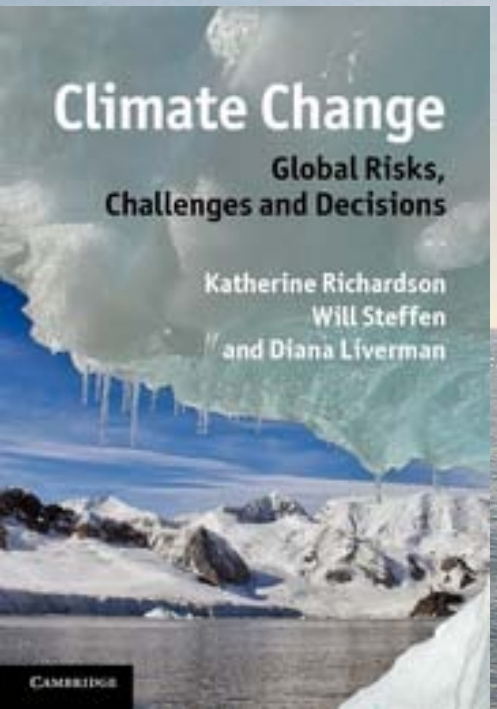
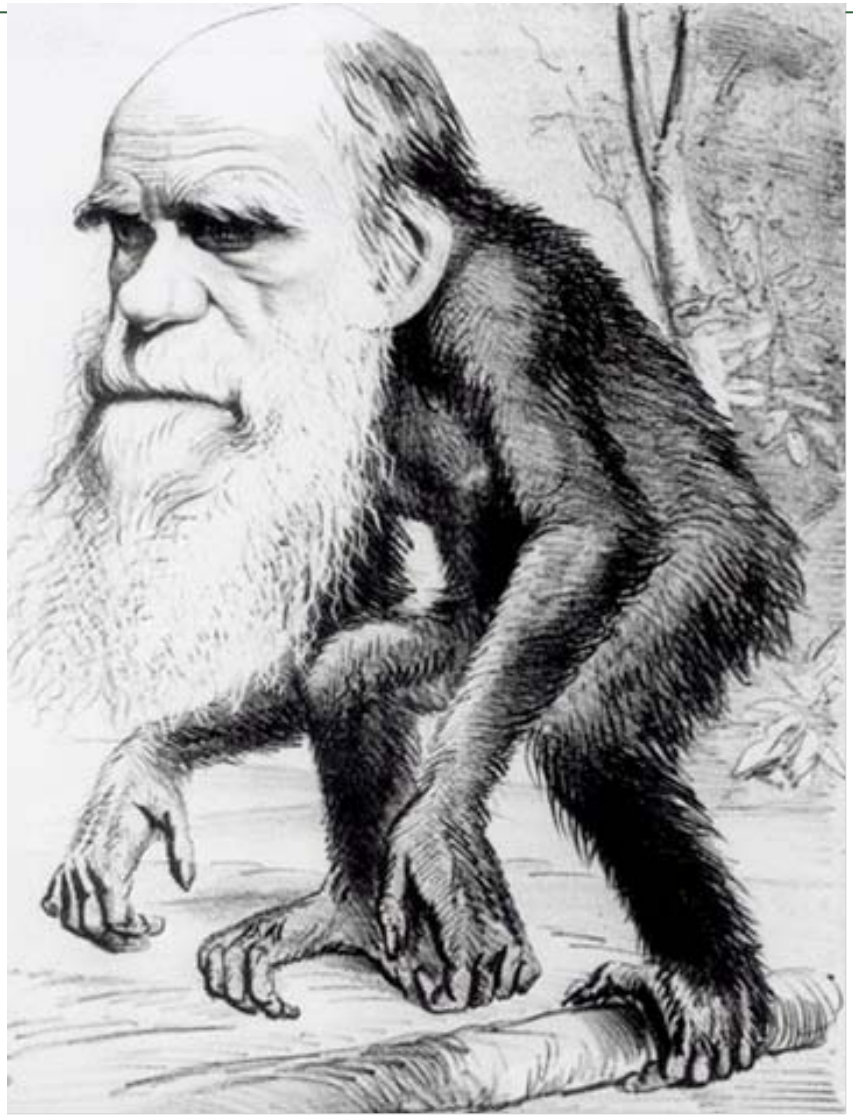
Challenges of the 21st Century

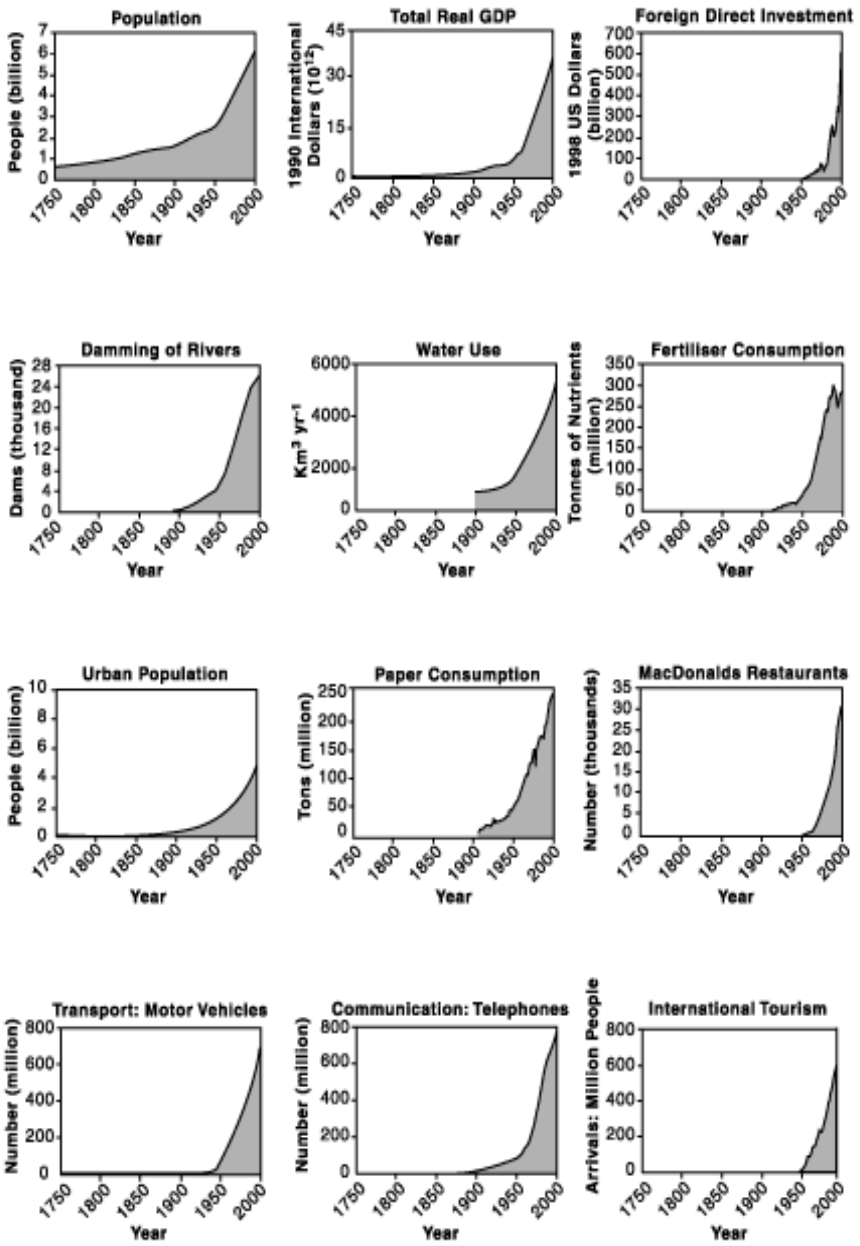


Katherine Richardson
Professor, University of Copenhagen

Cambridge University Press, March 2011



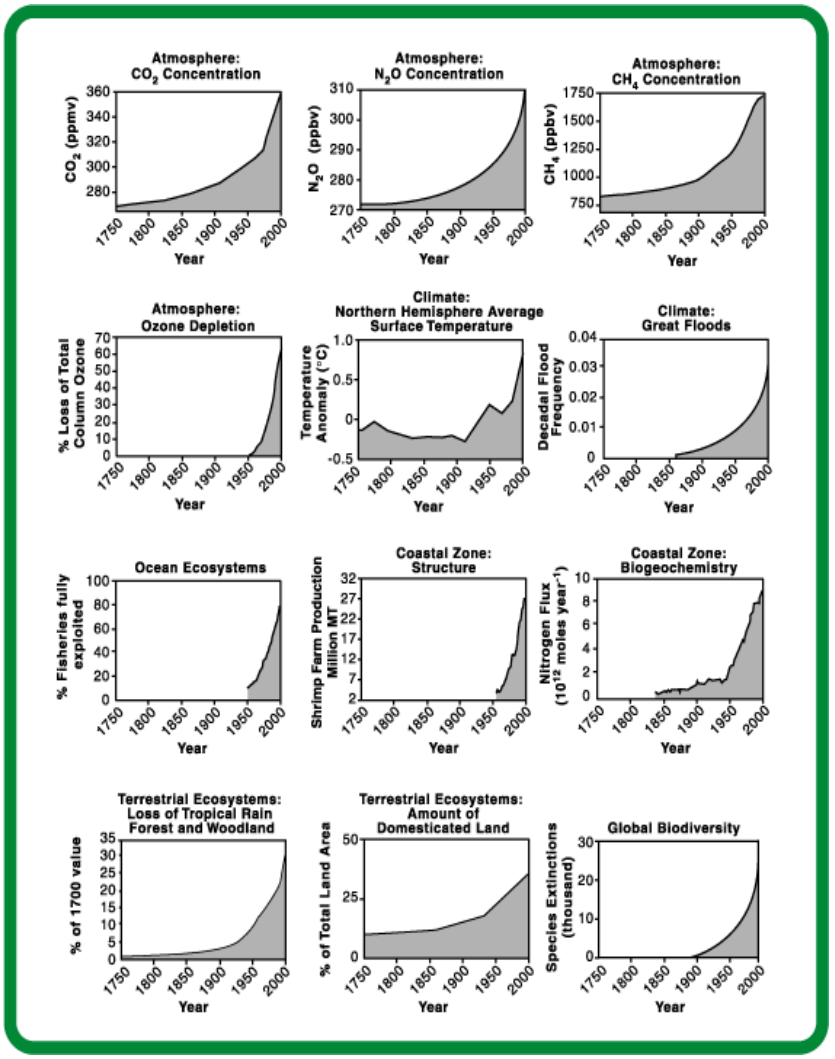
Human activities have dramatically increased over the last approx. 60 years



From: Steffen et al. 2004

The imprint of human activity can be seen in the Earth System…

Our ”real” currency is not money but natural resources….



Steffen, W., et al. 2004

The greatest challenge of the 21st Century is to develop mechanisms to share the Earth's resources among the (soon to be) 9 billion human inhabitants

Two important corallaries:

1. Economic and environmental considerations no longer follow separate tracks

2. The only ”growth” paradigm for the 21st century is one in which the focus is on effective use (and re-use) of resources and/or finding replacements for resources where demand is approaching supply

The Nordic countries have a good starting position here….and universitites have an important role to play…

Three kinds of resources;

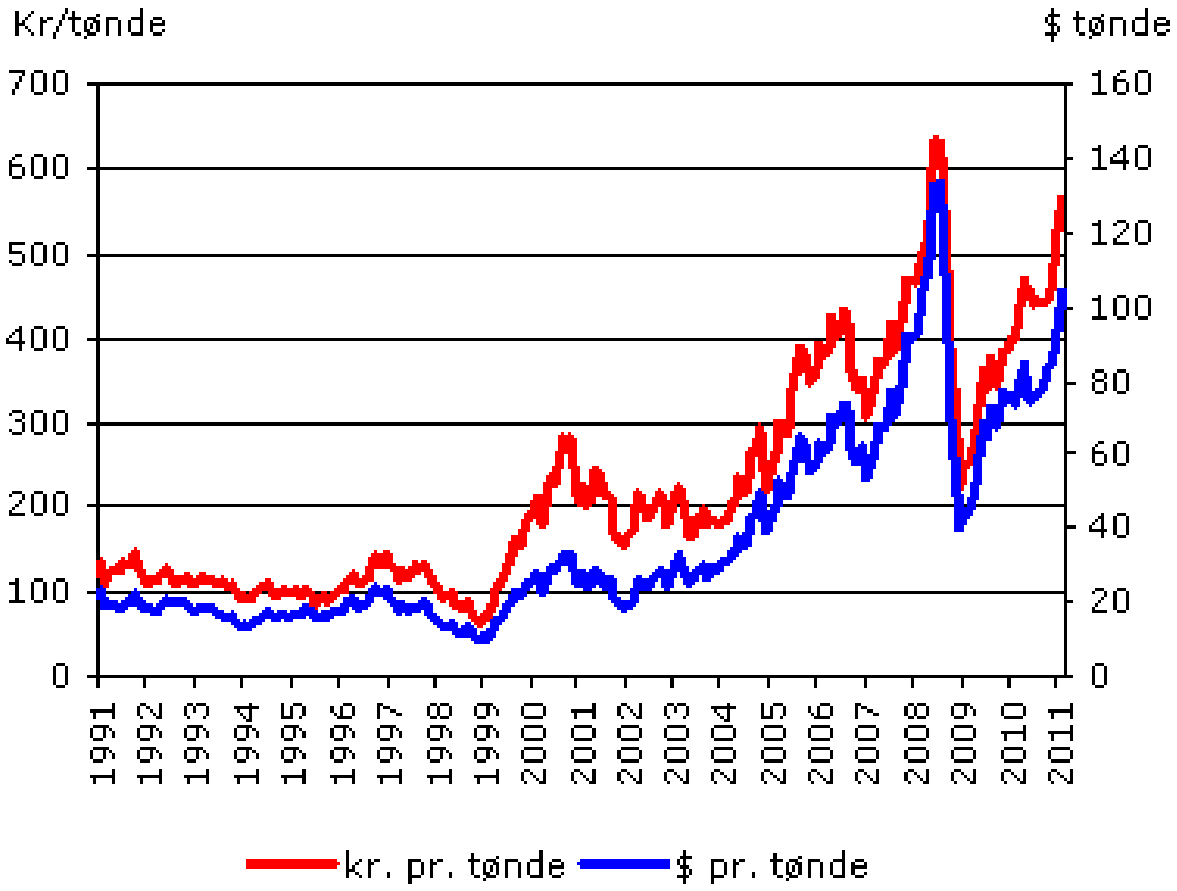
I. ”Provisioning goods and services”: Living and non-living resources that can be harvested for food, manufacturing, etc.

II. ”Supporting services”: i.e. Himalayan glaciers, upwelling, climate system, hydrological cycle, etc.

III. ”Regulating Services”: i.e., biological control of pests and diseases, regulation of the climate system through natural carbon sinks, etc.

We’re pretty good af putting a price/value on provisioning goods and services…

Økonomiske forudsætninger

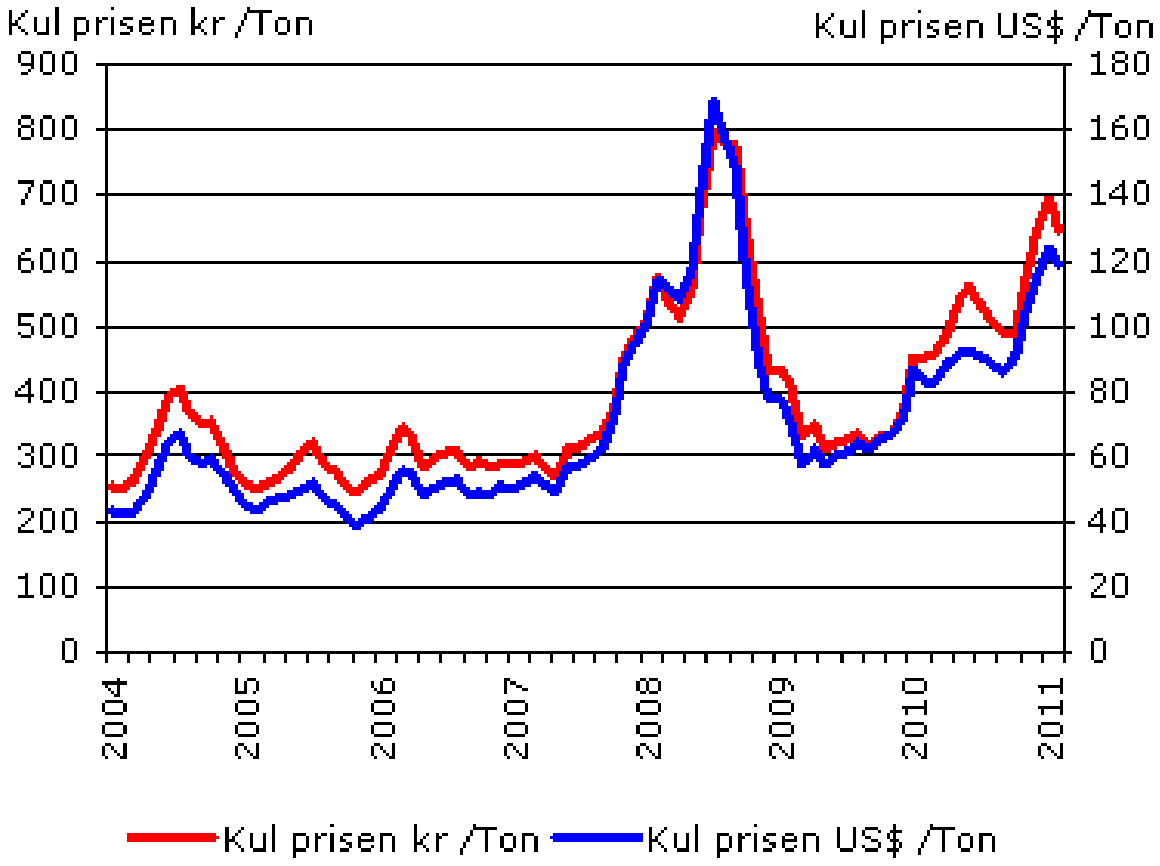


Prisen på olie

Kilde: Energistyrelsen

CONCITO

Økonomiske forudsætninger



Prisen på kul

Kilde: Energistyrelsen

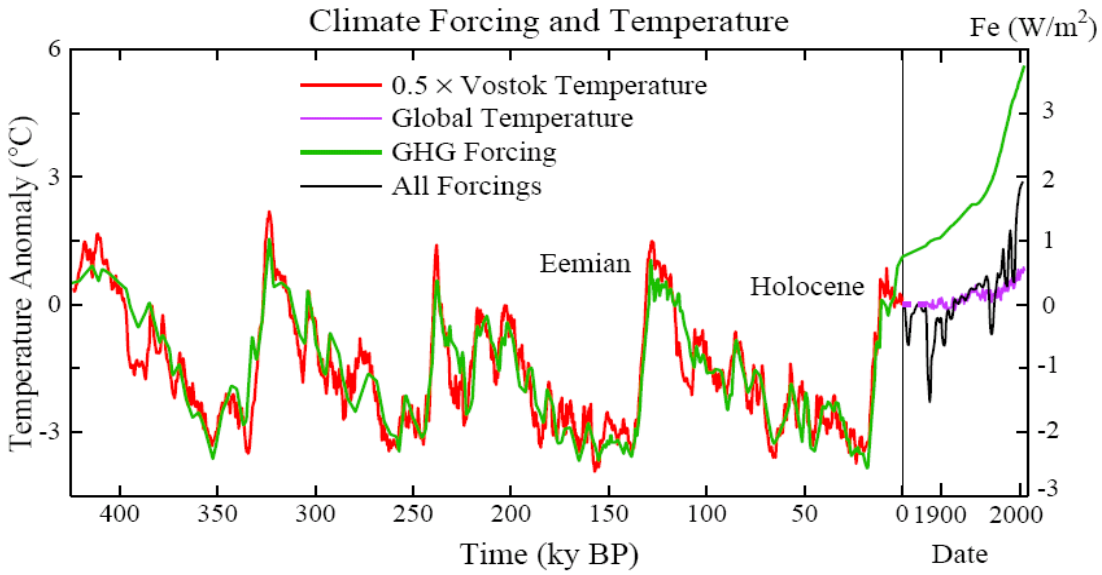
CONCITO

A much greater challenge is acknowleging the real value of the supporting and regulating resources…

Such as our common atmospheric garbage dump for greenhouse gas waste

Climate Change = Overuse of a supporting service resource

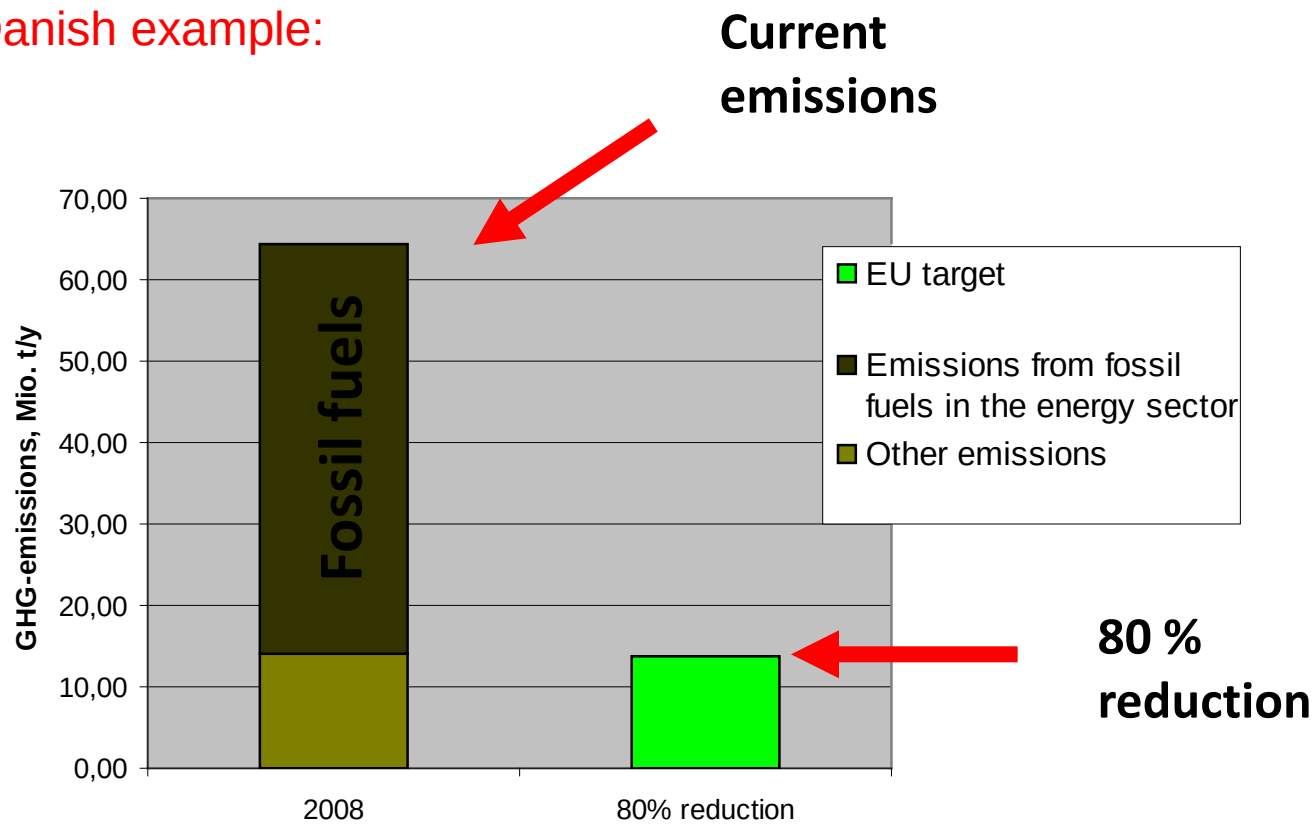
(global atmospheric garbage dump for waste greenhouse gases)



The good news is it links to a limited provisional resource (fossil fuels)

Combustion of fossil fuels generates the bulk of CO_2 emissions.

The Danish example:



A new ”global spec” for energy:

IEA : 50% increase in demand for energy by 2050.

Current supply source not able to meet demand:

Known oil reserves to approx. 42 years (World Energy Outlook)

CO_2 reduction (EU:GHG) 80-95% by 2050

IEA: Potential global market for alternative energy and energy efficiency technology: 60,000 BILLION DKK from now to 2030.

Investors are beginning to smell profit in alternative (non-fossil) energy systems… this gives me hope with regard to climate change

BUT climate change is only the tip of the iceberg

What about the other supporting and regulating goods and services?

Planetary Boundaries: Exploring the safe operating space for humanity in the Anthropocene (*Nature*, 461 : 472 – 475, Sept 24 - 2009)

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 years[1,2]. This period of stability — known to geologists as the Holocene — has seen human civilizations arise, develop and thrive. Such stability may now be under threat. Since the Industrial Revolution, a new era has arisen, the Anthropocene[3], in which human actions have become the main driver of global environmental change[4]. This could see human activities push the Earth system outside the stable environmental state of the Holocene, with consequences that are detrimental or even catastrophic for large parts of the world.

During the Holocene, environmental change occurred naturally and Earth's regulatory 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 reached 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 development[5]. Without pressure from humans, the Holocene is expected to continue for at least several thousands of years[2].

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 subsystems or processes. Although Earth's complex systems sometimes respond smoothly to changing pressures, it seems that this will prove to be the exception rather than the rule. Many subsystems of Earth react in a nonlinear, often abrupt, way, and are particularly sensitive around threshold levels of certain key variables. If these thresholds are crossed, then important subsystems, such as a monsoon system, could shift into a new state, often with deleterious or potentially even disastrous consequences for humans[6].

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: climate 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 Fig. 1 and Table).

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

E&S

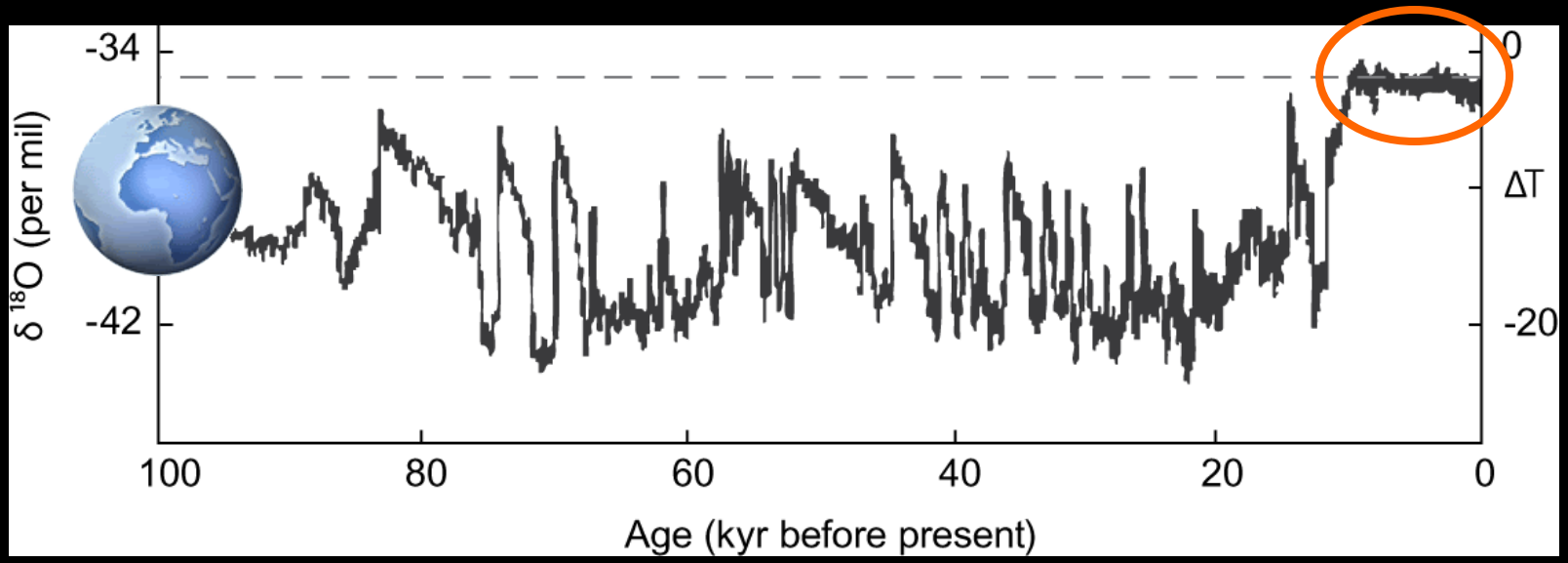
Research

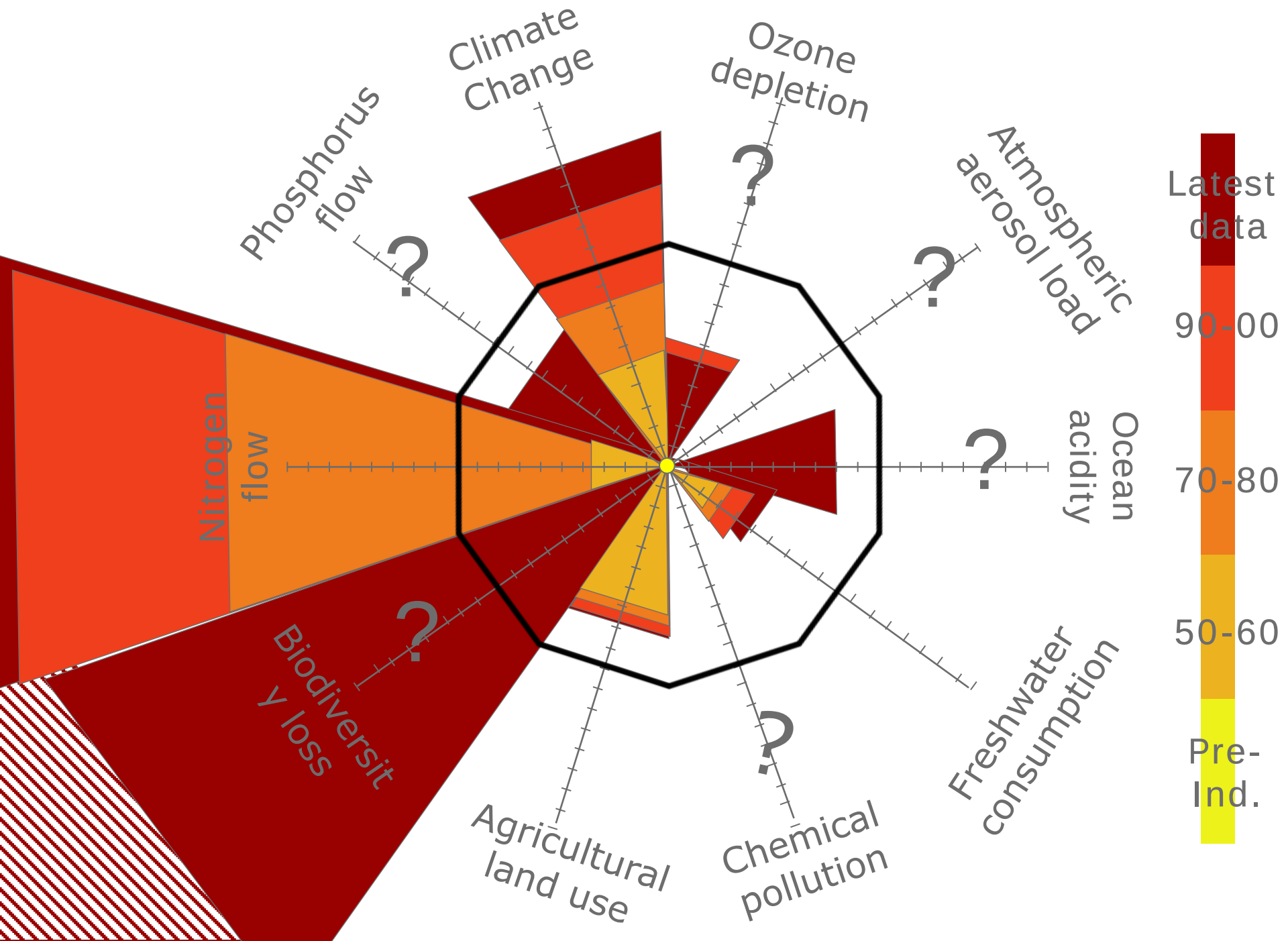
Planetary Boundaries: Exploring the Safe Operating Space for Humanity

Johan Rockström [1,2], *Will Steffen* [1,3], *Kevin Noone* [1,4], *Åsa Persson* [1,2], *F. Stuart III Chapin* [5], *Eric Lambin* [6], *Timothy M. Lenton* [7], *Marten Scheffer* [8], *Carl Folke* [1,9], *Hans Joachim Schellnhuber* [10,11], *Björn Nykvist* [1,2], *Cynthia A. de Wit* [4], *Terry Hughes* [12], *Sander van der Leeuw* [13], *Henning Rodhe* [14], *Sverker Sörlin* [1,15], *Peter K. Snyder* [16], *Robert Costanza* [1,17], *Uno Svedin* [1], *Malin Falkenmark* [1,18], *Louise Karlberg* [1,2], *Robert W. Corell* [19], *Victoria J. Fabry* [20], *James Hansen* [21], *Brian Walker* [1,22], *Diana Liverman* [23,24], *Katherine Richardson* [25], *Paul Crutzen* [26], and *Jonathan Foley* [27]

Ecology and Society **14**(2): 32
http://www.ecologyandsociety.org/vol14/iss2/art32/

Humanity's 12,000 years of grace



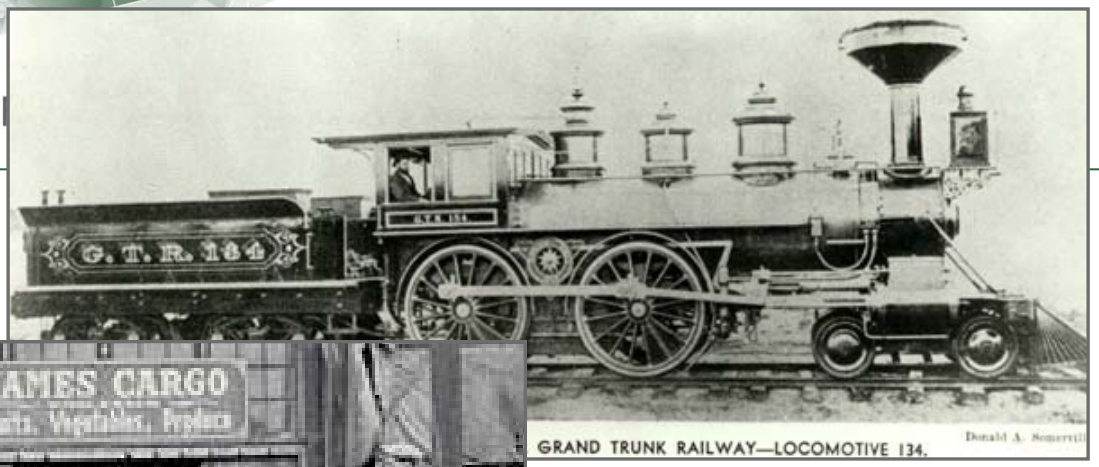

Climate Change
Ozone depletion
Atmospheric aerosol load
Ocean acidity
Freshwater consumption
Chemical pollution
Agricultural land use
Biodiversity loss
Nitrogen flow
Phosphorus flow
?
Latest data
90-00
70-80
50-60
Pre-Ind.

The GRAND CHALLENGE is to bring the human demand for natural resources into balance with respect to their supply (and in so far as possible to leave resource capital intact for future generations)

Putting things in perspective…

- The Earth was formed about 4.7 billion years ago
- The present form of our species showed up about 250,000 years ago…
- We are ca. generation # 10,000…
- Most generations lived in caves…

Inspired by O.J.Nielsen



- 6-8 generations ago, we replaced animal power with machines
- 4-5 generations we discovered the automobile…

- We are the first generation that KNOWS (thanks to research) that our combined activities impact the Earth at the system level…
- **The first generation with the POWER and RESPONSIBILITY to change and manage our species' relationship with the planet.**
- **The challenge 1 is to learn to respect that our REAL currency is the Earth's resources**