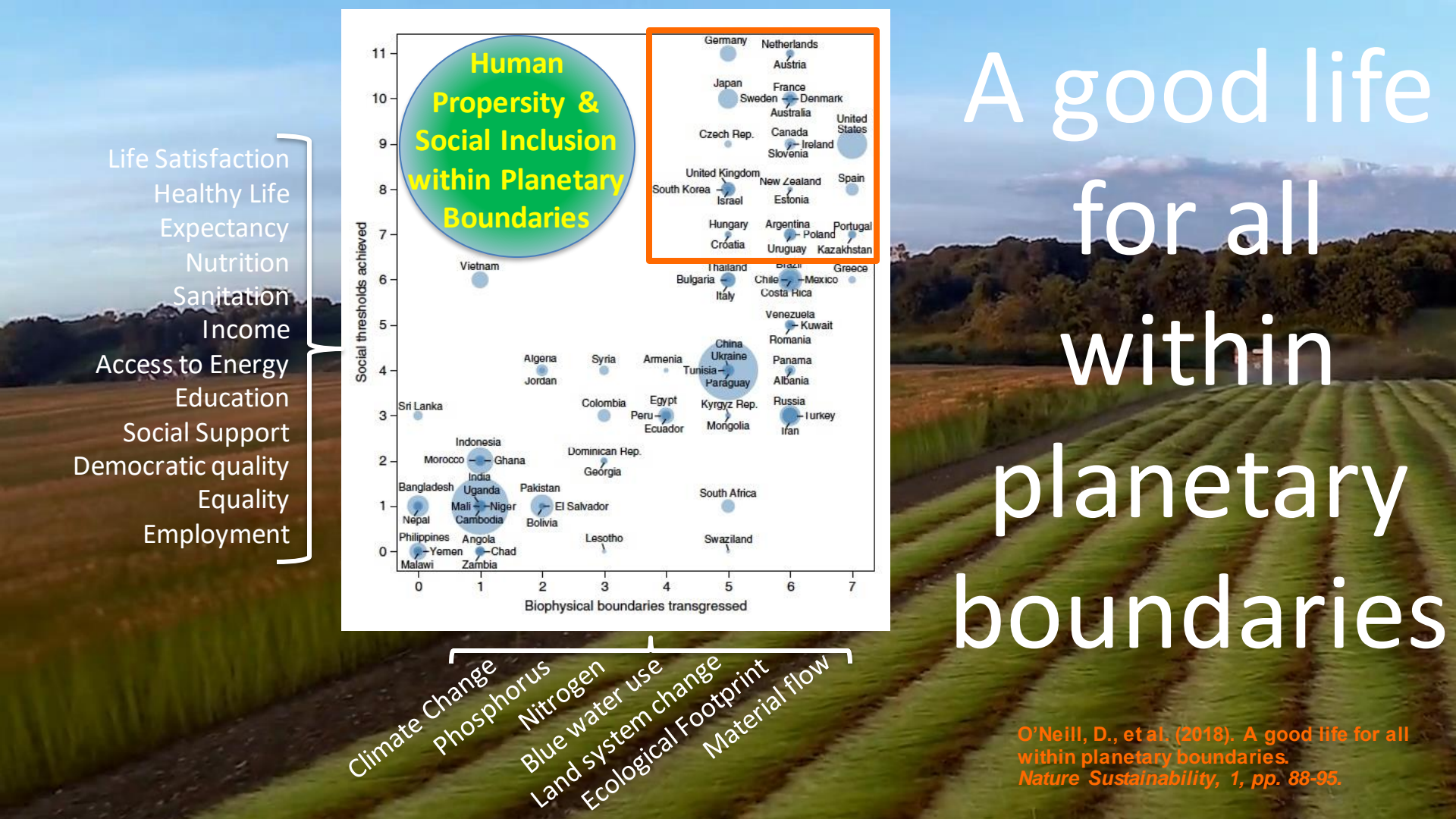


From a **small world** on a large planet ...



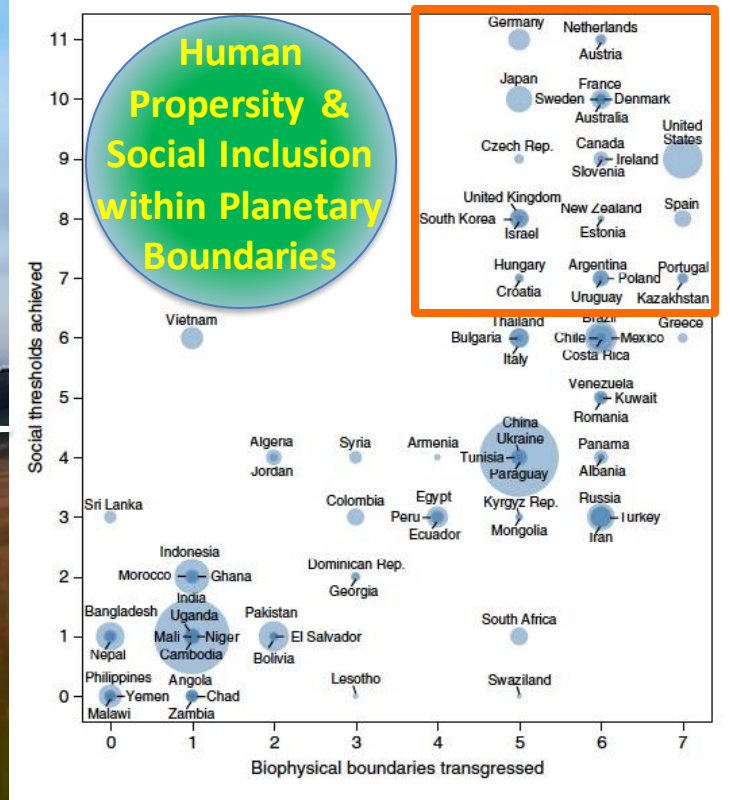
To a **large world** on a small planet ...





A good life for all within planetary boundaries

- Life Satisfaction
- Healthy Life Expectancy
- Nutrition
- Sanitation
- Income
- Access to Energy
- Education
- Social Support
- Democratic quality
- Equality
- Employment



- Climate Change
- Phosphorus
- Nitrogen
- Blue water use
- Land system change
- Ecological Footprint
- Material flow

O'Neill, D., et al. (2018). A good life for all within planetary boundaries. *Nature Sustainability*, 1, pp. 88-95.



Towards exponential Transformations

Six Global Transformations that are Necessary and Potentially Sufficient to attain the SDGs

[TWI2050, 2018 report to the HLPF in July 2018, work in progress]



THE CARBON LAW



POLICY FORUM

CLIMATE POLICY

A roadmap for rapid decarbonization

Emissions inevitably approach zero with a 'carbon law'

By **John Rockstrom**, **Oswa Gaffney**,
Jost Heugl, **Malin Mikellidou**,
Nehal Nalawati, and **Hans-Joachim
Schellnhuber**

Although the Paris Agreement's goal (2) is aligned with science (2) and, in principle, is technically and economically achievable (2), limiting emissions remains beyond reach for most countries. Despite progress during the 2016 Marrakech climate negotiations, progress goals can be trumped by political short-termism. Following the Agreement, which became international law earlier than expected, several countries published mid-century decarbonization strategies, with more due soon. Mid-century decarbonization assessments (3) and associated often struggle to capture transformative change and the dynamics associated with it: diversification, innovation, and nonlinear change in human behavior. For example, in just 3 years, China's coal use rose from 47% to 57% in 2015 to 2016, a 10% increase in 2015 to 2016 (4). To harness these dynamics and accelerate the pace of decarbonization, we propose framing the decarbonization challenge in terms of a global decadal roadmap based on a single, frontier-level, 'carbon law'—and halting gross anthropogenic carbon dioxide (CO₂) emissions every decade. Coupled together to immediately integrate, scale up carbon removal and efforts to ramp down land-use CO₂ emissions, this can lead to zero net emissions around mid-century, a path necessary to limit warming to well below 2°C. The Paris goal translates into finite planetary carbon budget: a 60% chance of limiting warming to 1.5°C by 2100 and a 50% probability of meeting the 2°C target imply that global CO₂ emissions peak no later than 2020, and gross emissions decline from ~40 gigatonnes (gigatons) of carbon dioxide (GtCO₂/yr) in 2020, to ~28 by 2030, ~18 by 2040, and ~5 by 2050 (2). (See the figure, left.) Risk could be further reduced by moderate increasing ambition to have emissions every decade (see the figure, bottom right). Following such a global carbon law means at least limiting cumulative total CO₂ emissions from 2017 until the end of the century to ~700 GtCO₂, which allows for a small but essential contingency (~150 GtCO₂) to compare with total CO₂ emissions in the pathway to the Paris goal for risk of anthropogenic carbon feedbacks (6) or delay in ramping up CO₂ removal technologies.

A carbon law applies to all sectors and countries at all scales and encourages bold action in the short term. It means, for example, availability of new-carbon shares in the energy system every 5 to 7 years, a rate con-

The need to global decarbonization must include removing energy from fossil fuels in Germany, and reorganize transport technologies.

istent with the trajectory of the past decade (see the figure, bottom left). All sectors, i.e., agriculture, construction, finance, manufacturing, transport need comparable transformation pathways. In addition, in the absence of viable alternatives, the world must aim at rapidly scaling up CO₂ removal by technical means from 200 million to at least 6 GtCO₂/yr by 2030, 1.5 to 2 GtCO₂/yr, and 6 to 20 GtCO₂/yr, CO₂ emissions from land-use must decrease about a nonlinear trajectory from a GtCO₂/yr in 2010 to 2 by 2030, 1 by 2040, and 0 by 2050 (see the figure, bottom right). The endgame is for cumulative CO₂ emissions since 1870 to be brought back from around 700 GtCO₂ to below 200 GtCO₂ by the end of the century (see the figure, top) and atmospheric CO₂ concentration to return to 380 ppm by 2100 (currently at 400 ppm).

Roadmaps are planning instruments, taking decisions on targets to long-term goals. They help align science and organizations in unique technological and institutional breakthroughs to meet a collective challenge. As explicit carbon roadmaps for having entire-system emissions every decade, endorsed by and for all relevant sectors, could help promote disruptive, nonlinear technological advances toward a zero-emission world. The key to such a carbon law will be dual strategy that pushes renewables and other zero-emissions technology up the creation and dissemination trajectory, while simultaneously pulling fossil-fuel value propositions from the market. Thus, the transformation unfolds at a pace governed by zero-emissions rather than by inertia imposed by incumbent technologies (see the figure, bottom left).

We sketched out a broad decadal decarbonization narrative in four dimensions—innovation, institutions, investments, and instruments—to provide evidence of feasibility and depth of transformation for economies to step on a carbon-law trajectory. The narrative provides no guarantees but identifies crucial steps grounded in published scenarios combined with expert-led analyses. Each step has two game actions for rapid near-term emissions reductions, and actions for systemic and long-term impact, creating the base for the next steps. Such a narrative, specifically designed with decadal targets and incentives, could provide key elements for national and international climate strategies.

2017-2020: NO INCREASES
Annual emissions from fossil fuels must start falling by 2020. Willpower and leadership (non-technical) priority instruments such as carbon tax schemes, cap-and-trade

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SECTIONS HOME SEARCH

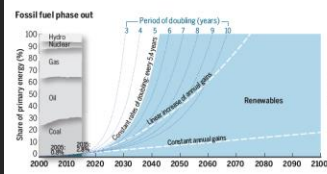
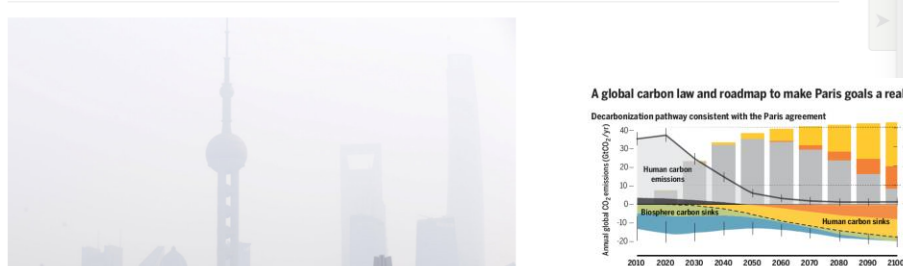
The New York Times owengaffney

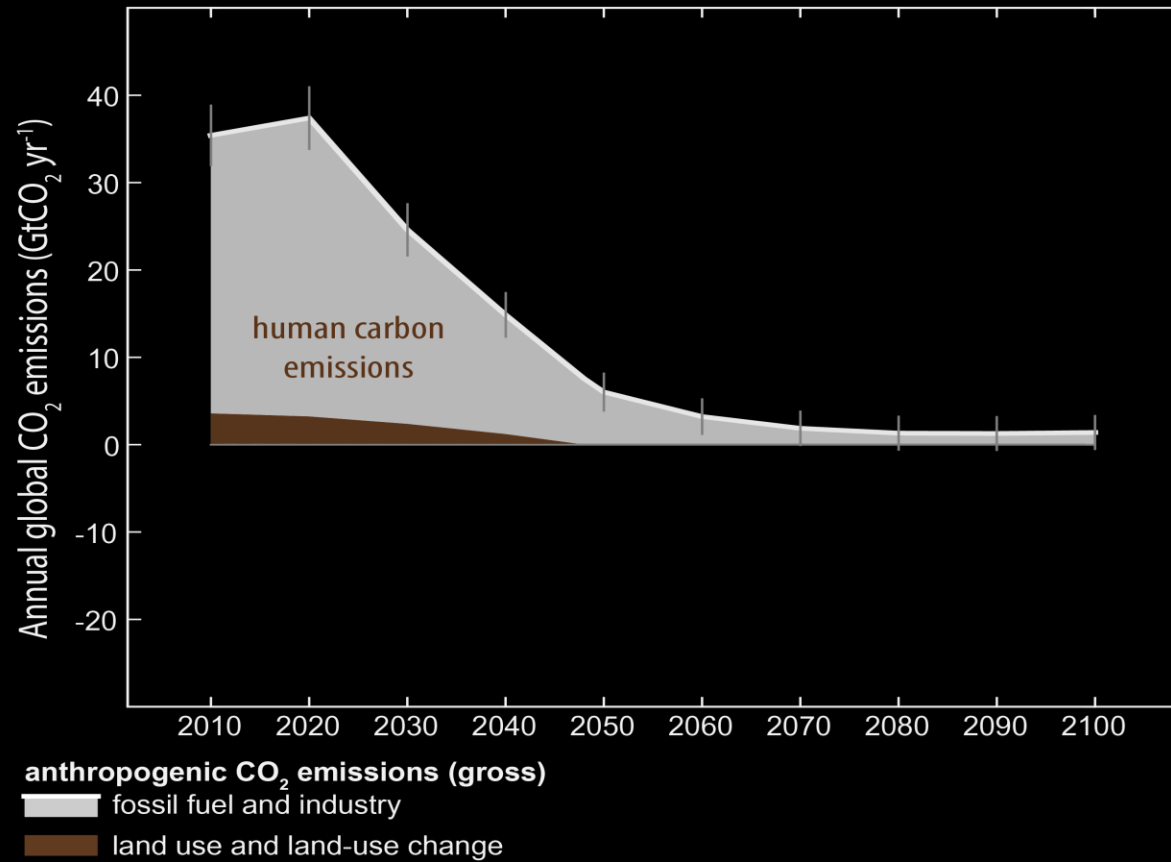
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- Police Officer Who Fatally Shot 15-Year-Old...
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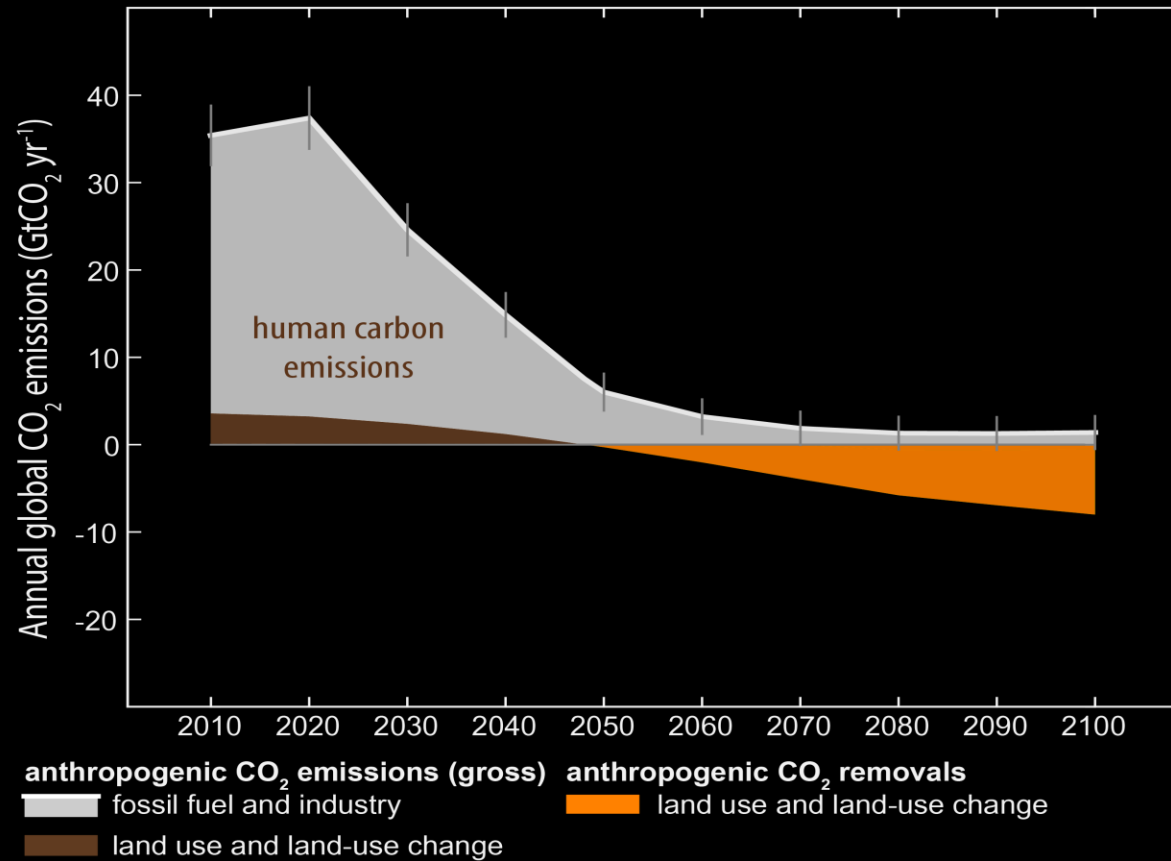
The Opinion Pages | OP-ED CONTRIBUTOR

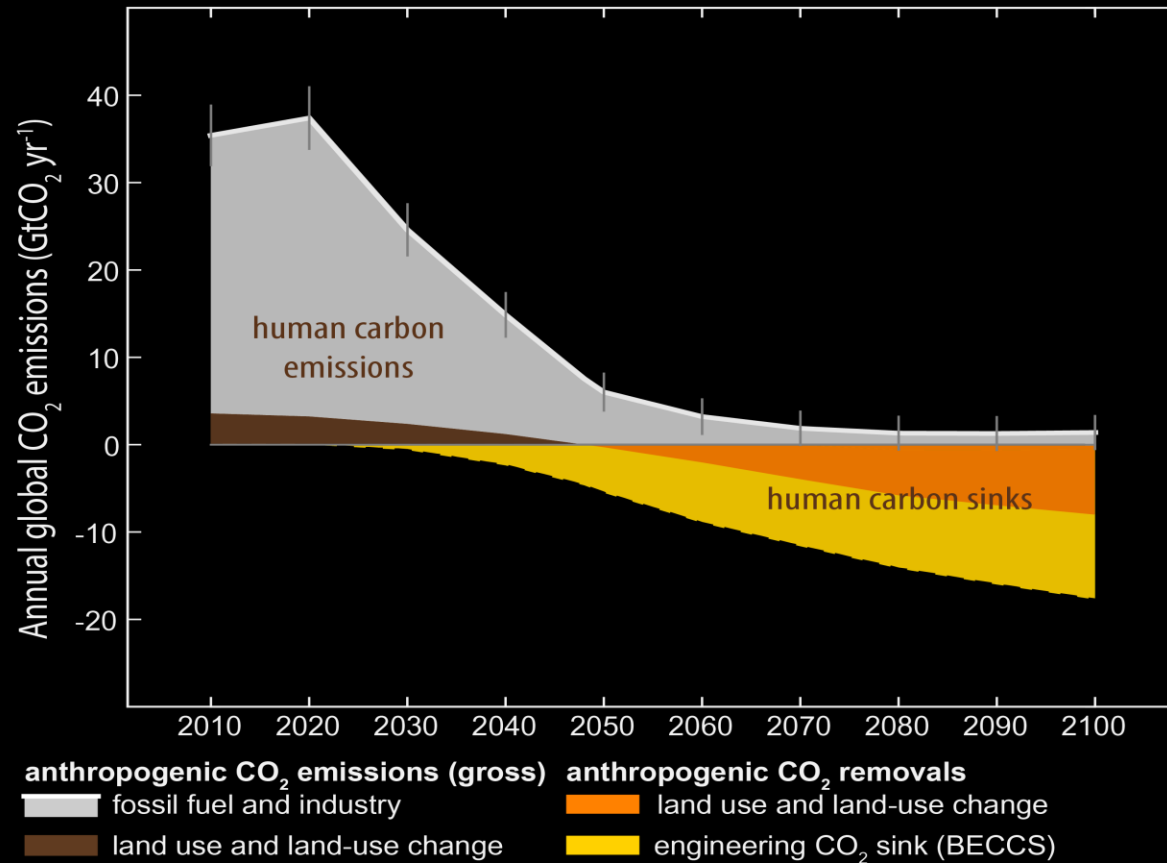
Why the World Economy Has to Be Carbon Free by 2050

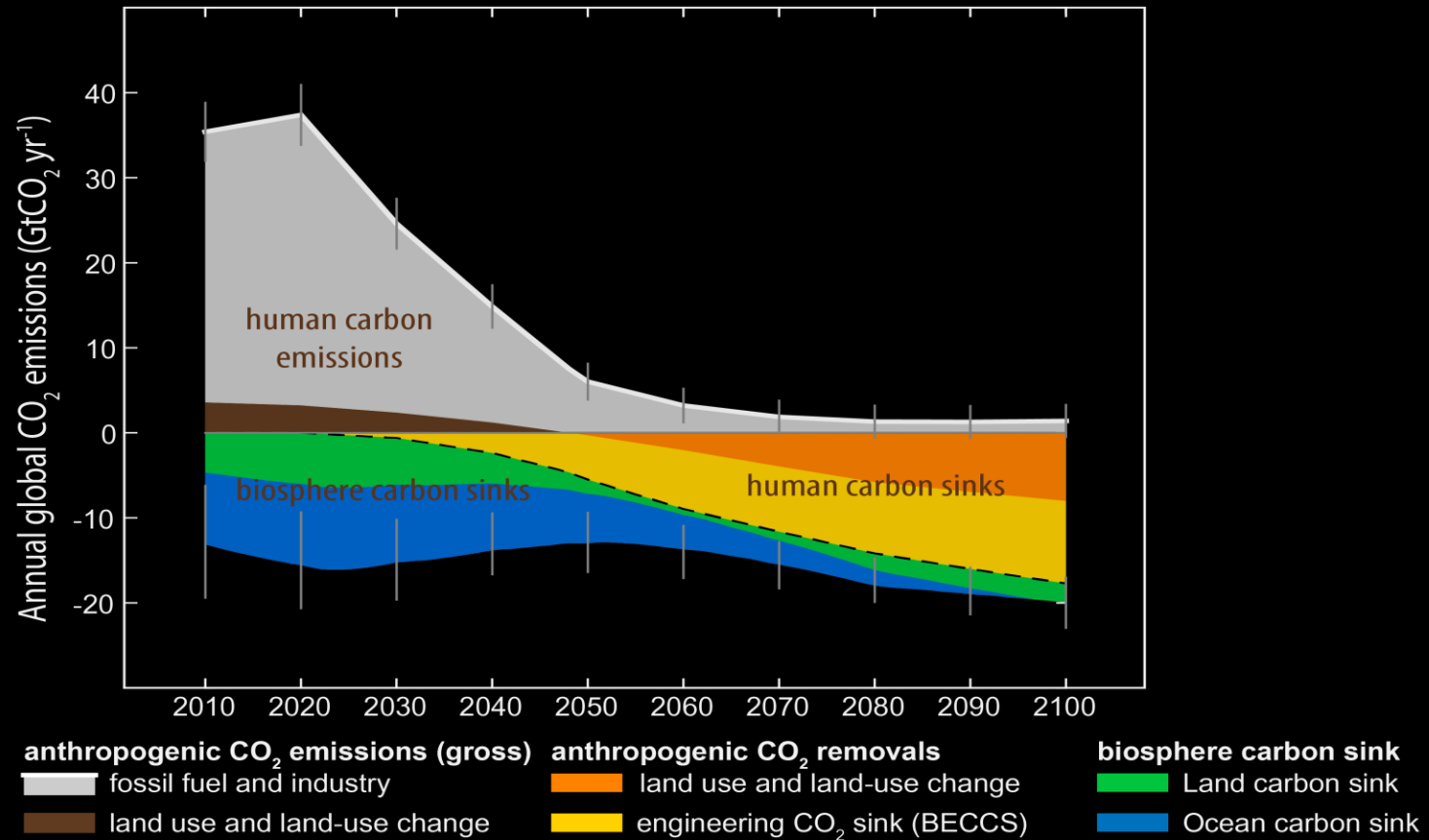
By **JOHAN ROCKSTROM** MARCH 23, 2017





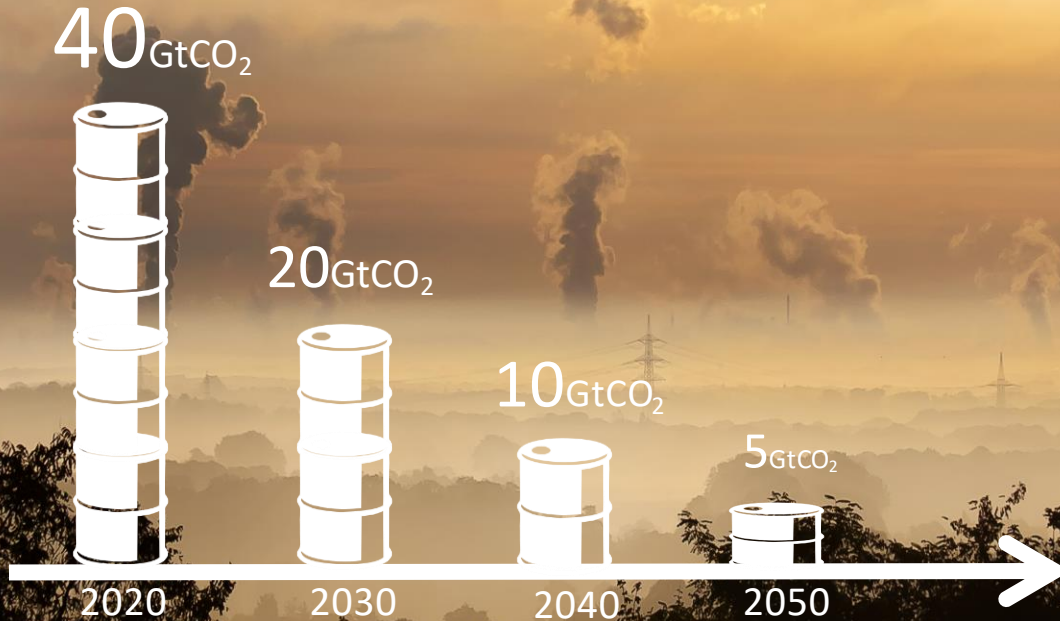






A Global Carbon Law

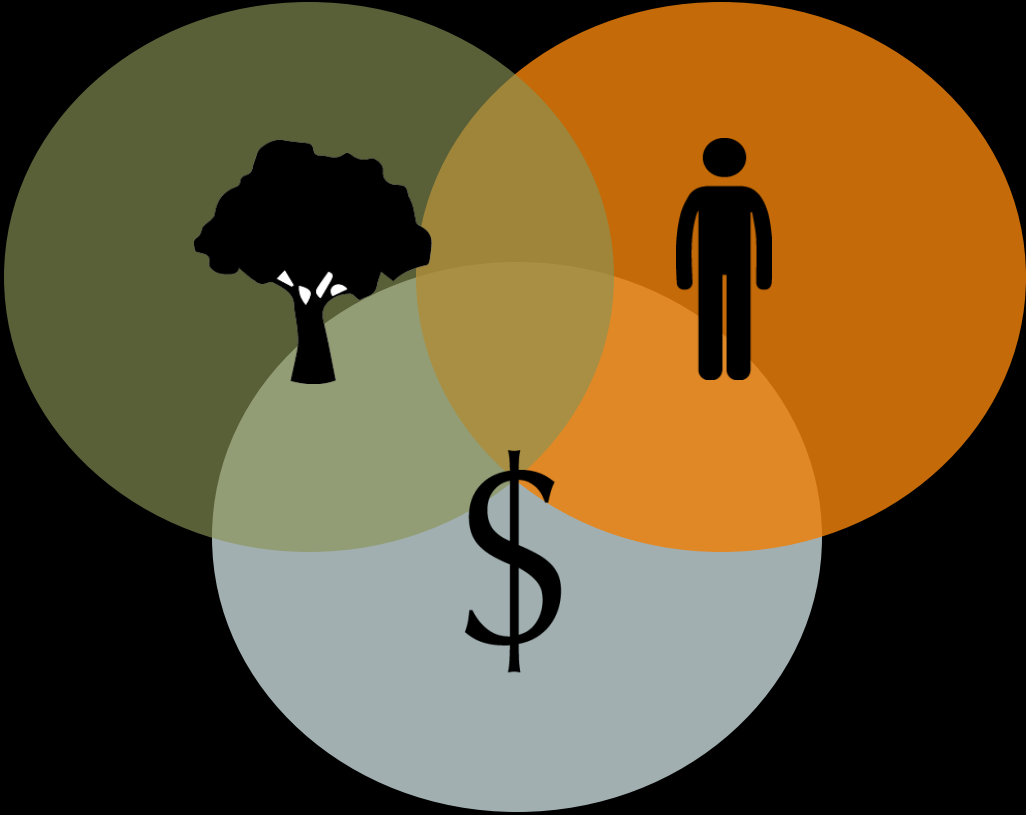
Halving Emissions Every Decade





Planetary Stewardship

THE GLOBAL GOALS
For Sustainable Development





SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

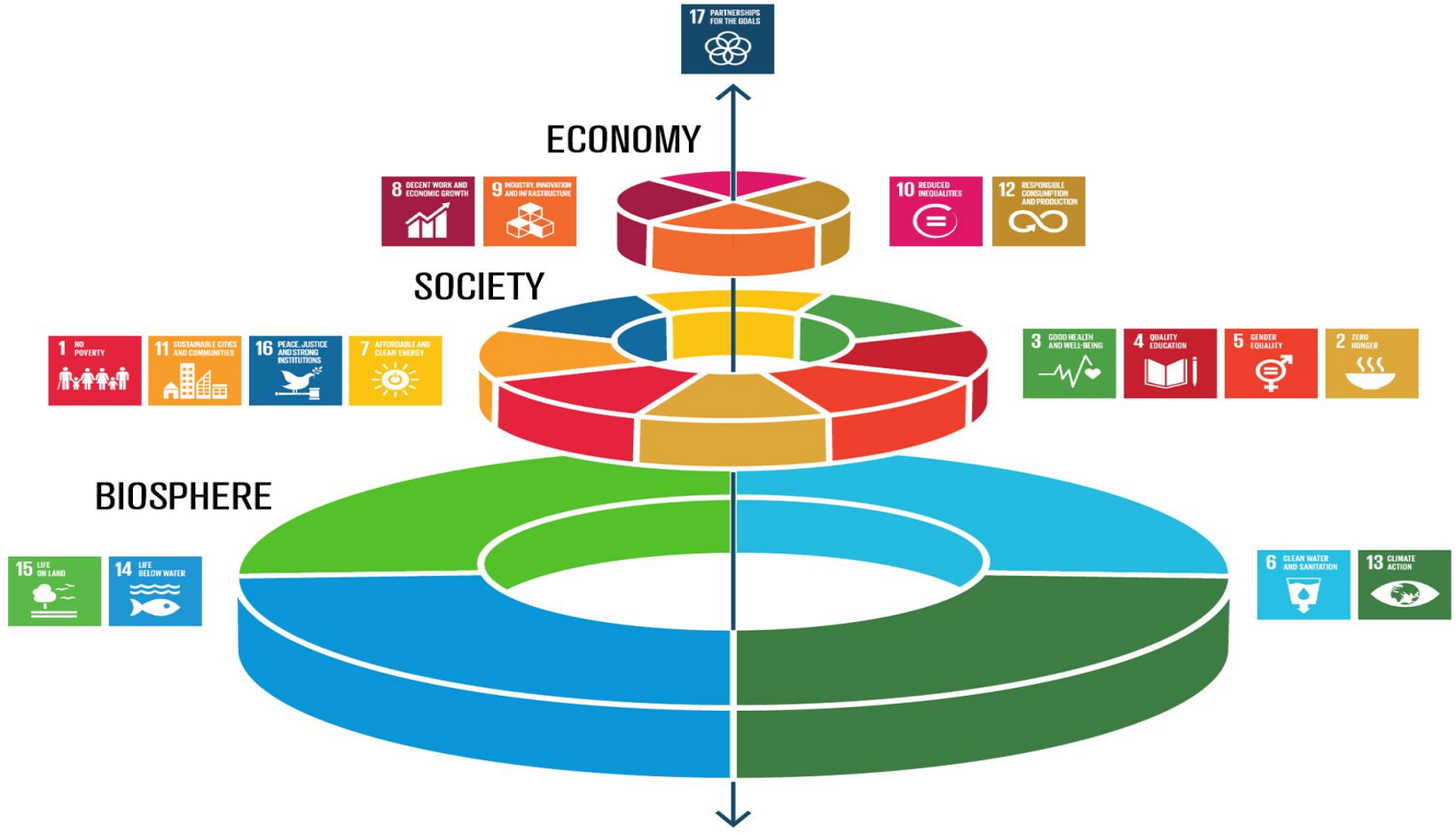
14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

SUSTAINABLE DEVELOPMENT GOALS



We face unprecedented global environmental risks, but also
unprecedented opportunities

Are we at a global sustainability tipping point?



Transformations to human prosperity and social inclusion
within Planetary Boundaries Necessary, Possible, and
Beneficial

Ecosystems and the biosphere is the fundamental path to
Success



Thank you
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Photo: O.Heinriksson/Azote