SVENSKA ARALSJÖSÄLLSKAPET

Swedish Aral Sea Society

2. Resource flows

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Uppsala University

For Uzbekistan by Karakalpak State University and SASS
Master Course on Sustainable Development and Sustainability Science
Spring 2022

Something New Under the Sun

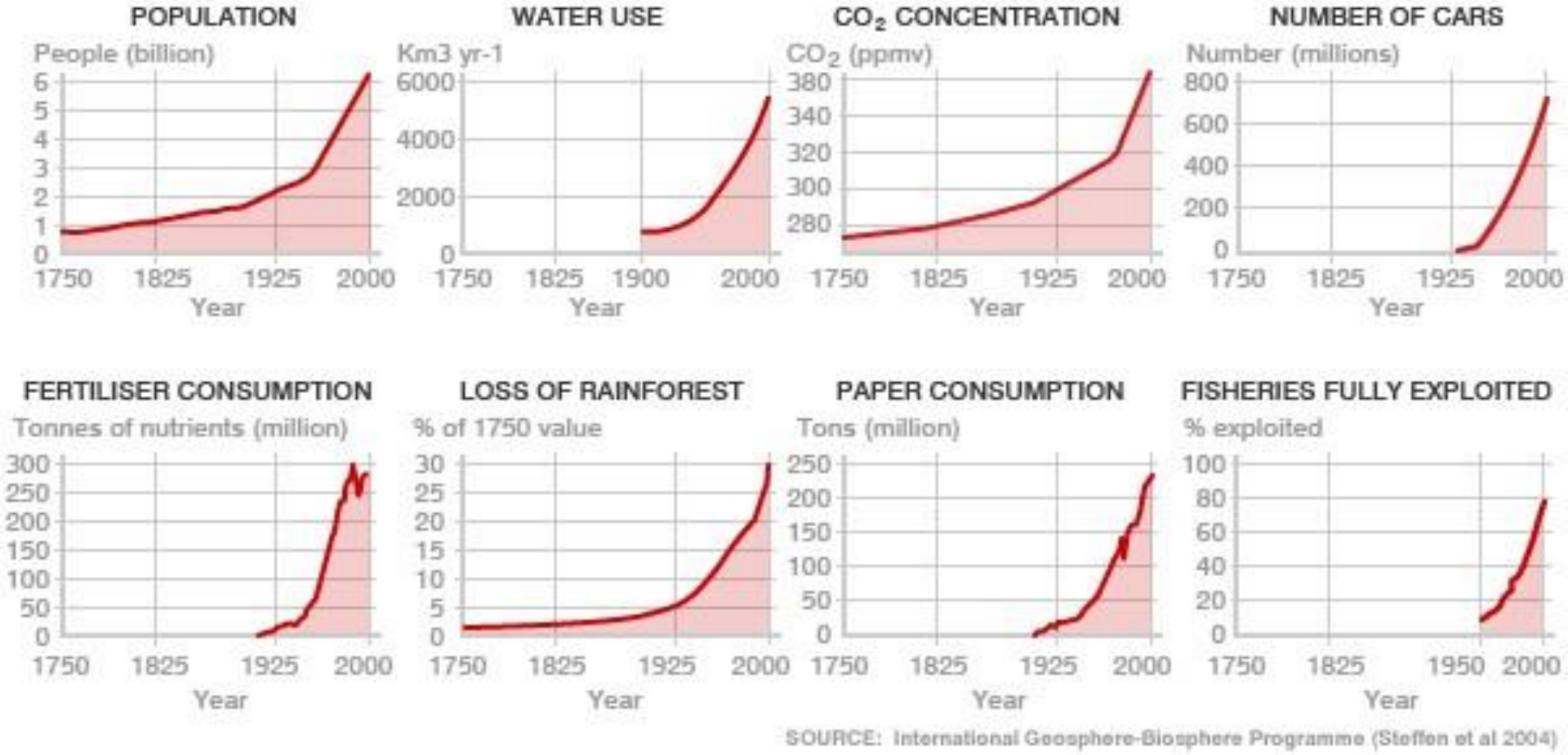
John McNeill, 2000

Development 1900 – 2000

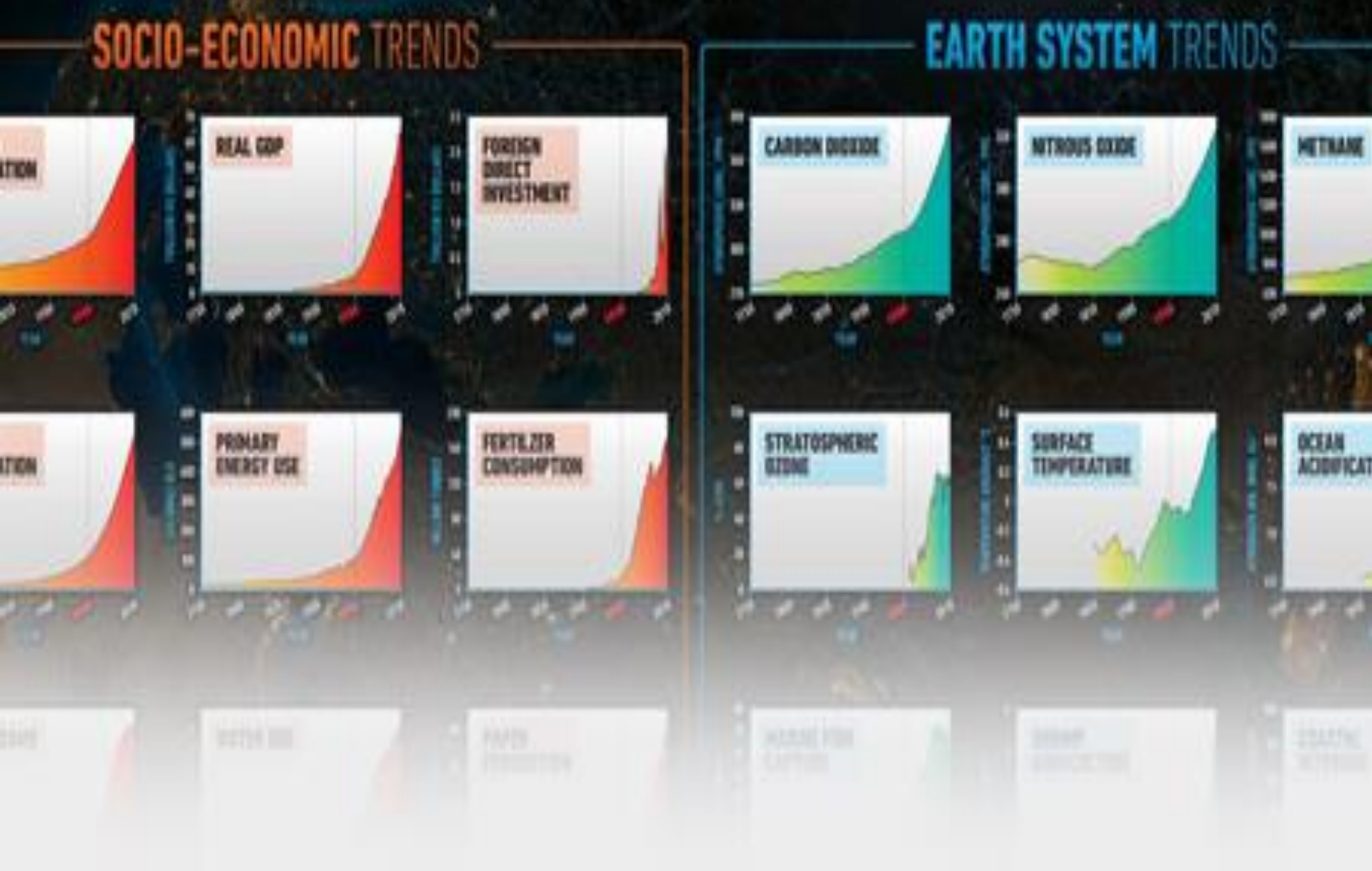
- global population 4 x
- global economy 14 x
- industrial production 40 x
- energy use 16 x
- carbon dioxide emissions 17 x
- sulphur dioxide emissions 13 x
- ocean fishing catches 35 x
- number of pigs 9 x
- forests 0.8 x
- agricultural fields 2 x
- blue whale 0.0025 x

Alan AtKisson

Exponential Growth



THE GREAT ACCELERATION




”We live
in the
Anthropocene”

Non-renewable resources

Mined from the crust of the earth
They are slowly emptied

The environmental consequences
of the accumulation of the end product
will often appear before the resource is emptied.

Fossil fuels
coal, oil, gas

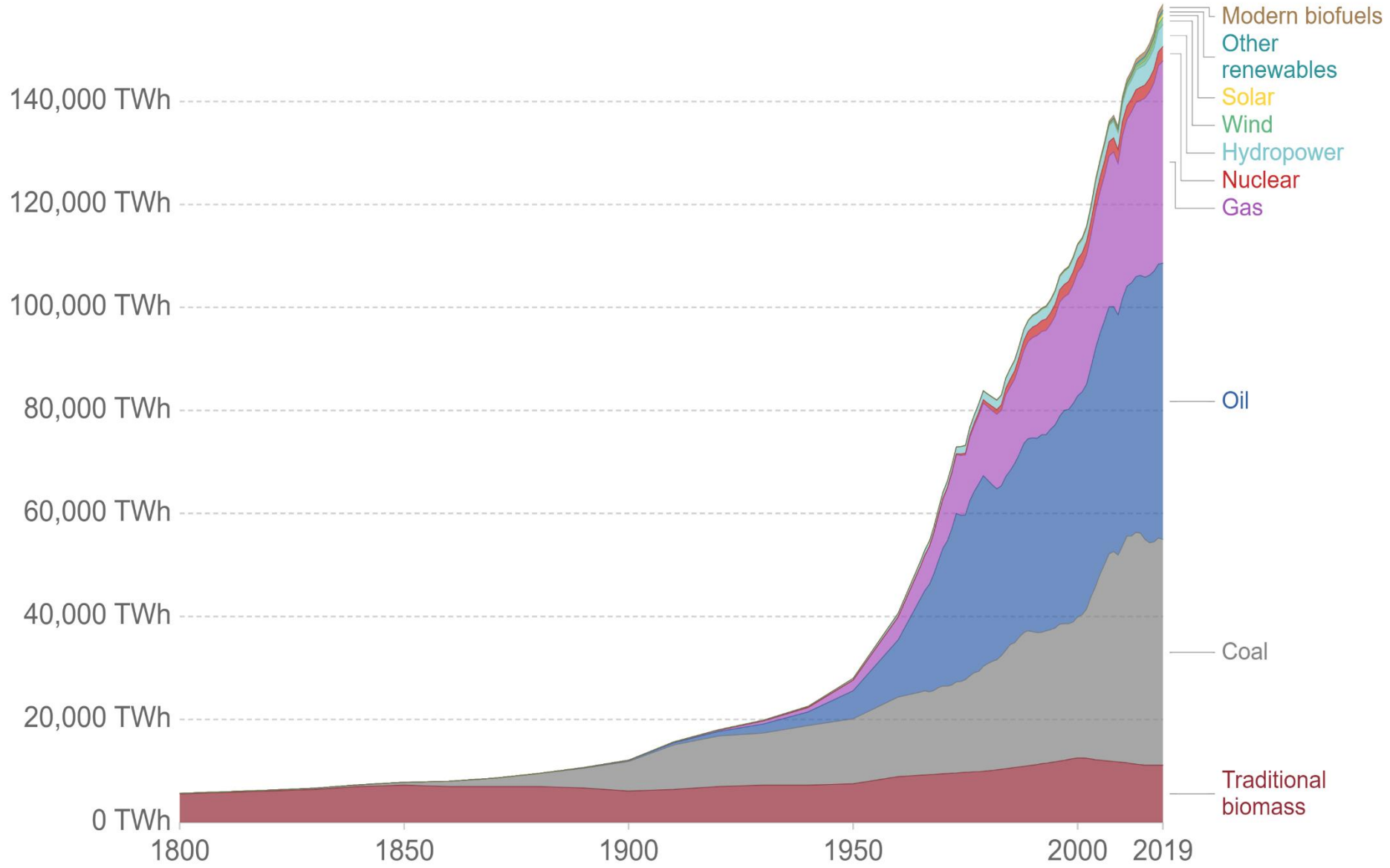
Lignite mining
Germany


Lignite Power Plant Belchatow, Poland

Global direct primary energy consumption

Direct primary energy consumption does not take account of inefficiencies in fossil fuel production.

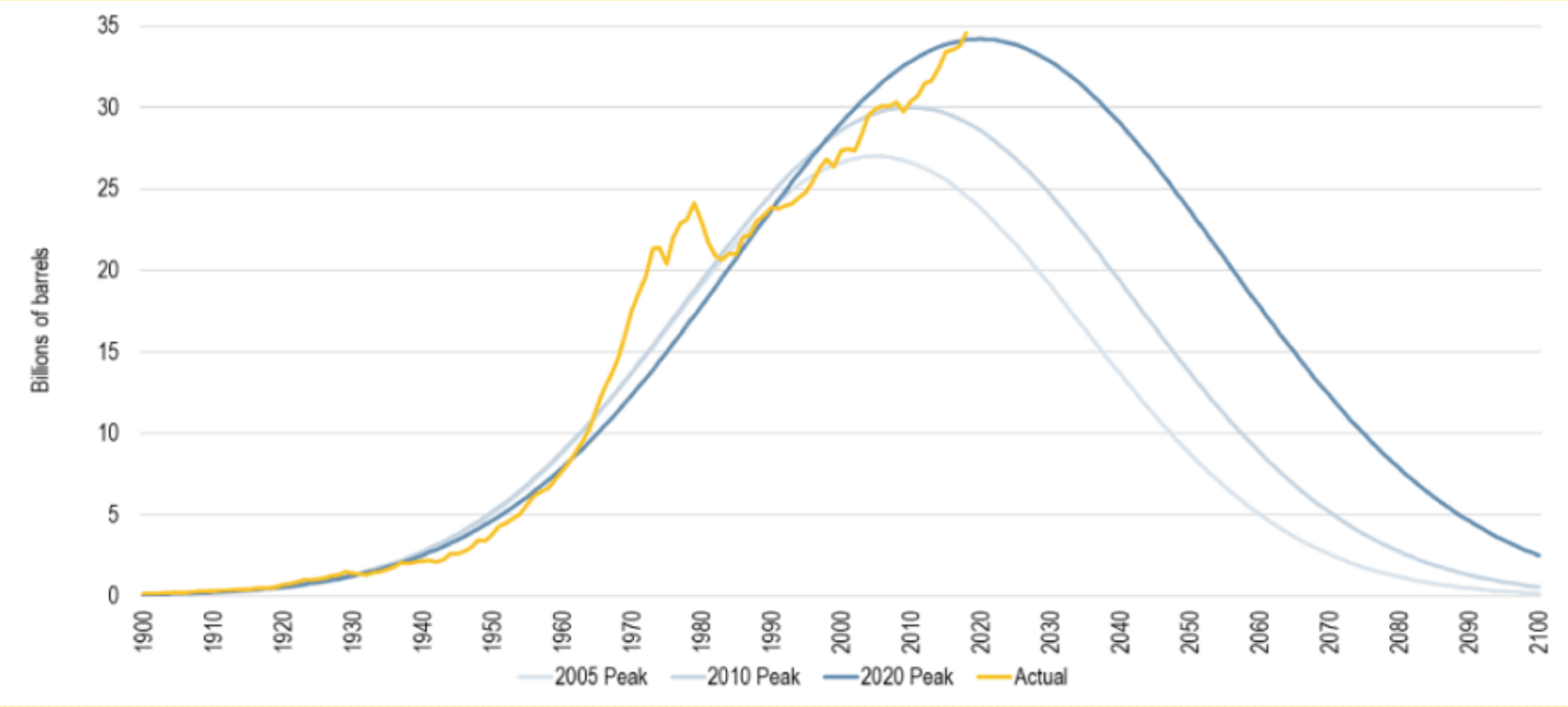
Our World in Data



Source: Vaclav Smil (2017) and BP Statistical Review of World Energy

OurWorldInData.org/energy • CC BY

World Annual Oil Production and Peak Oil

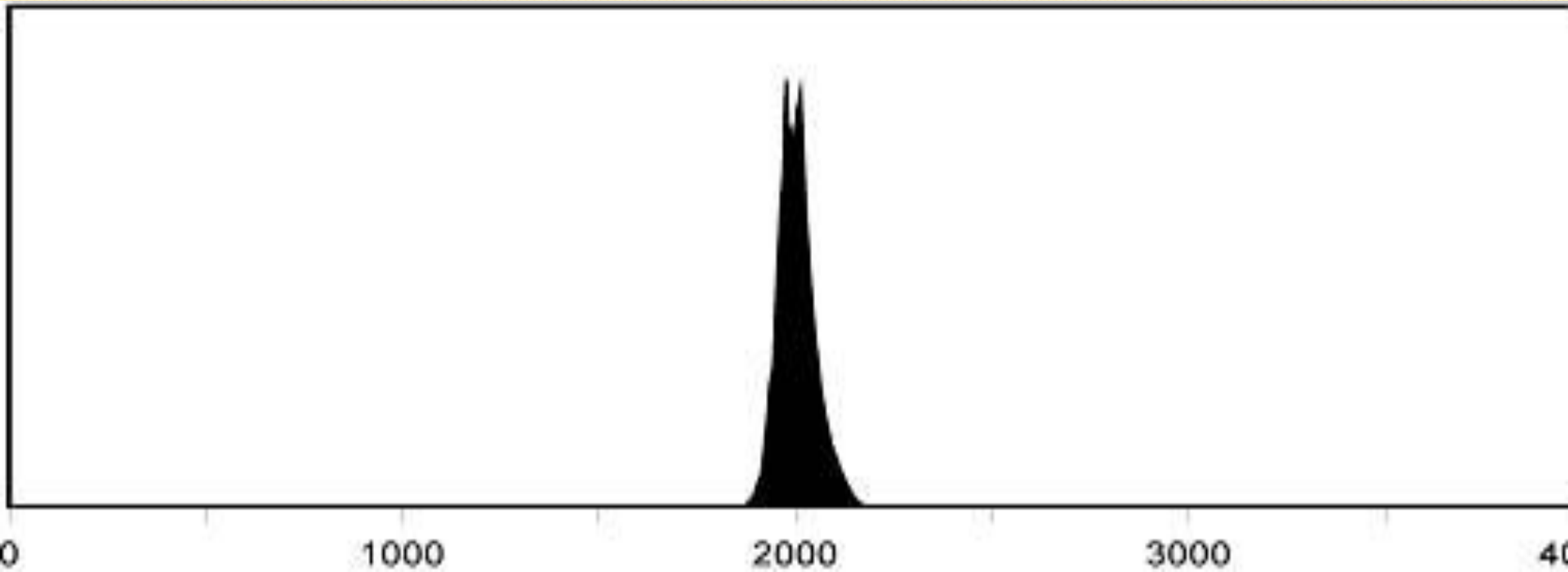


Source: https://transportgeography.org/contents/chapter4/transportation-and-energy/peak-oil/

The future of energy

Economist.com

The end of the Oil Age




Efforts to out-phase fossils are ongoing in building sector, transport sector by developing new energy sources to combat climate change

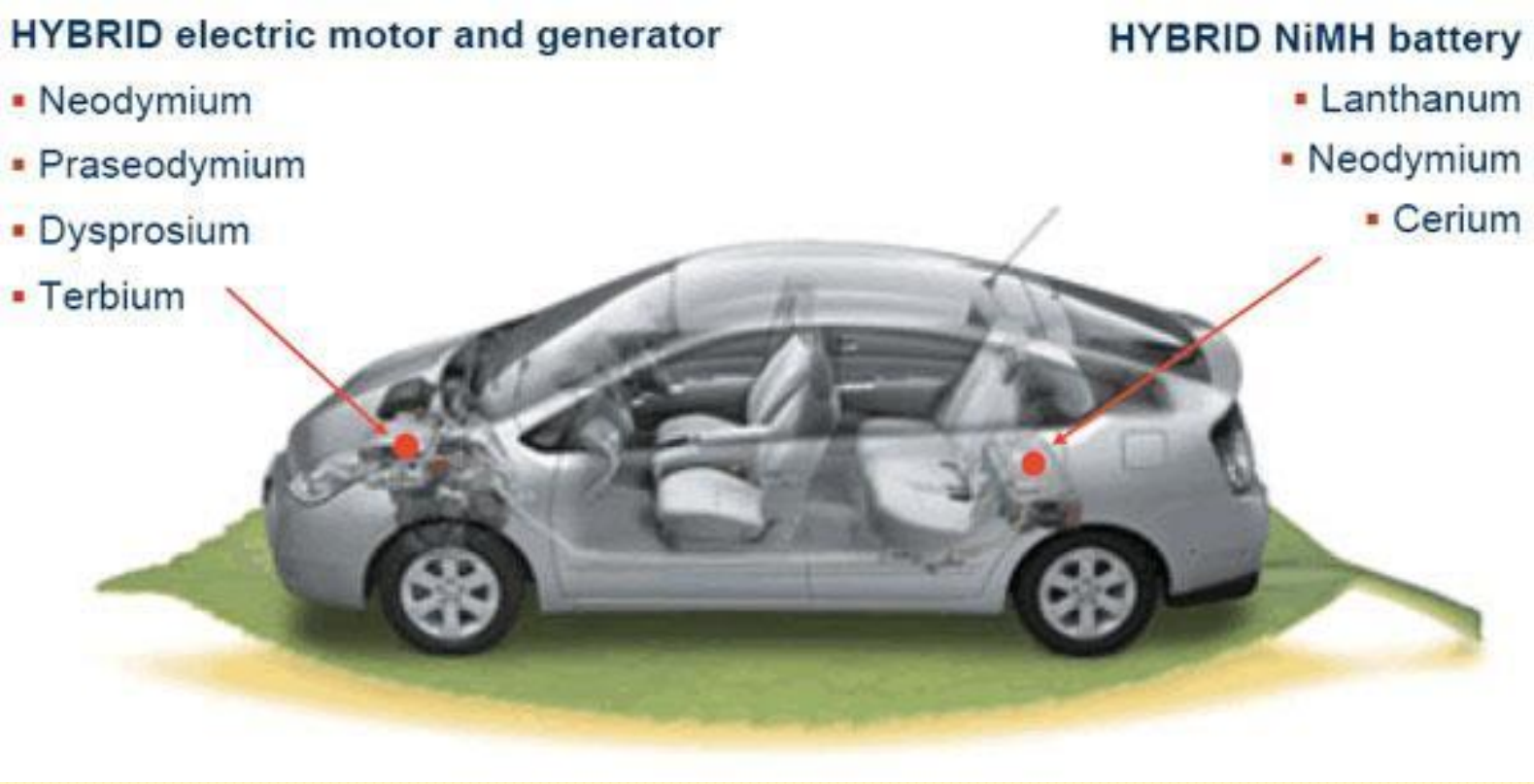
Iron mine Kiruna Sweden

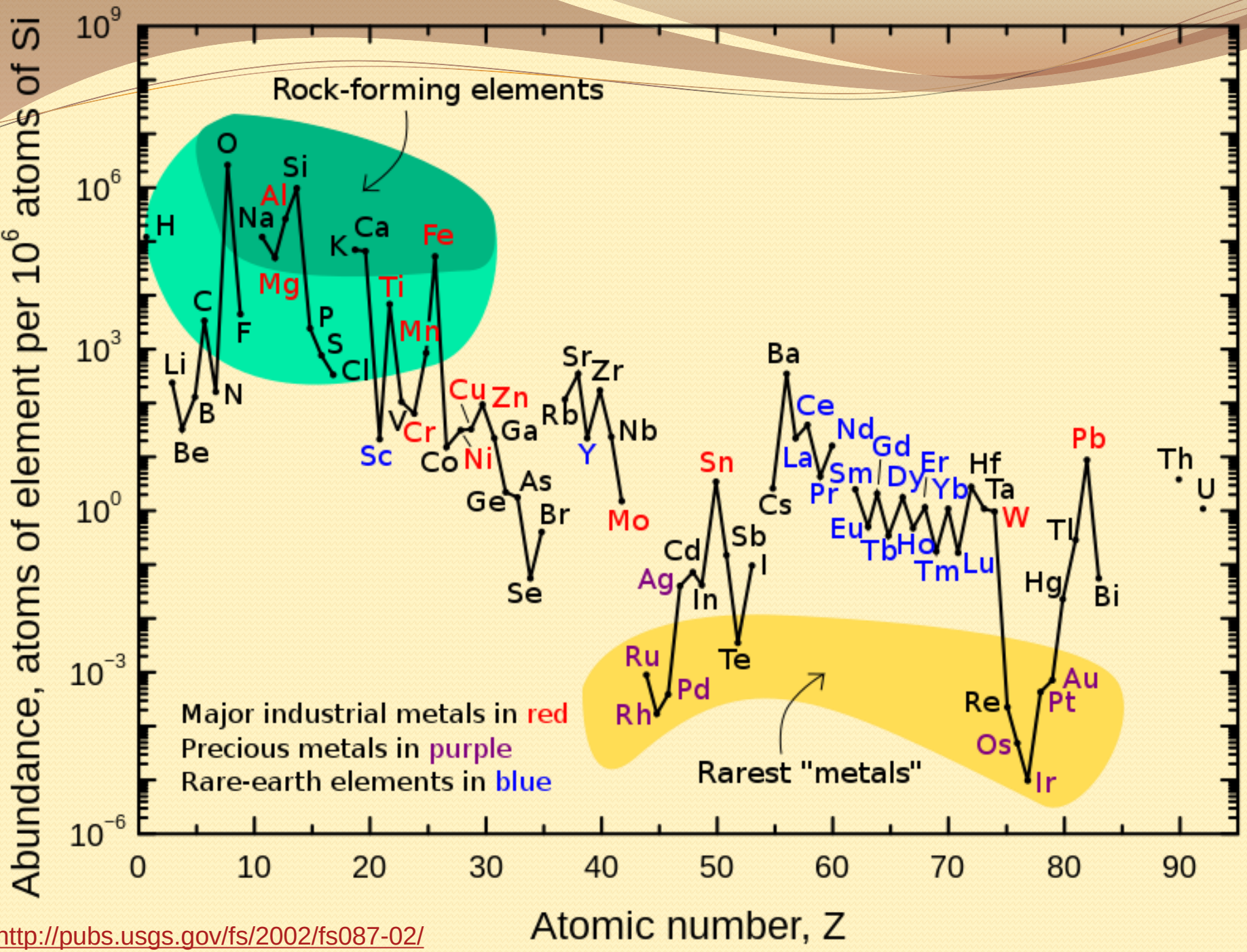
Looming crisis in rare earth metals

China produces and exports 95% of the rare earth metals in the world. Virtually every developed nation in the world imports REM. Rare earths are vital to new technologies such as iphones, flat screen televisions and green energy technology.

Lately REM has declining worldwide supply and skyrocketing prices. This has Western governments worried, as rare earth metals are also key to high tech military applications.

Hybrid technology is totally dependent on Rare Earths





http://pubs.usgs.gov/fs/2002/fs087-02/

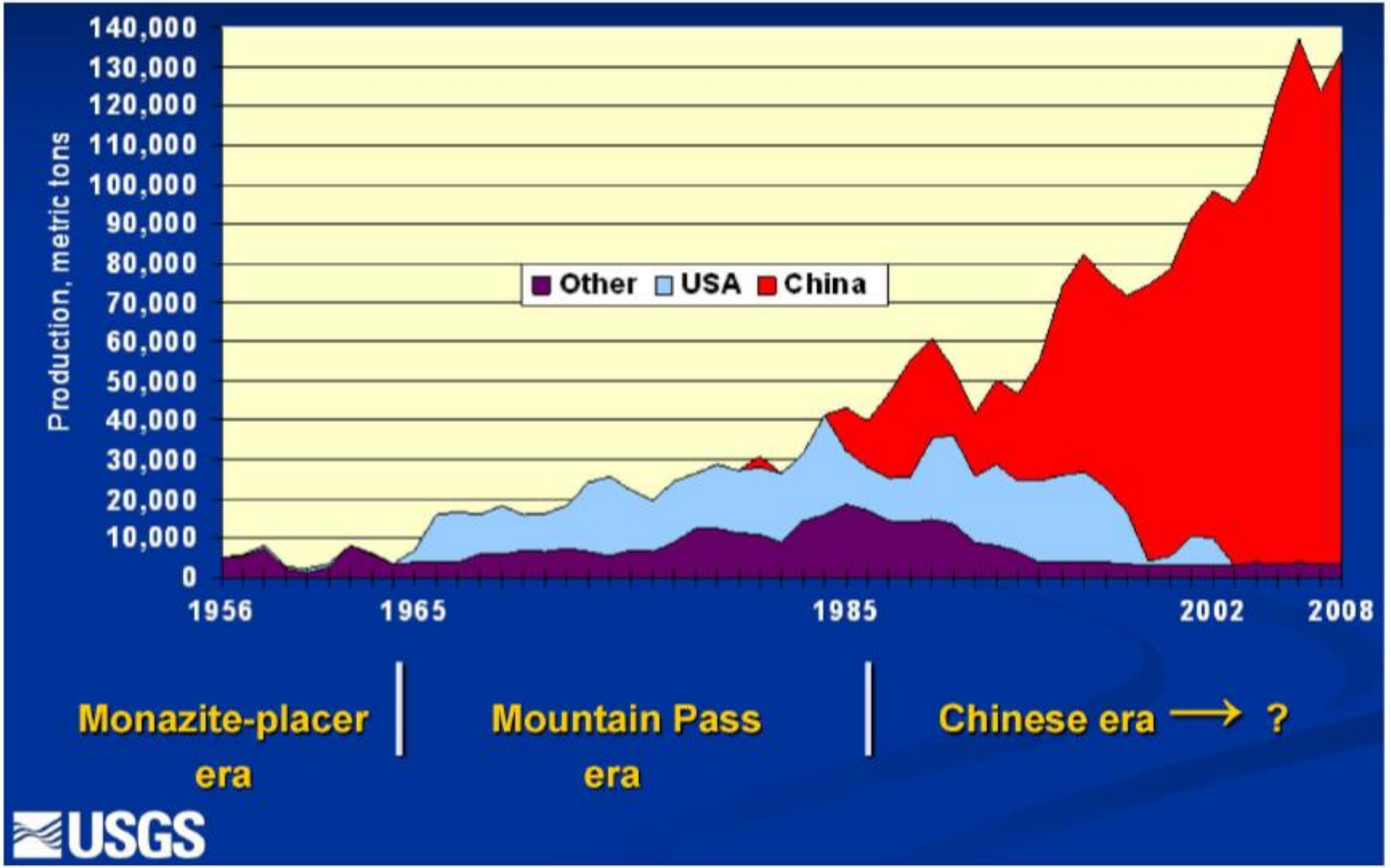


Figure 1. Global rare-earth-oxide production trends. The Mountain Pass deposit is in California, U.S.A. Graph from D.J. Cordier (U.S. Geological Survey, written commun., 2011) was updated from Haxel and others (2002, fig. 1).

Source: Global rare-earth-oxide production trends, 1956-2008 (USGS)

Recycling of non-renewable resources – metals

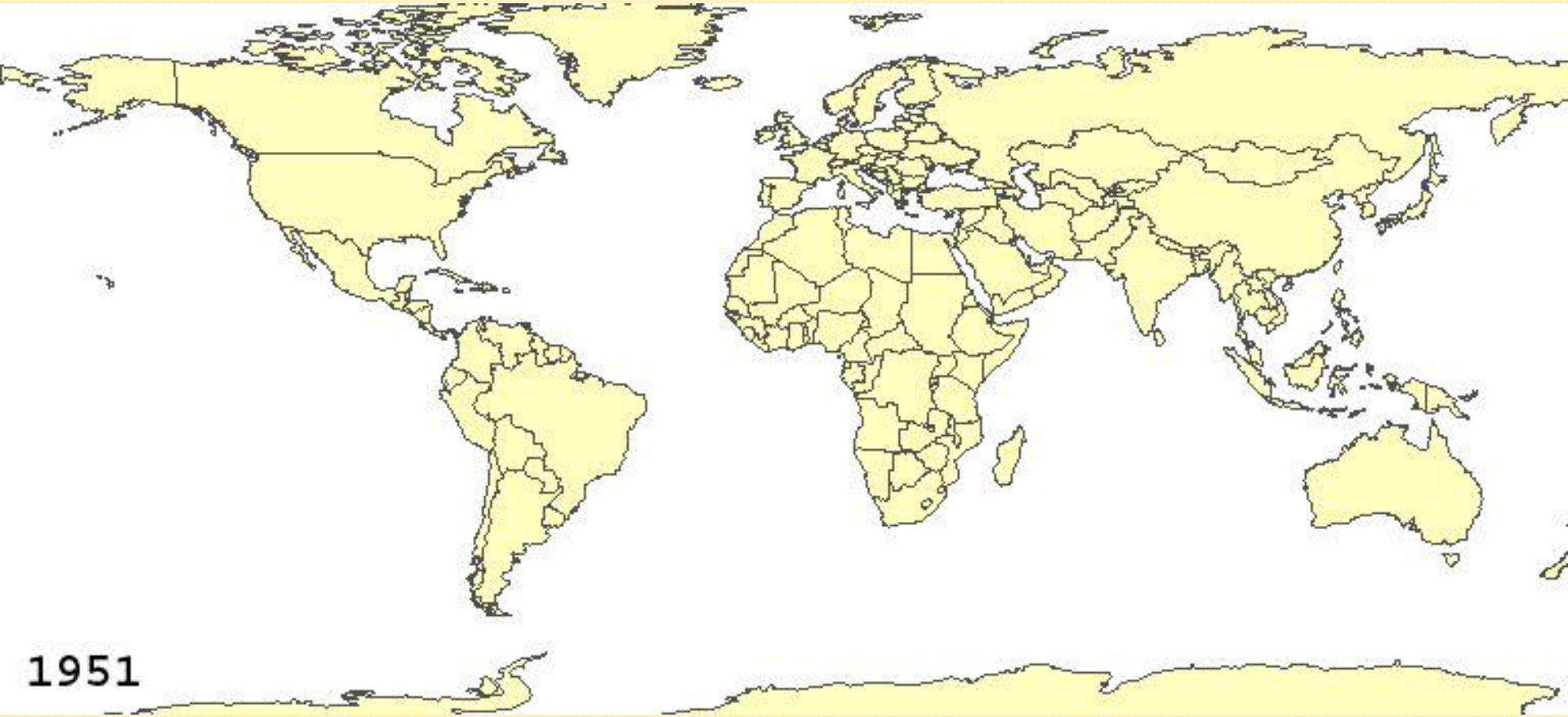
- **Steel** is today produced from scrap iron and some virgin metal.
- Recycled **copper** is paid well
- **Lead** recyling is requested by law and is >99%
- **Mercury** is taken out of resource flow and stored
- Rycycling of **REM** has to be improved

Renewable resources

These can not be harvested faster then the reproduction rate;
Also renewable resources can be emptied.


FISHERIES

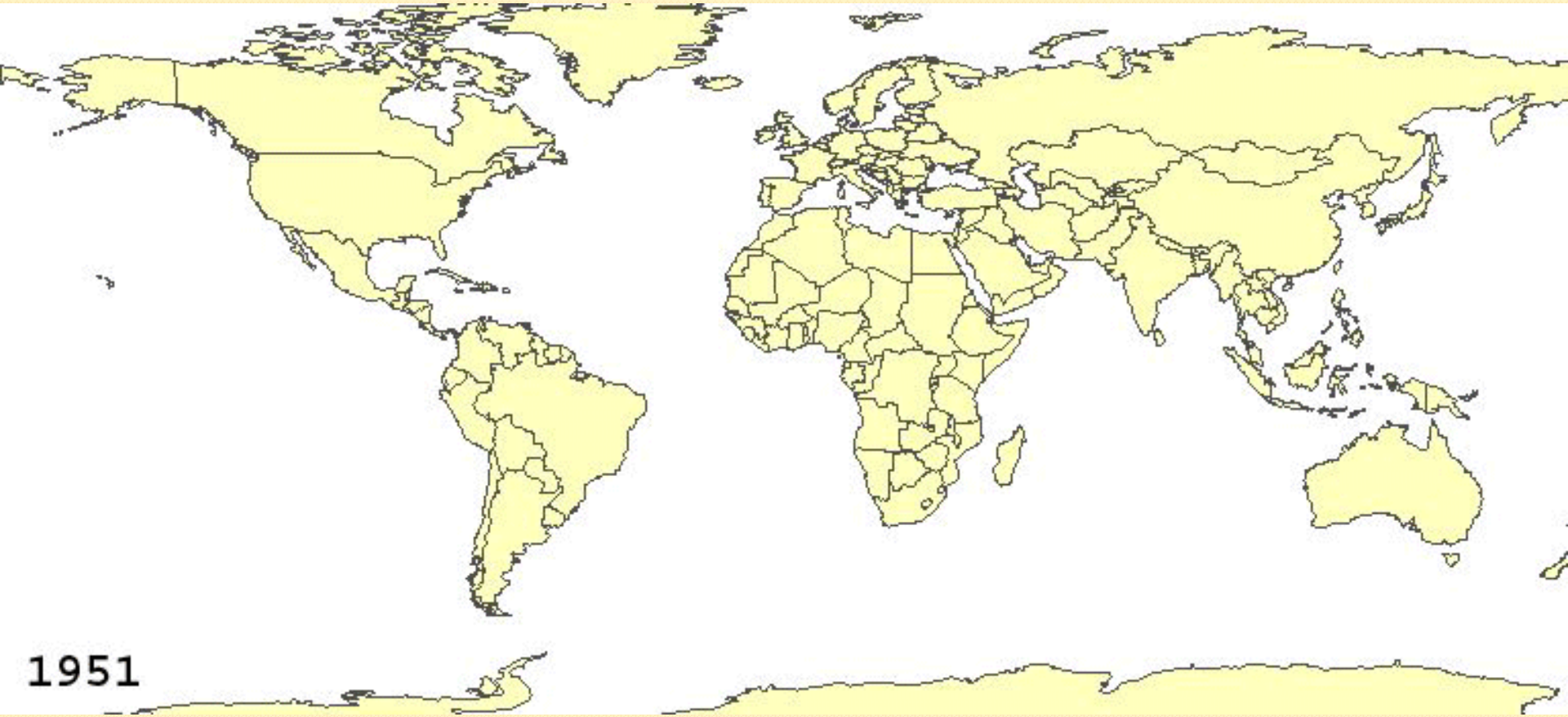
Fisheries



Year of Peak Fish Harvest

- Pre-peak
- Harvest peak
- Post-peak

Source: Millennium Ecosystem Assessment and Sea Around Us project



Year of Peak Fish Harvest

Pre-peak

Harvest peak

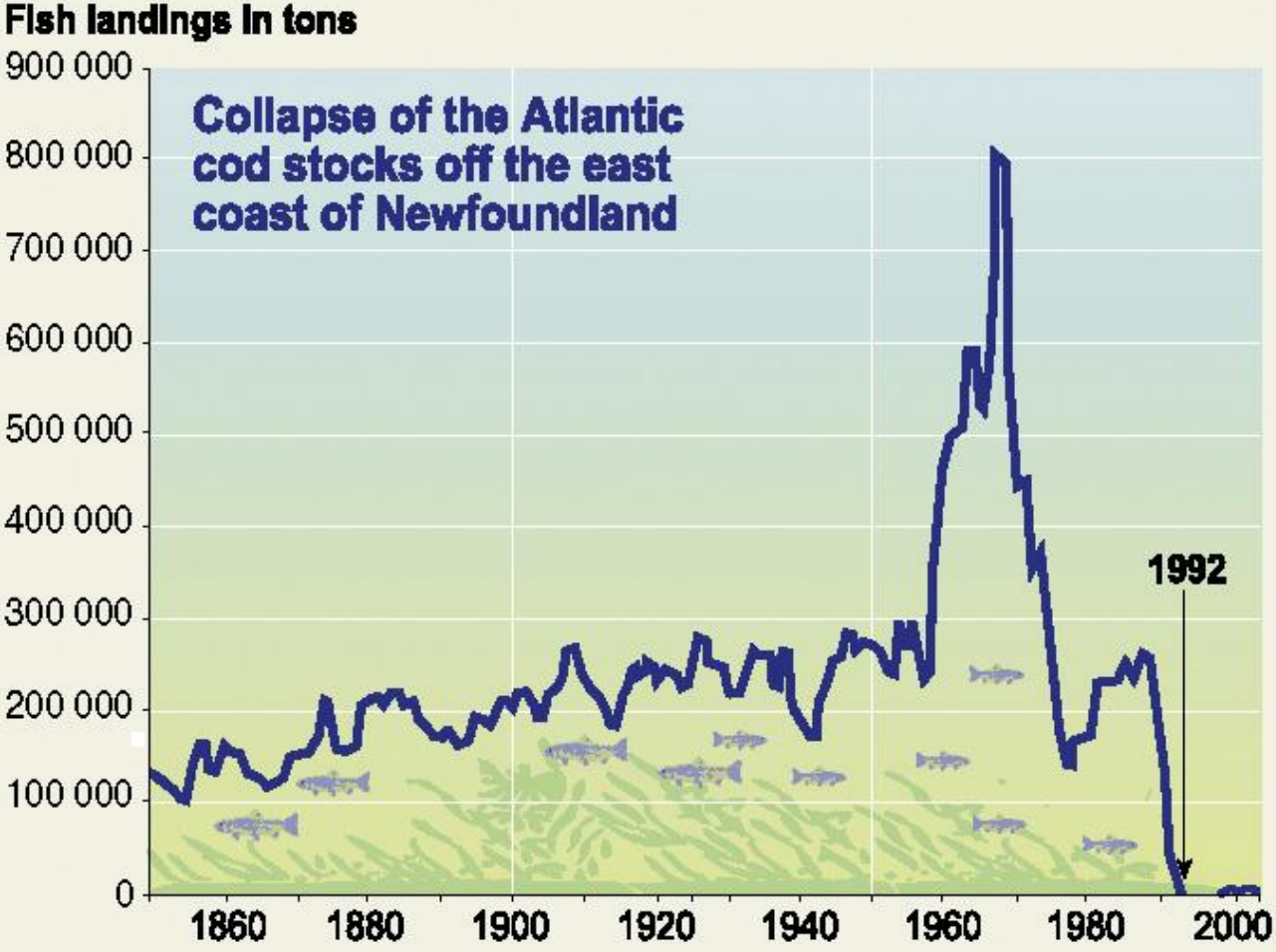
Post-peak

Source: Millennium Ecosystem Assessment and Sea Around Us project

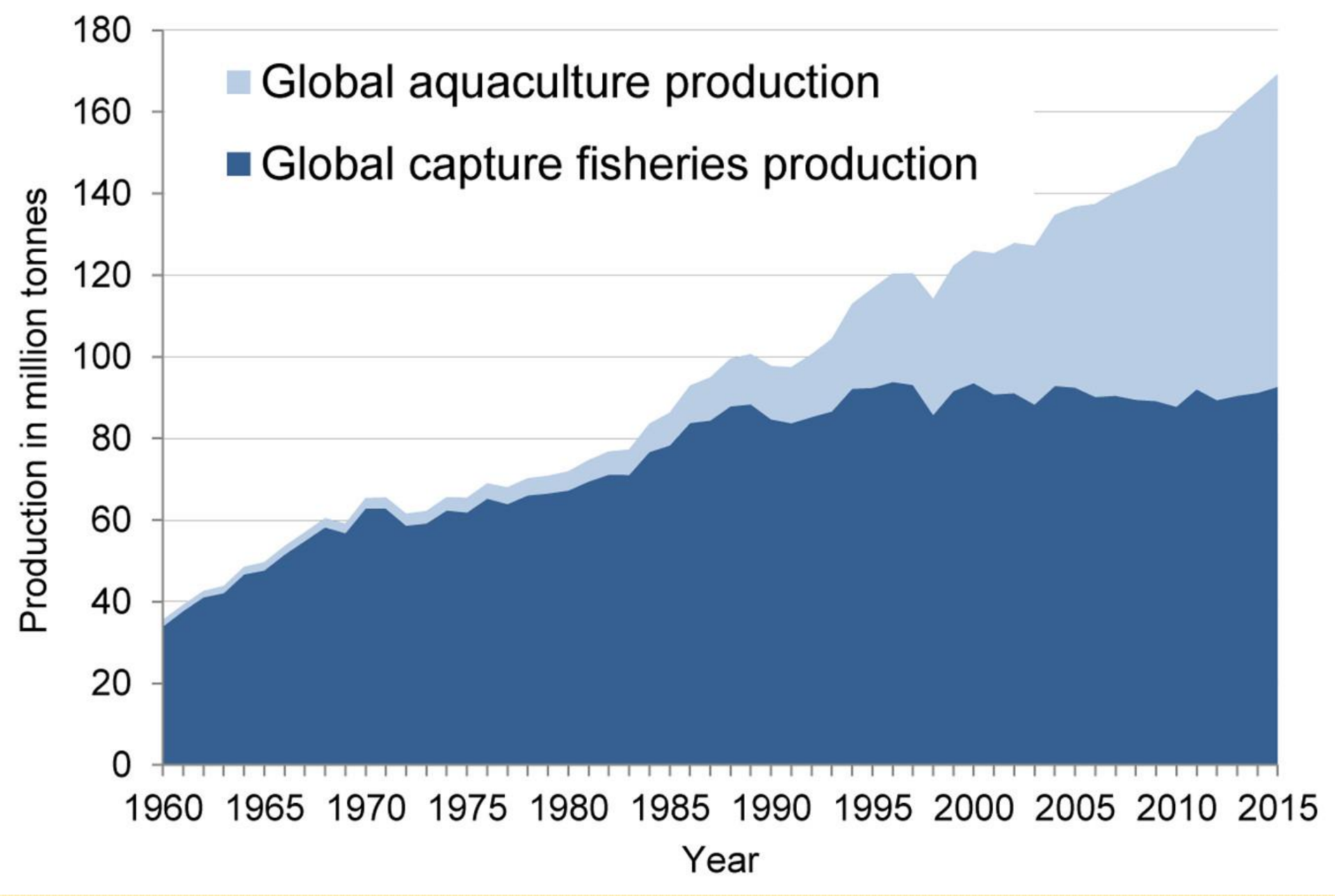
Global Footprint Network

Marine Fisheries

The dramatic collapse of cod stocks off Newfoundland illustrates how quickly the services of an ecosystem can disappear when its resources are overexploited.



Source: Millennium Ecosystem Assessment


Global aquaculture production
Global capture fisheries production
Production in million tonnes
180
160
140
120
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

FORESTS

Sustainable Forestry is a main concern in Sustainable Development

Wood
Timber
Paper

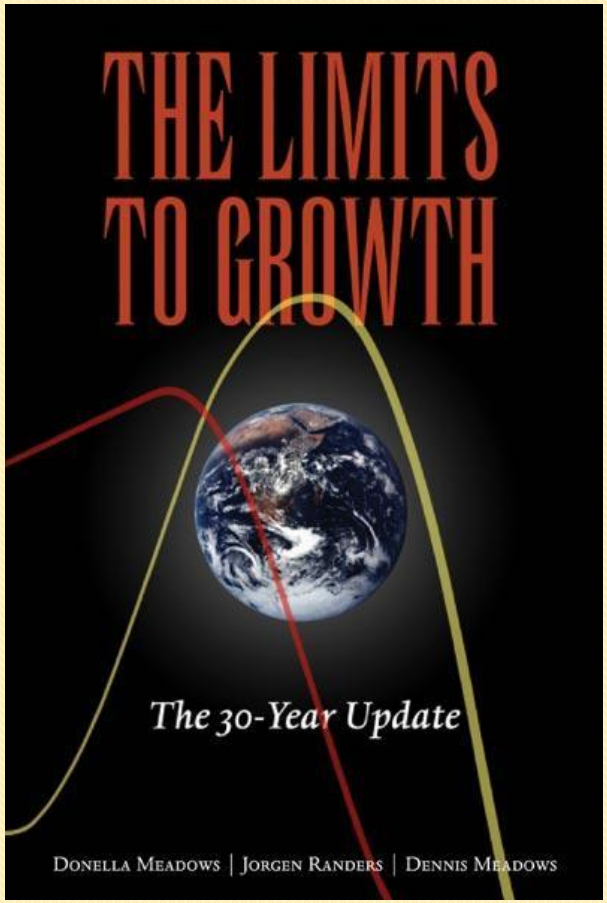
TOP SOIL


WATER

The study of the limits of global resources

1. *Limits To Growth*, Meadows et al (1972) first computer model; the Limits To Growth a 30 year update (2003). Jörgen Randers 2052 (2012)
2. *Ecological footprint network* and biocapacities, 1990s (Rees and Wackernagel).
3. *Material flows* Wuppertal Institute and the ecological rucksack, *MIPS and Factor 10*. 1990s (Schmidt-Bleek).
4. *Socio-ecological Principles* for a Sustainable Society Holmberg 1994, Chalmers, Göteborg. Natural Step Foundation,
5. *Planetary Boundaries* Stockholm Environment Institute, Stockholm Resilience Centre, 2009.

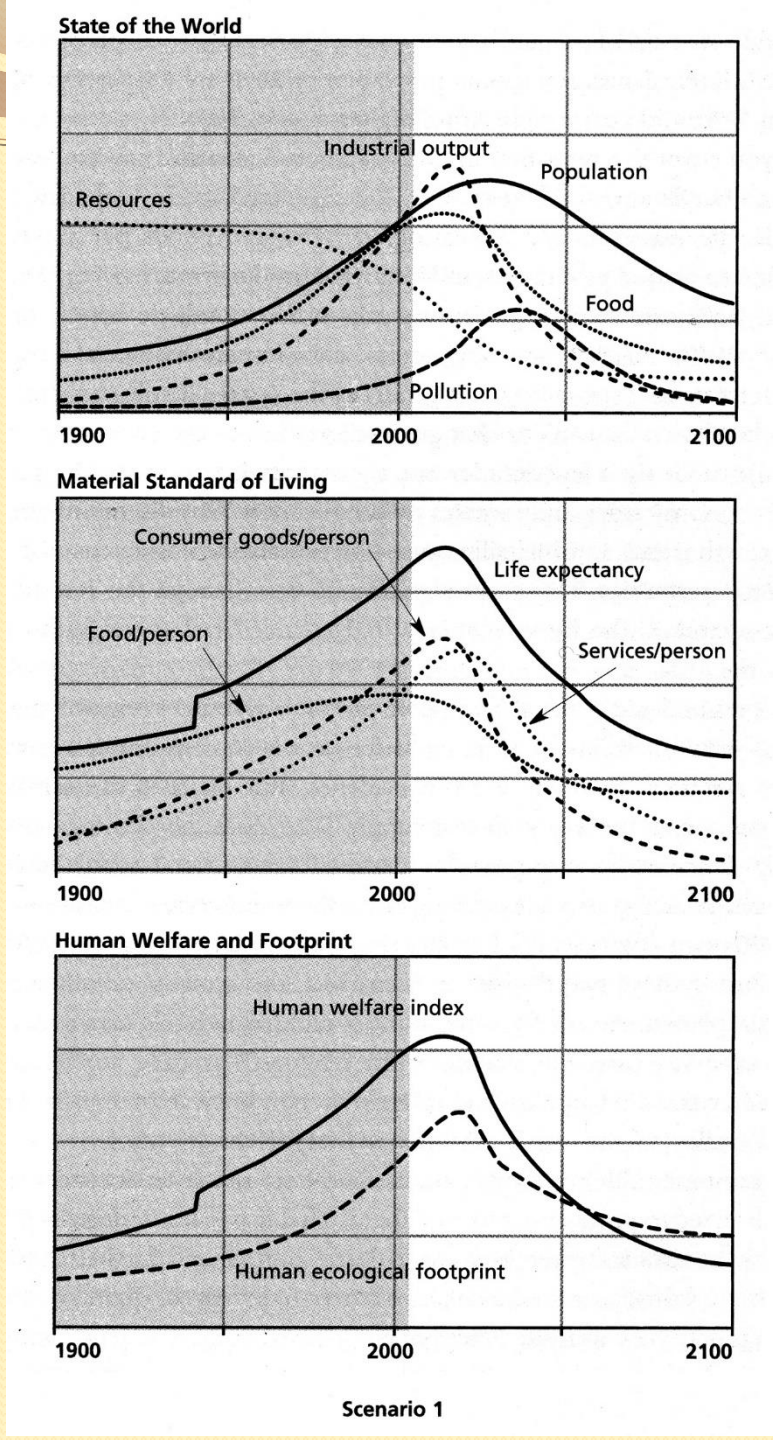
Limits to Growth (1972): The 30 year update (2003) We are Witnessing a Terrible Validation



- Original "Club of Rome Report" alerted world to the dangers of continued **exponential growth against natural limits in a finite system**
- Noted that humanity had the capacity to create **systems that were sustainable**
- Vehemently attacked at the time, especially by economists
- Now validated — unfortunately — by over 30 years of data

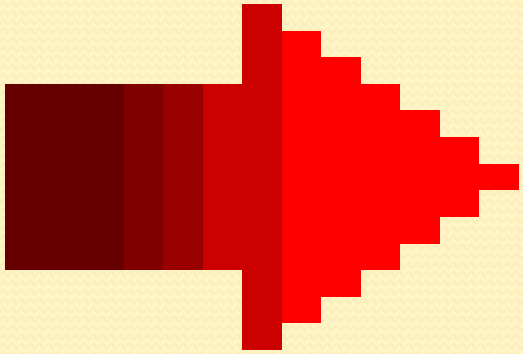
Basic scenario in Limits to Growth 2003

World3

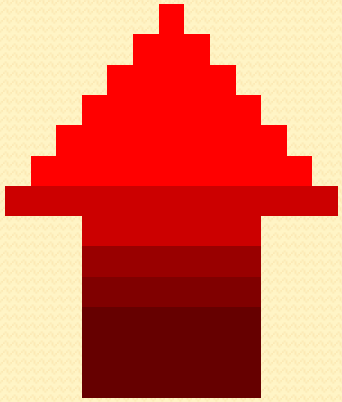


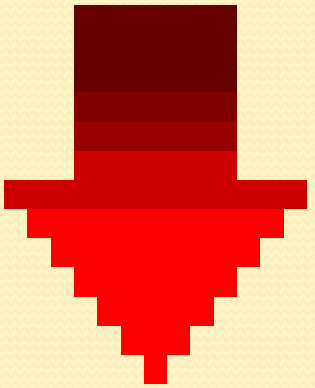
Resource Management can be improved!

Production



Consumption

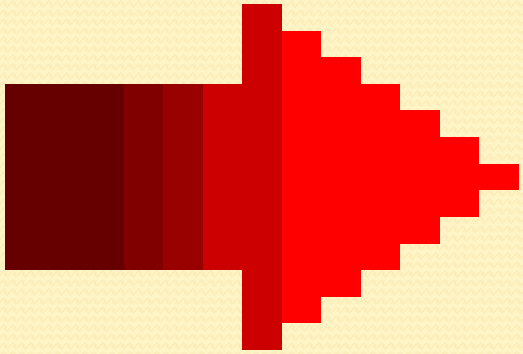




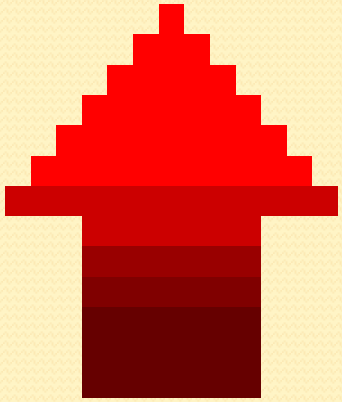
Resource

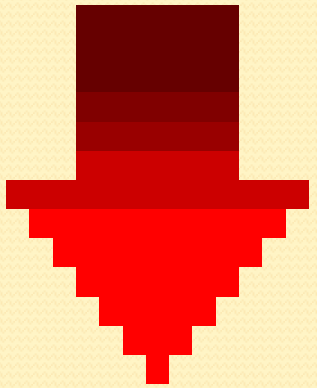
Waste

Production

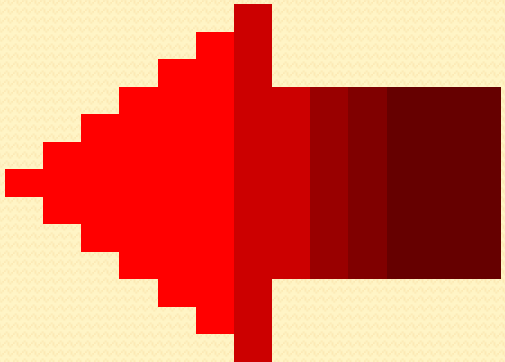


Consumption





Resource



Waste

3R

Reduce-Reuse-Recycle

3R

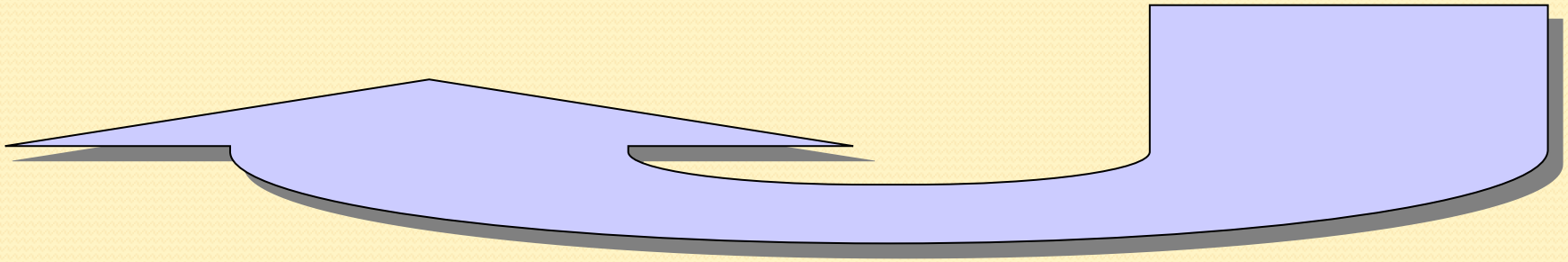
Reduce-Reuse-Recycle

4R

Reduce-Reuse-Recycle-Recover

We need Perfect recycling

Resource → Production → Use → End-of-life

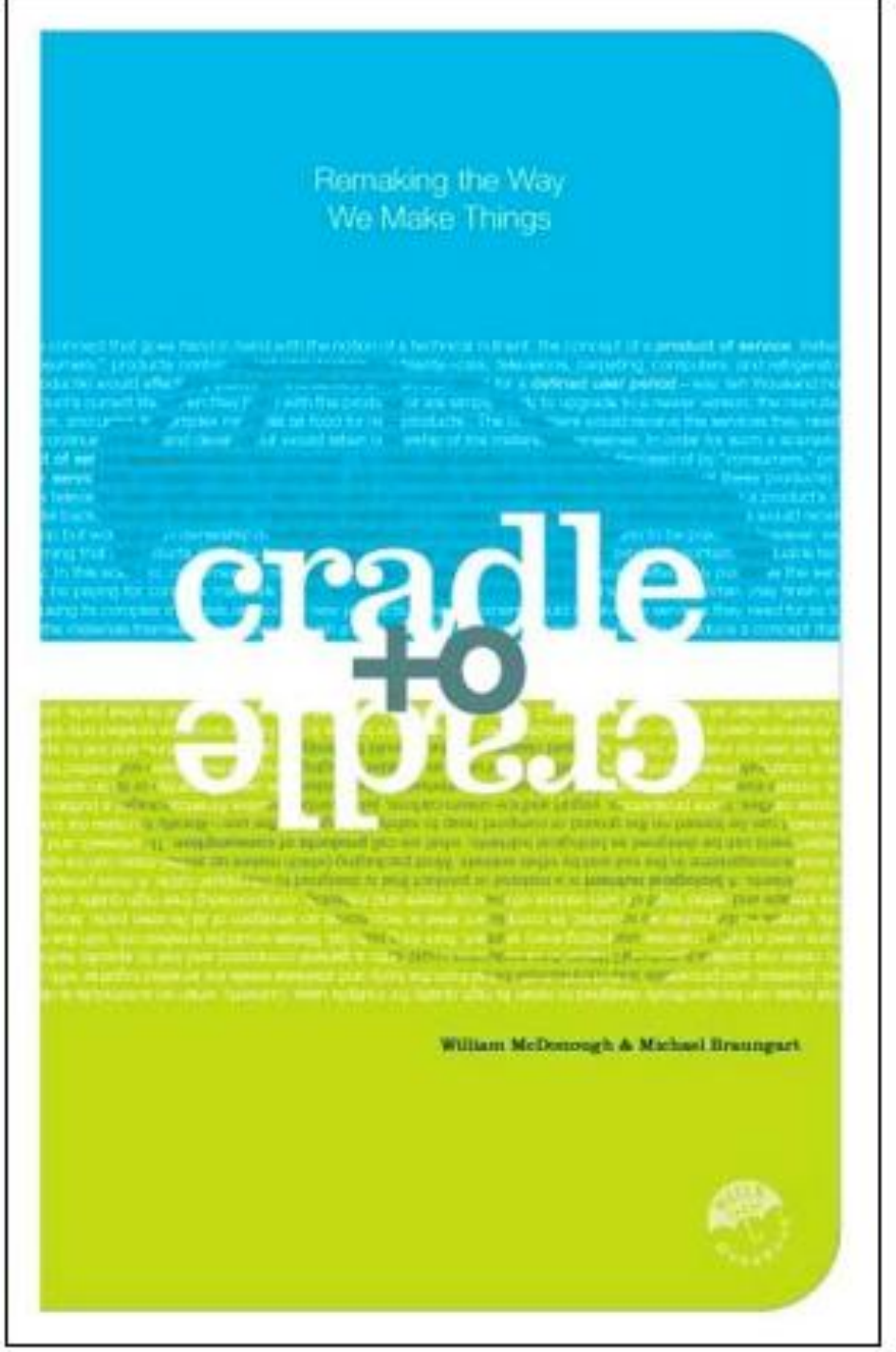


Cradle to Cradle Products Innovation Institute

Developed by
Michael Braungart , Hamburg and
William McDonough, San Fransisco

http://www.mcdonough.com/

cradle_to_cradle.htm



30 minutes

- Discuss what you do yourself to improve resource use.
- Do you apply the 3R?
- How do you manage waste?

After 20 minutes you tell me.

(Students who did not talk so far. It is your turn!)

II. Quantification of resource flows

Ecological Rucksack

Today, less than 5 % on average of the material resources taken from nature ends up in products. The rest becomes waste on the way. Some 30 tons of nature is used to create one ton of car – without counting water consumption - and for many industrial goods the ratio is similar.

Information and Communication Technology [ICT]: the costs for one message on Internet is equal to that of producing four aluminum cans for beer.

Wuppertal Institute – Material Intensity factors of materials and energy sources
https://www.gdrc.org/sustdev/concepts/27-rucksacks.html

Life Cycle Assessments, LCA Material intensities

Material intensities can be used for calculating LCA for many products.

Ecological Rucksack for the cradle to the point of sale, the amount of material used which is not in the product itself can be calculated from LCA.

MIPS for cradle to cradle Material Input [in kg] Pro unit Service (per unit value or utility) obtained.

Material intensities and LCA for many products are available in databases. Total Material Flows, TMF output and input, are available for many countries.

Ecological Footprints

Ecologial Footprints

- William Rees introduced the concept of ecological footprint in 1992.
- The ecological footprint is ”*the surface area a population needs to continually satsify its needs and produce its products and services”*. It is measured in so-called global ha. There is today about 1.8 Gha/cap on the planet.
- Ecological footprint is today of wide use in society – the general public, companies and authorities.
- Ecological footprint is a quantitative information and not the same as environmental labelling.
- http://www.footprintnetwork.org


Forest Products
Carbon Footprint
Cropland
Pasture
Built-up Land
Fisheries

Total Ecological Footprint

Food, fibre, and timber footprint

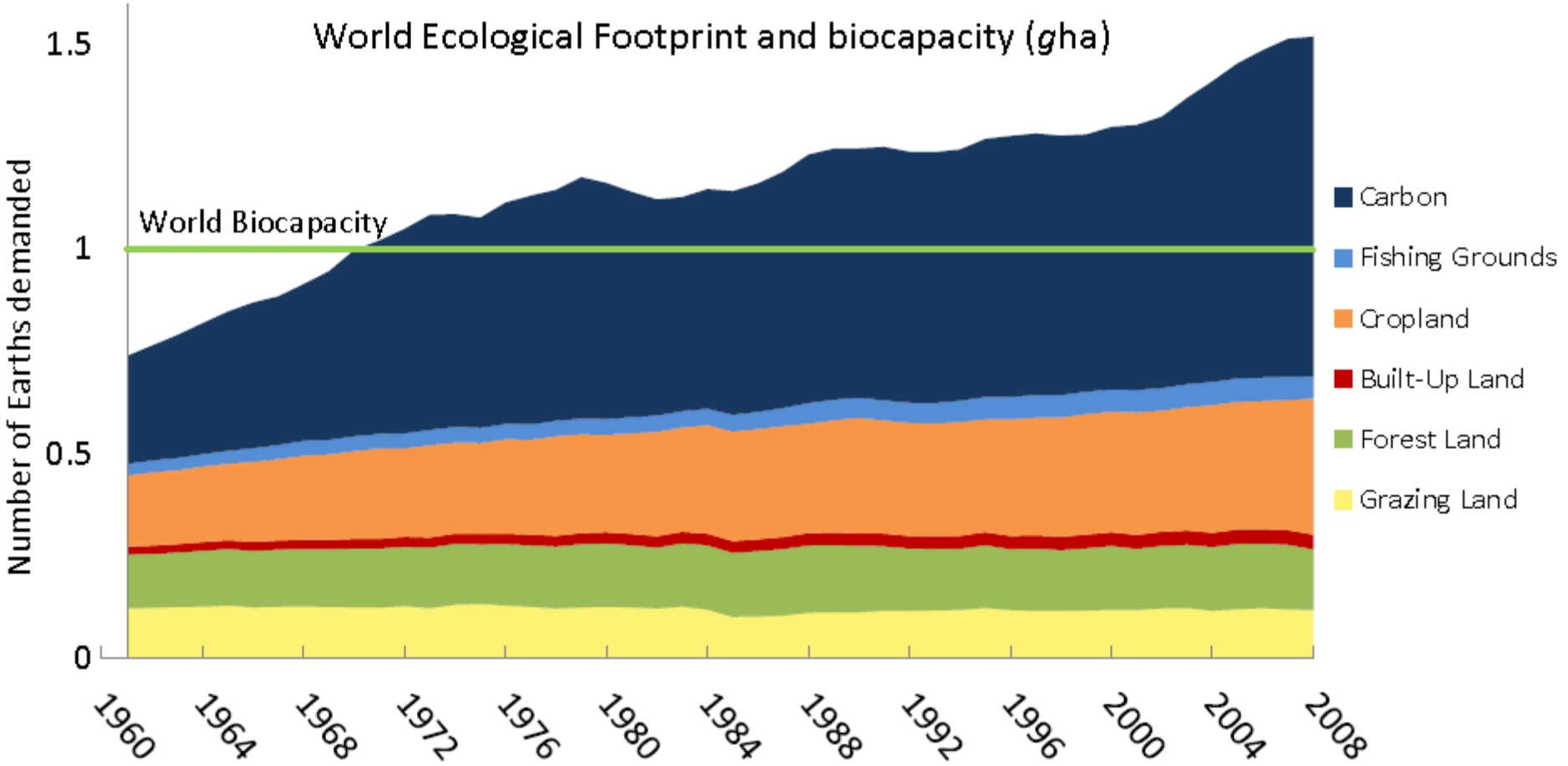
Cropland, Forest, Grazing land, Fishing ground

Energy footprint

CO_2 from fossil fuels, Fuel wood, Nuclear, Hydro, Built-up land

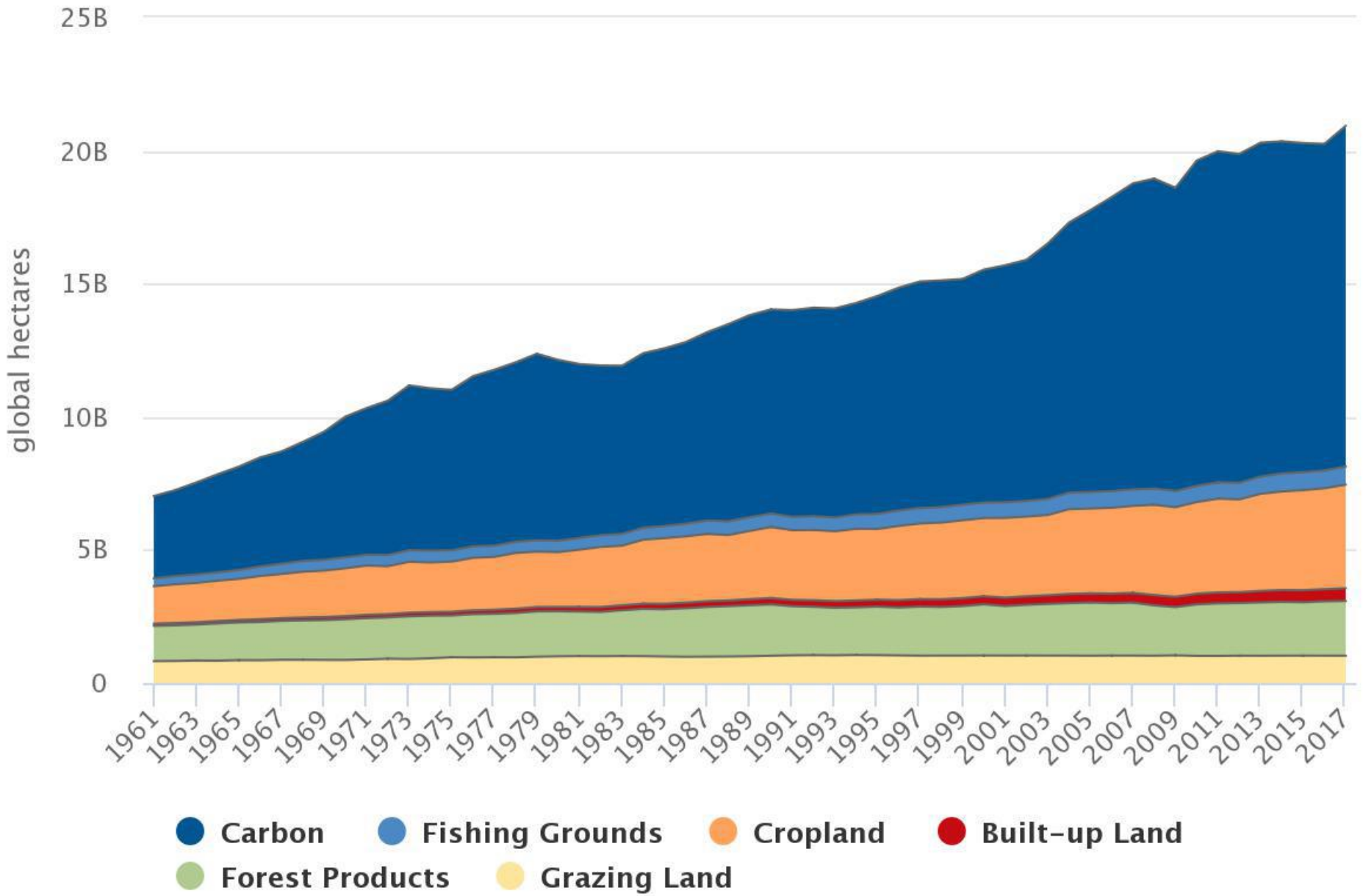
Bio capacity

Cropland, Grazing land, Forest, Fishing ground

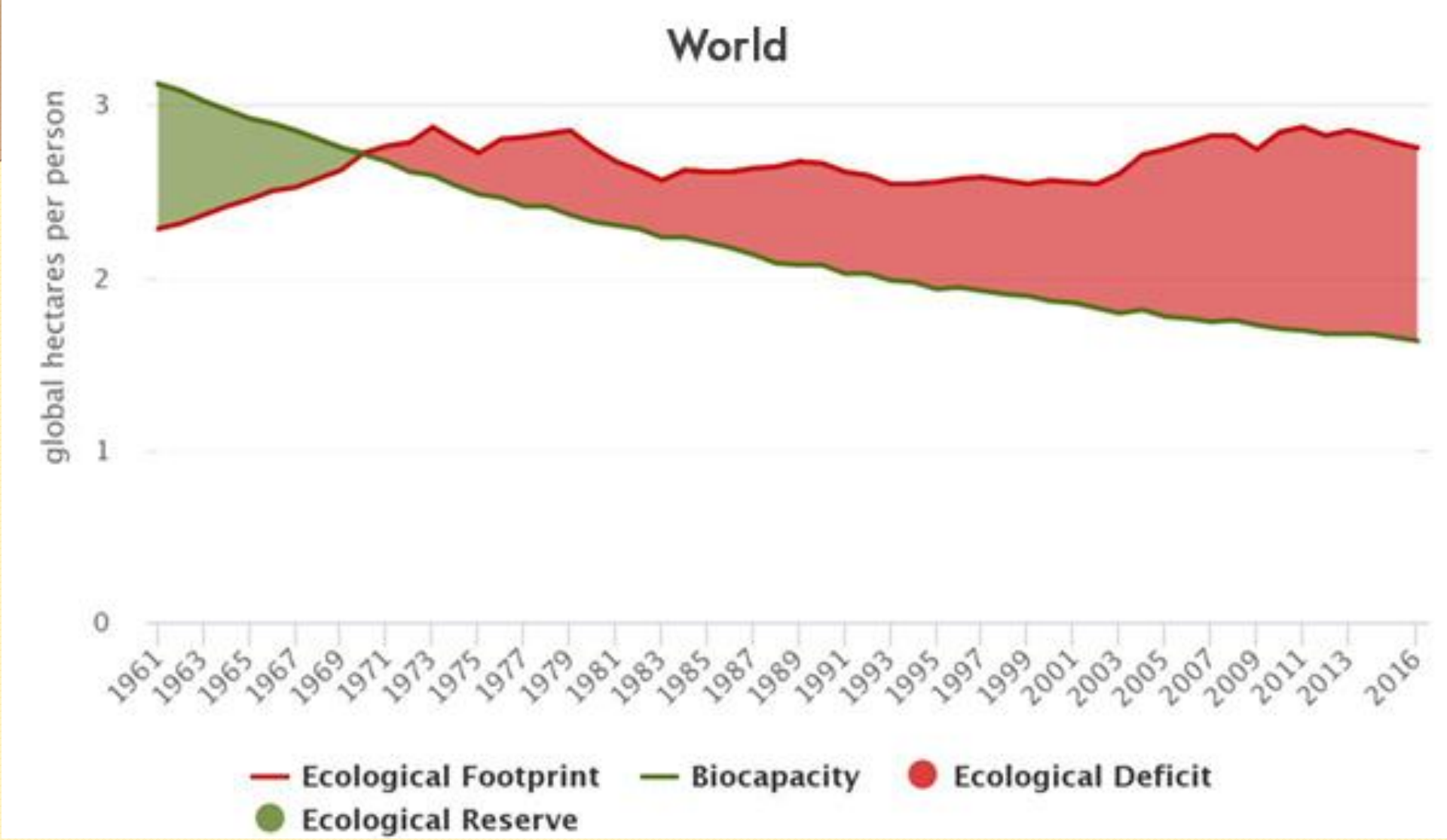


The National Footprint Accounts, 2011 Edition. Global Footprint Network
http://www.footprintnetwork.org/images/uploads/NFA_2011_Edition.pdf

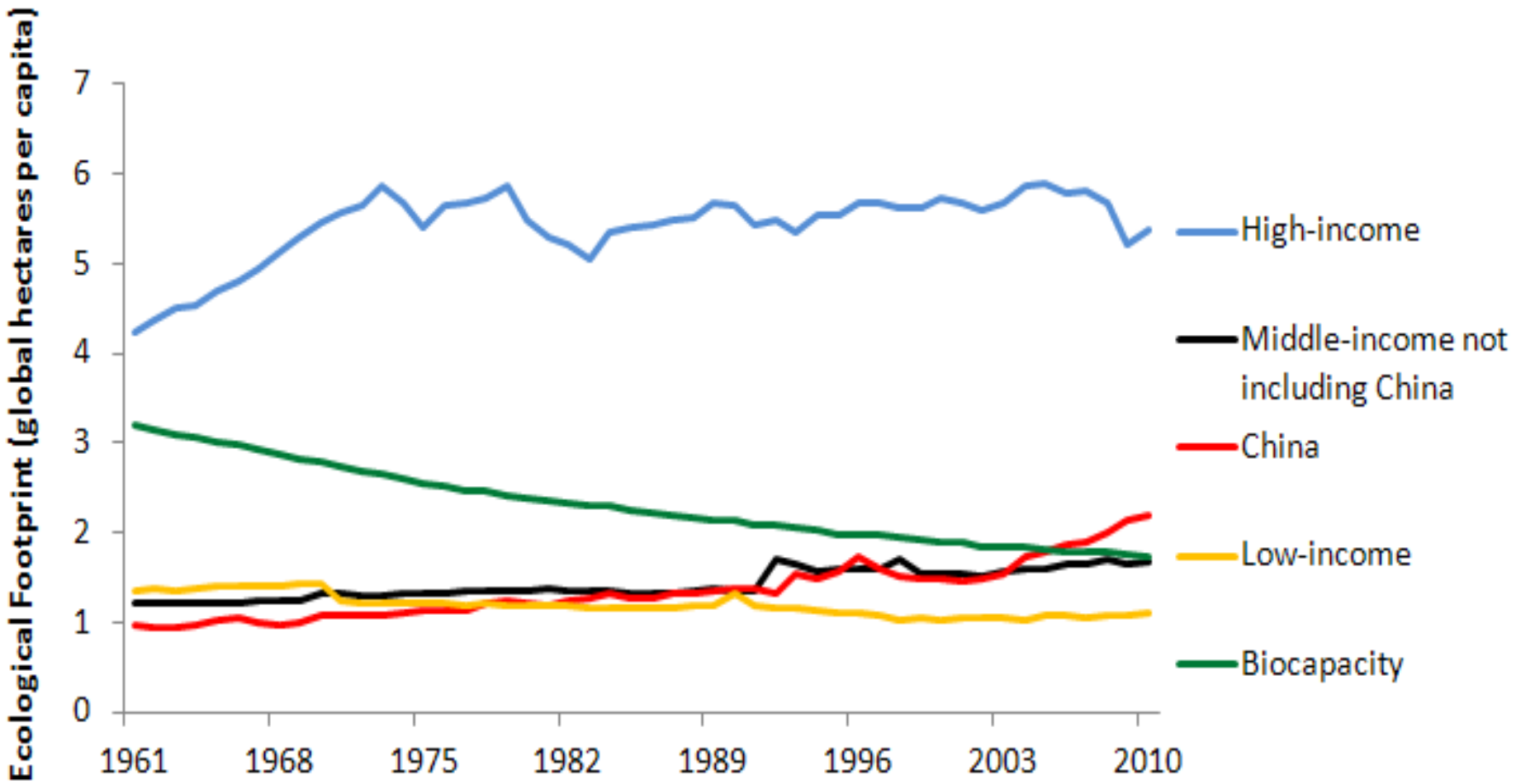
World Ecological Footprint by Land Type



Global Footprint Network, 2021 National Footprint and Biocapacity Accounts


World
global hectares per person
3
2
1
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2016
Ecological Footprint
Biocapacity
Ecological Deficit
Ecological Reserve

Ecological Footprint Per Capita in High-, Middle- and Low-Income Countries



Global earth overshoot day 2021 was July 29

in Uzbekistan October 20, in Sweden April 6

Global ecological overshoot became a reality in the early 1970s and is driven by these key factors: how much we consume, how efficiently products are made and used, how many people are living on our planet, and how much nature's ecosystems are able to produce.

Global biocapacity is 1.6 gha per person (in 2017). To support human activities today we use just over 1.6 Earths per year. To keep up with our level of demand by 2030 we would need the capacity of two Earths. This puts the well-being of many of the planet's residents at risk.

Estimate your footprint

1. **Global Footprint Network**

   How much land area does it take to support your lifestyle? Take this quiz to find out your Ecological Footprint, discover your biggest areas of resource consumption, and learn what you can do to tread more lightly on the earth. www.footprintcalculator.org.

2. **World Wildlife Found, WWF**

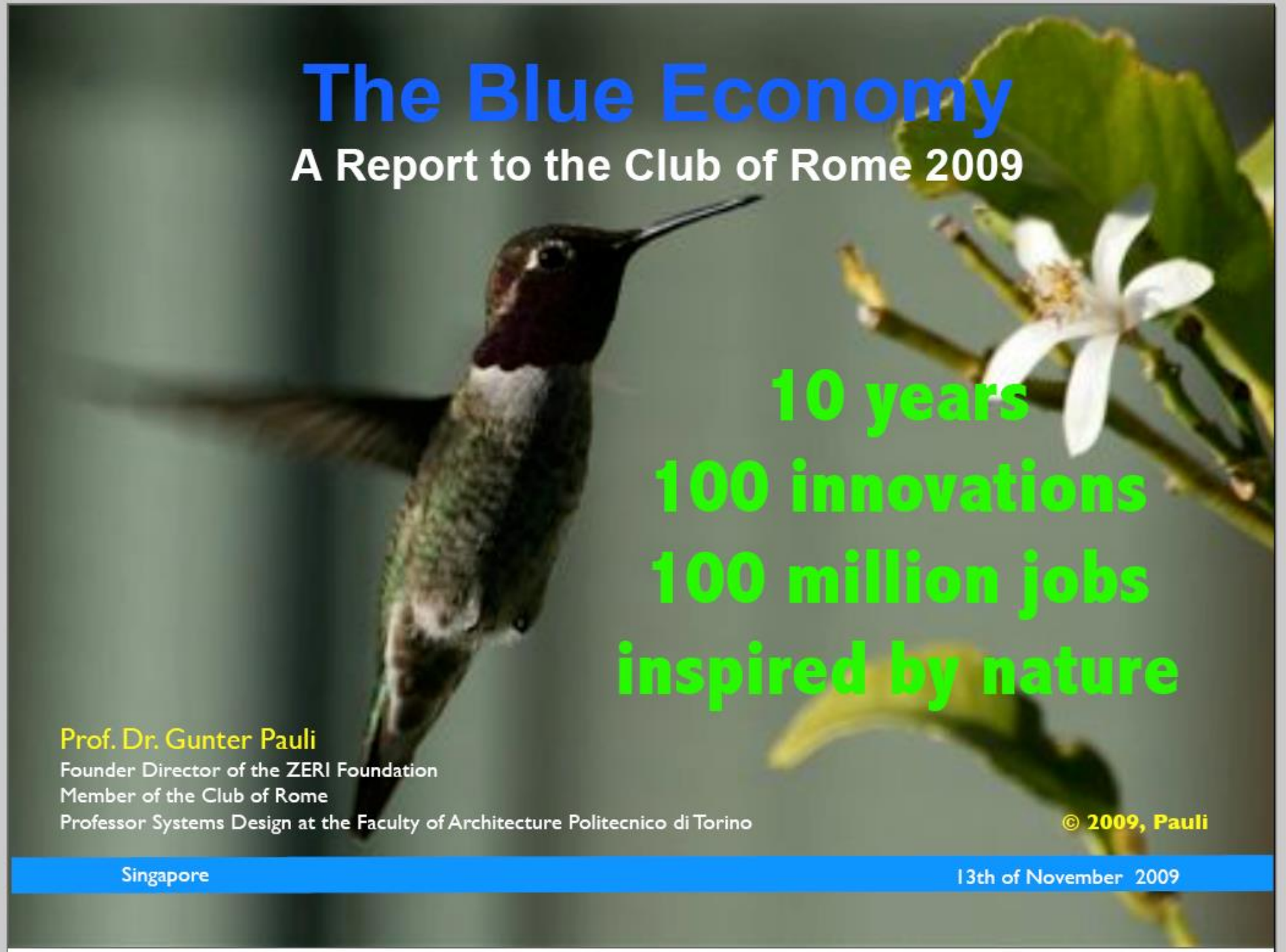
   Worried about your impact on the environment? The way we use the planet's resources makes up our ecological footprint. Measuring yours takes less than 5 minutes and could set you on a life-changing journey…
   https://footprint.wwf.org.uk/#/

3. **Earthday Network**

   Welcome to the Earthday Network Footprint calculator
   https://www.footprintcalculator.org/
   https://footprintcalculator.henkel.com/us

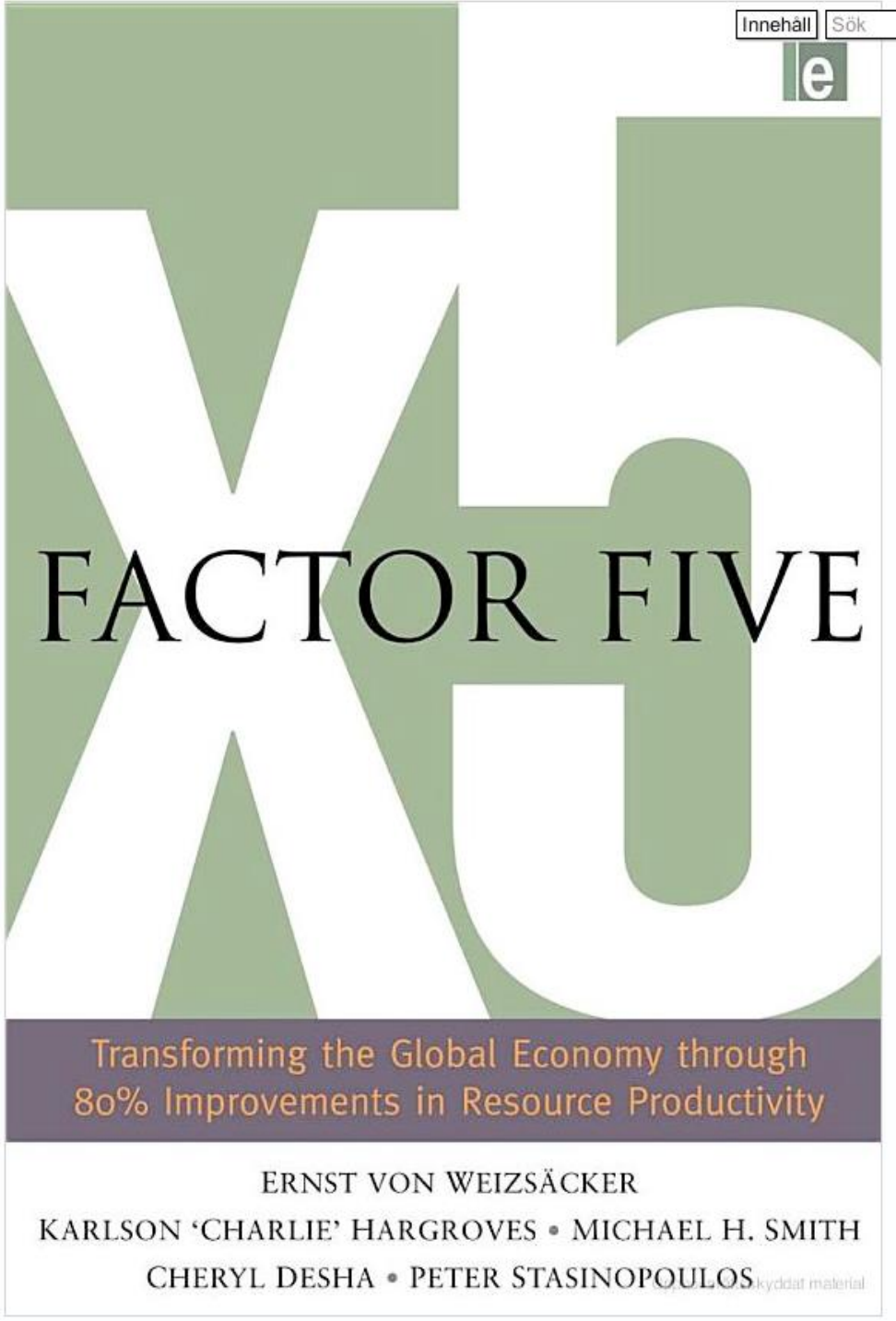
How can we improve things?

There are many ways to resource efficiencies!


The Blue Economy
A Report to the Club of Rome 2009
10 years
100 innovations
100 million jobs
inspired by nature
Prof. Dr. Gunter Pauli
Founder Director of the ZERI Foundation
Member of the Club of Rome
Professor Systems Design at the Faculty of Architecture Politecnico di Torino
© 2009, Pauli
Singapore
13th of November 2009

Wuppertal Institute for Climate, Environment, and Energy

http://www.wupperinst.org/en/home/index.html



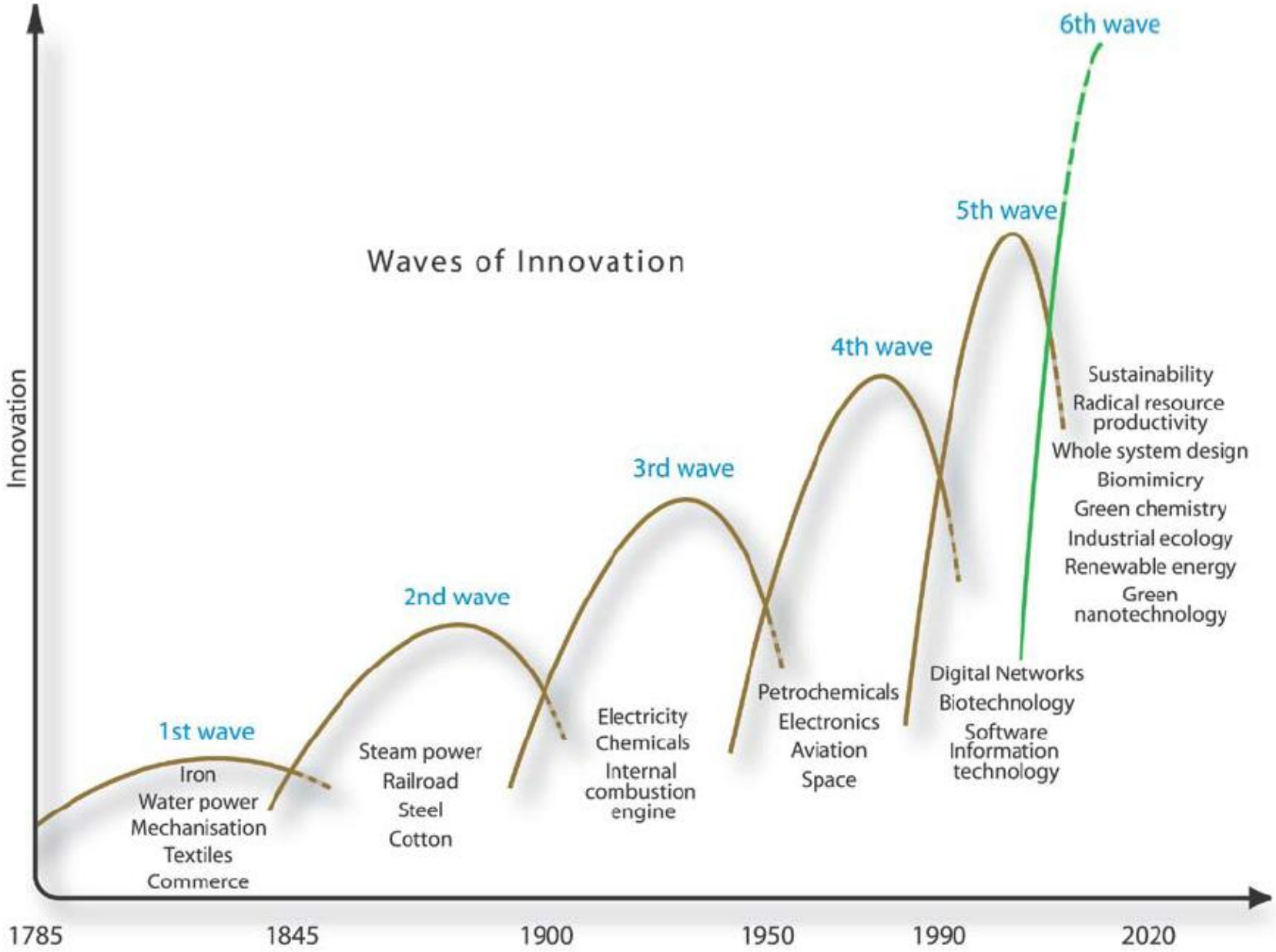


Figure 4 *Waves of Innovation*

Source: Courtesy of The Natural Edge Project[19]

The production itself is a very important part – it may be improved tremendously by

Cleaner Production, CP

Cleaner Production is good not only for the environment but also for the economy!

Of course!

You make products efficiently, not pollutants - inefficiently

Planetary Boundaries: A stable operating space for humanity

NATURE 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.

Planetary boundaries

Climate
350 ppm CO_2
+1 W/m^2

Ozone depletion
276 DU

Biogeochemical loading
35 MT N/yr
11 MT P/yr

Atmospheric aerosol loading
TBD

Biodiversity loss
10 E/MSY

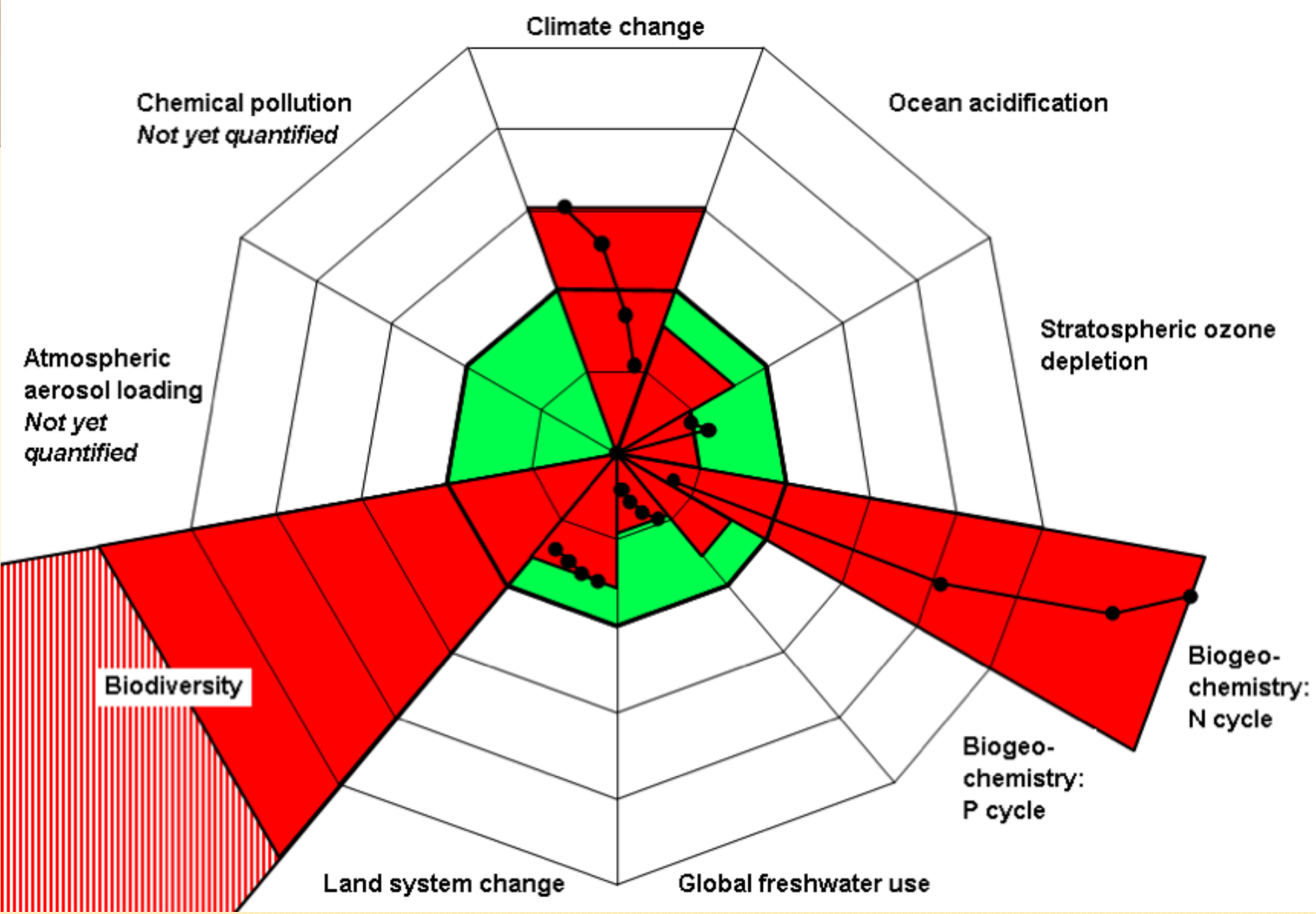
Ocean acidification
Aragonite saturation ratio > 2.75

Freshwater use
4000 km^3/yr

Agricultural land use
15%

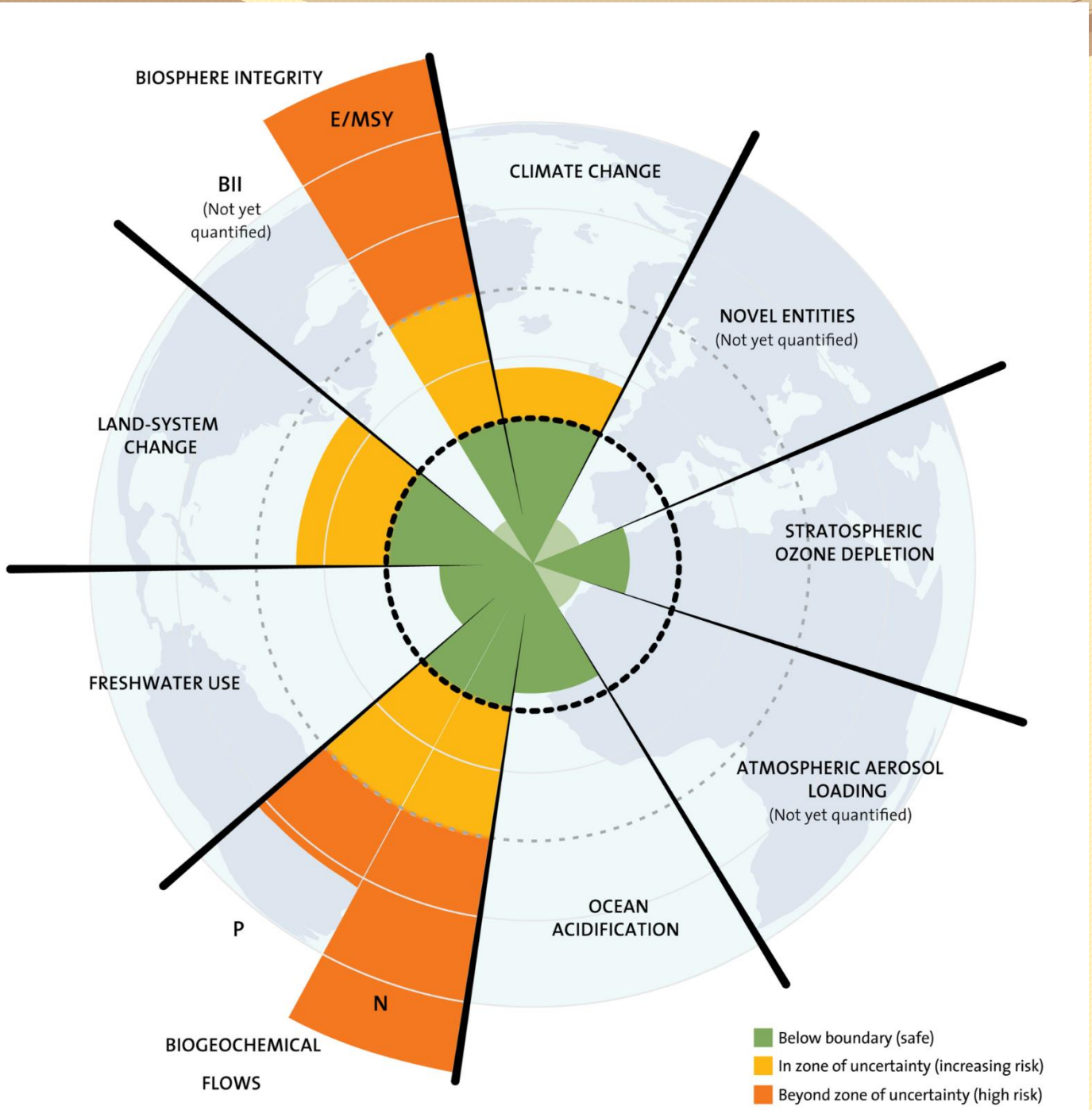
Chemical pollution
TBD

J. Rockström et al Nature, September 24, 2009



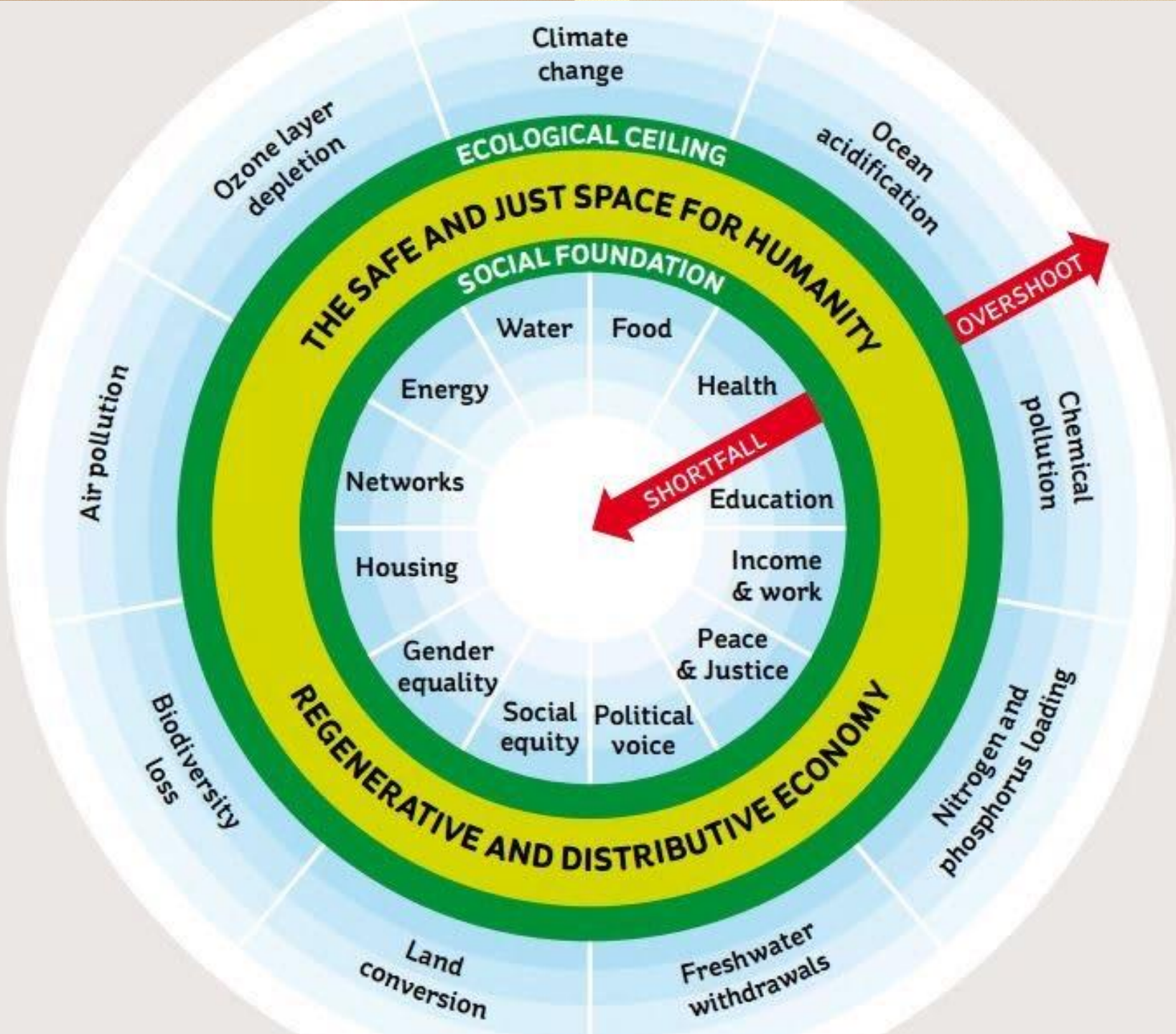
Rockström, J. et al., 2009. Nature, September 24, 2009.

Source:
J. Lokrantz/Azote based on Steffen et al. 2015.



The **Doughnut**, or **Doughnut economics**, combine the planetary boundaries with social boundaries. It is a concept proposed by the British economist Kate Raworth.

https://www.kateraworth.com/doughnut/


Climate change
Ozone layer depletion
Ocean acidification
ECOLOGICAL CEILING
THE SAFE AND JUST SPACE FOR HUMANITY
SOCIAL FOUNDATION
OVERSHOOT
Water
Food
Energy
Health
SHORTFALL
Networks
Education
Housing
Income & work
Peace & Justice
Gender equality
Social equity
Political voice
REGENERATIVE AND DISTRIBUTIVE ECONOMY
Air pollution
Chemical pollution
Biodiversity loss
Nitrogen and phosphorus loading
Land conversion
Freshwater withdrawals

To read

Lecture 2. Resources

- Sustainable Use and Management of Natural Resources. Chapter 2 *The planet and its natural resources*. pp 26-45.

- Sustainable Use and Management of Natural Resources. Chapter 11 *Reducing the resource flows by a Factor of 4, 5 or 10*. pp 189-207.