Reconnecting World Development to Planet Earth

Implementing the 2030 Agenda For Sustainable Development

UNU 40th Anniversary Celebration
Keynote presentation
6th November, UNU HQ, Japan

Prof. Johan Rockström
Stockholm Resilience Centre

Photo Mattias Klum

Stockholm Resilience Centre
Sustainability Science for Biosphere Stewardship
Stockholm University

A PARTNER WITH
The Beijer Institute of Ecological Economics
Kungl. Vetenskaps-Akademien
The Royal Swedish Academy of Sciences

FUNDED BY
MISTRA
The Swedish Foundation for Strategic Environmental Research

Article

Will Steffen, Paul J. Crutzen and John R. McNeill

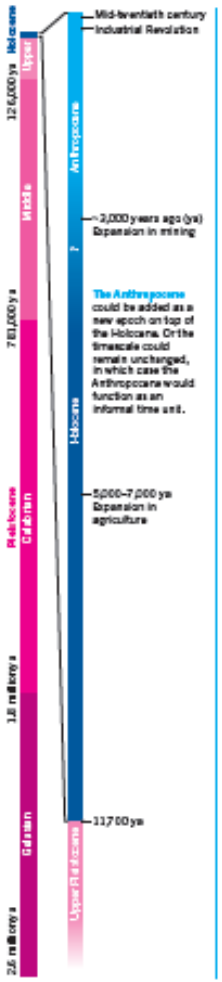
The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?

Photos: Mattias Klum

The human age

Momentum is building to establish a new geological epoch that recognizes humanity's impact on the planet. But there is fierce debate behind the scenes.

BY RICHARD MONASTERSKY

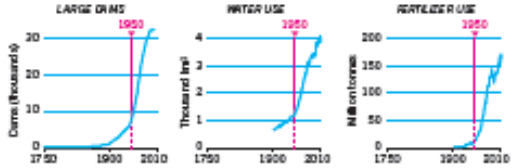


Humans at the helm

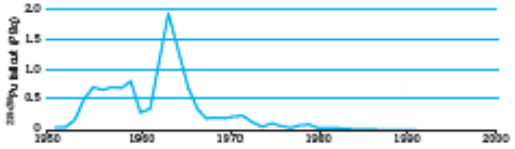
Researchers are studying whether the geological timescale should be modified to include the Anthropocene, a unit of time during which humans became a major force on the planet. Some support starting the Anthropocene in the mid-twentieth century, whereas others propose much earlier dates.

LATE-ANTHROPOCENE PROPOSAL

Human impacts on the environment surged in the mid-twentieth century, a trend visible in many records. That time has been called the Great Acceleration.

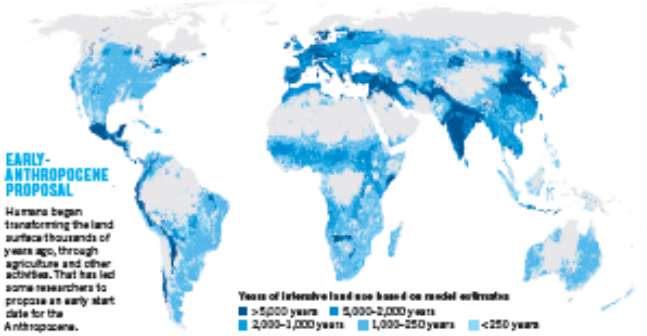


Radioactive fallout from nuclear blasts peaked in the mid-twentieth century, leaving a signal visible in sediments that has been proposed as a marker for the start of the Anthropocene.

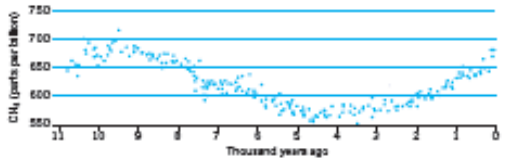


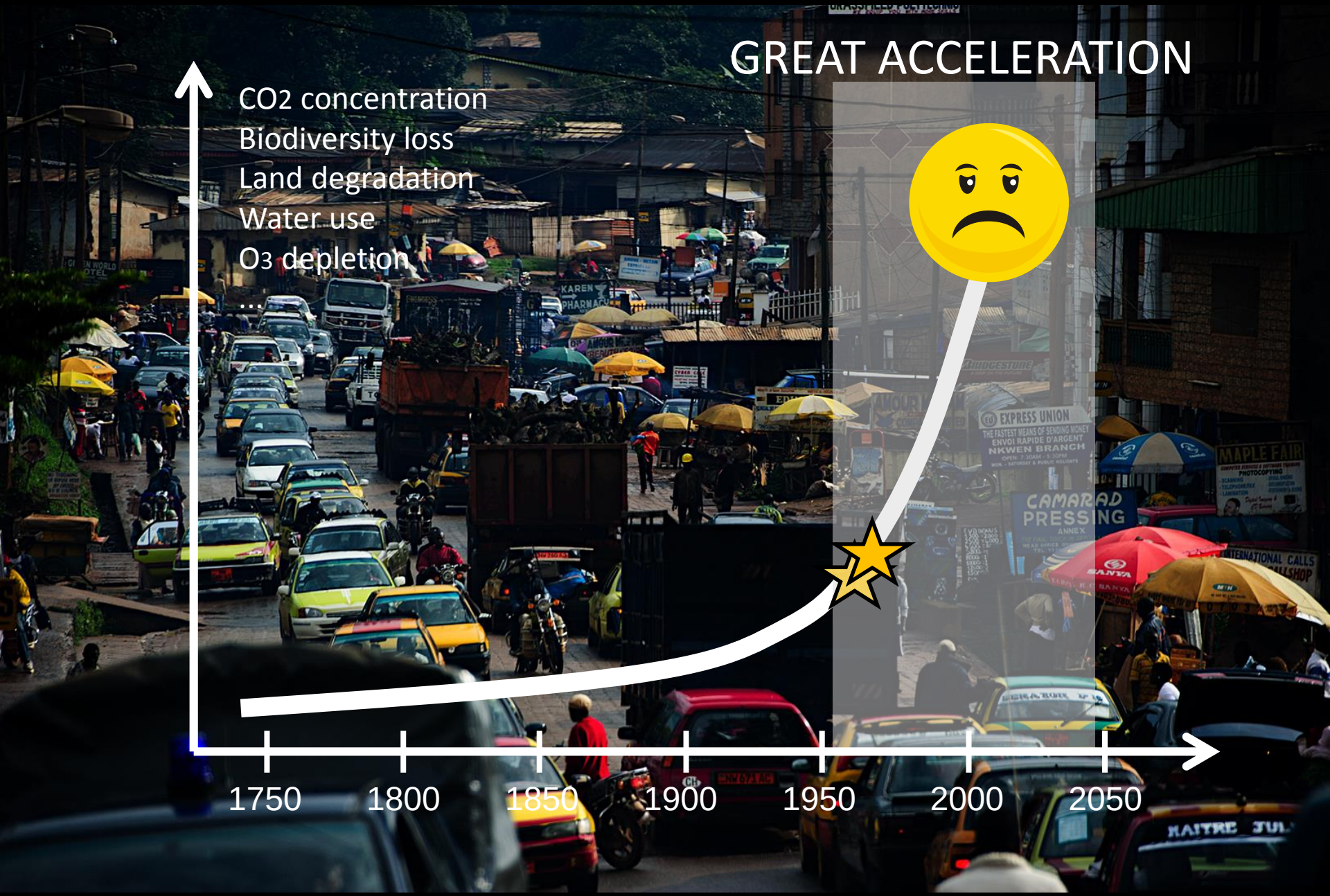
EARLY-ANTHROPOCENE PROPOSAL

Humans began transforming the land surface thousands of years ago, through agriculture and other activities. That has led some researchers to propose an early start date for the Anthropocene.



One potential stratigraphic marker is a rise in the atmospheric concentration of methane millennia ago, which is recorded in glacial ice. This could reflect increases in farming and animal herding.




GREAT ACCELERATION
CO2 concentration
Biodiversity loss
Land degradation
Water use
O3 depletion
...
1750
1800
1850
1900
1950
2000
2050

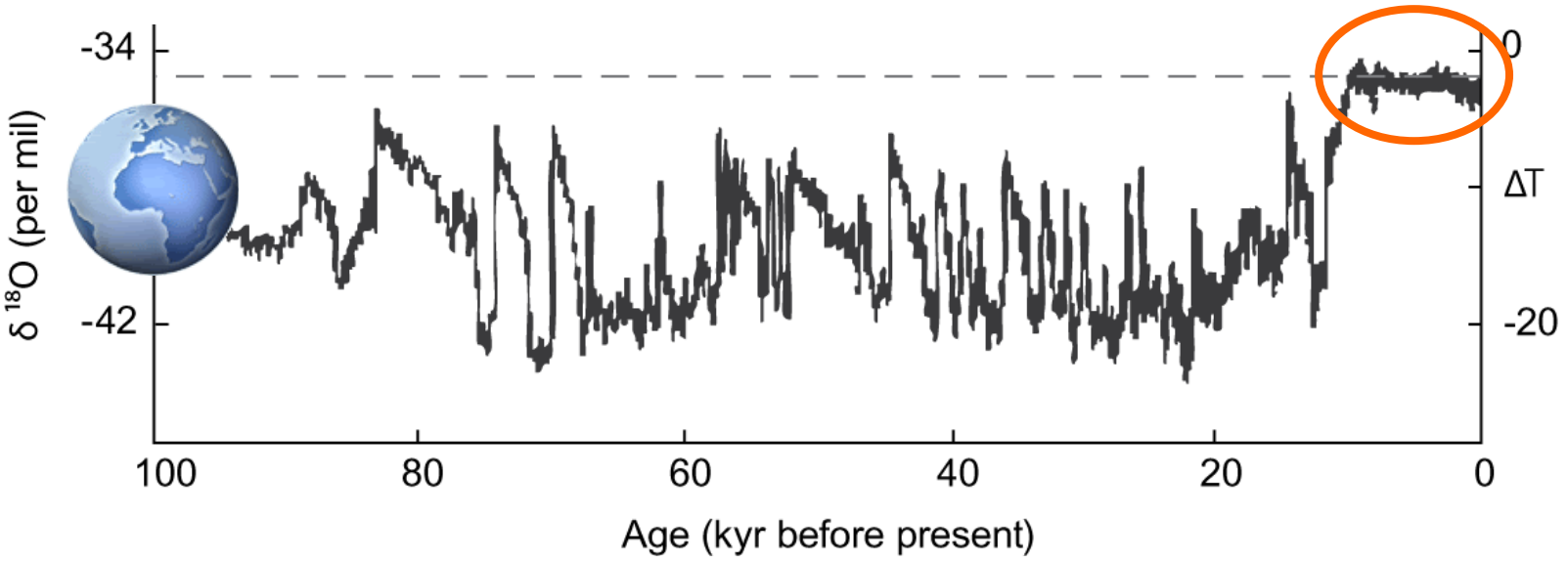
From a small world on a large planet …

To a large world on a small planet …

The Holocene

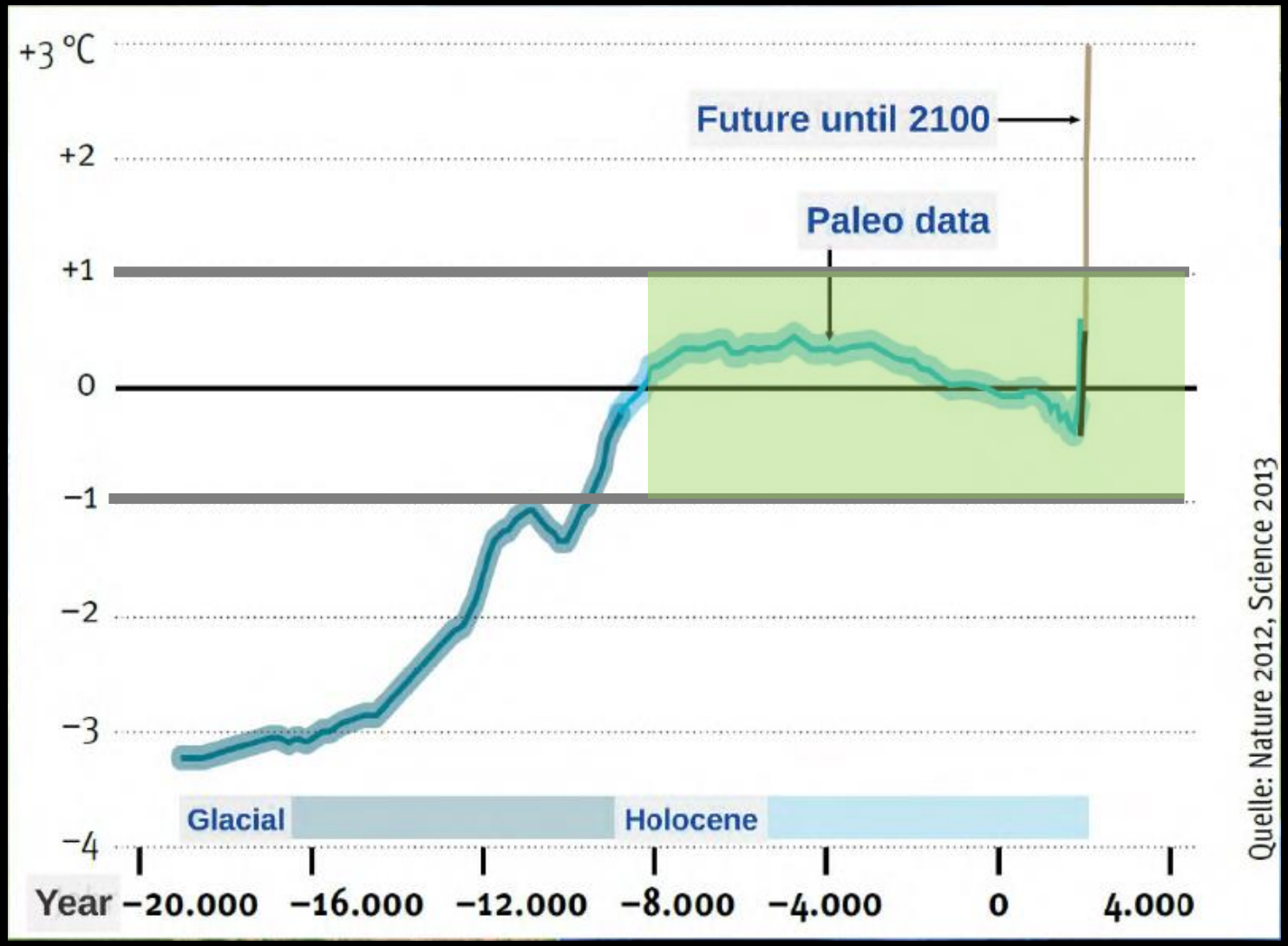
Our Eden

Humanity's 10,000 years of grace



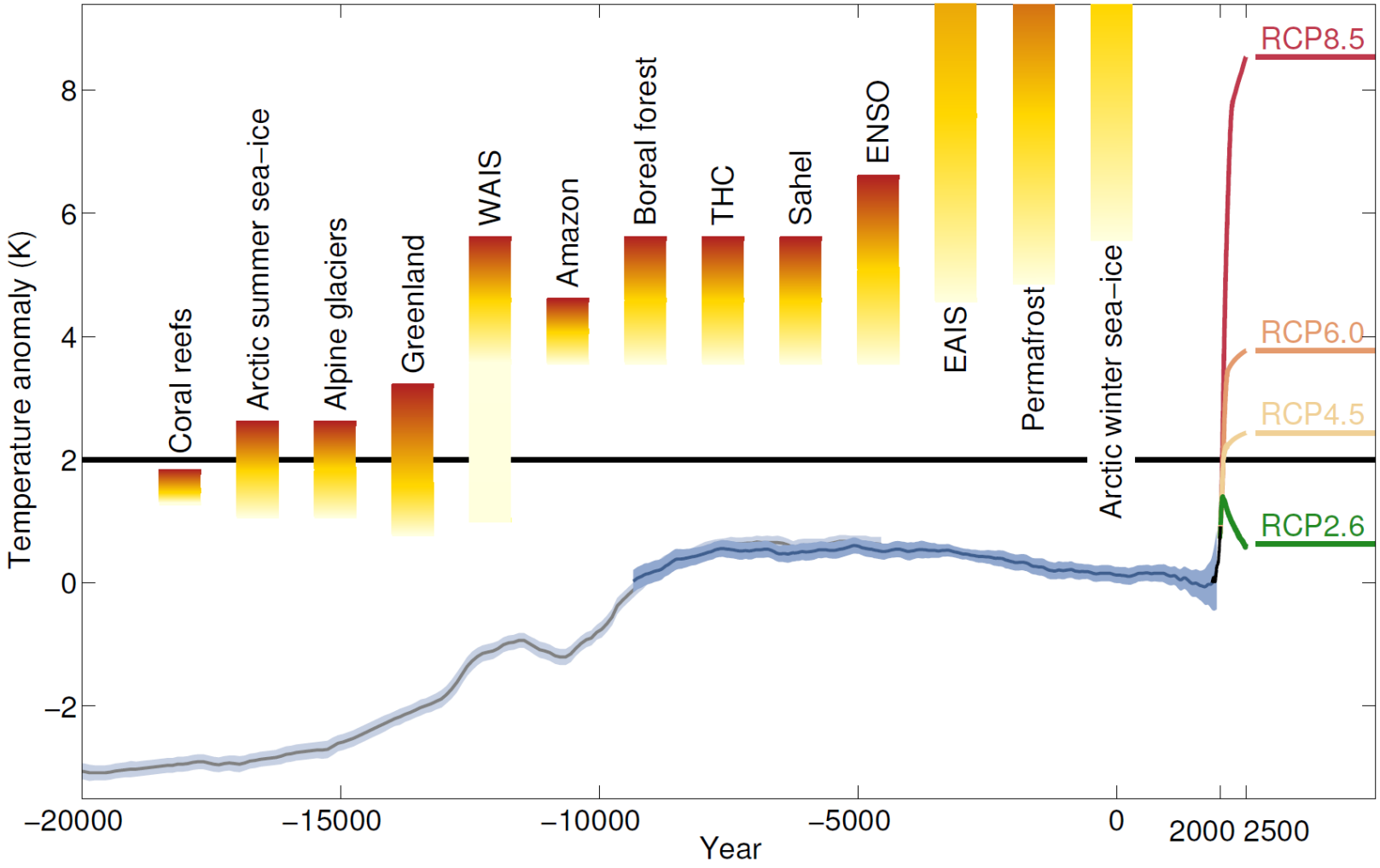
Earth Tipping Points

Global Temperature Since last Ice Age



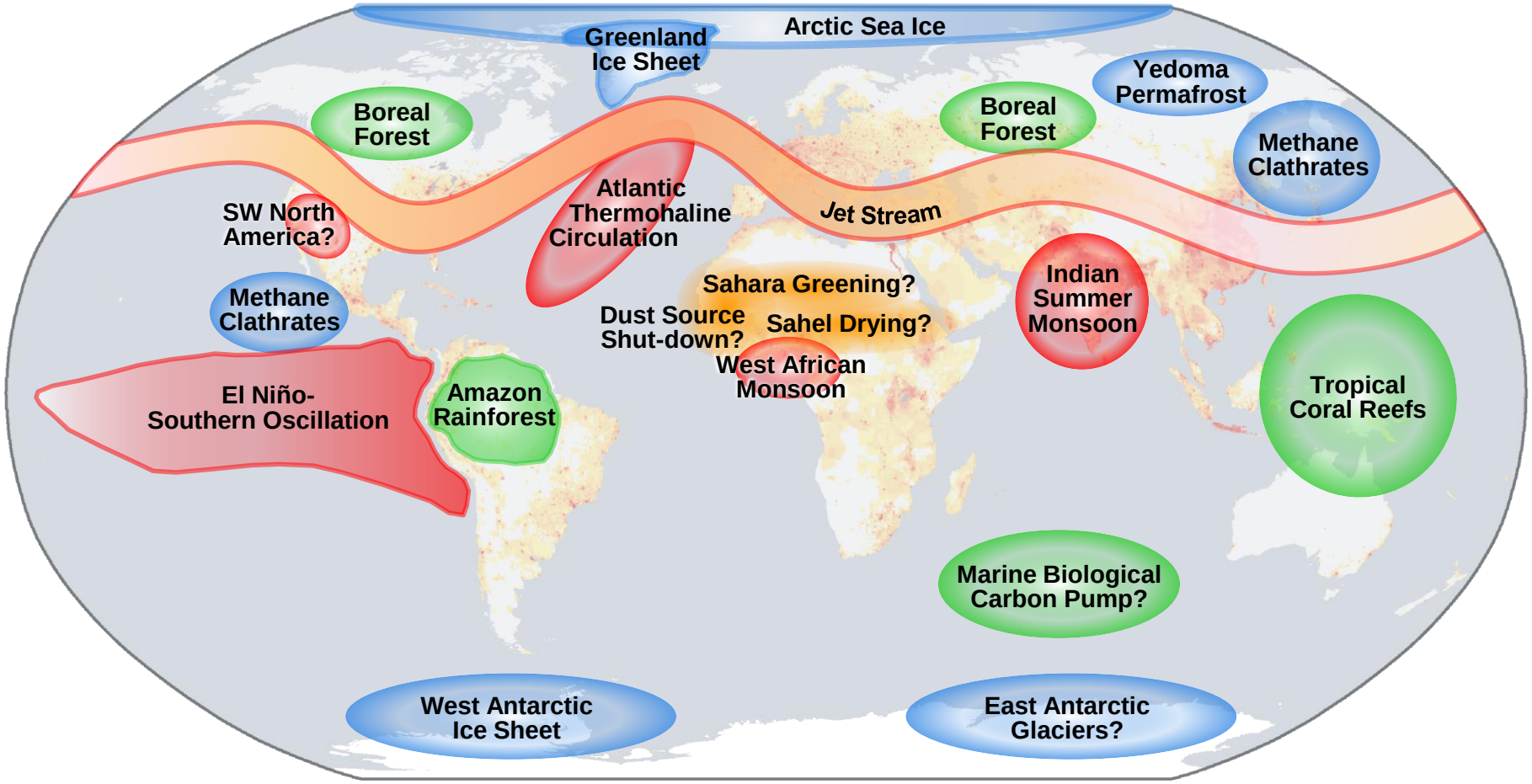
Adapted by Stefan Rahmstorf

Tipping Points Related to 2°C-Guardrail



Schellnhuber et al., under review.

Looming Risks: Tipping Elements in the Earth System



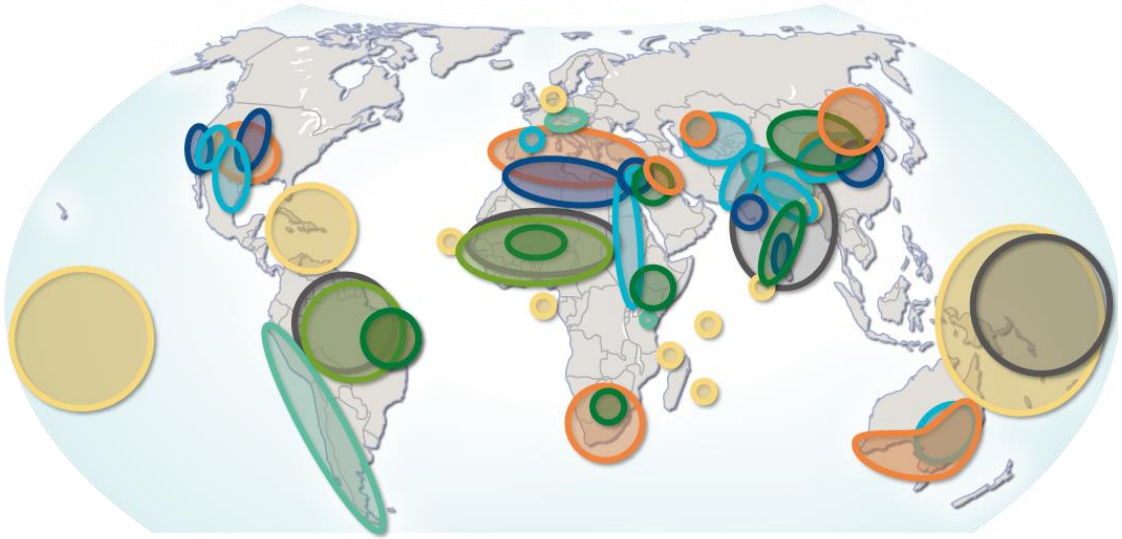
- Cryosphere Entities
- Circulation Patterns
- Biosphere Components

Population Density [persons per km²]

no data | 0 | 5 | 10 | 20 | 100 | 200 | 300 | 400 | 1000

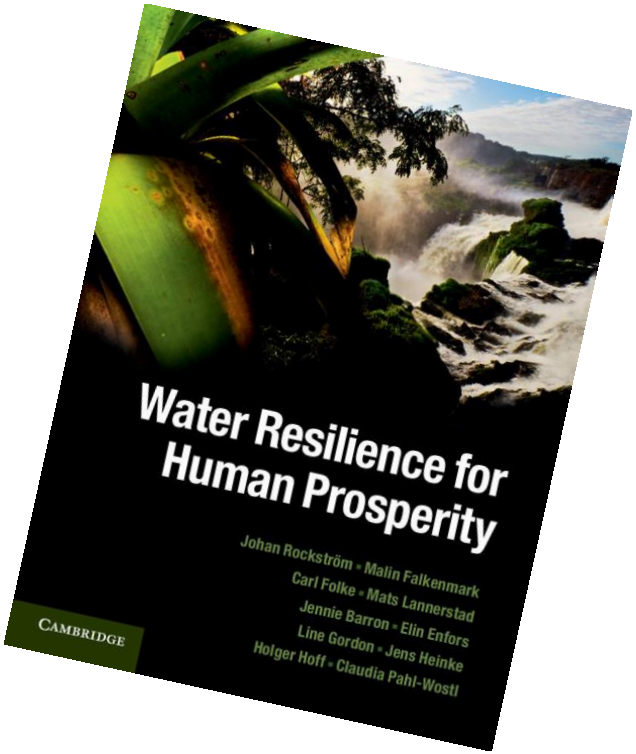
PIK, after Lenton et al. 2008

Water related Tipping Elements in the Earth system



Water related possible tipping points

- Deforestation moisture feedback
- Land mismanagement (e.g. soil loss, land degradation)
- Salinisation
- Glacier melt
- Groundwater collapse
- River basin closure/river depletion
- Regional processes
- Sea level rise and salt water intrusion
- Drastic rainfall regime change



Anthropocene

+

Tipping Points

+

Holocene

=

Planetary Boundaries

Planetary Boundaries

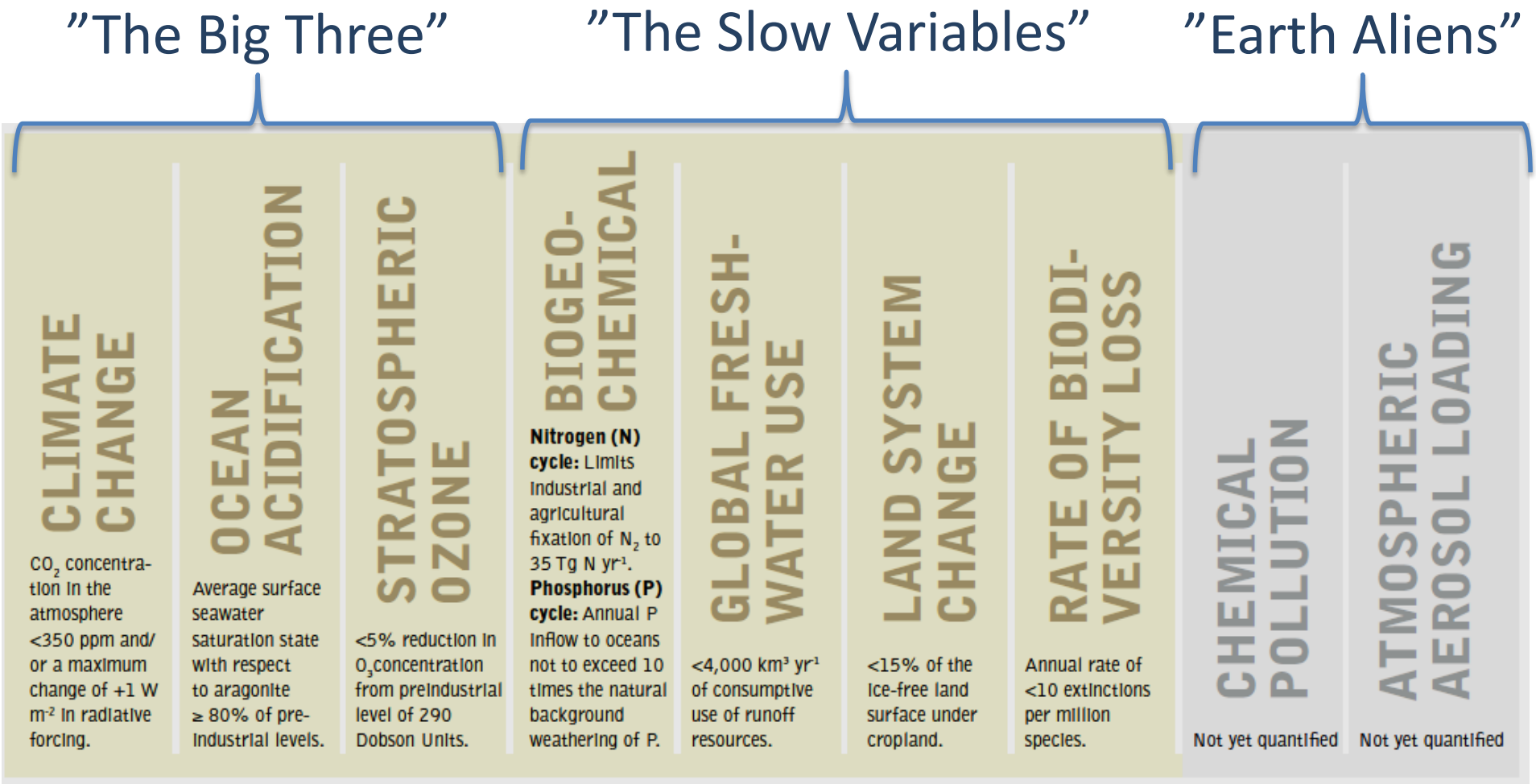
RESEARCH ARTICLE

SUSTAINABILITY

Planetary boundaries: Guiding human development on a changing planet

Will Steffen,[1,2]* Katherine Richardson,[3] Johan Rockström,[1] Sarah E. Cornell,[1] Ingo Fetzer,[1] Elena M. Bennett,[4] Reinette Biggs,[1,5] Stephen R. Carpenter,[6] Wim de Vries,[7,8] Cynthia A. de Wit,[9] Carl Folke,[1,10] Dieter Gerten,[11] Jens Heinke,[11,12,13] Georgina M. Mace,[14] Linn M. Persson,[15] Veerabhadran Ramanathan,[16,17] Belinda Reyers,[1,18] Sverker Sörlin[19]

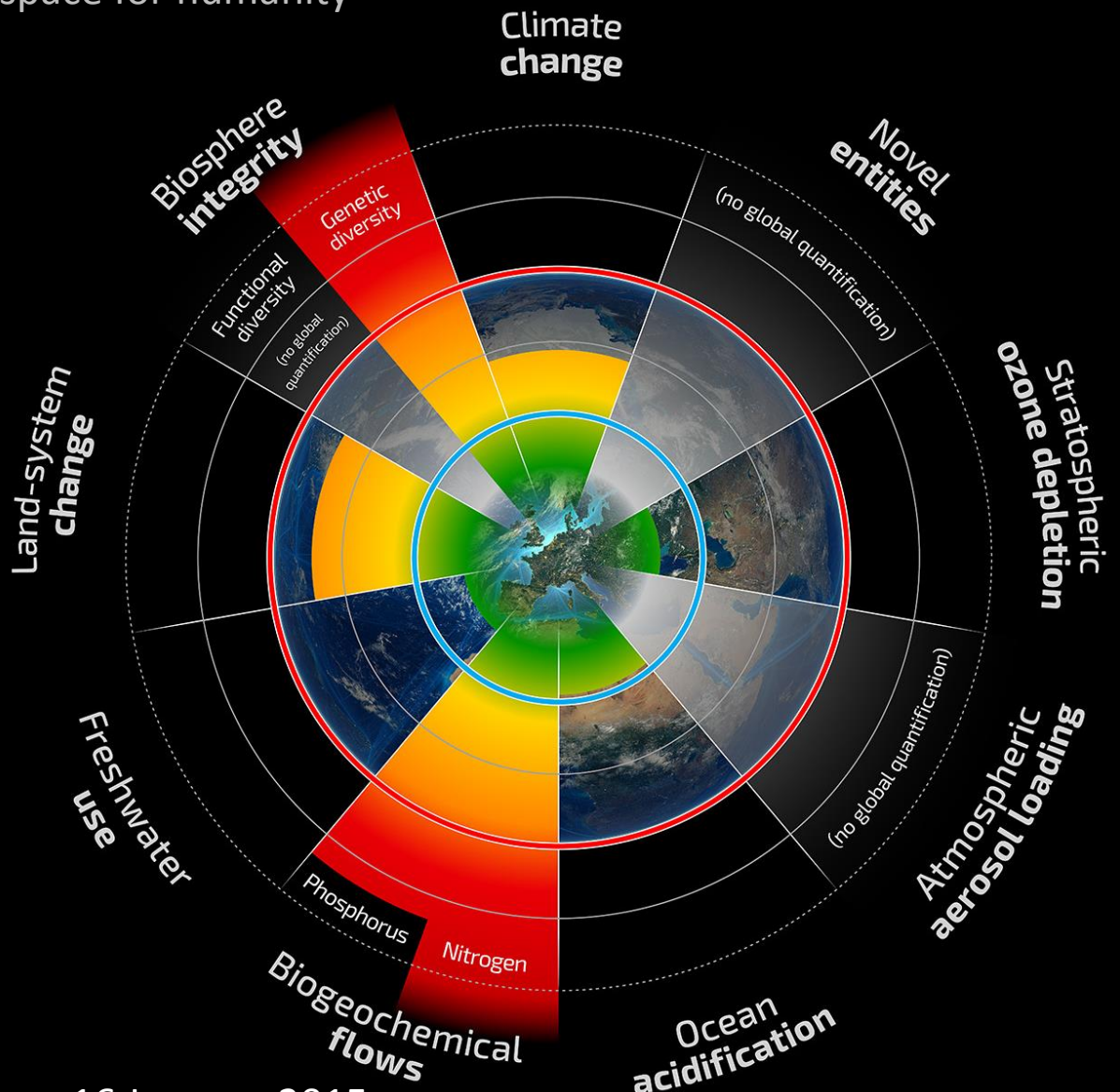
Defining Planetary Boundaries 1.0



Climate change
Ocean acidification
Stratospheric ozone depletion
Nitrogen cycle (biogeochemical flow boundary)
Phosphorus cycle
Global freshwater use
Change in land use
Biodiversity loss
Atmospheric aerosol loading (not yet quantified)
Chemical pollution (not yet quantified)

Planetary Boundaries

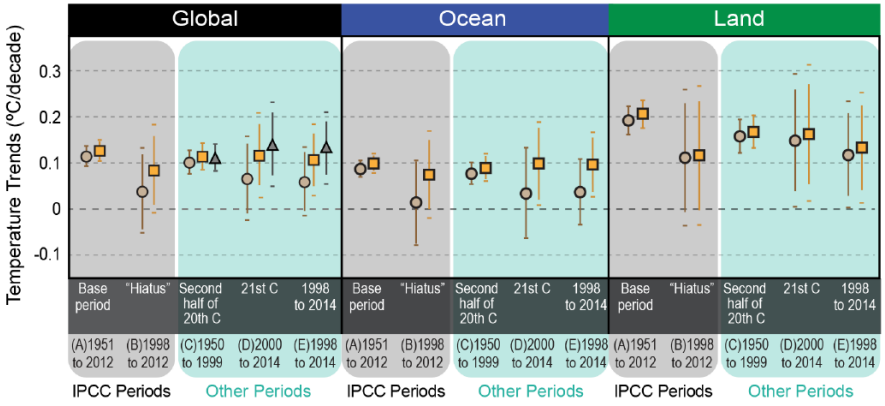
A safe operating space for humanity

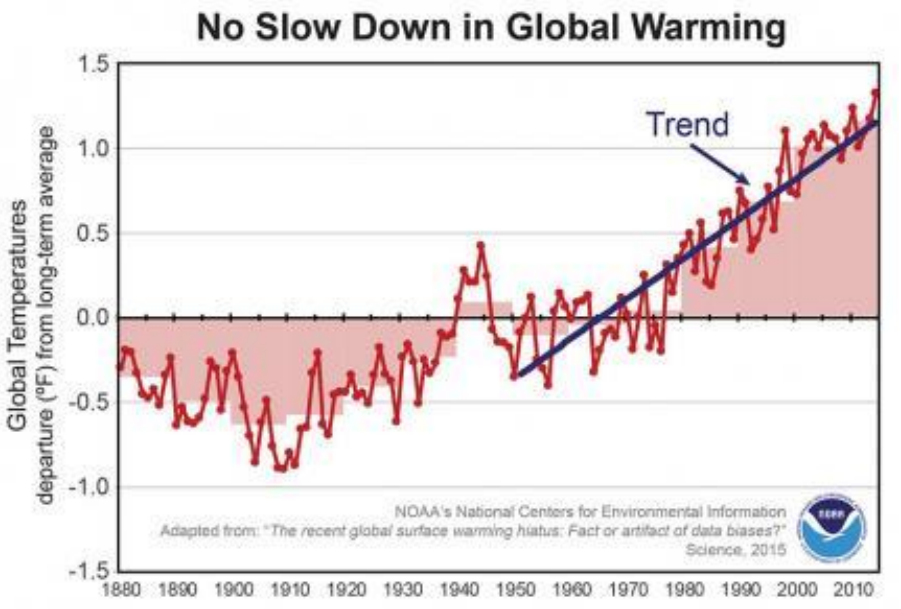


Steffen *et al* Science 16 January 2015

Transgressing the Climate Boundary

No slow-down in global warming, rather speed-up

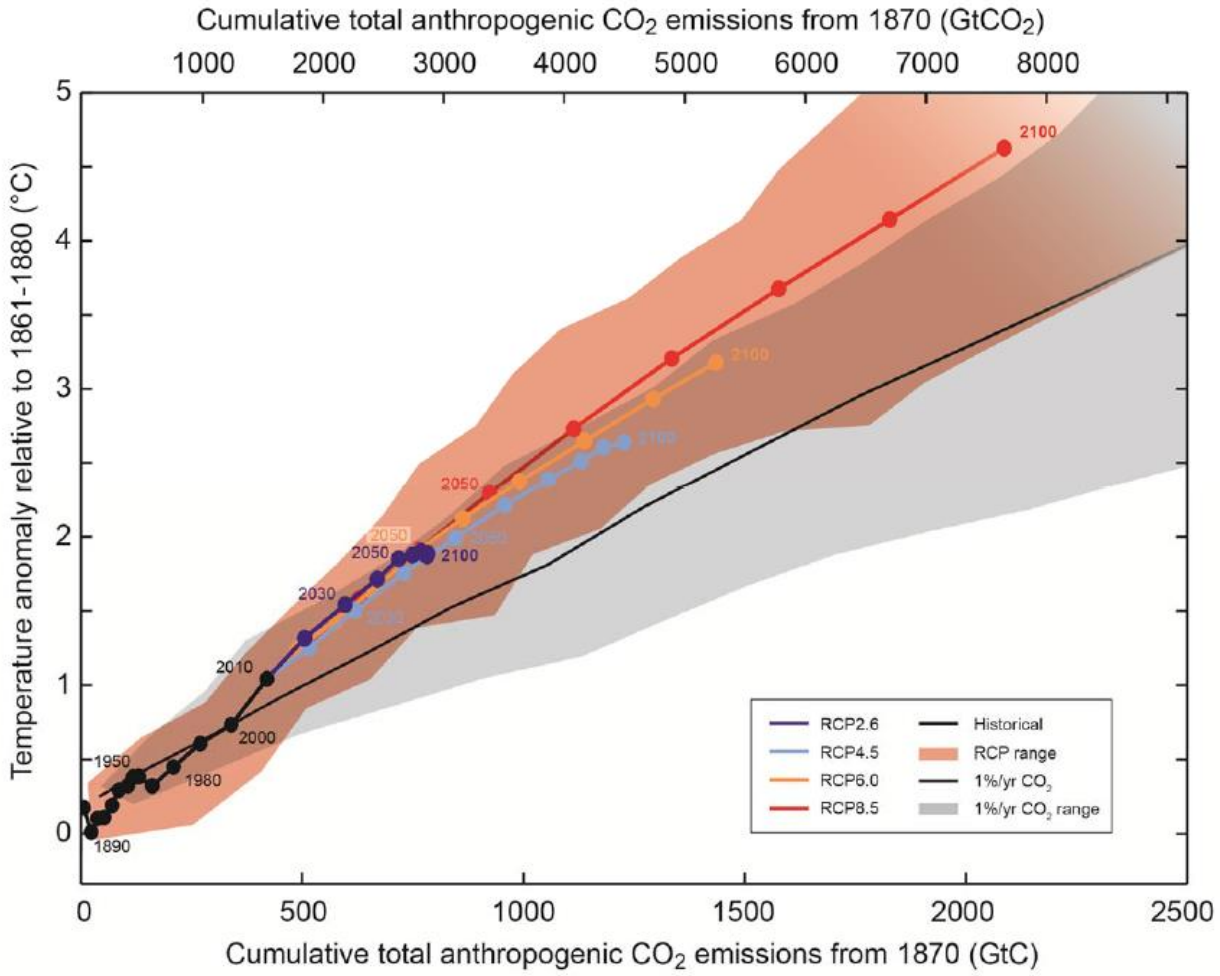




Possible artifacts of data biases in the recent global surface warming hiatus

Thomas R. Karl,[1]* Anthony Arguez,[1] Boyin Huang,[1] Jay H. Lawrimore,[1] James R. McMahon,[2] Matthew J. Menne,[1] Thomas C. Peterson,[1] Russell S. Vose,[1] Huai-Min Zhang[1]

Figure SPM.10 [FIGURE SUBJECT TO FINAL COPYEDIT]



2 ºC > 66% → 1000 GtC

Non-CO2 forcing (RCP2.6) → 800 GtC

Used ~560 GtC 2014

Gives ~240 GtC left

→ 890 Gt CO_2

35 Gt CO_2 /yr…

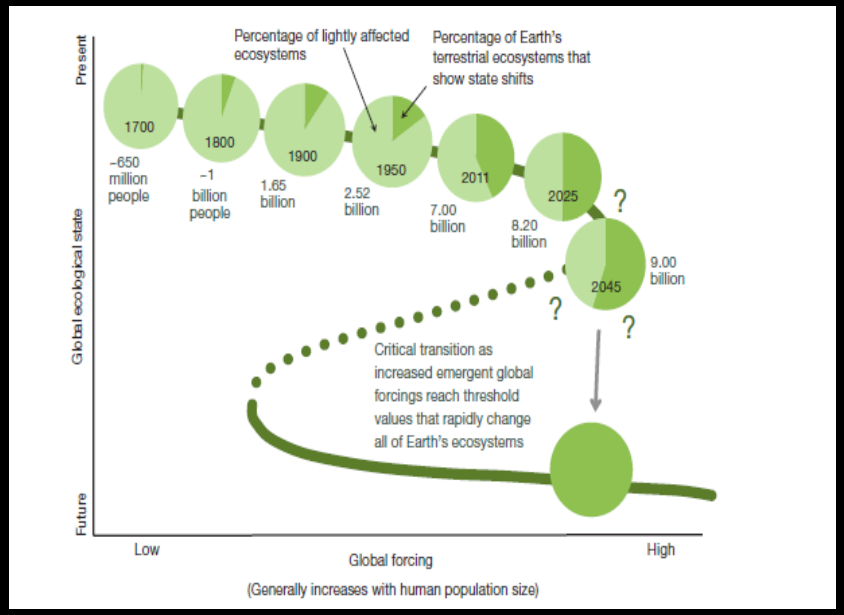
27 years remaining…

IPCC AR5 WGI 2013

Transgressing the Biosphere Integrity Boundary

A living biospere on a Sustainable Planet

Basis for human wellbeing

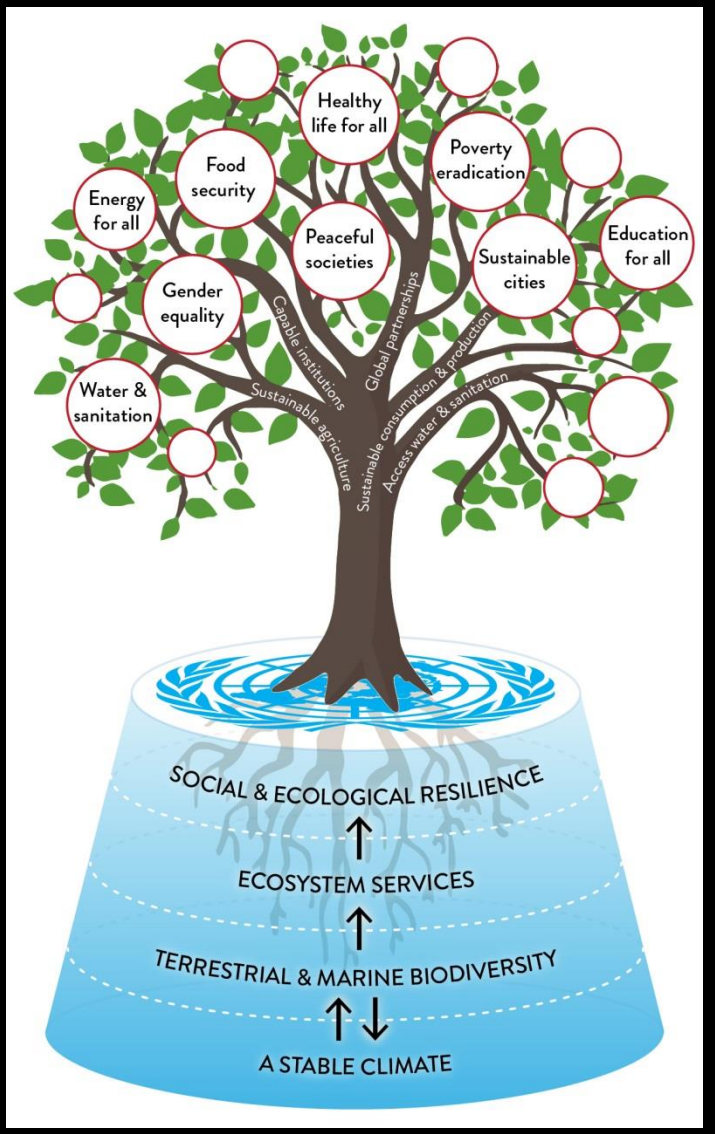


REVIEW

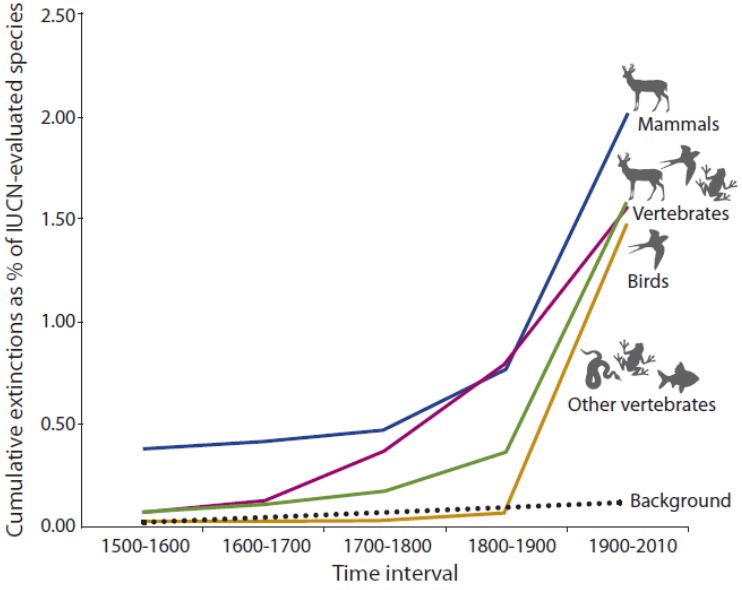
doi:10.1038/nature11018

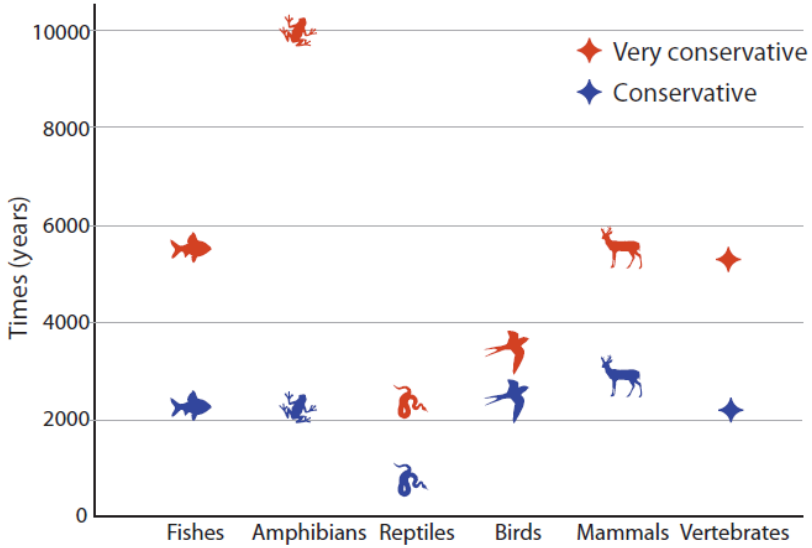
Approaching a state shift in Earth's biosphere

Anthony D. Barnosky[1,2,3], Elizabeth A. Hadly[4], Jordi Bascompte[5], Eric L. Berlow[6], James H. Brown[7], Mikael Fortelius[8], Wayne M. Getz[9], John Harte[9,10], Alan Hastings[11], Pablo A. Marquet[12,13,14,15], Neo D. Martinez[16], Arne Mooers[17], Peter Roopnarine[18], Geerat Vermeij[19], John W. Williams[20], Rosemary Gillespie[9], Justin Kitzes[9], Charles Marshall[1,2], Nicholas Matzke[1], David P. Mindell[21], Eloy Revilla[22] & Adam B. Smith[23]



”Arguably the most serious aspect of the environmental crisis is the loss of biodiversity – the other living things with which we share Earth





RESEARCH ARTICLE

ENVIRONMENTAL SCIENCES

Accelerated modern human–induced species losses: Entering the sixth mass extinction

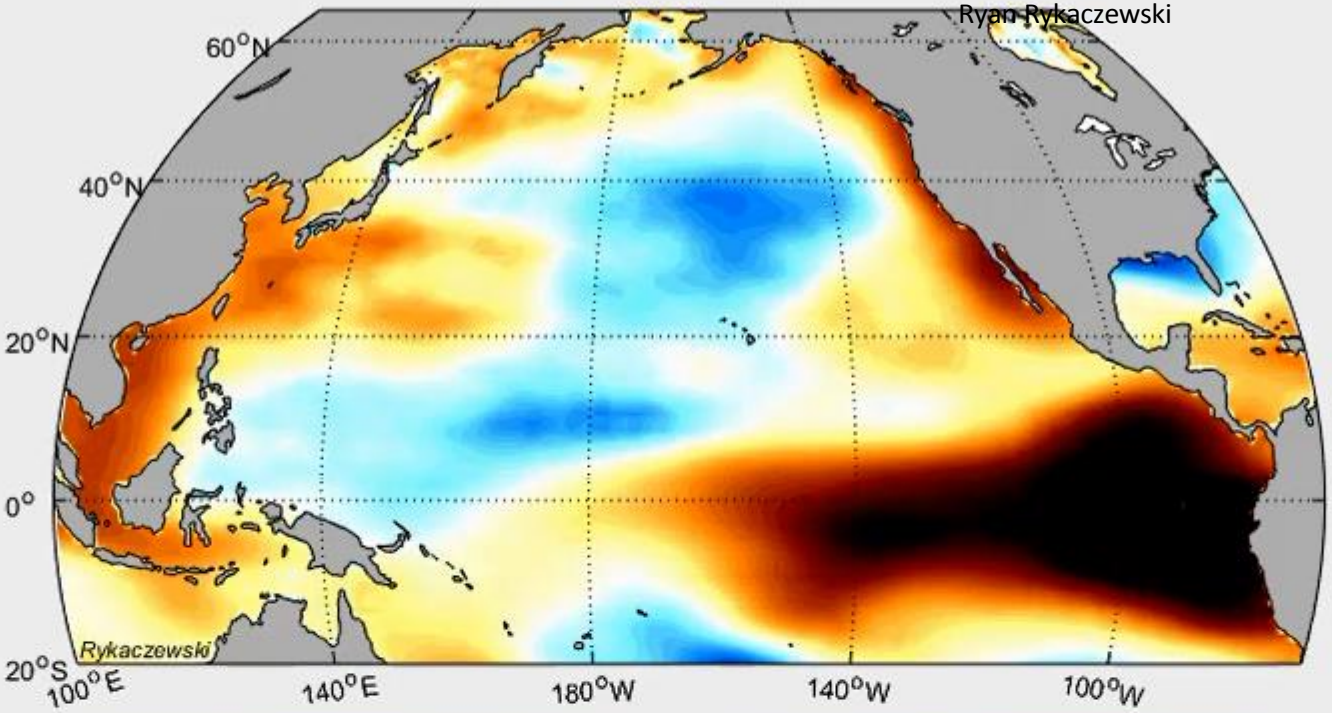
Gerardo Ceballos,[1]* Paul R. Ehrlich,[2] Anthony D. Barnosky,[3] Andrés García,[4] Robert M. Pringle,[5] Todd M. Palmer[6]

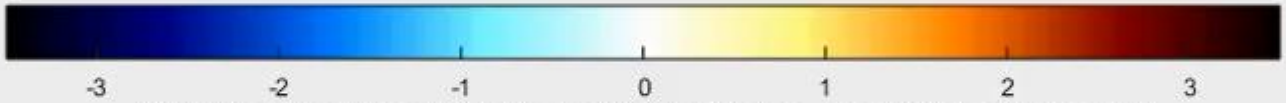
Photo: Mattias Klum

SST from the COBE-SST Dataset
Japan Meteorological Agency

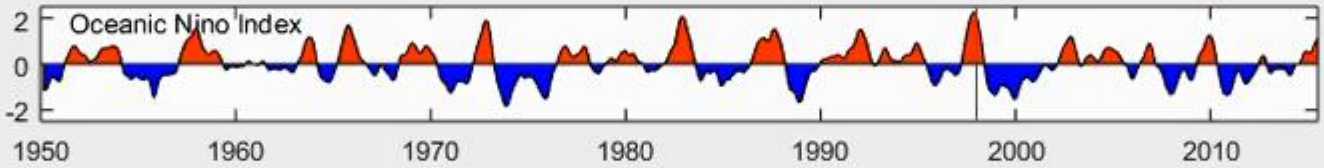
Jan 1998

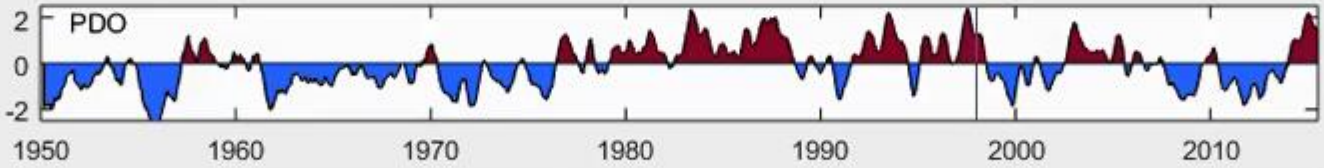
Ecosystem Oceangraphy Lab
University of South Carolina
Ryan Rykaczewski





3-mo running mean SST Anomaly (in std. dev. from 1891-2014 mean)

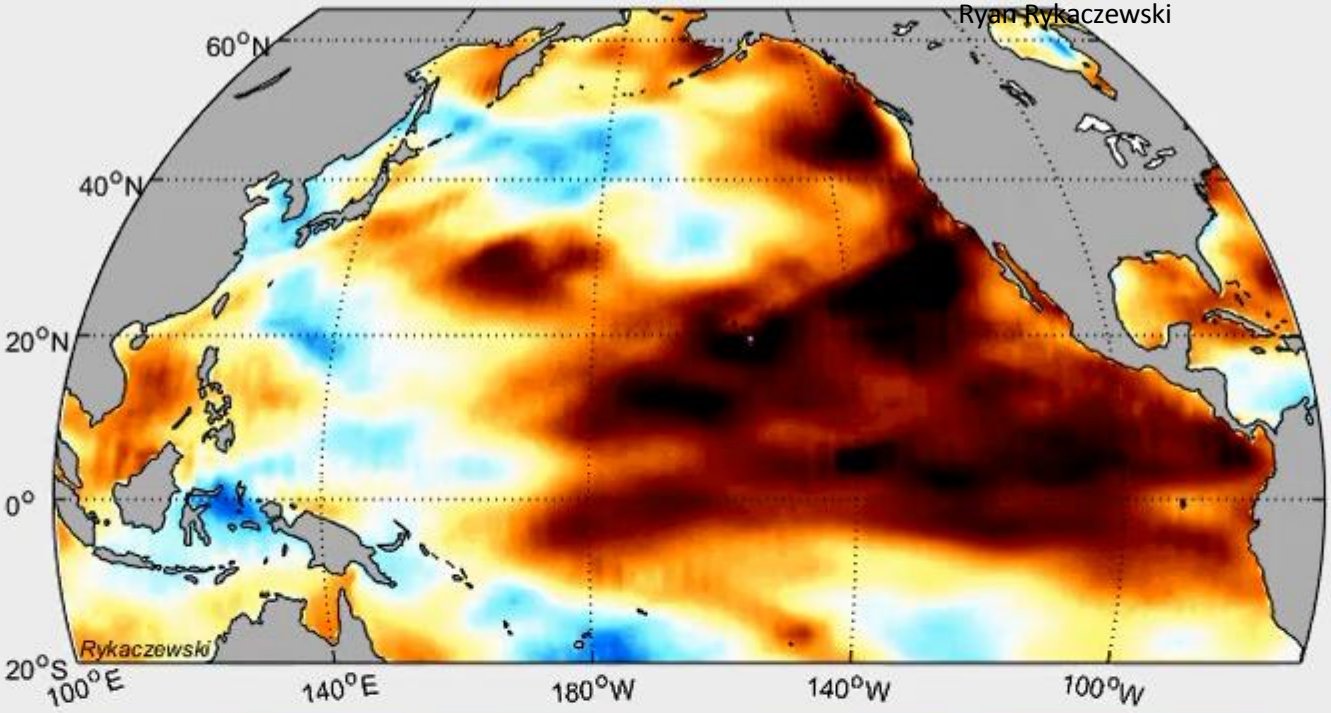


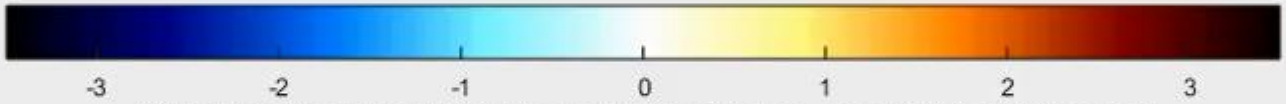


SST from the COBE-SST Dataset
Japan Meteorological Agency

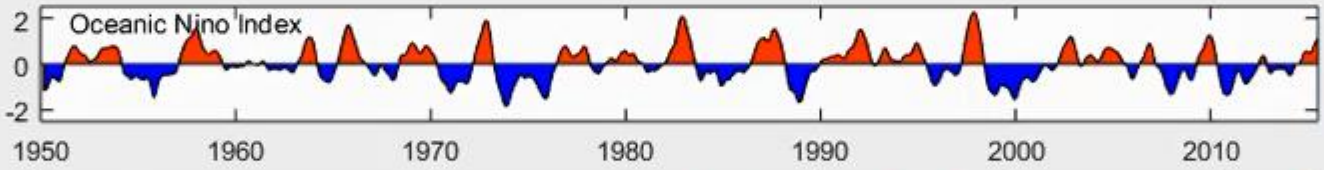
Aug 2015

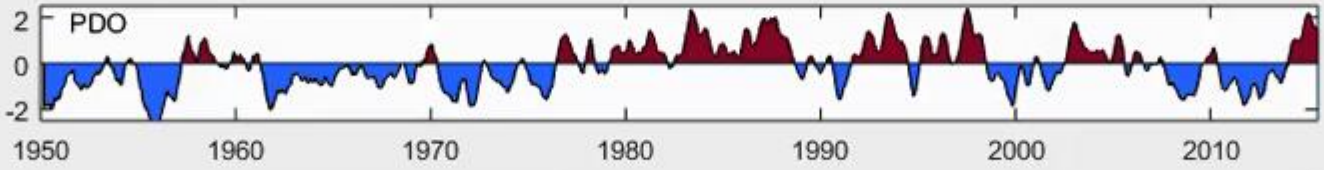
Ecosystem Oceangraphy Lab
University of South Carolina
Ryan Rykaczewski





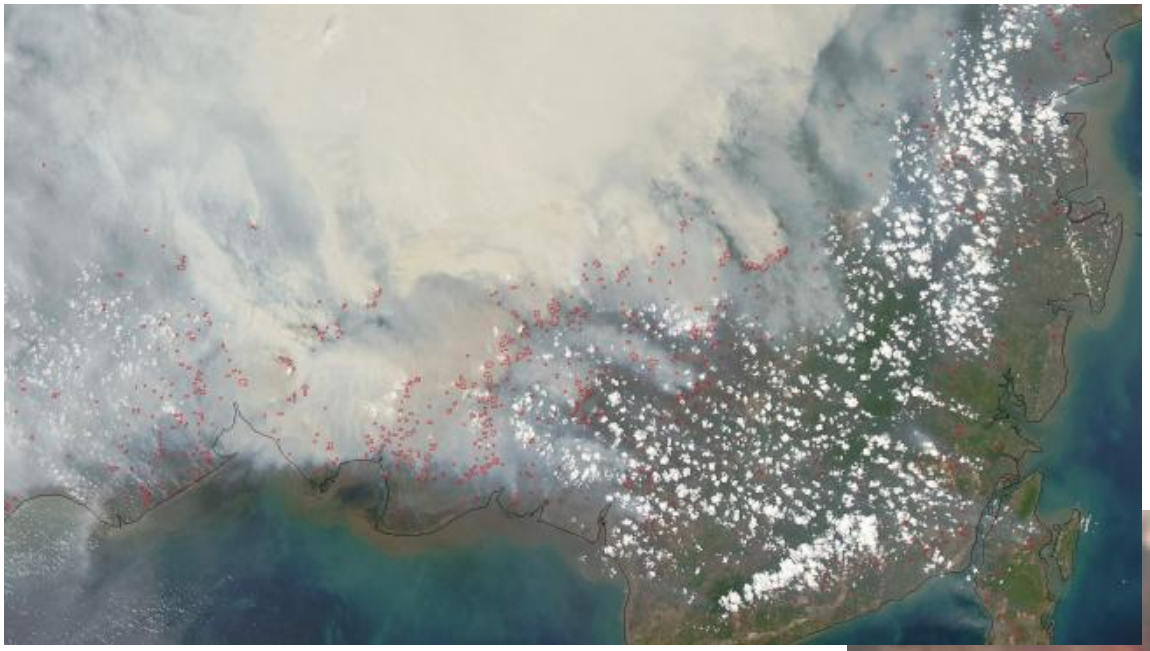
3-mo running mean SST Anomaly (in std. dev. from 1891-2014 mean)





El Nino hitting S-E Asia, causing worst ever Forest Fires, according to NASA.

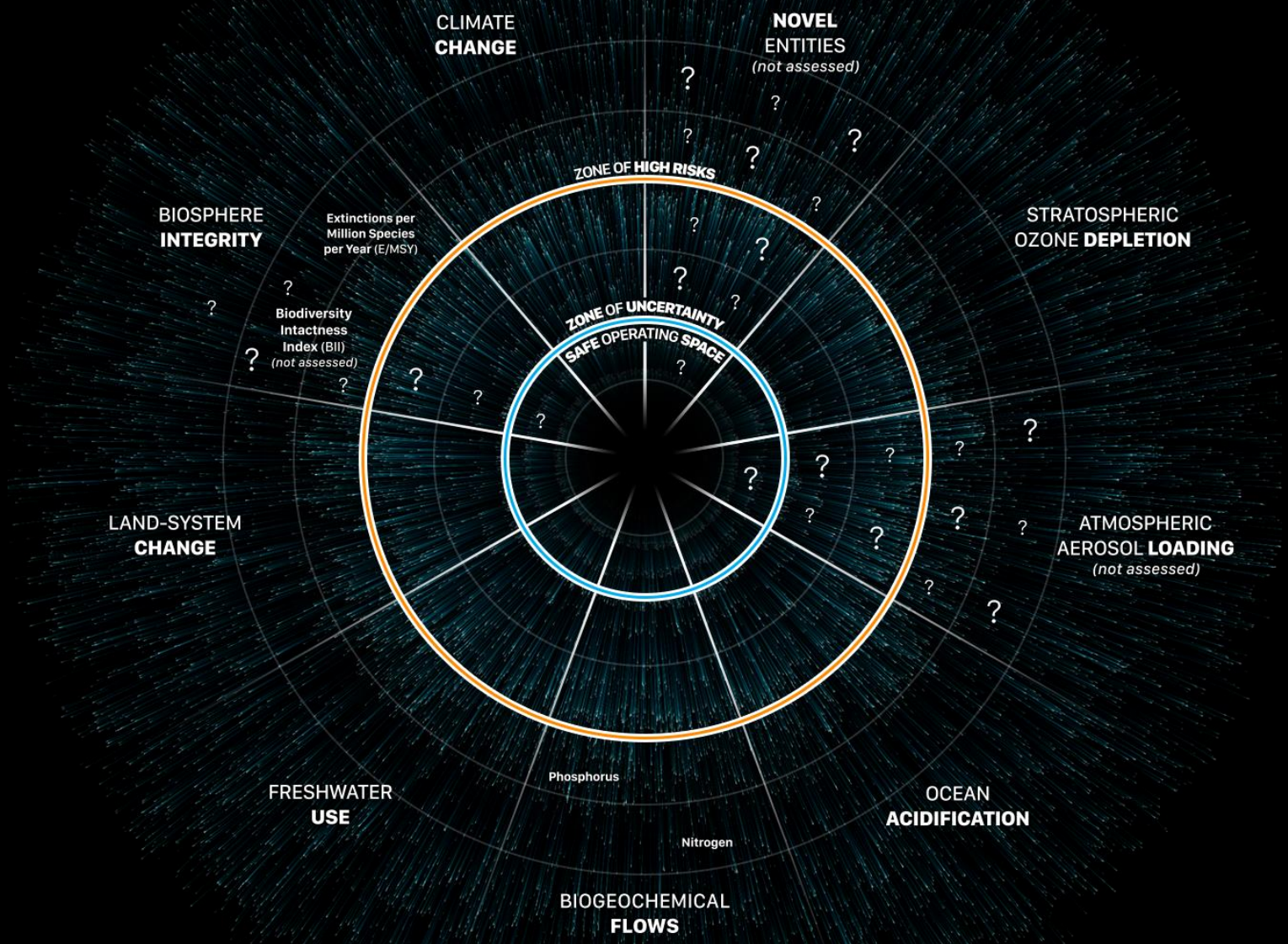
Environmental Disaster as smoke blankets six countries



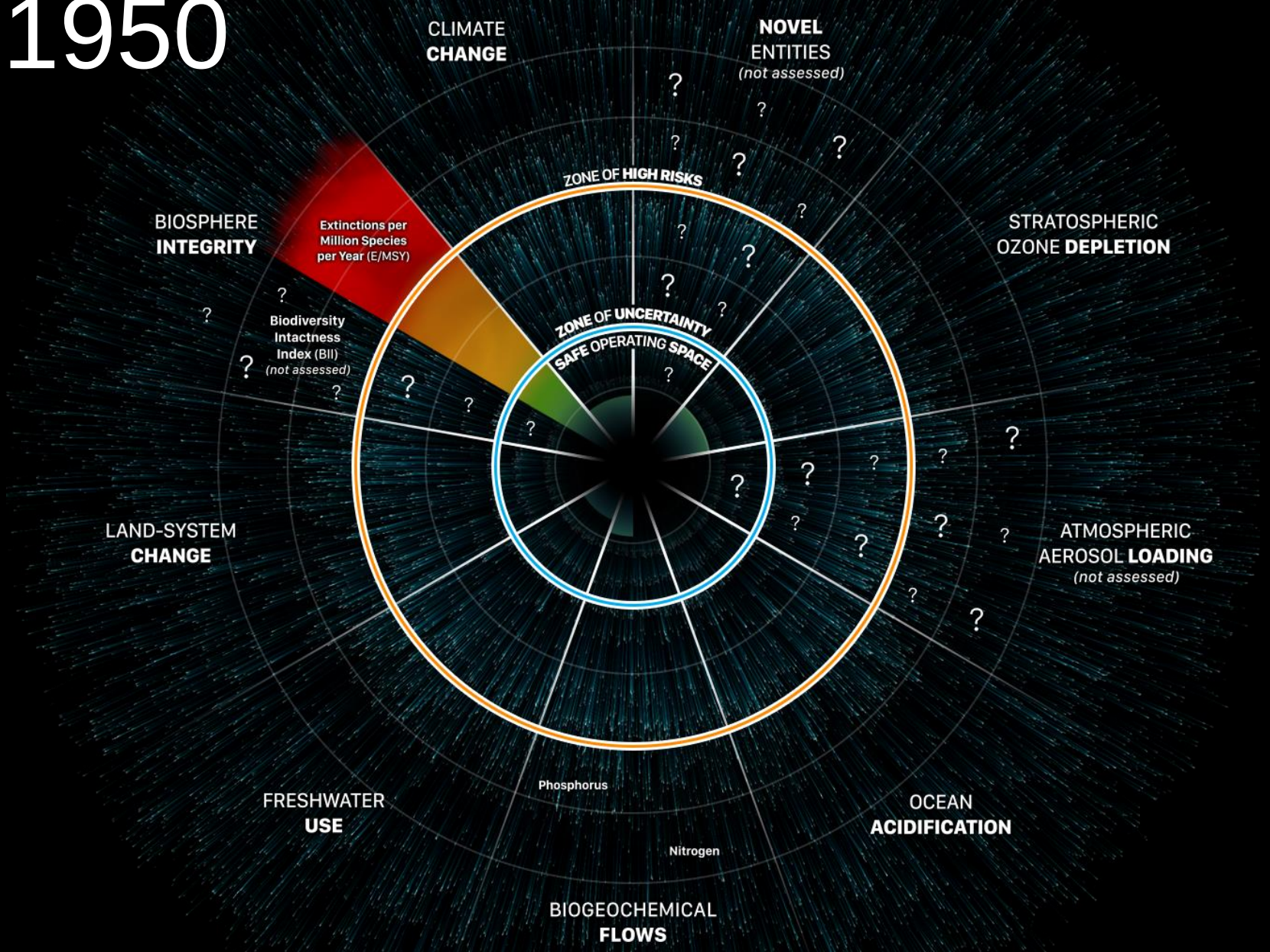
Equivalent to > 600
Million tons
CO2eq
Or > Germany
Annual Emissions

Becoming Planetary Stewards

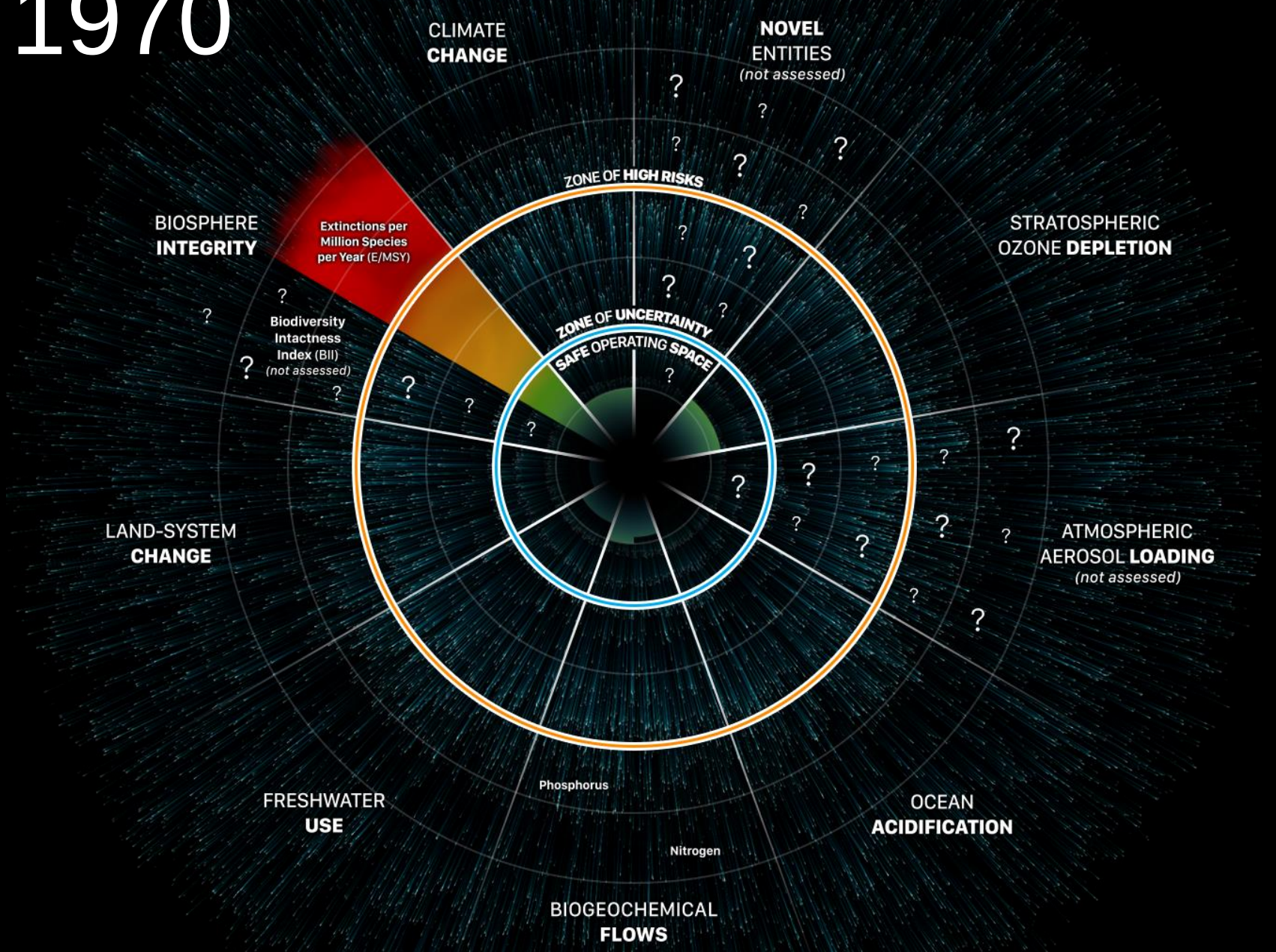
Pre-industrial



1950


CLIMATE CHANGE
NOVEL ENTITIES (not assessed)
STRATOSPHERIC OZONE DEPLETION
ATMOSPHERIC AEROSOL LOADING (not assessed)
OCEAN ACIDIFICATION
BIOGEOCHEMICAL FLOWS
Phosphorus
Nitrogen
FRESHWATER USE
LAND-SYSTEM CHANGE
BIOSPHERE INTEGRITY
Extinctions per Million Species per Year (E/MSY)
Biodiversity Intactness Index (BII) (not assessed)
ZONE OF HIGH RISKS
ZONE OF UNCERTAINTY
SAFE OPERATING SPACE

1970


CLIMATE CHANGE
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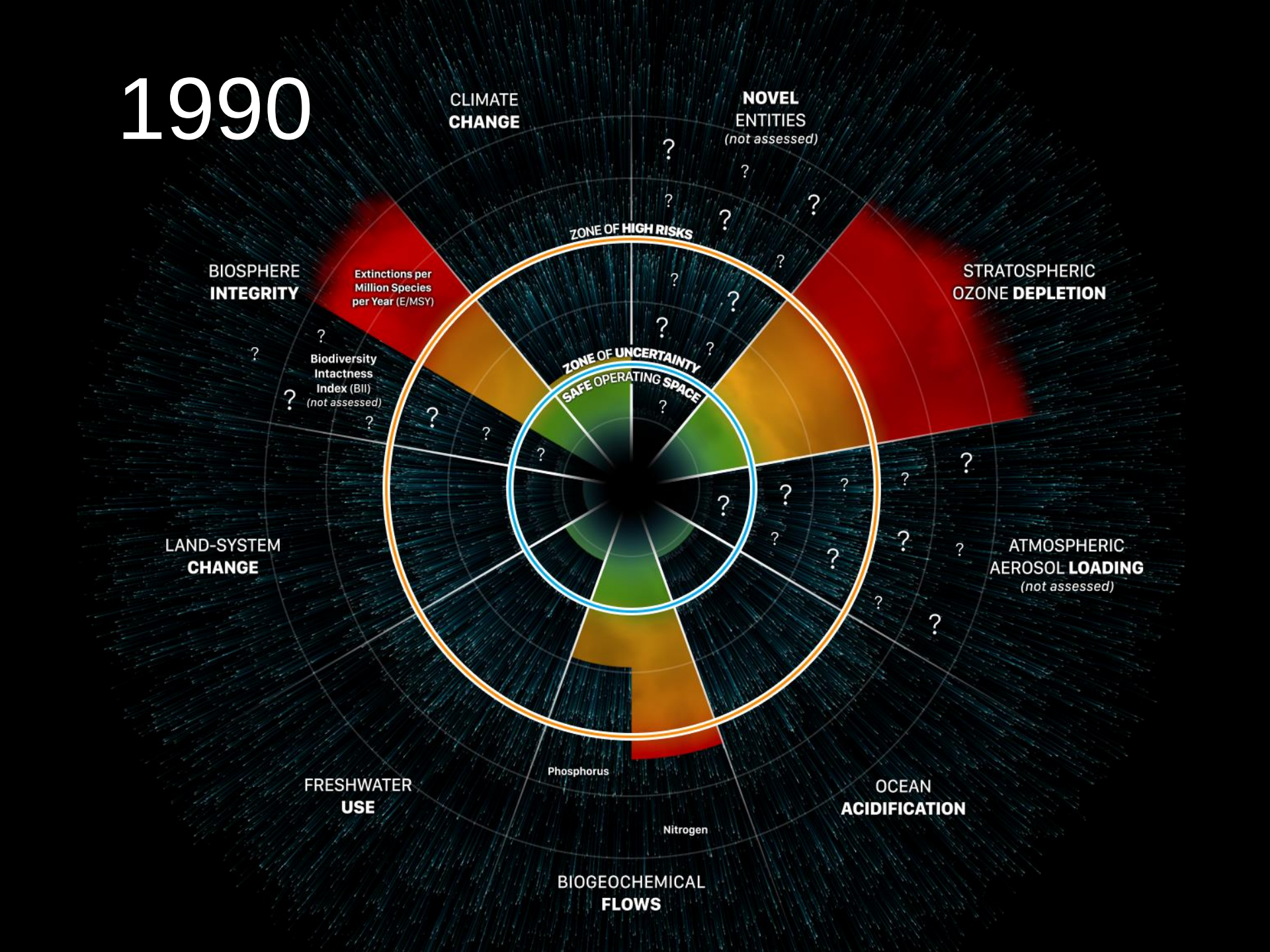
ZONE OF UNCERTAINTY
SAFE OPERATING SPACE


1990
CLIMATE CHANGE
NOVEL ENTITIES (not assessed)
STRATOSPHERIC OZONE DEPLETION
ATMOSPHERIC AEROSOL LOADING (not assessed)
OCEAN ACIDIFICATION
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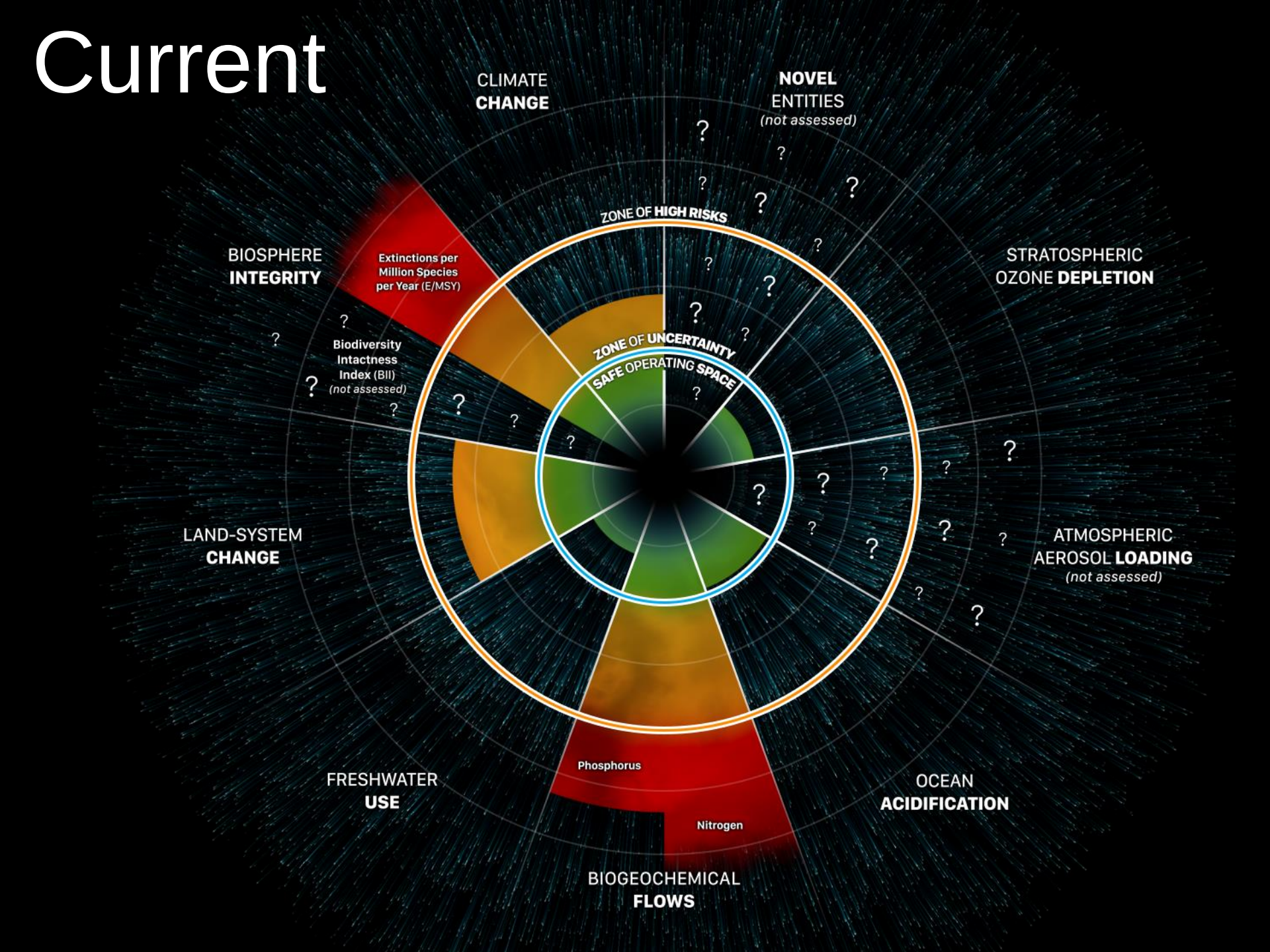
ZONE OF HIGH RISKS
ZONE OF UNCERTAINTY
SAFE OPERATING SPACE

Current


CLIMATE CHANGE
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Phosphorus
Nitrogen
ZONE OF HIGH RISKS
ZONE OF UNCERTAINTY
SAFE OPERATING SPACE

Global CO_2 Emissions & Distribution (GtC)

365 (335-395)

180 (100-260)

545 (230-250)

ATMOSPHERE

240 (230-250)

OCEANS

155 (125-185)

TERRESTRIAL ECOSYSTEMS

150 (60-240)

Functions and status of earth's biomes that regulate planetary resilience

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

The polar regions regulate global temperature, regional climate systems and ocean circulation. Melting faster than anticipated.

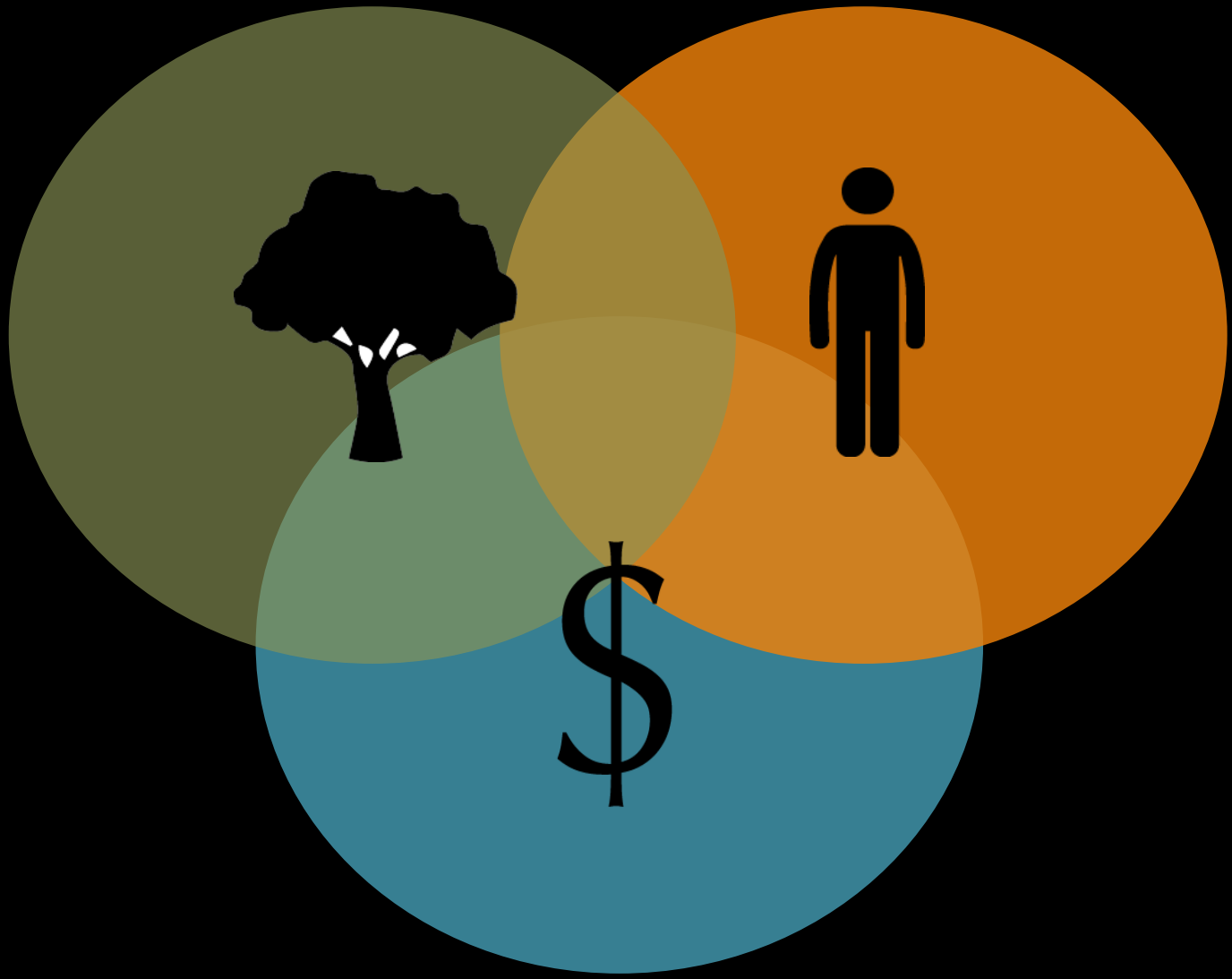
The World's rainforests act as carbon sinks, provide moisture feedback, are banks for genetic diversity and generate oxygen. In rapid decline but the rate has declined somewhat.

The ocean's marine systems act as a heat conveyer, carbon sink, a bank for genetic diversity and generates oxygen. In rapid decline

The world's temperate organic systems (such as permafrost) act as carbon & methane sinks and generate oxygen. Faster than anticipated thawing of permafrost & methane release

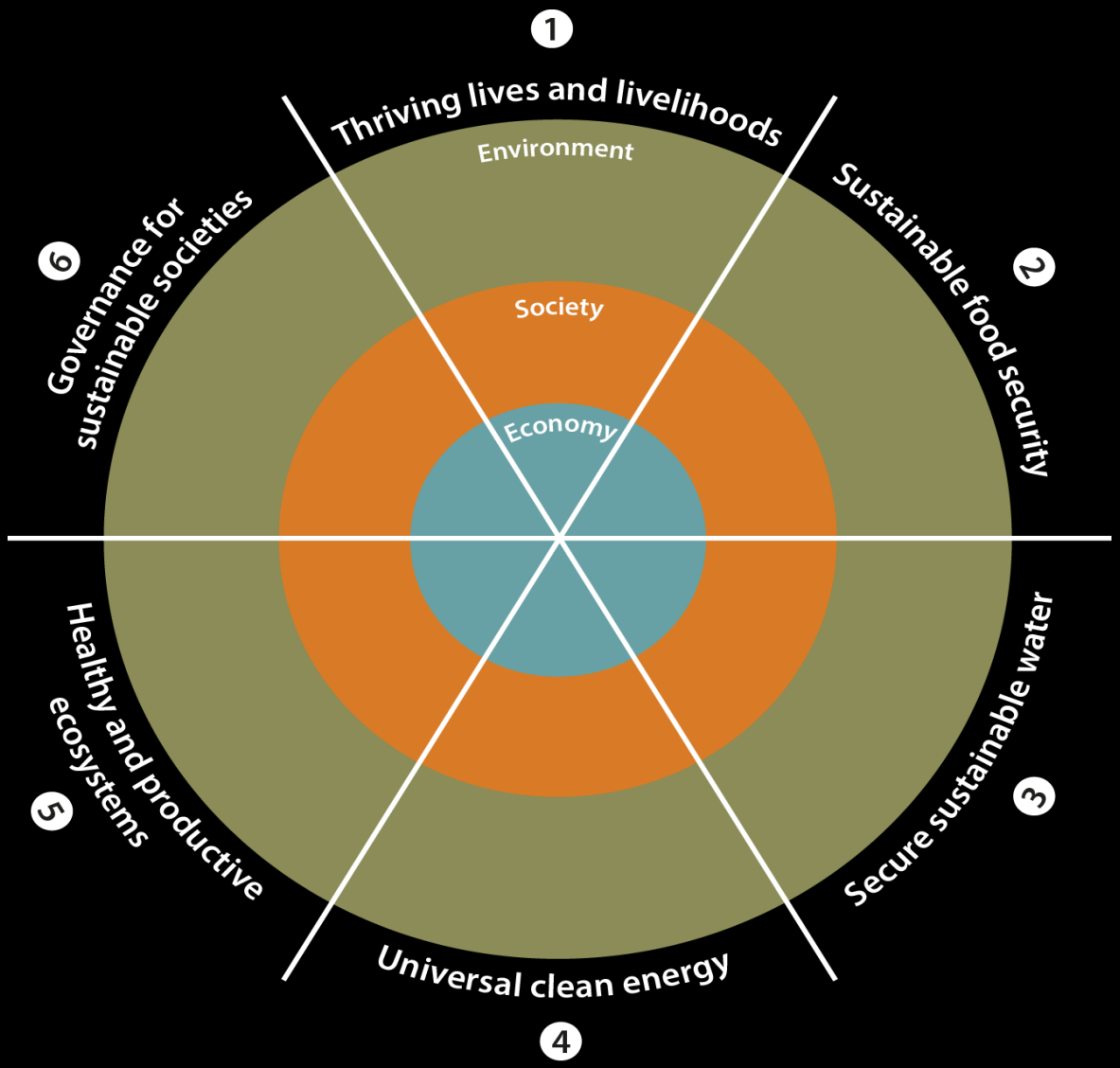
Temperate forests act as carbon sinks, regulate rainfall patterns & generate oxygen. Relatively stable but concern over rate of deforestation in Russia and severe warming impacts on disease.

Tropical savannah systems play a role in moisture feedback , regional rainfall patterns and act as carbon sinks. They remain relatively stable.



A new direction: People and Planet

Setting the agenda on Sustainable Development Goals



nature

International weekly journal of science

Policy: Sustainable development goals for people and planet

David Griggs, Mark Stafford-Smith, Owen Gaffney, Johan Rockström, Marcus C. Öhman, Priya Shyamsundar, Will Steffen, Gisbert Glaser, Norichika Kanie & Ian Noble

Nature 495, 305–307 (21 March 2013) doi:10.1038/495305a

Published online 20 March 2013

Planetary stability must be integrated with United Nations targets to fight poverty and secure human well-being, argue David Griggs and colleagues.

The United Nations Rio+20 summit in Brazil in 2012 committed governments to create a set of sustainable development goals (SDGs) that would be integrated into the follow-up to the Millennium Development Goals (MDGs) after their 2015 deadline. Discussions on how to formulate these continue this week at UN headquarters in New York.

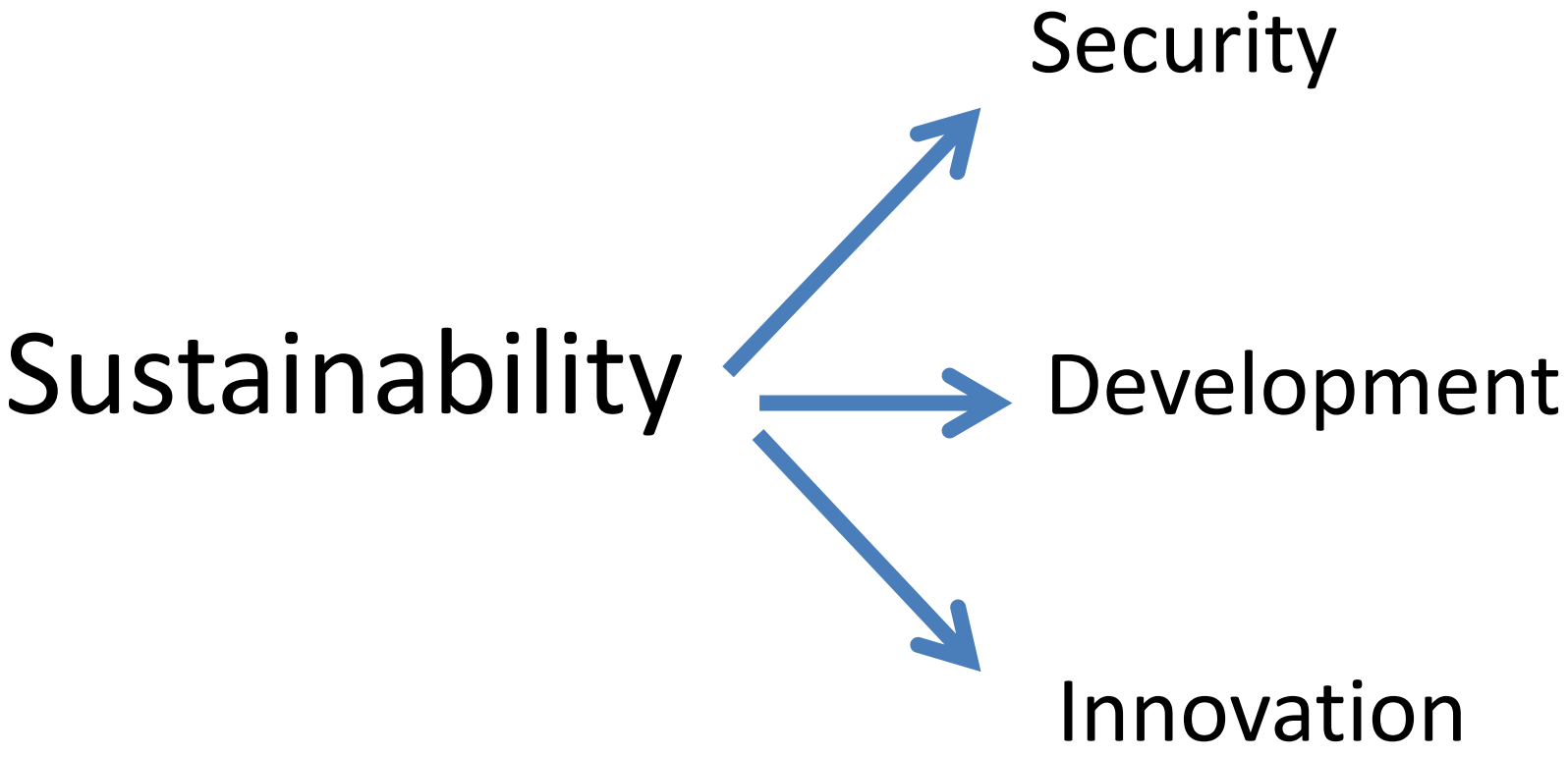
We argue that the protection of Earth's life-support system and poverty reduction must be the twin

THE GLOBAL GOALS

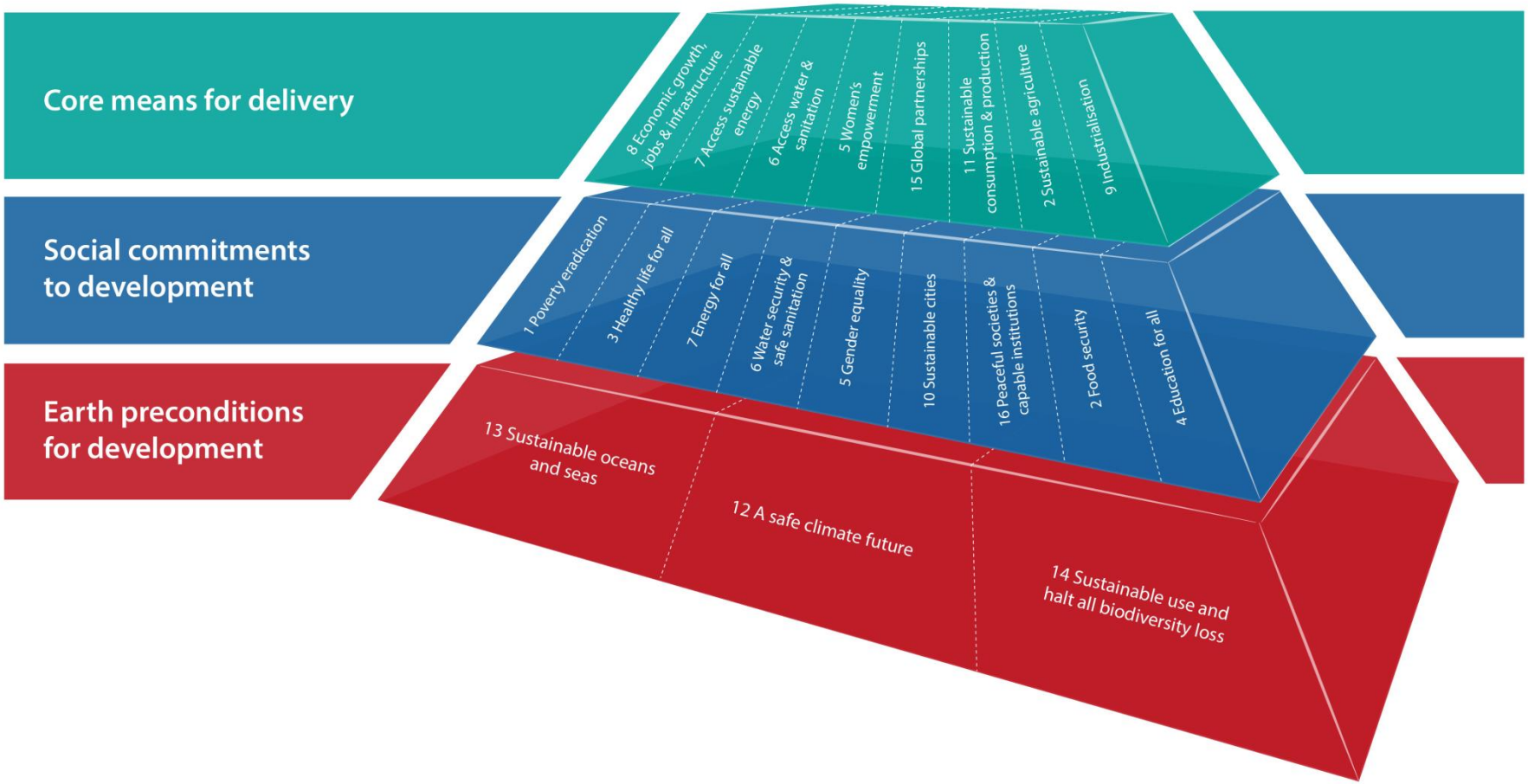
For Sustainable Development

Universal SDGs for People and Planet


THE GLOBAL GOALS
For Sustainable Development


Security
Sustainability
Development
Innovation

Sustainable Development Goals for People and Planet



7 PRINCIPLES OF RESILIENCE THINKING


Maintain diversity & redundancy


Manage connectivity


Manage slow variables and feedbacks


Foster complex adaptive systems thinking


Encourage learning


Broaden participation


Promote polycentric governance systems

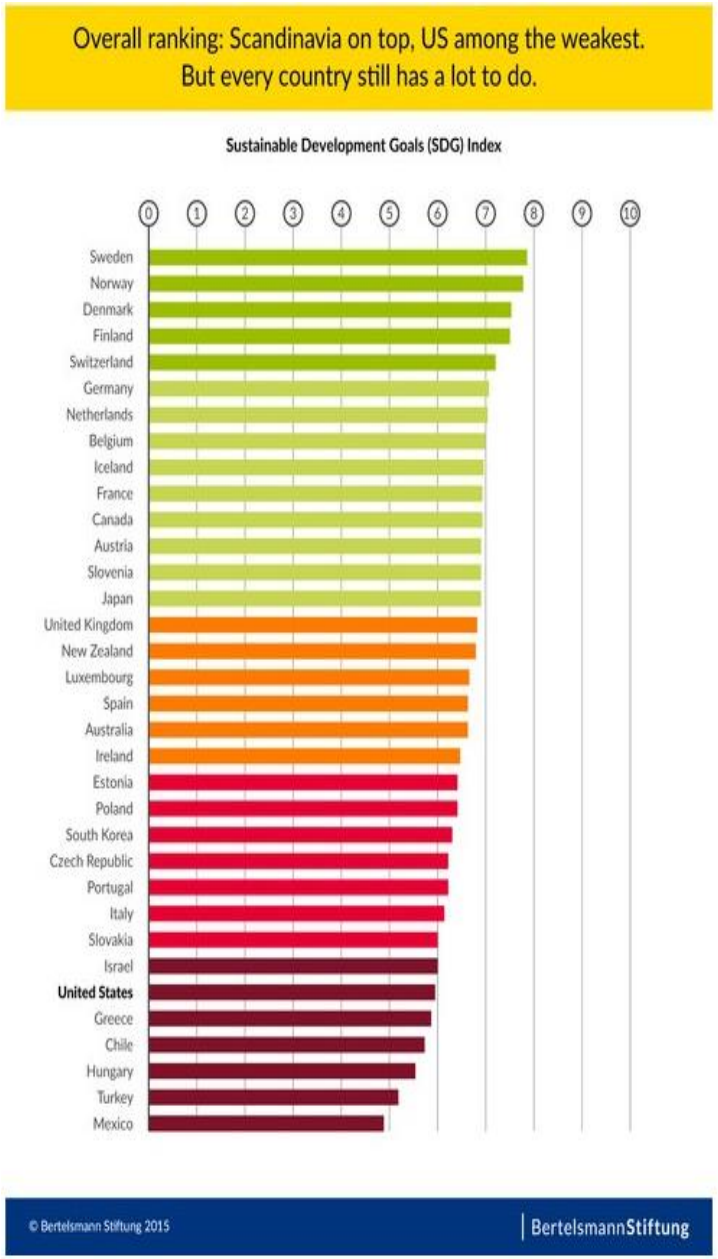
The Earth Statement

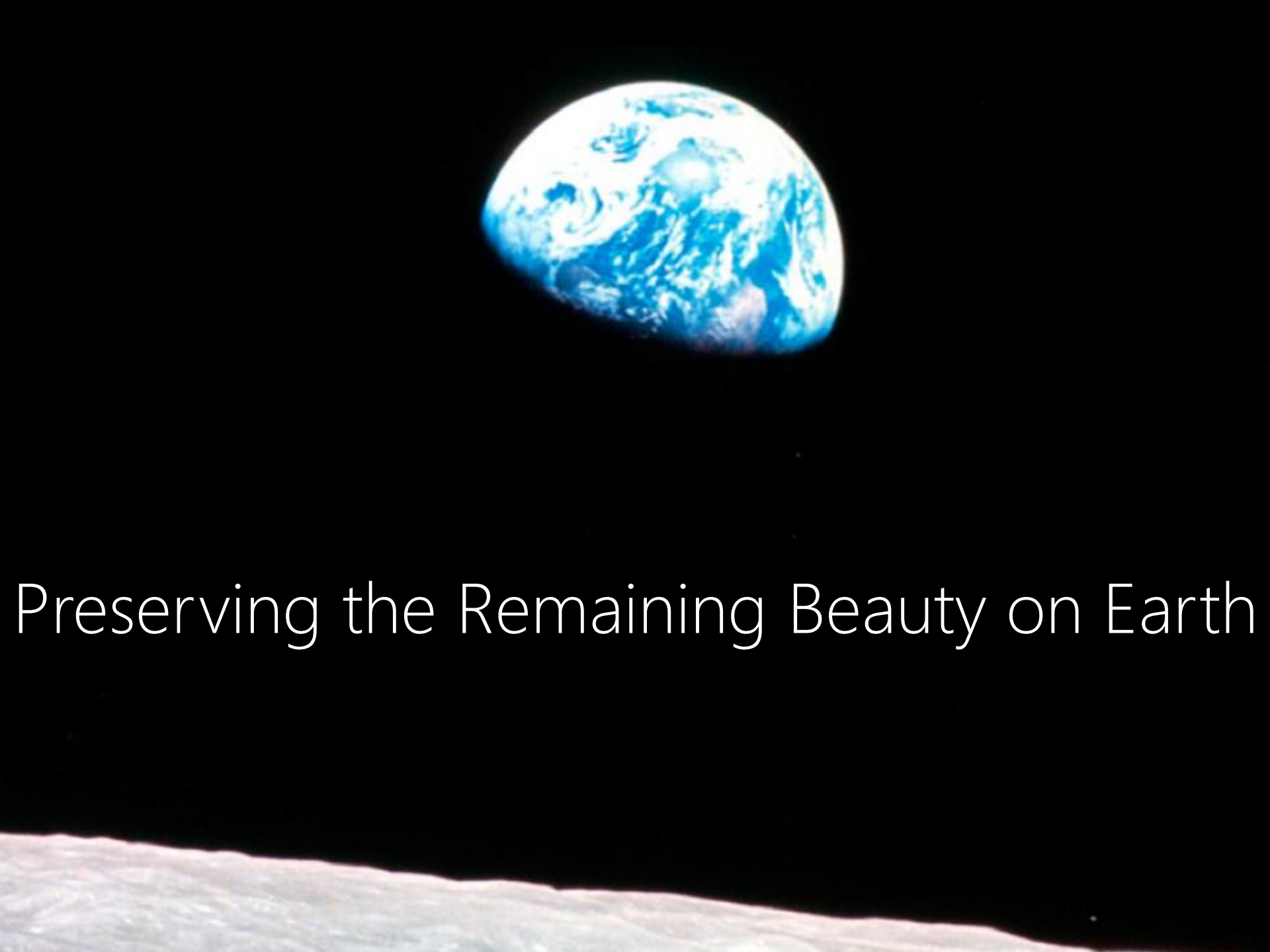
8 Essential Elements for a Successful Paris Deal

THE GLOBAL GOALS

For Sustainable Development

Of the OECD countries the Nordics are in best position to achieve the SDGs




Preserving the Remaining Beauty on Earth


Growth Without Limits
Limits to Growth
Growth within Limits
Thriving within Planetary Boundaries