The Planetary Boundaries Framework

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Webinar,
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A biosphere shaped by humans

Anthropocene

Scale, Speed, Inter-connections
Stability landscape showing the pathway of the Earth System out of the Holocene
Climate Crisis

Health Crisis

Ecosystem Crisis
Climate crisis: 11,000 scientists urge ‘untold suffering’

Statement sets out ‘vital signs’ as indicators of magnitude of climate emergency

- Most countries’ climate plans ‘totally inadequate’ -
Welcome to the Anthropocene
The Great Acceleration

Are We Leaving the Garden of Eden?
Global Temperature since the Last Ice Age
Tipping Points are Real
Looming Risks: Tipping Elements in the Earth System
Climate tipping points – too risky to bet against

Timothy M. Lenton, Johan Rockström, Owen Gaffney, Stefan Rahmstorf, Katherine Richardson, Will Steffen & Hans Joachim Schellnhuber

RAISING THE ALARM
Evidence that tipping points are under way has mounted in the past decade. Domino effects have also been proposed.

TOO CLOSE FOR COMFORT
Abrupt and irreversible changes in the climate system have become a higher risk at lower global average temperatures.

Global average temperature: -1 °C above pre-industrial levels

Nature, 28 November, 2019
Two Questions Guide the Planetary Boundaries Framework:

1. Which are the biophysical systems and processes that regulate the state of the Earth System?

2. What are the quantitative boundaries for each of these systems/processes that define a safe operating space of a stable Earth System?
Planetary Boundaries 2009

Rockström et al., Nature 2009
The Big Three

- **Climate Change**
  - CO₂ concentration in the atmosphere <350 ppm and/or a maximum change of <1 W m⁻² in radiative forcing.

- **Ocean Acidification**
  - Average surface seawater saturation state with respect to aragonite <80% of pre-industrial levels.

- **Stratospheric Ozone**
  - <5% reduction in O₃ concentration from preindustrial level of 290 Dobson Units.

The Slow Variables

- **Biogeochemical**
  - Nitrogen (N) cycle: Limits Industrial and agricultural fixation of N₂ to 35 Tg N yr⁻¹.
  - Phosphorus (P) cycle: Annual P inflow to oceans not to exceed 10 times the natural background weathering of P.

- **Global Freshwater Use**
  - <4,000 km³ yr⁻¹ of consumptive use of runoff resources.

- **Land System Change**
  - <15% of the ice-free land surface under cropland.

- **Rate of Biodiversity Loss**
  - Annual rate of <10 extinctions per million species.

Earth Aliens

- **Chemical Pollution**
  - Not yet quantified

- **Atmospheric Aerosol Loading**
  - Not yet quantified

Definition of Planetary Boundaries 1.0
The Concept of Planetary Boundaries

Steffen et al, Science 2015
Freshwater use is one of the current planetary boundaries, yet affecting only a small component of the hydrosphere, which includes numerous stores of water. Since we focus on the near-surface hydrosphere, we consider land (part of the lithosphere) and ocean (part of the hydrosphere) as important related Earth System components.
Planetary Boundaries: A New Scientific Agenda

Ein transdisziplinäres Beispiel am PIK:

copan
coevolutionary pathways
Anthropocene new Geological Epoch
But
NOT (yet) a new State
Pliocene and Eocene provide best analogs for near-future climates


December 26, 2018
We have never exceeded 2°C in the last Three Million Years
Introducing a new definition of Sustainable Development

Prosperity and Equity within Planetary Boundaries
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

Conceptual Framework EAT-Lancet Commission
THE FOOD SYSTEM TRANSGRESSES PLANETARY BOUNDARIES

Rockström et al., Nature Food, 2020
Feeding 10 bn people within planetary boundaries is possible

- Half of current food production depends on planetary boundary transgressions
- An u-turn towards sustainable food production and consumption would enable enough food for ~10 bn people – within the boundaries
- However this requires radical co-transformations across sectors
A roadmap for rapid decarbonization

Climate experts and policy makers are working together to develop a plan for reducing carbon emissions to zero by 2050. To achieve this goal, they need to consider the following:

1. **Economic incentives:** Implementing policies that incentivize the use of renewable energy sources, such as solar and wind power.
2. **Technological advancements:** Investing in research and development to create more efficient and cleaner technologies.
3. **Regulatory frameworks:** Implementing strong regulations to limit greenhouse gas emissions from industries.
4. **International cooperation:** Encouraging countries to work together to reduce their carbon footprints.

By adopting these measures, we can ensure a sustainable future for our planet. (Source: The New York Times)
A Roadmap for Rapid Decarbonization

Rockström, Gaffney, Rogelj, Meinshausen, Nakicenovic, Schellnhuber. Science 24 March 2017
Six Transformations to achieve the Sustainable Development Goals

Jeffrey D. Sachs¹, Guido Schmidt-Traub²,³, Mariana Mazzucato³, Dirk Messner⁴, Nebojsa Nakicenovic⁵ and Johan Rockström⁶
Planetary Boundaries and Social Justice

Raworth 2012, nach Rockström et al., Nature 2009
Leach, Raworth and Rockström, WSSR 2012
Earth Targets for our global commons

Self-determined, integrated earth system teams e.g., land, climate, biodiversity, etc.
Science base provided by independent global scientific assessment

Overall Science-Based Targets

Specific Science-Based Targets/Pathways
When no established global policy process exists, multistakeholder groups will create informal processes to fill knowledge gaps

Earth Commission
Identify metrics, assess risk, & define ranges

Global Policy Processes
(Formal & Informal)
Assess, operationalize, & coordinate process

Science-Based Targets Initiative +
Translate, develop methods, create data architecture, promote, engage, & mobilize

Businesses & Investors

National Governments

Cities

SCIENCE
CIVIL SOCIETY, THINK TANKS, ACADEMICS, & CONSULTANTS
STAKEHOLDERS & IMPLEMENTERS
INTEGRATION & FACILITATION
The World In 2050

Radical transformative pathways to meet the SDGs within planetary boundaries

Degree of Global Sustainable Development

Planetary Boundaries

2030 2040 2050 Year

The World in 2050

www.twi2050.org
A Safe Operating Space for Humanity
Thank You!