

Do we need to worry about the Planet?

Megatrends in global
natural resource use
KSLA
8th June 2011



Prof. Johan Rockström
Stockholm Resilience Centre
Stockholm Environment Institute

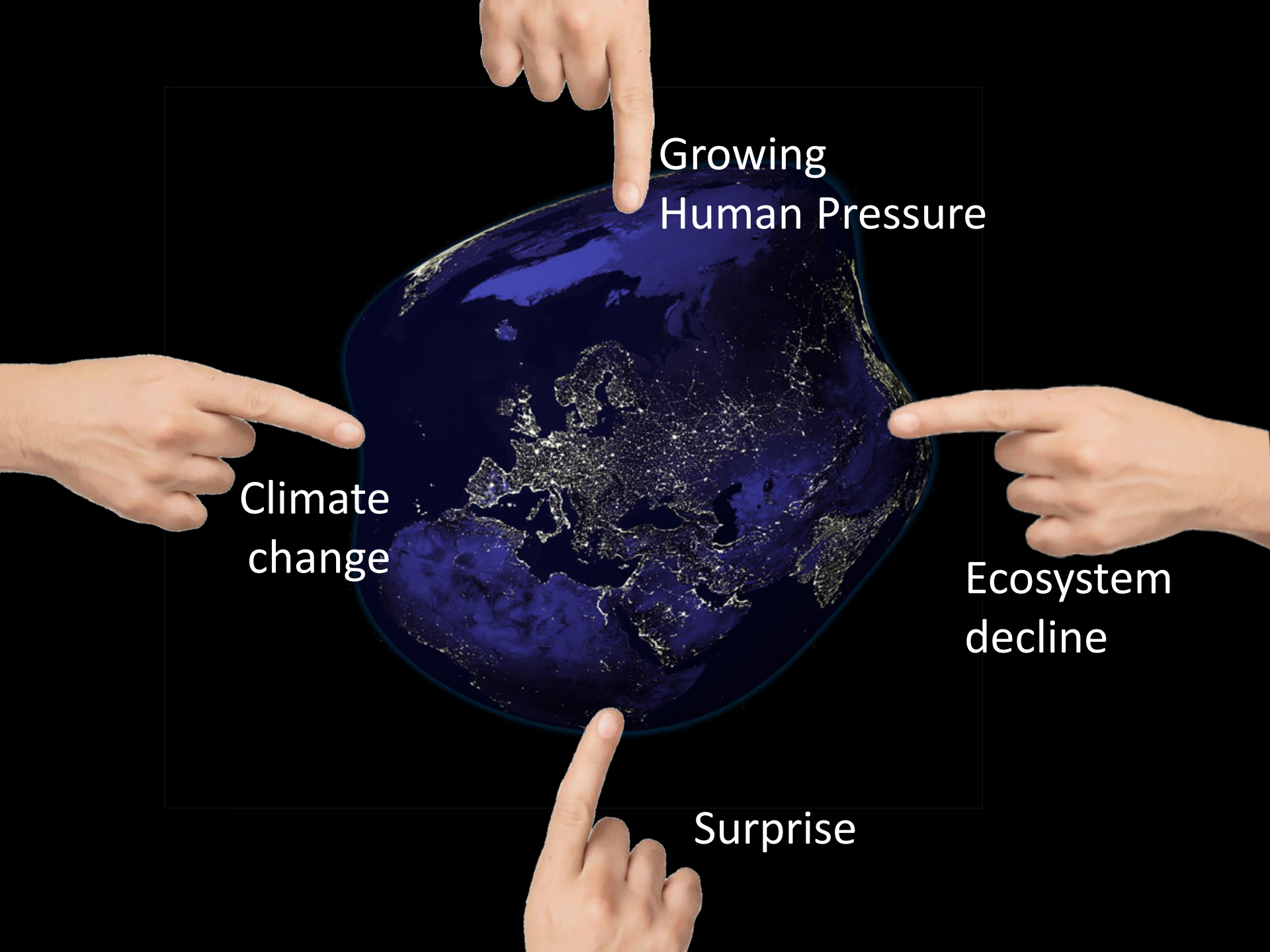


Stockholm Resilience Centre
Research for Governance of Social-Ecological Systems



A centre with:





Growing
Human Pressure

Climate
change

Ecosystem
decline

Surprise



Stockholm Resilience Centre
 Research for Governance of Social-Ecological Systems



A centre with:





3rd
Nobel Laureate Symposium
on Global Sustainability
Transforming the World in an Era of Global Change
Stockholm, Sweden, May 16-19 2011

The Stockholm Memorandum
Tipping the Scales towards Sustainability
18 May 2011

Humanity has reached a planetary saturation point

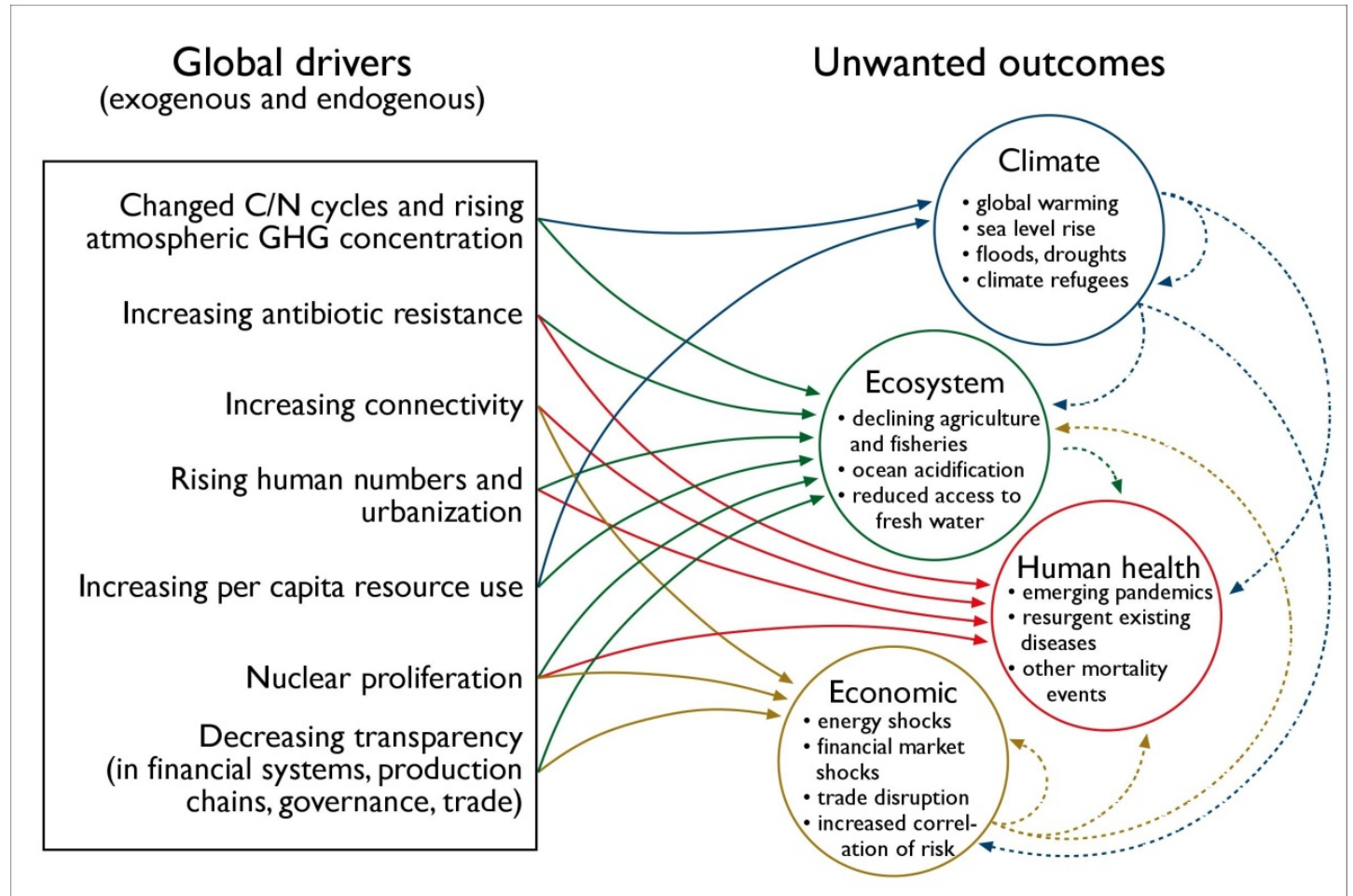
A resilient biosphere the basis for human development

It is not only about climate change

A great transformation to global sustainability necessary, possible, and desirable

Looming global scale failures and missing institutions

Walker, B. et al., 2009. Science, 325: 1345-1346



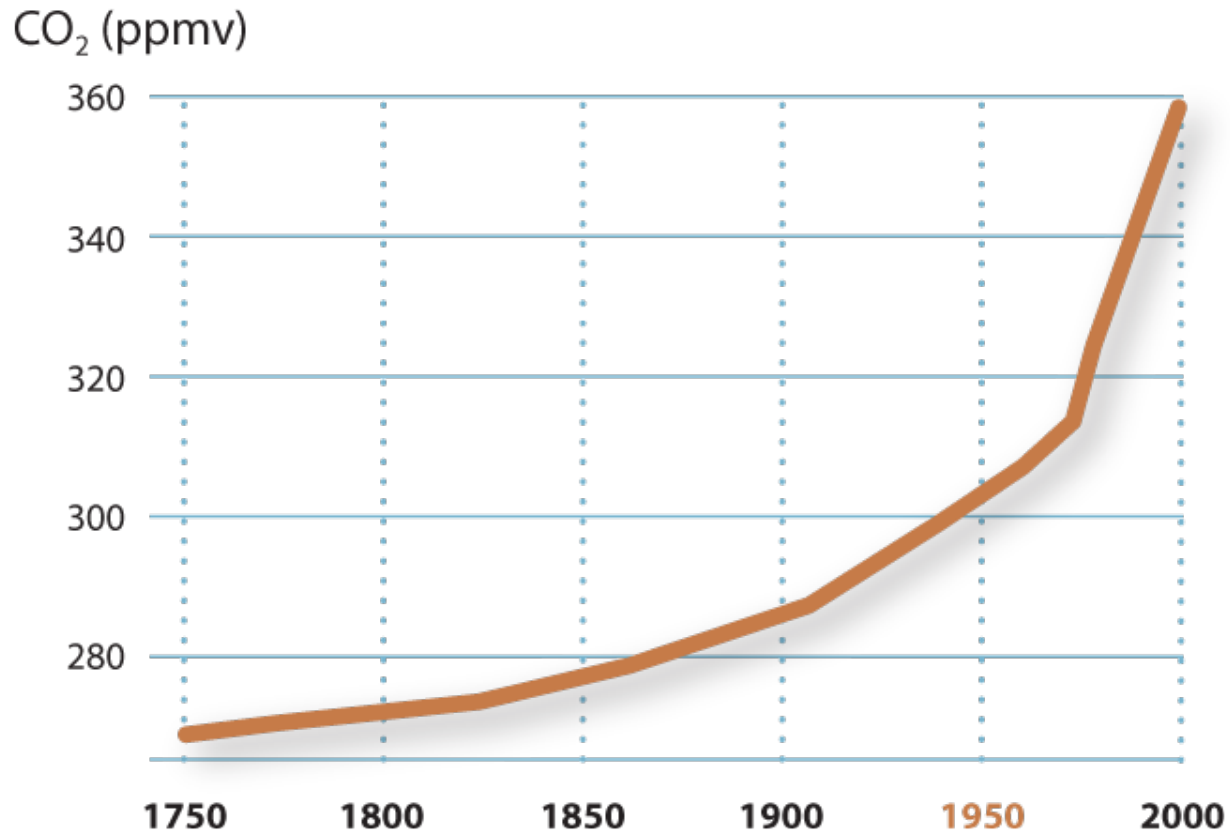
Earth System Science for Global Sustainability: Grand Challenges

Progress in understanding and addressing both global environmental change and sustainable development requires better integration of social science research.

W. V. Reid,^{1*} D. Chen,² L. Goldfarb,² H. Hackmann,³ Y. T. Lee,² K. Mokhele,⁴ E. Ostrom,⁵
K. Raivio,² J. Rockström,⁶ H. J. Schellnhuber,⁷ A. Whyte⁸

12 NOVEMBER 2010 VOL 330 SCIENCE www.sciencemag.org
Published by AAAS

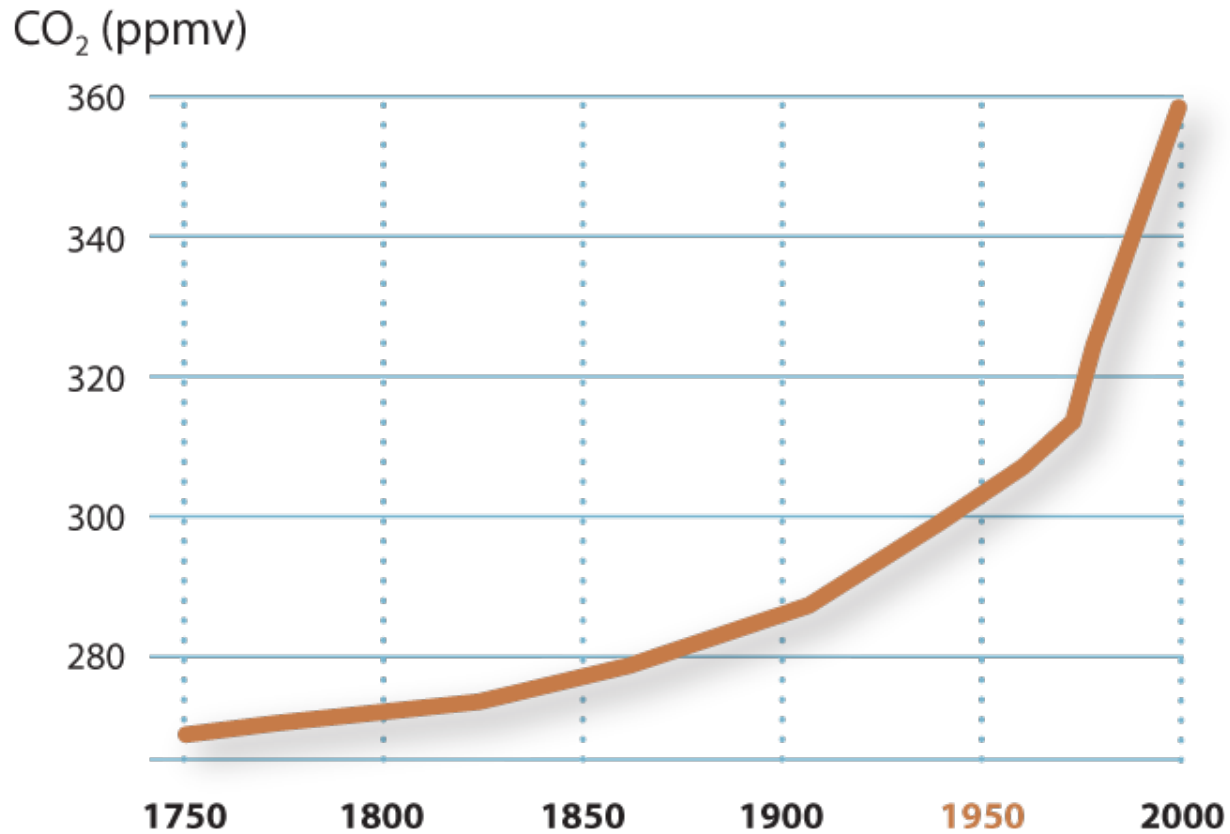
Atmospheric CO₂ concentration



Etheridge et al. Geophys Res 101: 4115-4128

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

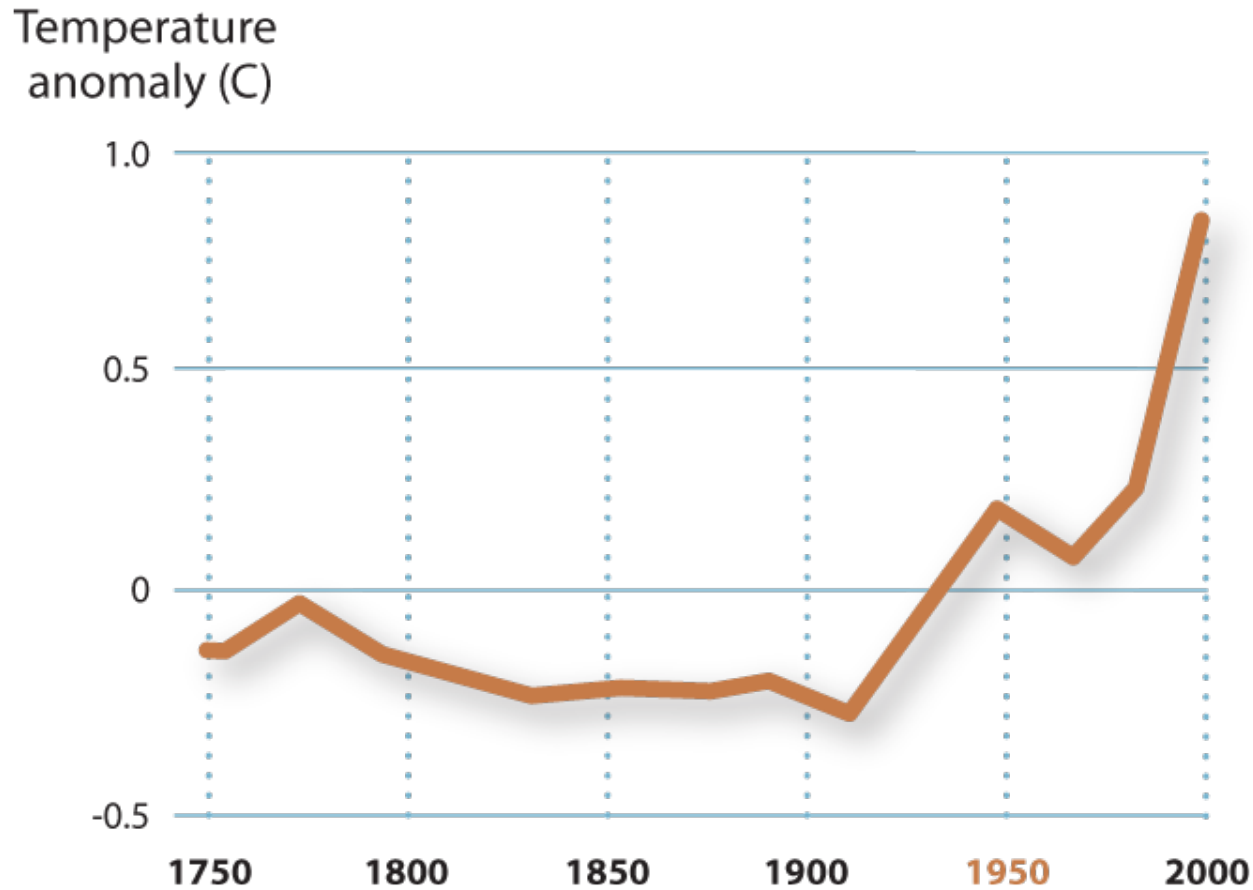
Atmospheric CO₂ concentration



Etheridge et al. Geophys Res 101: 4115-4128

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

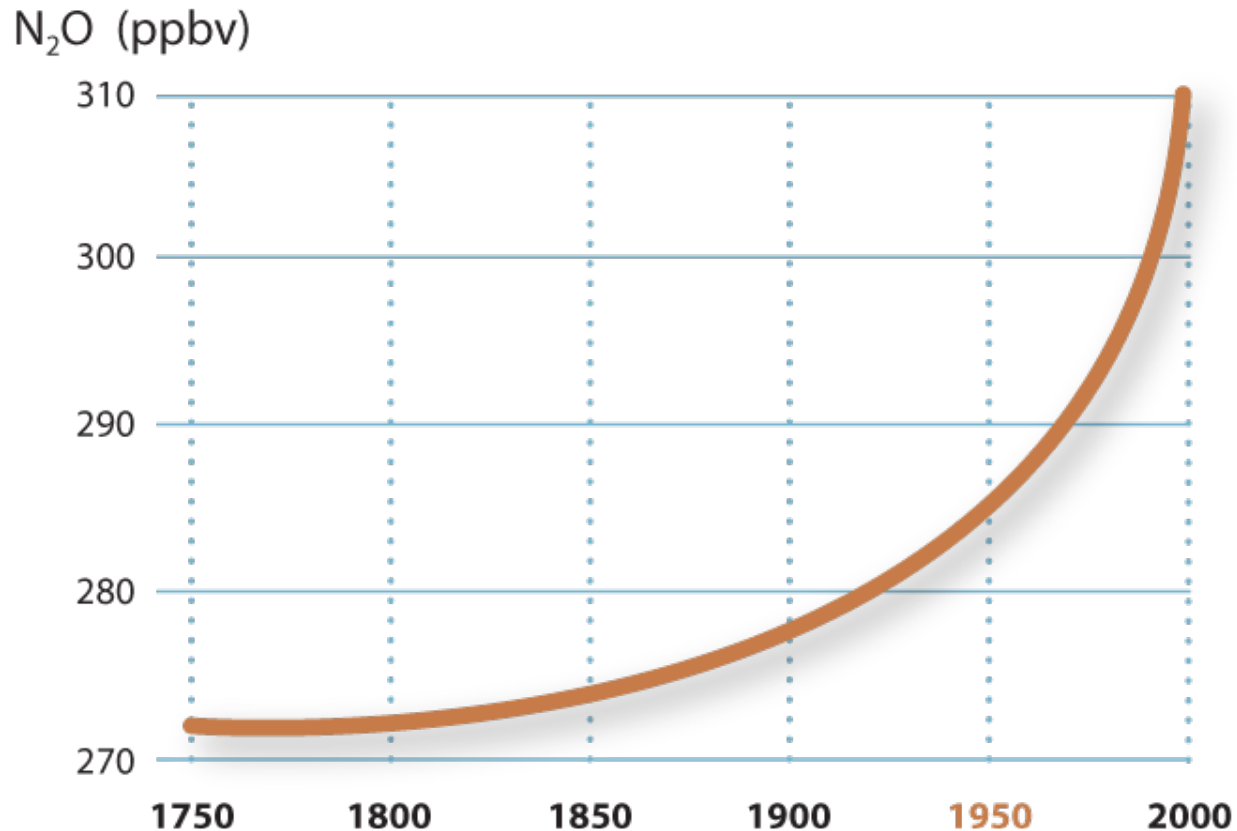
Northern hemisphere average surface temperature



Mann et al Geophys Res Lett 26(6): 759-762

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

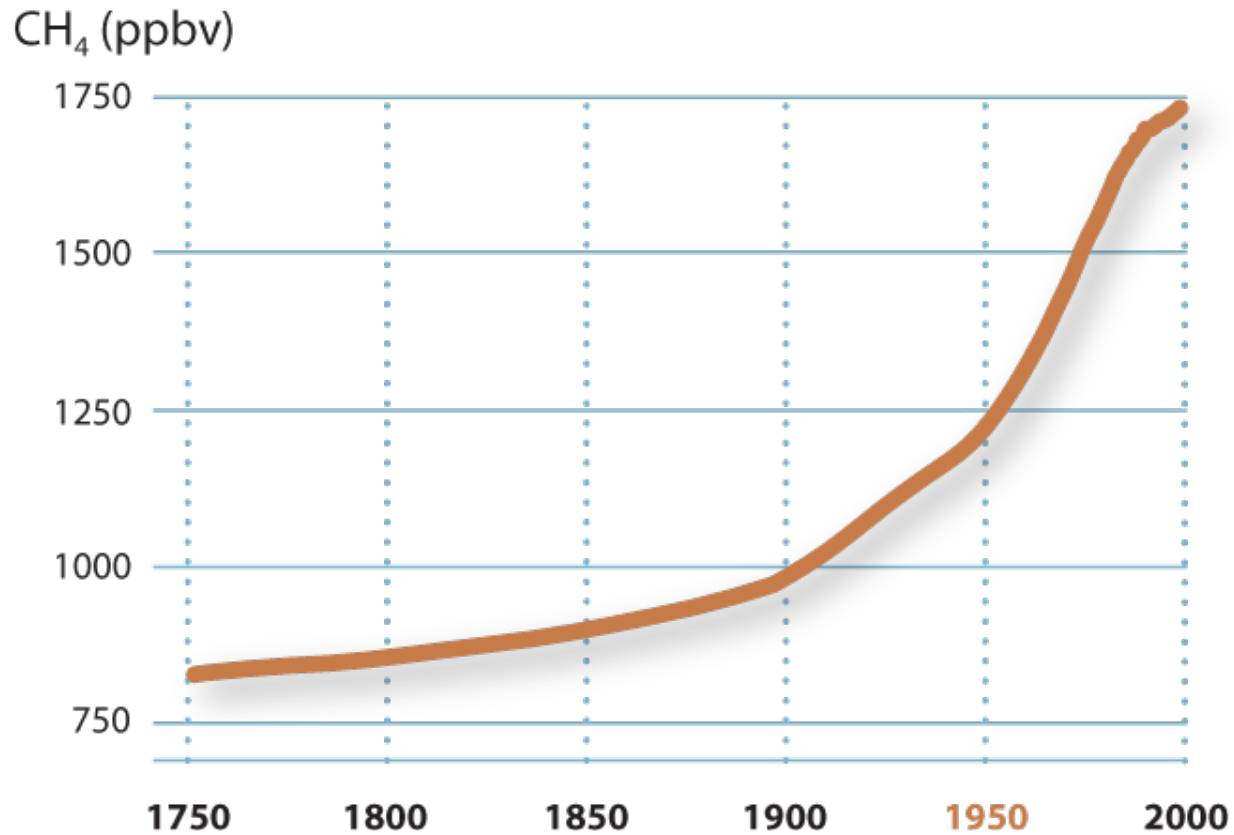
Atmospheric N₂O concentration



Machida et al Geophys Res Lett 22:2921-2925

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Atmospheric CH₄ concentration

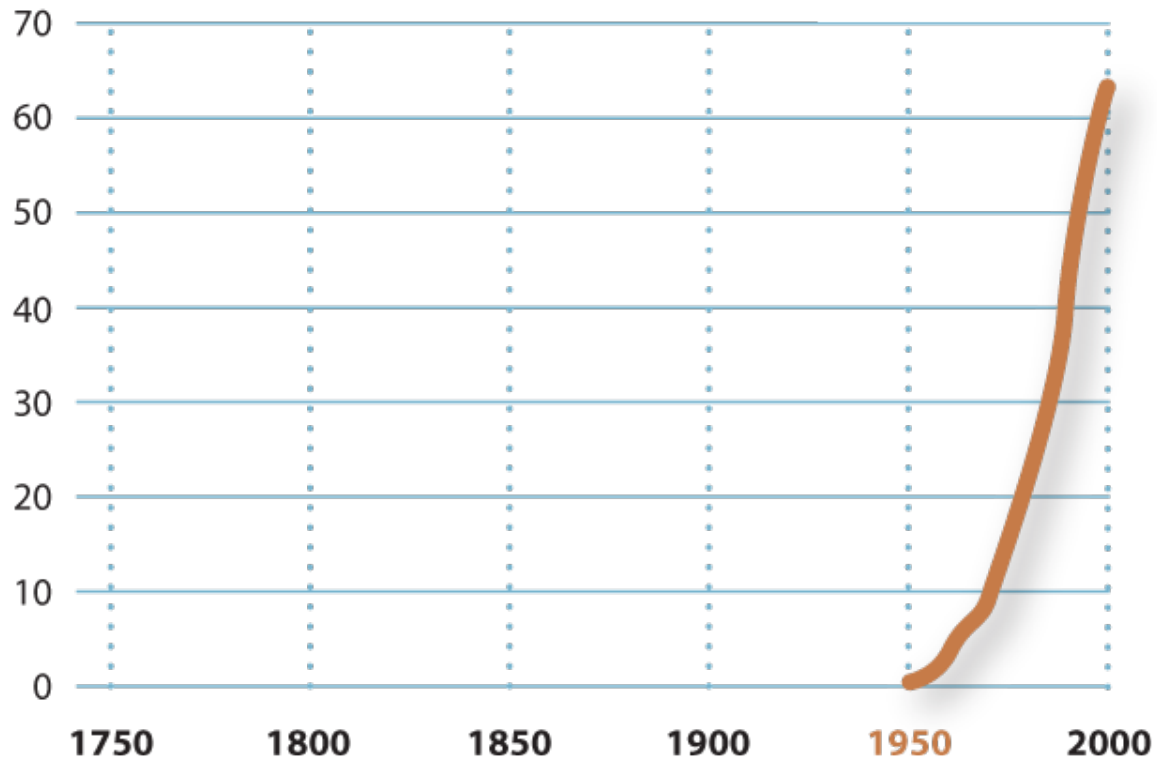


Blunier et al J Geophys Res 20: 2219-2222

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Ozone depletion

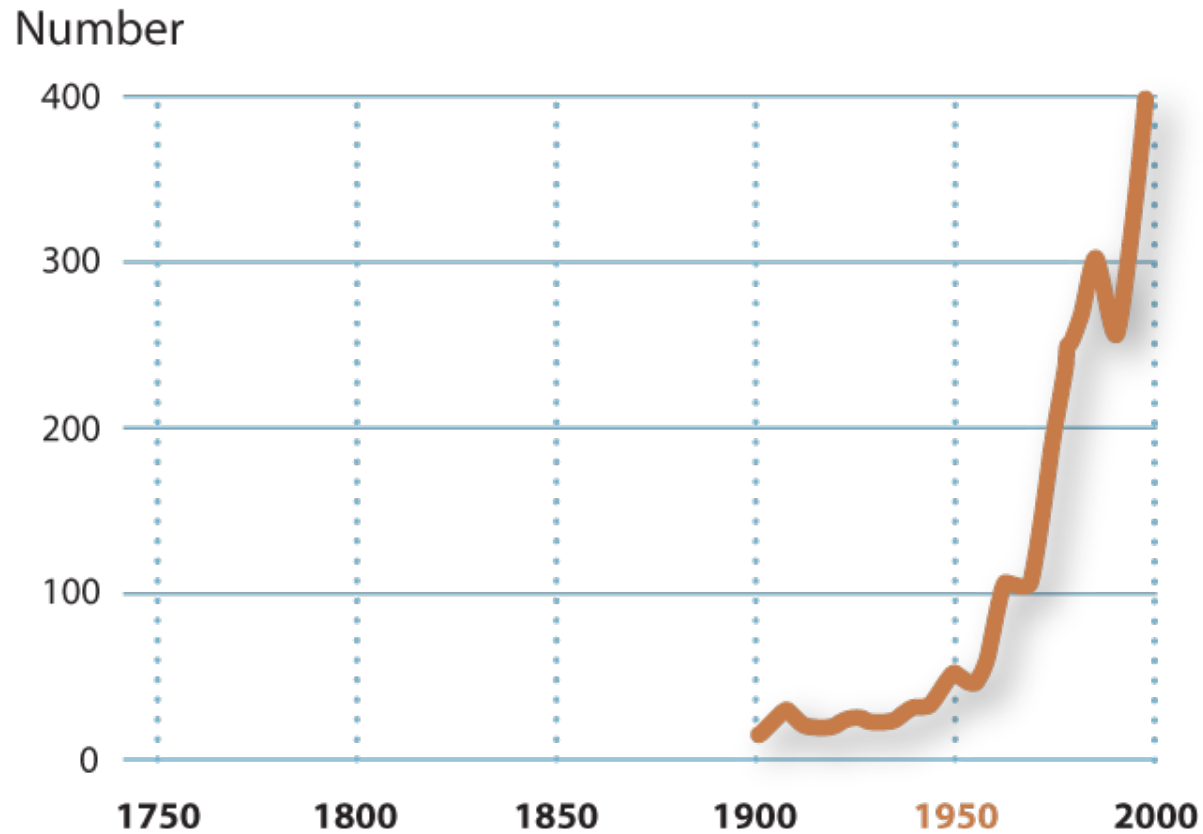
% loss of total column ozone



JD Shanklin British Antarctic Survey

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

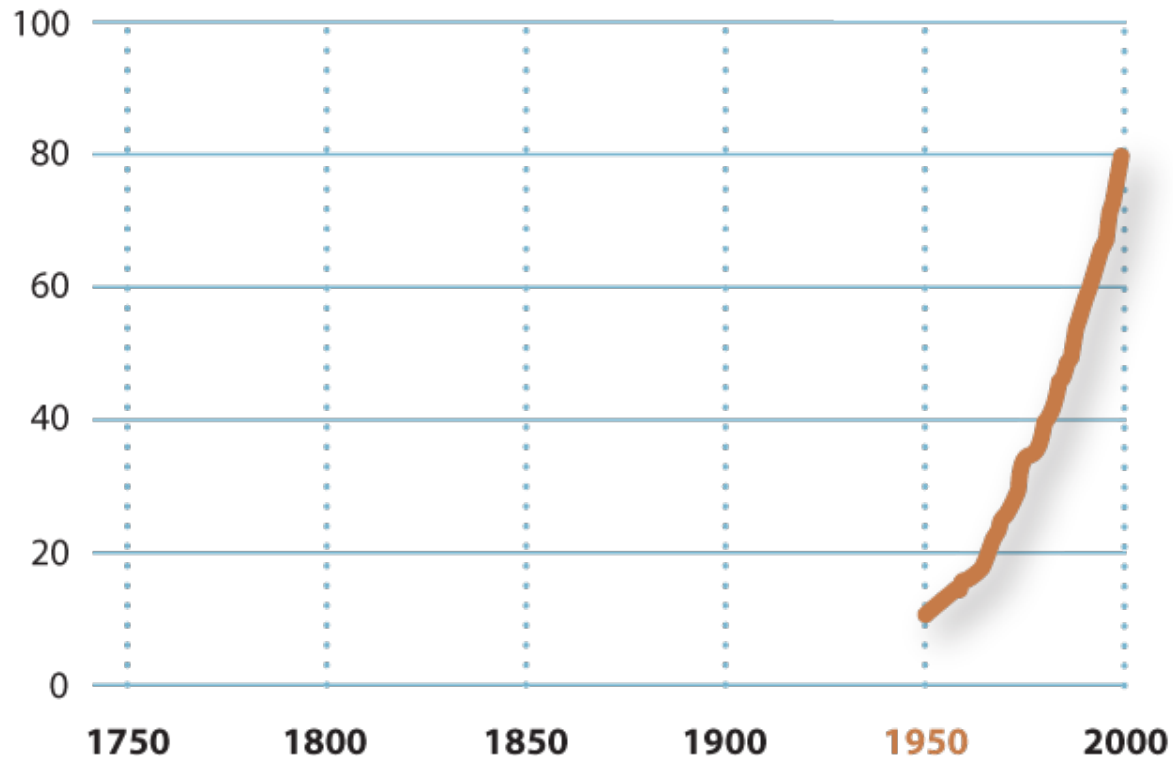
Natural climactic disasters



IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Ocean ecosystems

% fisheries fully exploited

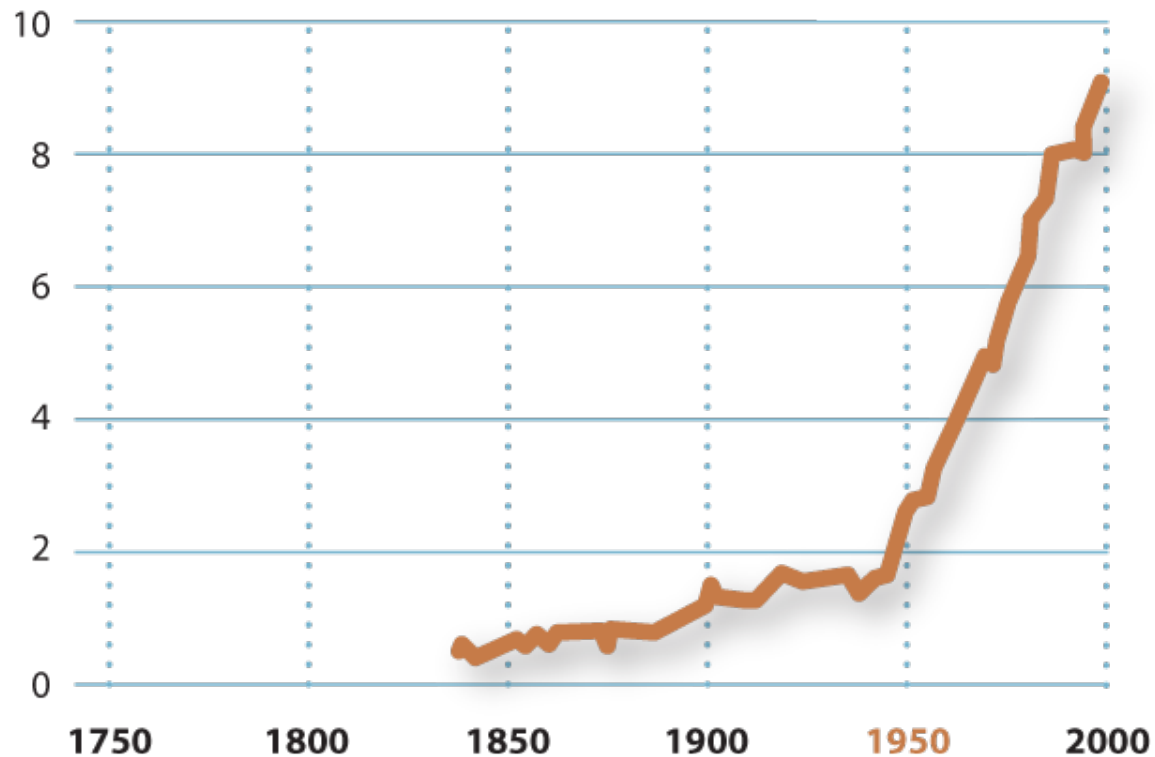


FAOSTAT 2002 Statistical database

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Coastal zone nitrogen flux

(10^{12} moles year⁻¹)

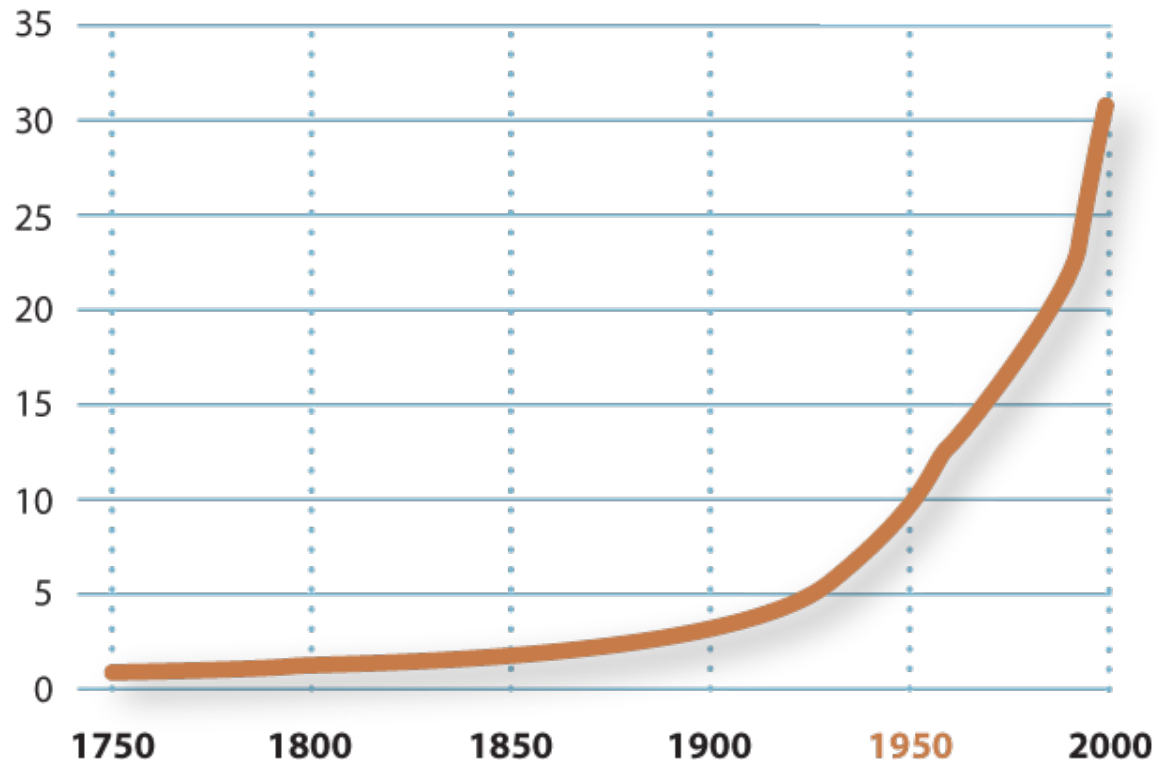


Mackenzie et al 2002.

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Tropical rainforest and woodland loss

% of 1700 value

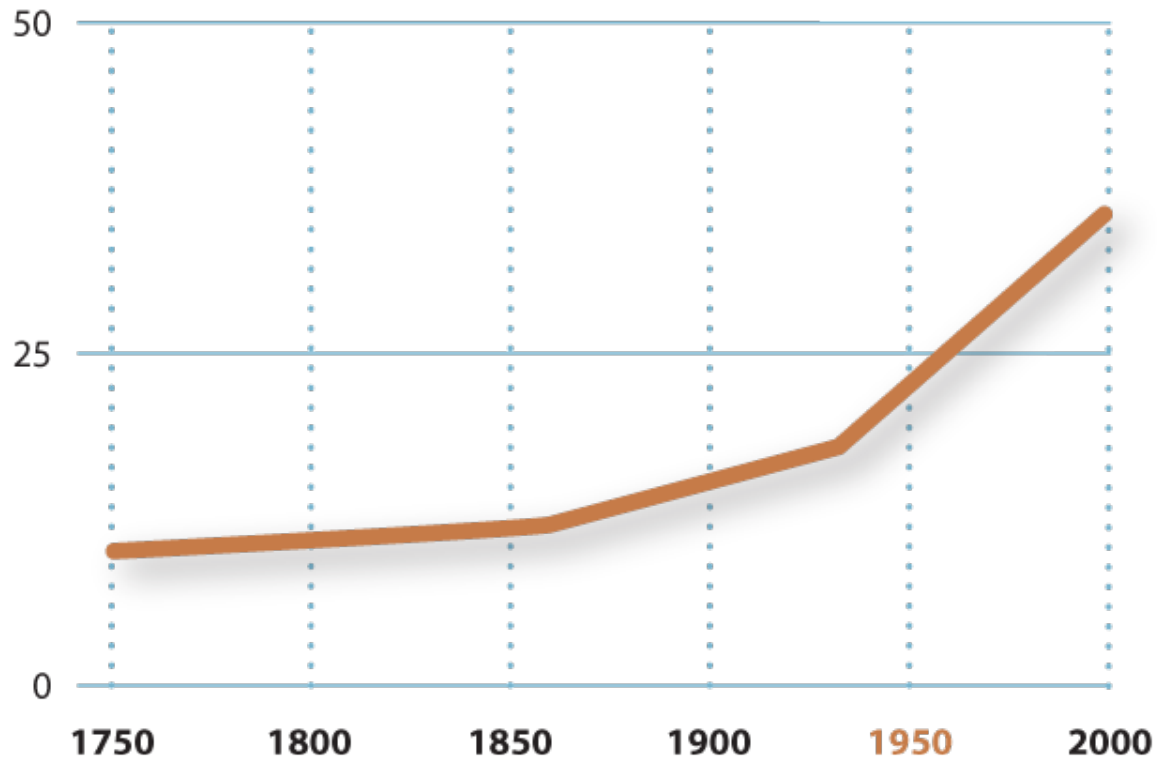


Richards, the Earth as transformed by human action, Cambridge University Press

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Domesticated land

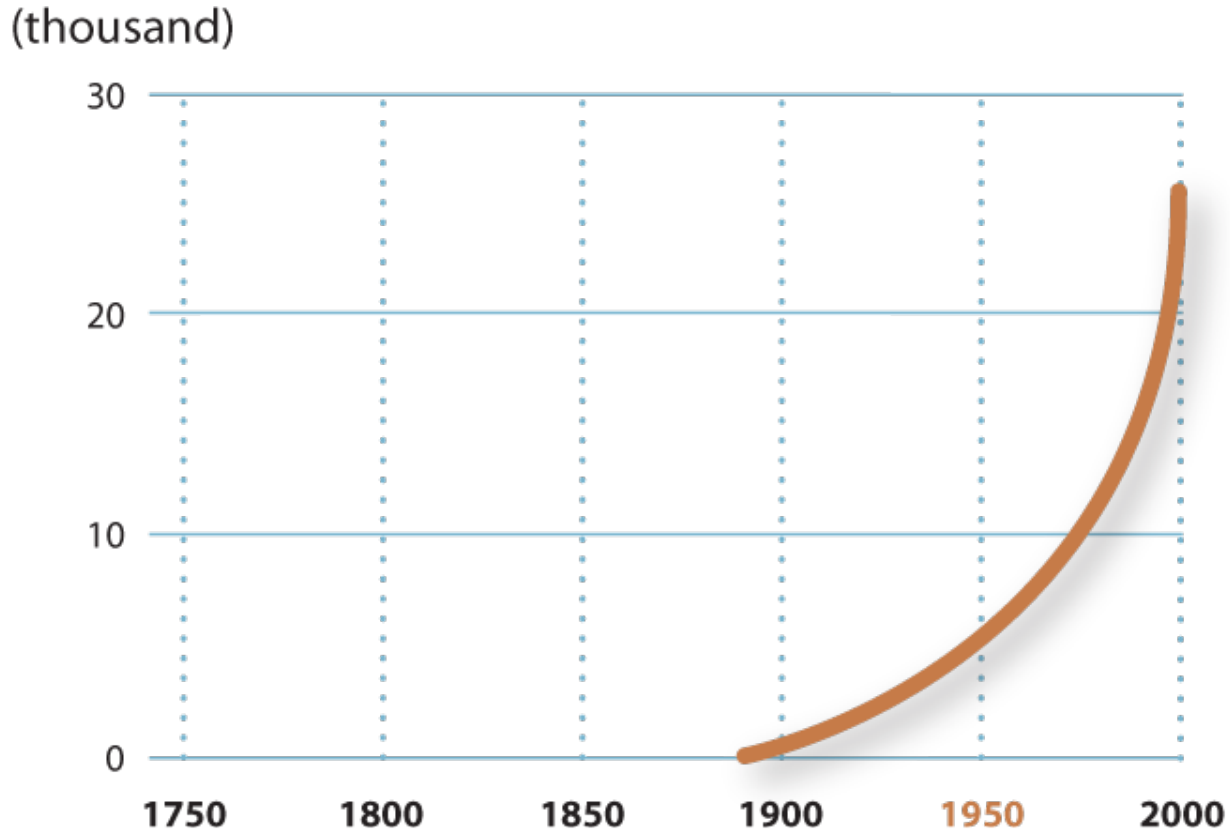
% of total land area



Klein Goldewijk and Batties

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

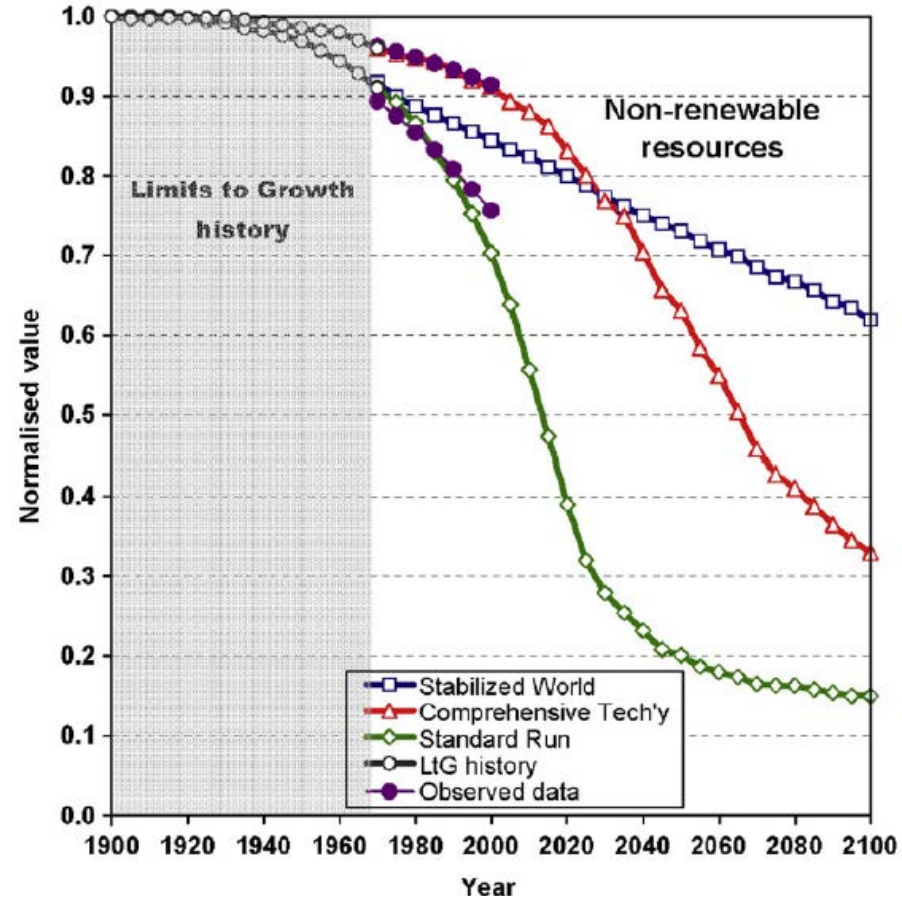
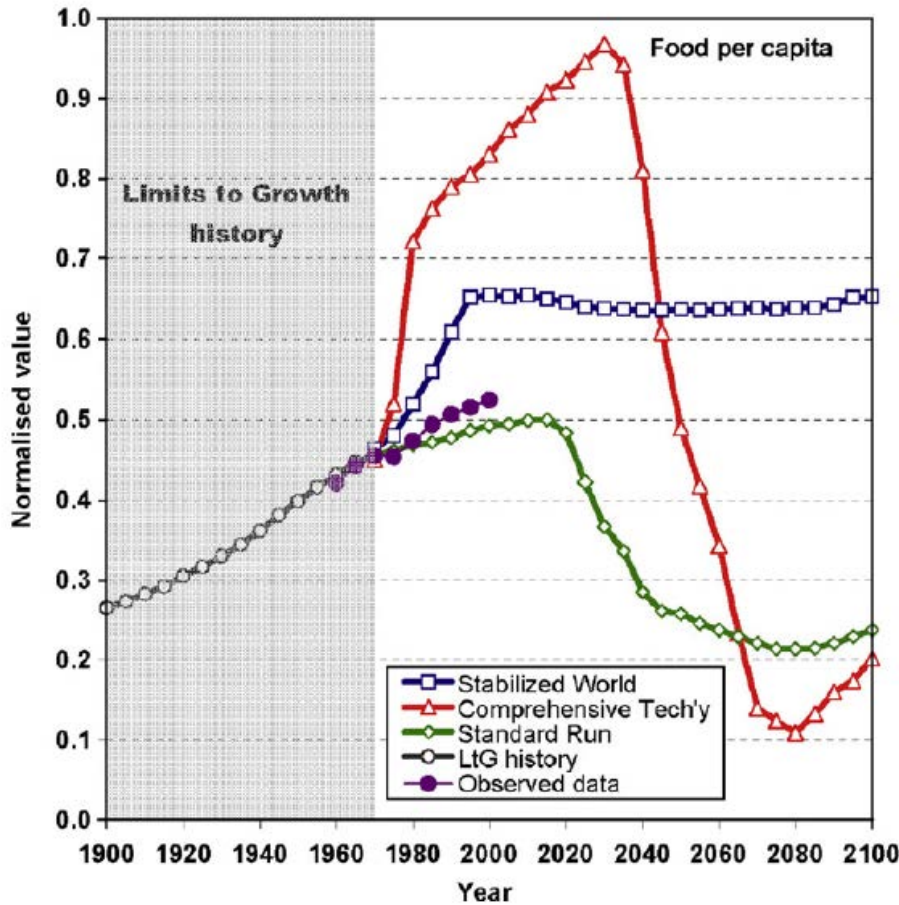
Species extinctions



Wilson, the Diversity of Life.

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Limits to Growth – Scenarios versus Reality



Global Environmental Change 18 (2008) 397–411



Contents lists available at ScienceDirect

Global Environmental Change

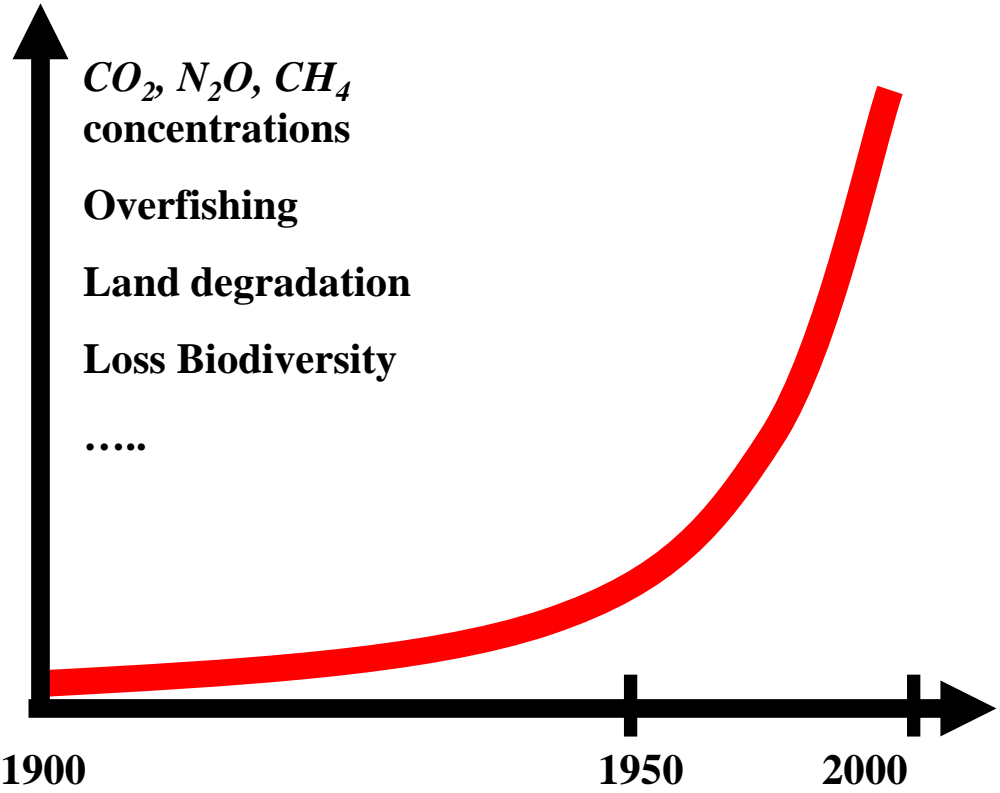
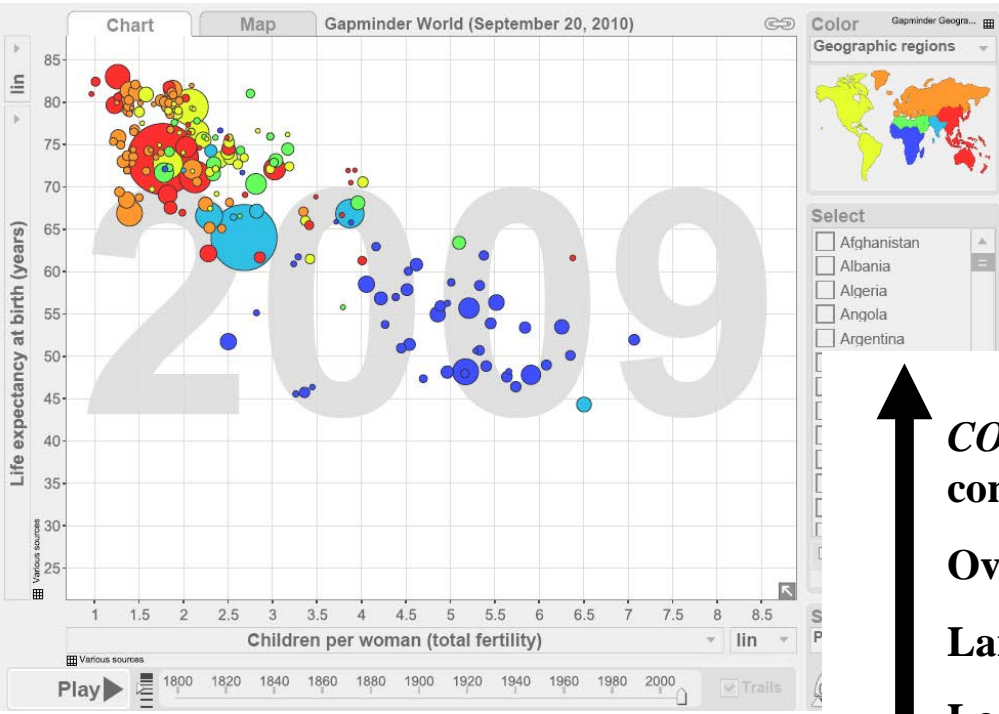
journal homepage: www.elsevier.com/locate/gloenvcha



A comparison of *The Limits to Growth* with 30 years of reality

Graham M. Turner*

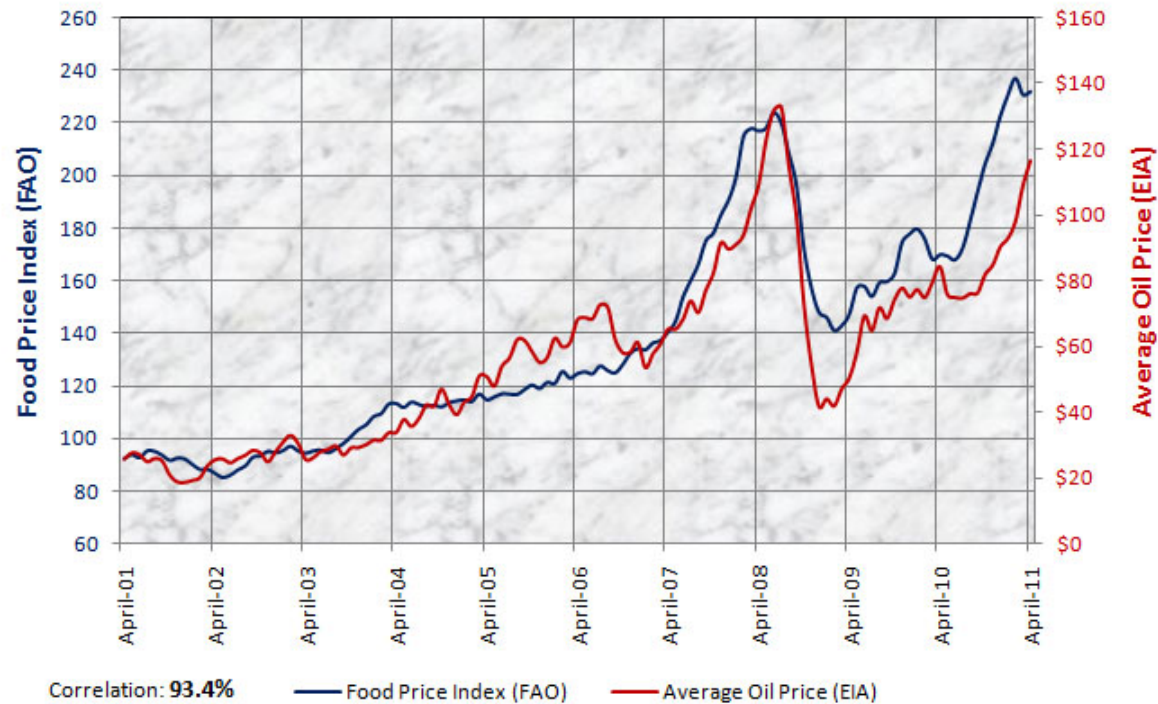
CSIRO Sustainable Ecosystems, GPO Box 284, Canberra City, ACT 2601, Australia



P x A x T = width
times height times
length of three
boxes representing
human impact in
1900, 1950 and
2011.

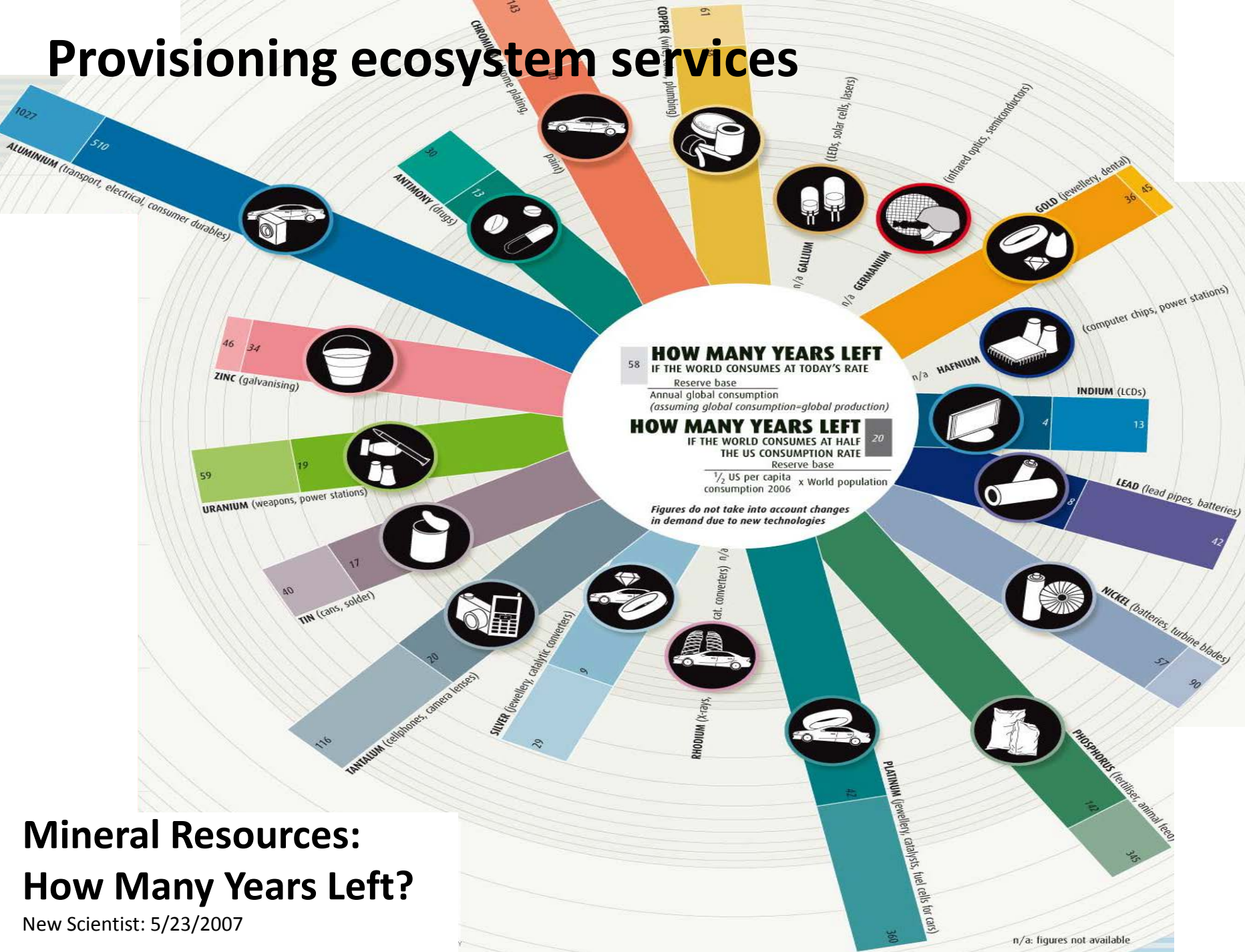


World Food and Oil Prices April 2001 to April 2011



www.paulchefurka.ca; FAO, IEA

Provisioning ecosystem services

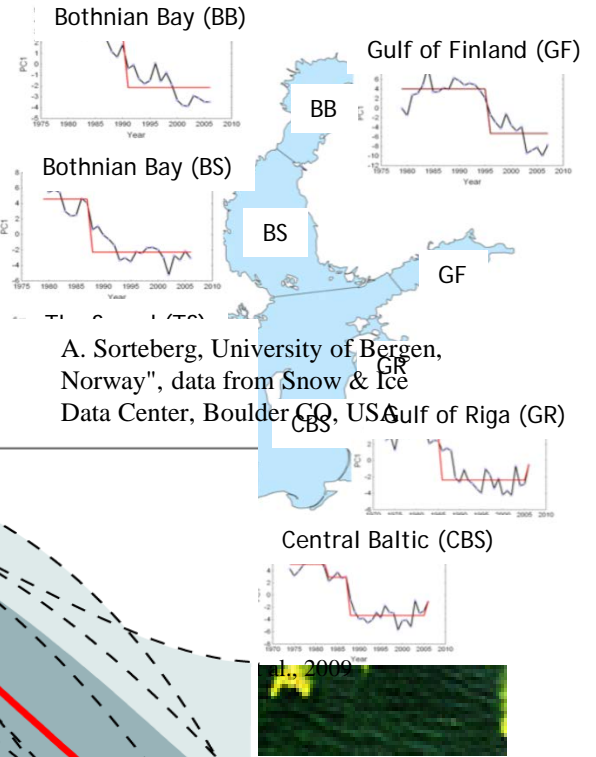


Mineral Resources: How Many Years Left?

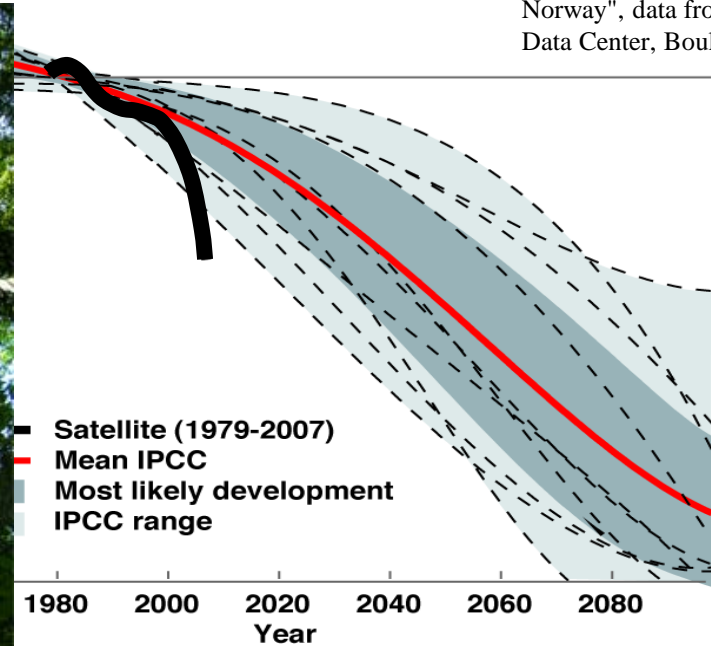
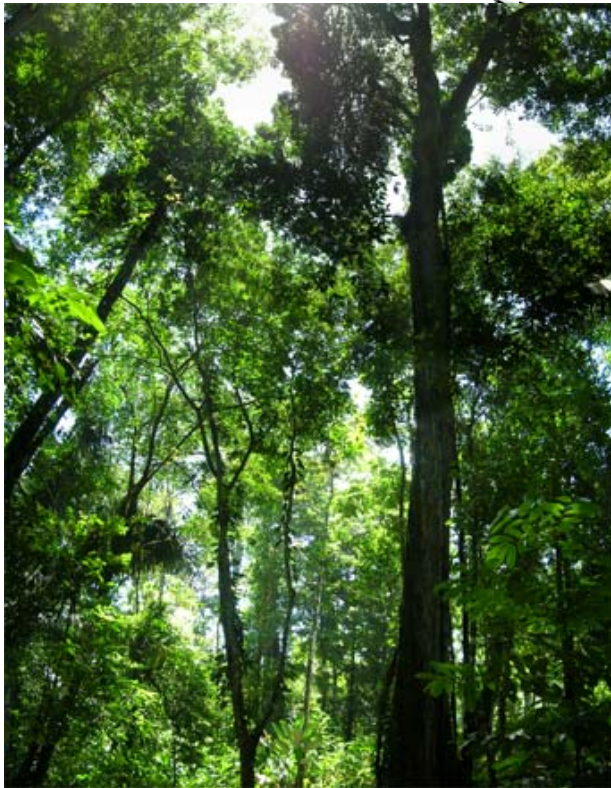
New Scientist: 5/23/2007

n/a: figures not available

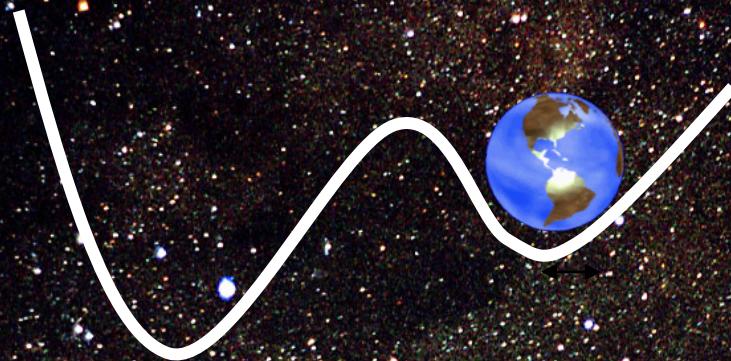
Regime shifts in all systems



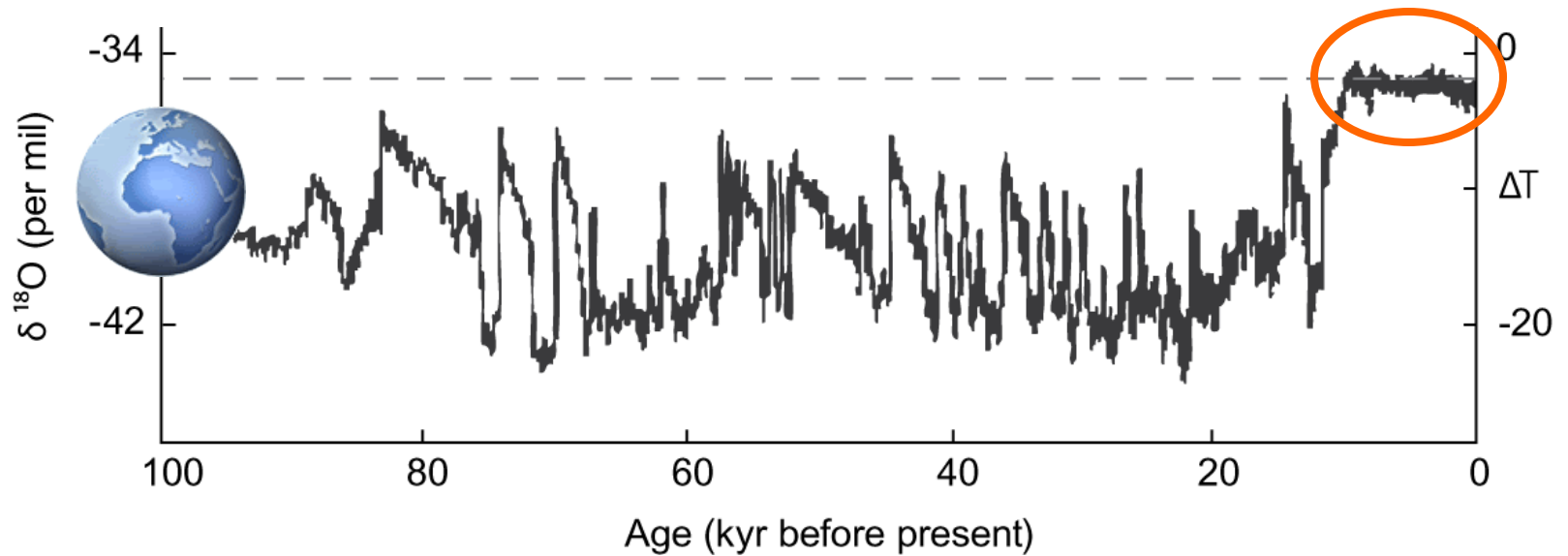
25



The Resilience of the Earth System



Humanity's 10,000 years of grace



Transgressing safe boundaries

nature

FEATURE

Vol 461/24 September 2009

A safe operating space for humanity

Identifying and quantifying planetary boundaries that must not be transgressed could help prevent human activities from causing unacceptable environmental change, argue **Johan Rockström** and colleagues.

SUMMARY

- New approach proposed for defining preconditions for human development
- Crossing certain biophysical thresholds could have disastrous consequences for humanity
- Three of nine interlinked planetary boundaries have already been overstepped

Although Earth has undergone many periods of significant environmental change, the planet's environment has been unusually stable for the past 10,000 years¹. This period of stability — known as the Holocene — has seen human civilisations arise, develop and thrive. Such stability may now be under threat. Since the Industrial Revolution, a new era has emerged: the Anthropocene², in which human actions have become the main driver of global environmental change³. This could see human activities push the Earth system outside the stable environmental state of the Holocene, with consequences for large parts of the world, even catastrophic for large parts of the world.

During the Holocene, environmental conditions changed naturally and Earth's regenerative capacity maintained the conditions that enabled human development. Regular temperatures, freshwater availability and biogeochemical flows all stayed within a relatively narrow range. Now, largely because of a rapidly growing reliance on fossil fuels and industrialized forms of agriculture, human activities have seen a level that could damage the systems that keep Earth in the desirable Holocene state. The result could be irreversible and, in some cases, abrupt environmental change, leading to a state less conducive to human development⁴. Without progress to sustain the Holocene is expected to continue for at least several thousands of years⁵.

Planetary boundaries

To meet the challenge of maintaining the Holocene state, we propose a framework based on 'planetary boundaries': These boundaries define the safe operating space for humanity with respect to the Earth system and are associated with the planet's biophysical complex systems sometimes respond smoothly to changing pressures, it seems that the Earth system of Earth react in this will prove to be the exception rather than the rule. Many subsystems of Earth have a nonlinear, often abrupt, way, and are particularly sensitive around threshold levels of certain key variables. If these thresholds are crossed, the important subsystems, such as a monsoon system, could shift into a new state, often with deleterious or potentially even disastrous consequences for humanity⁶.

Most of these thresholds can be defined by a critical value for one or more control variables, such as carbon dioxide concentration. Not all processes or subsystems on Earth have well-defined thresholds, although human actions that undermine the resilience of such processes or subsystems — for example, land and water degradation — can increase the risk that thresholds will also be crossed in other processes, such as the climate system.

We have tried to identify the Earth-system processes and associated thresholds which, if crossed, could generate unacceptable environmental change. We have found nine such processes for which we believe it is necessary to define planetary boundaries (terrestrial change, rate of biodiversity loss (terrestrial and marine), interference with the nitrogen and phosphorus cycles, stratospheric ozone depletion, ocean acidification, global freshwater use, change in land use, chemical pollution, and atmospheric aerosol loading (see Table)).

Fig. 1 and Table

In general, planetary boundaries are values for control variables that are either a 'safe' distance from thresholds — for processes with evidence of threshold behaviour — or at dangerous levels — for processes without

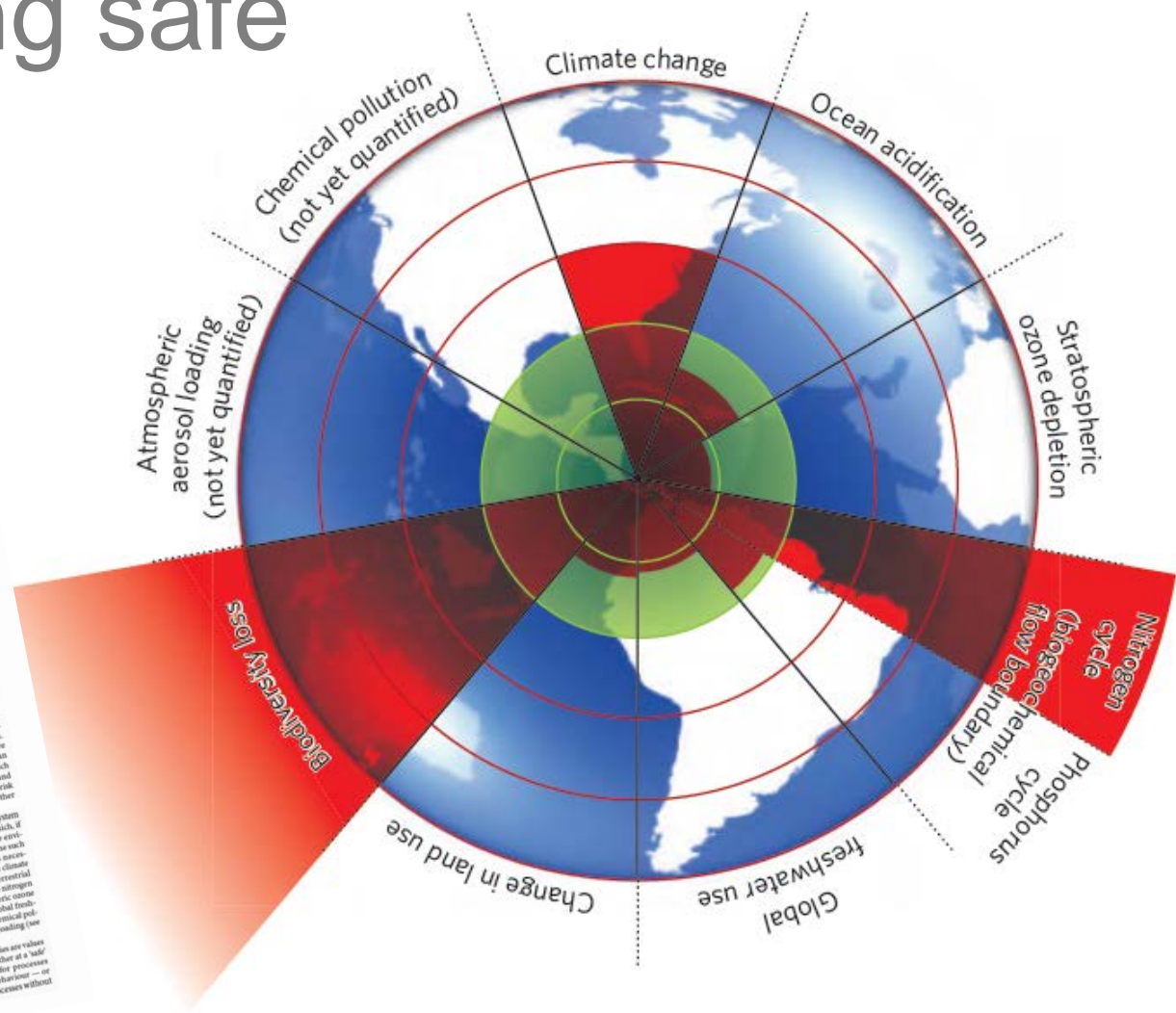
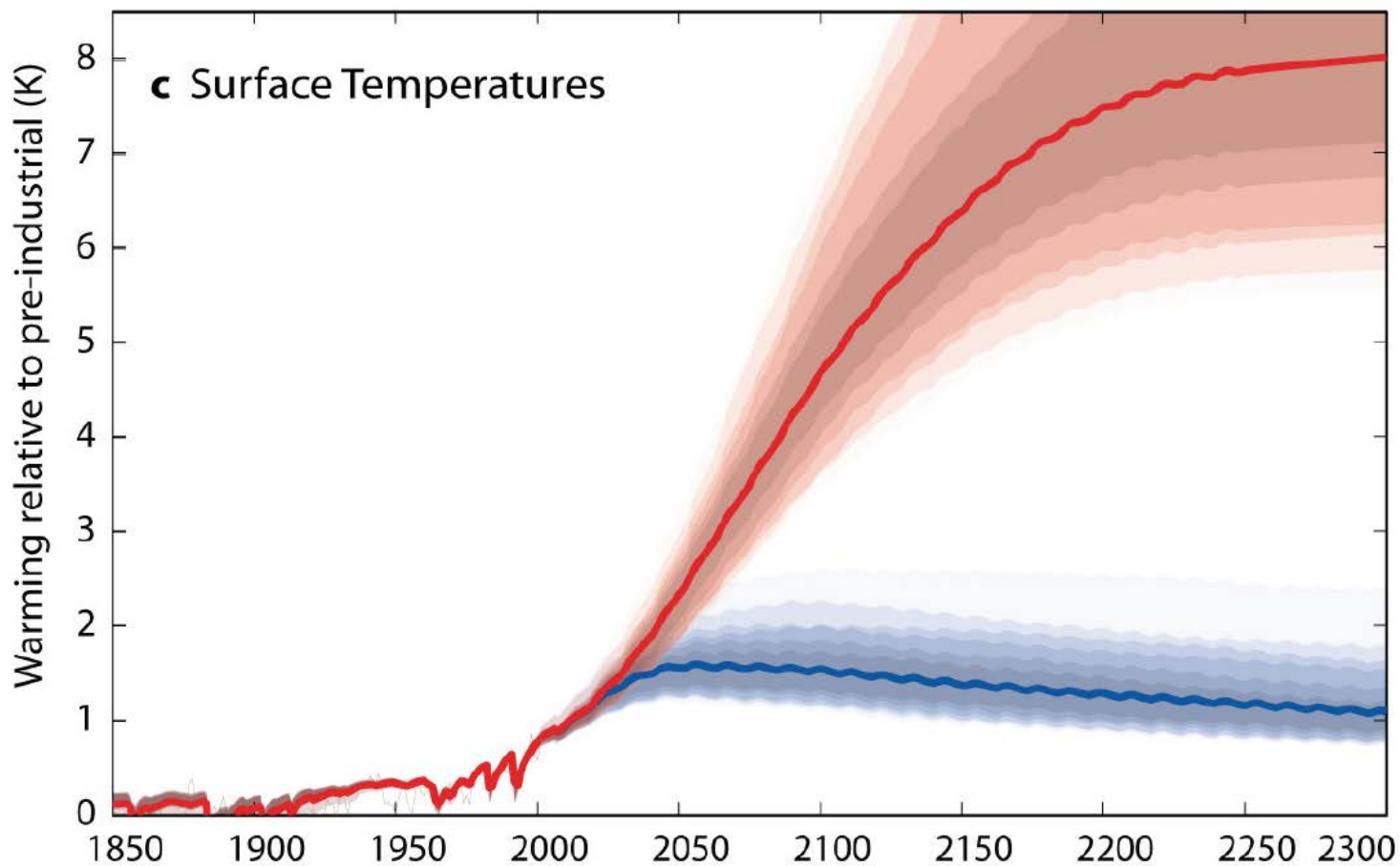


Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in these systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

Rockström et al. 2009 Nature, 461 (24): 472-475

A new "global spec" for world food production

1. Stay within 350 ppm, an agricultural system that goes from being a source to a global sink
2. Essentially a green revolution on current cropland (expansion from 12 % to 15 %)
3. Keep global consumptive use of blue water < 4000 km³/yr, we are at 2,600 km³/yr today and rushing fast towards 4000 km³/yr
4. Reduce to 25 % of current N extraction from atmosphere
5. Not increase P inflow to oceans
6. Reduce loss of biodiversity to < 10 E/MSY from current 100-1000 E/MSY



ipcc

INTERGOVERNMENTAL PANEL ON climate change

Final Plenary

Special Report Renewable Energy Sources (SRREN)

Summary for Policy Makers

Coordinating Lead Authors:

Ottmar Edenhofer (Germany), Ramon Pichs-Madruga (Cuba), Youba Sokona (Ethiopia/Mali), Kristin Seyboth (Germany/USA)

Lead Authors:

Dan Arvizu (USA), Thomas Bruckner (Germany), John Christensen (Denmark), Jean-Michel Deverny (France), Andre Faaij (The Netherlands), Manfred Fischedick (Germany), Barry Goldstein (Australia), Ger Hansen (Germany), John Huckerby (New Zealand), Arnulf Jäger-Waldau (Italy/Germany), Susanne Kadner (Germany), Daniel Kammen (USA), Volker Krey (Austria/Germany), Arun Kumar (India), Anthony Lewis (Ireland/United Kingdom), Oswaldo Lucon (Brazil), Patrick Matschoss (Germany), Lourdes Maurice (France), Catherine Mitchell (United Kingdom), William Moomaw (USA), José Moreira (Brazil), Alain Nadai (France), Lars J. Nilsson (Sweden), John Nyboer (Canada), Atiq Rahman (Bangladesh), Jayant Sathaye (USA), Robert Sawin (USA), Roberto Schaeffer (Brazil), Tormod Schei (Norway), Steffen Schlömer (Germany), Ralf U. Sommer (New Zealand), Christoph von Stechow (Germany), Aviel Verbruggen (Belgium), Kevin Urama (Kenya/Nigeria), Ryan Wisser (USA), Francis Yamba (Zambia), Timm Zwicker (Germany)

Special Advisor:

Jeffrey Logan (USA)



Stockholm Resilience Centre
Research for Governance of Social-Ecological Systems



A centre with:

