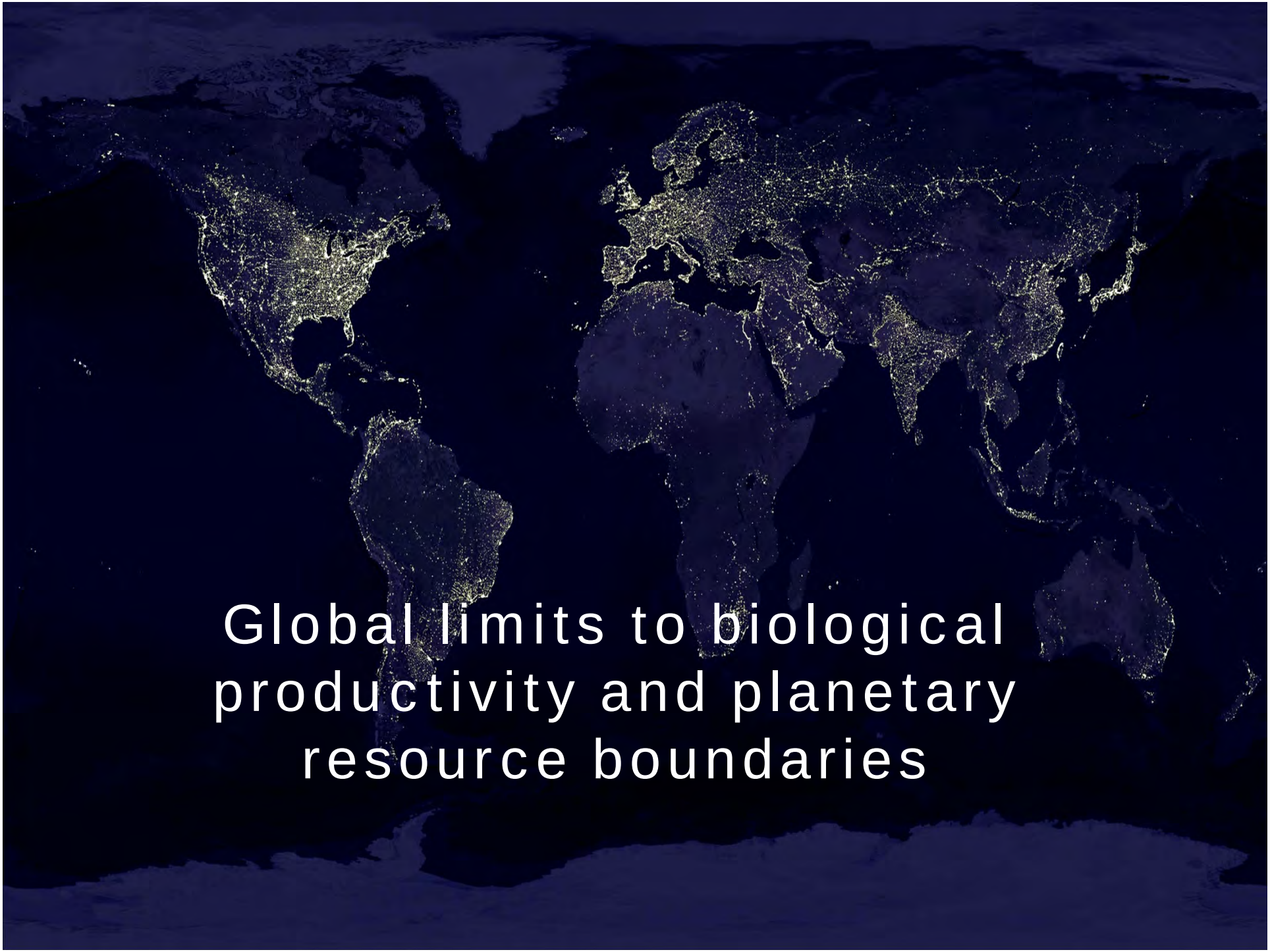


Global limits to biological productivity and planetary resource boundaries

IGBP CLIMATE-CHANGE INDEX

Combining data to expose underlying global-change trends for the public and policymakers

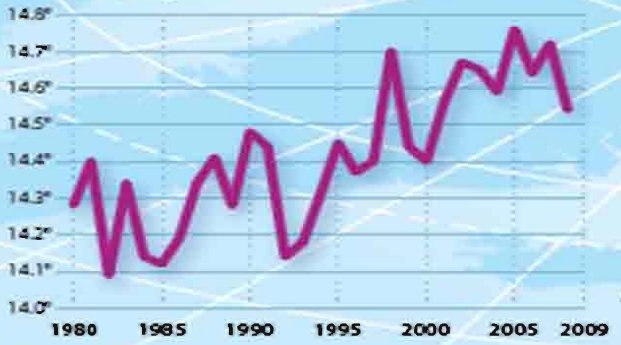
SEA-LEVEL RISE

Sea-level rise (millimeters)

Source: Church and White global mean sea-level reconstruction, Permanent Service for Mean Sea Level, Proudman Oceanographic Laboratory, Natural Environment Research Council

GLOBAL AVERAGE TEMPERATURE

(absolute, degrees C)



Source: NASA

Rising index
A shift away from the current stable climate of the last 10,000 years

Falling index
A return to the planet's stable climate

The IGBP climate-change index combines the four key metrics that help unravel what is happening to the planet: temperature, carbon dioxide levels, sea level and Arctic sea ice. The index combines annual changes in each of these directly-measured parameters. Each year's change is added to the previous year. Natural variability sometimes obscures general trends in these metrics. By drawing together the four metrics as a single figure, the IGBP climate-change index exposes the underlying trend.

Developed by the International Geosphere Biosphere Programme

CURRENT TRAJECTORIES

Years to reach 450ppm CO_2 40 years
Years to reach 550ppm CO_2 100 years

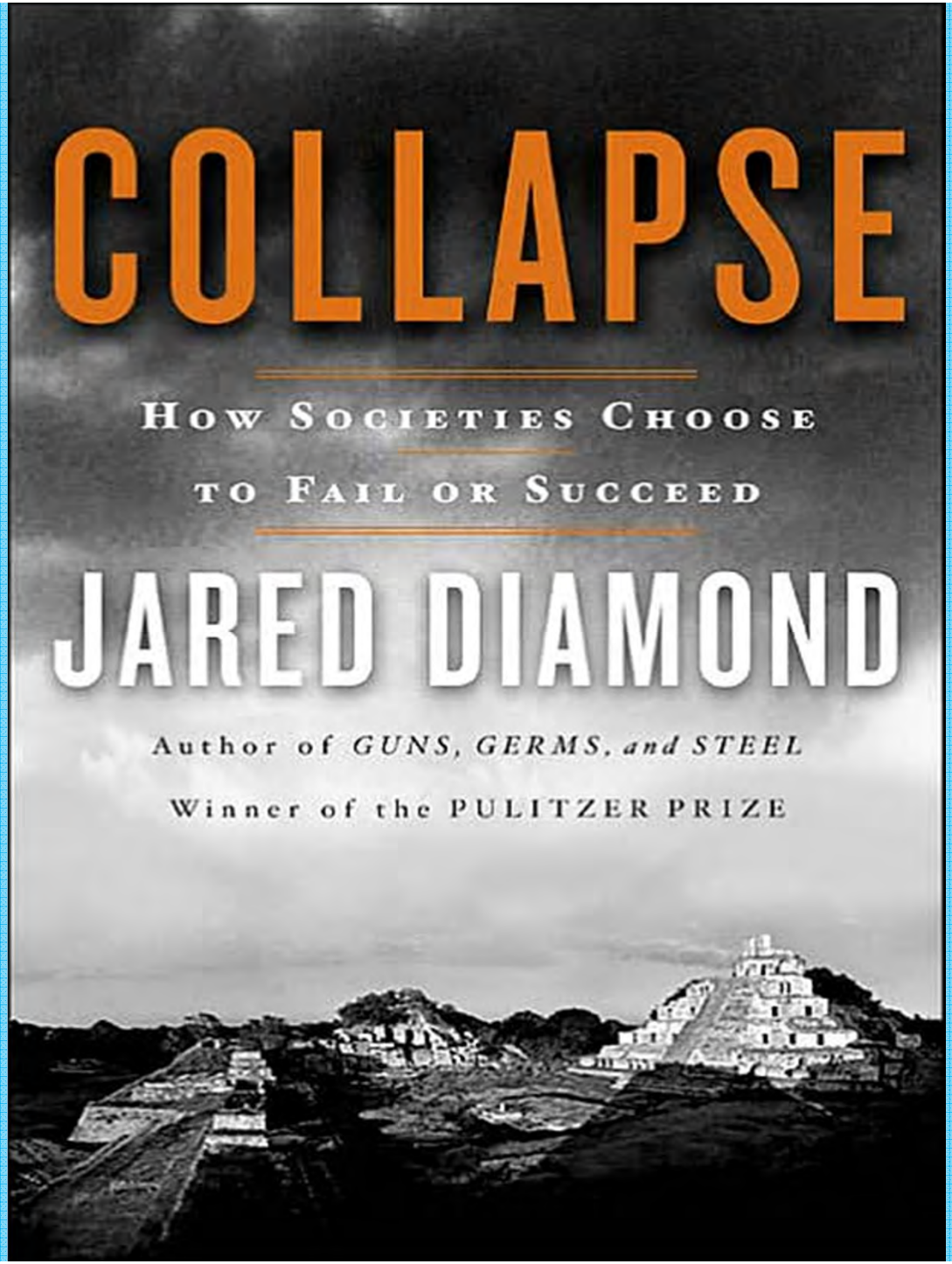
ATMOSPHERIC CO_2

(parts per million by volume)

Source: Carbon Dioxide Information Analysis Center, Mauna Loa

ARCTIC SEA-ICE COVER

Northern hemisphere summer sea-ice minimum (millions of square kilometers)

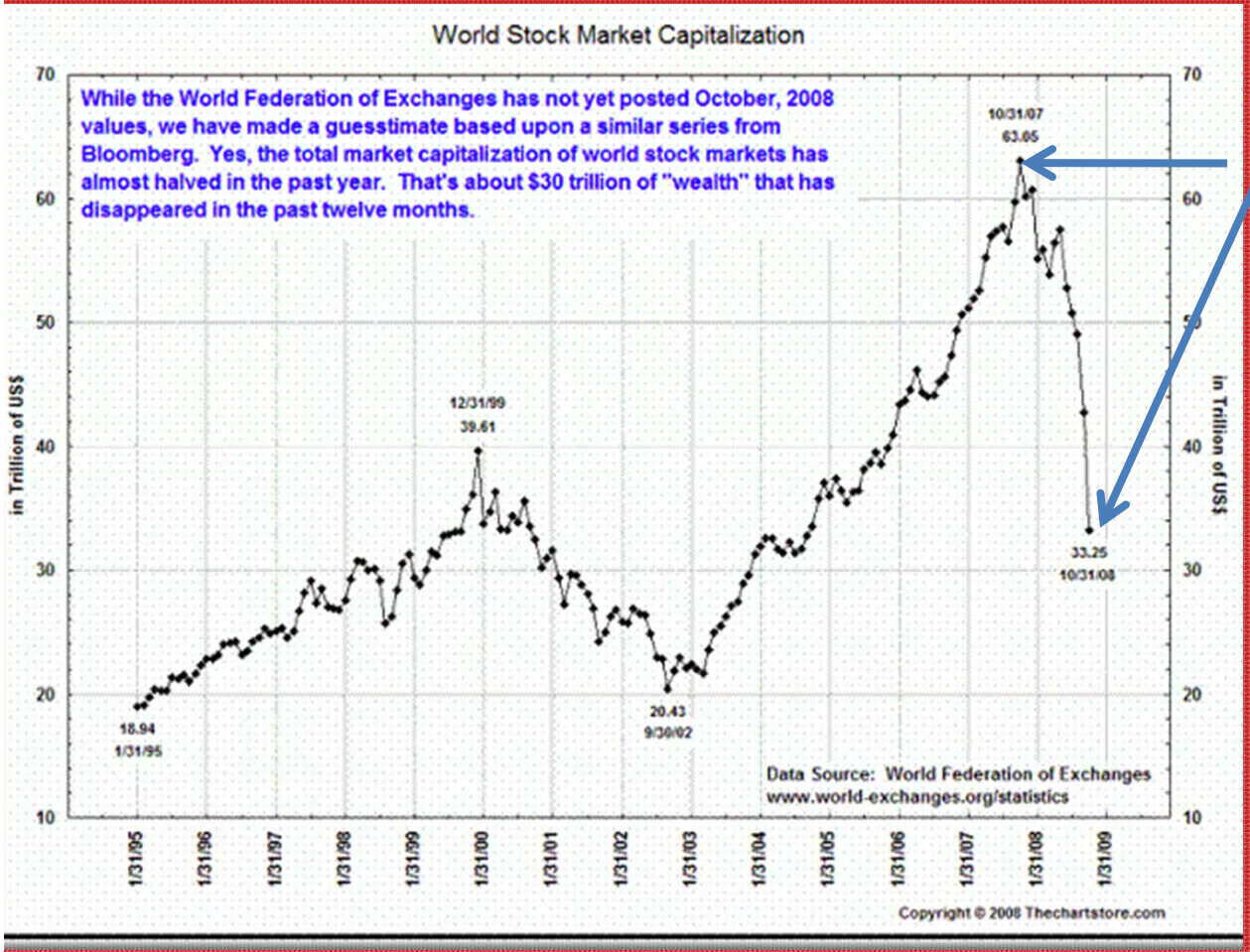


Major changes in trends of biospheric consumption must occur in the next 30 years.

Will this be our fate?

Alan Greenspan (US House of Representatives testimony Oct 24, 2008)

"I discovered a flaw in the model that I perceived is the critical functioning structure that defines how the world works"

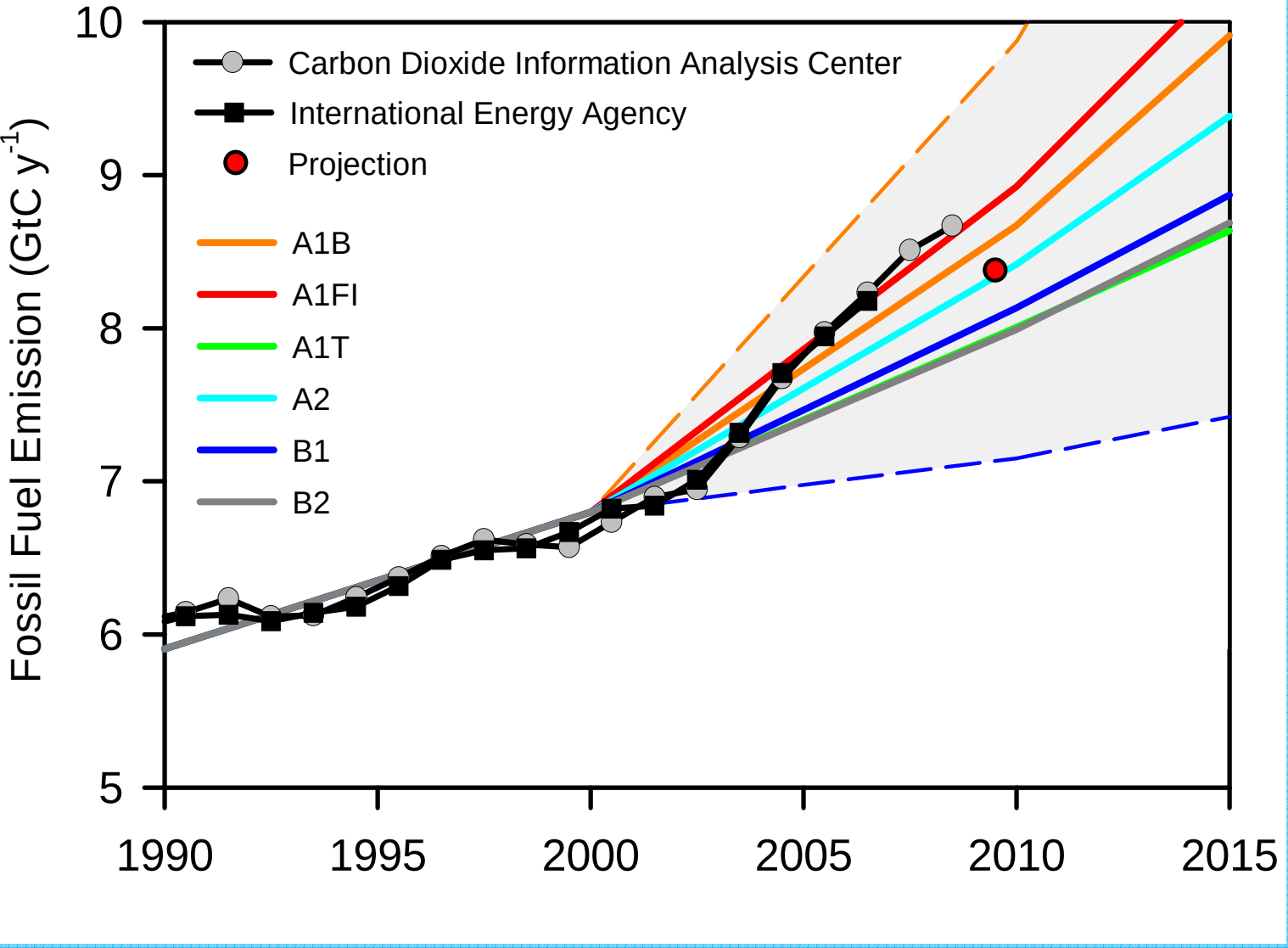


$30 TRILLION !!!

WE UNDERSTAND THE GLOBAL CLIMATE BETTER THAN THE GLOBAL ECONOMY!!!

If we thought wrecking the global economy was a big deal, that's NOTHING compared to wrecking the BIOSPHERE

Fossil Fuel Emissions: Actual vs. IPCC Scenarios

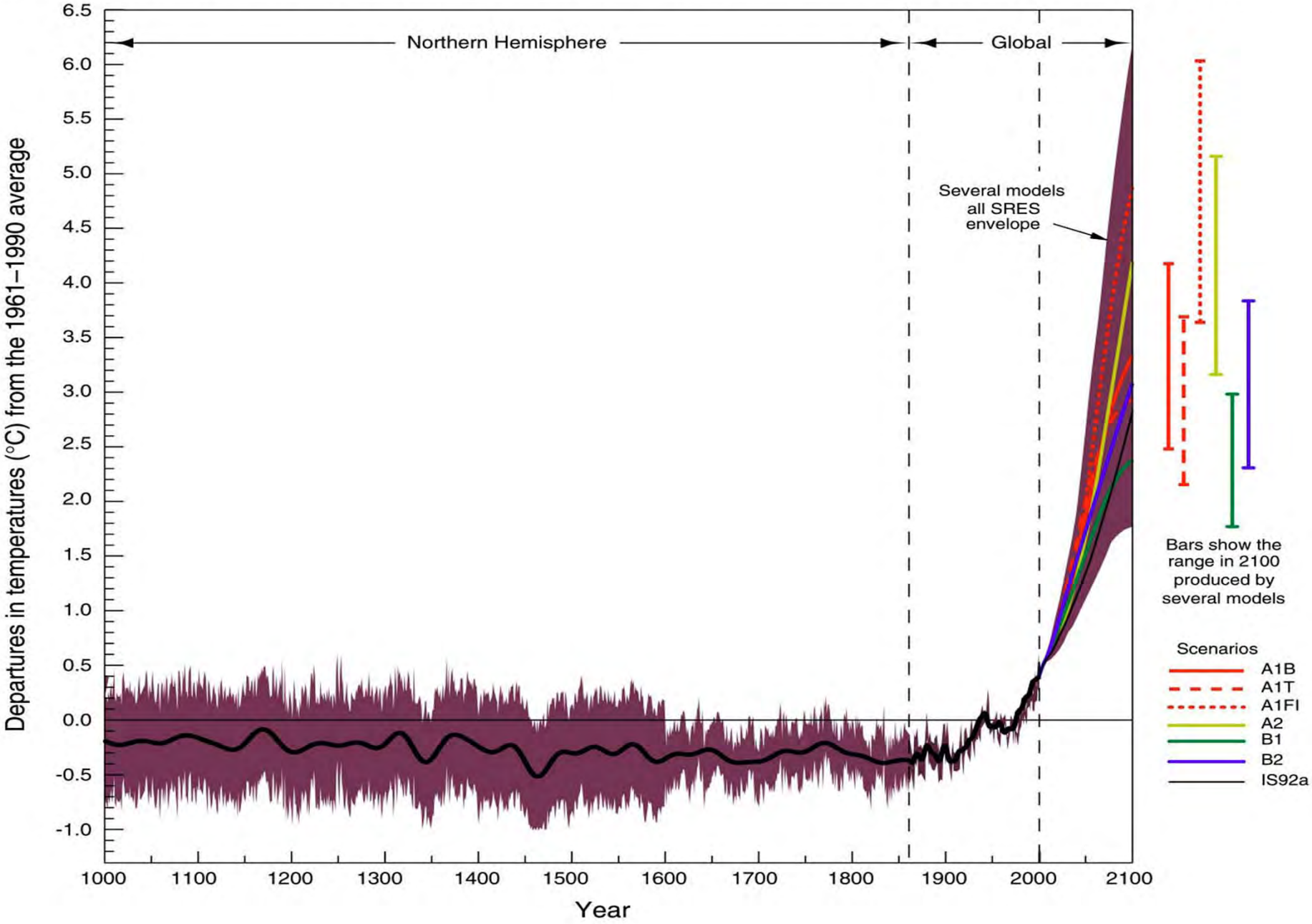


Projection 2009
Emissions: -2.8%
GDP: -1.1%
C intensity: -1.7%

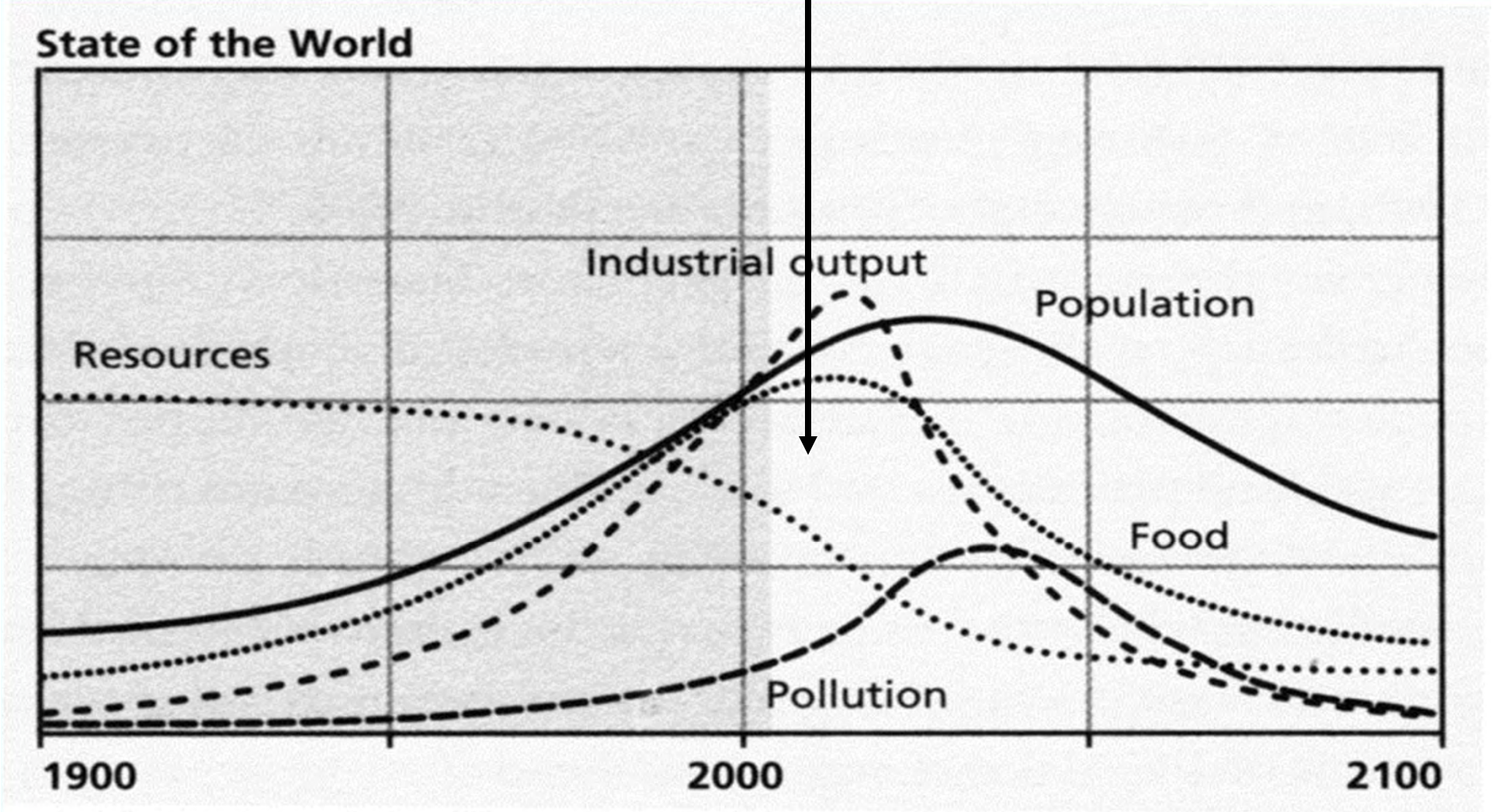
Raupach et al. 2007, PNAS, updated; Le Quéré et al. 2009, Nature-geoscience; International Monetary Fund 2009

Variations of the Earth's surface temperature; 1000 to 2100

1000 to 1861, N.Hemisphere, proxy data; 1861 to 2000 Global, instrumental; 2000 to 2100, SRES projections



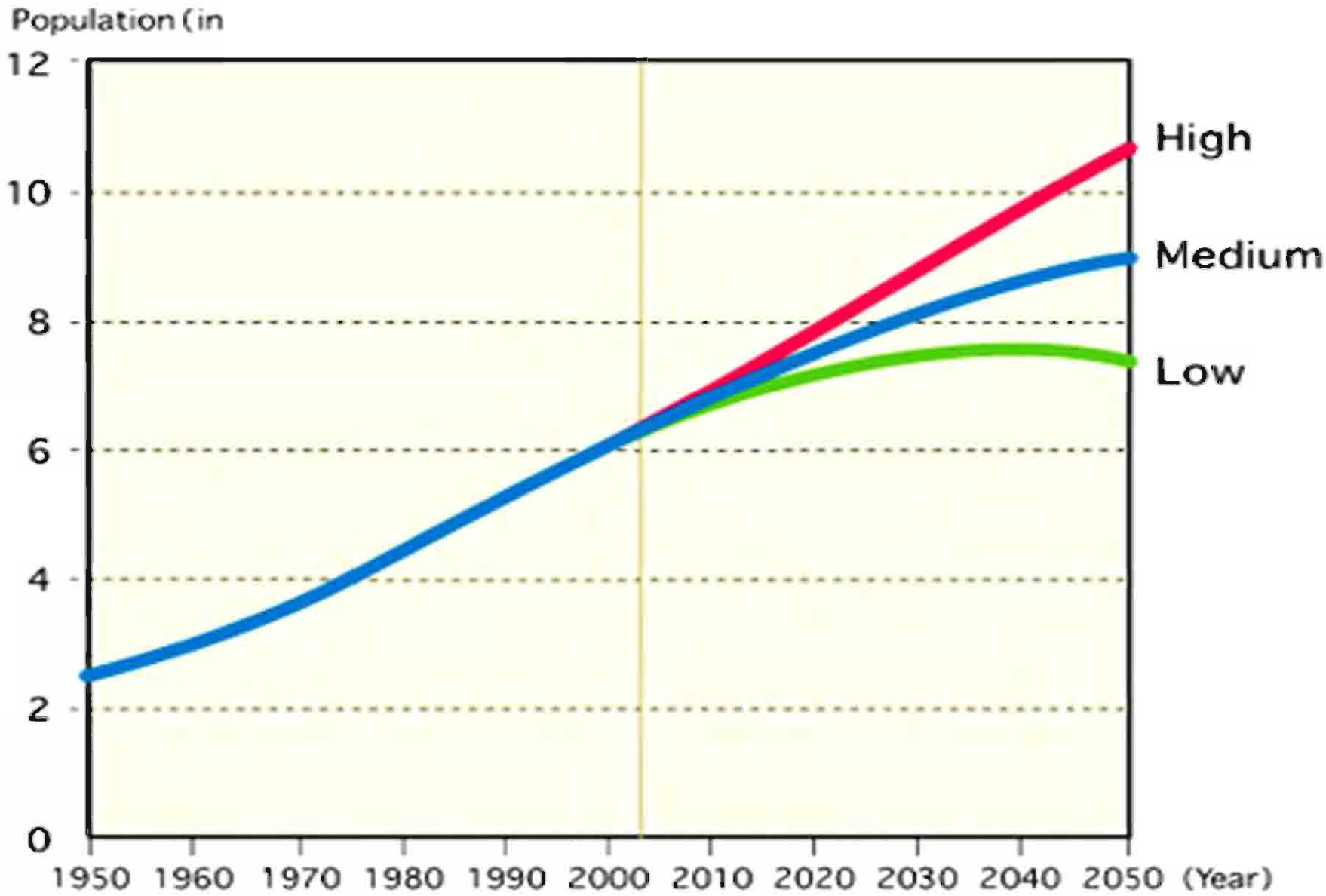
"Limits to Growth" Scenario in 1972 for 2009



From G. Turner, Global Env Change 18:397-411. 2008

Figure 1 United Nations World Population Projections, 1950-2050

Source: World Population Prospects



How will Biospheric Production meet a population increase of 40% *and* multiple demands from 2009 - 2050?

Primary (Vegetation) Production is normally increased by:

- Engaging more land
- Irrigation/fertilization
- Genetic improvements

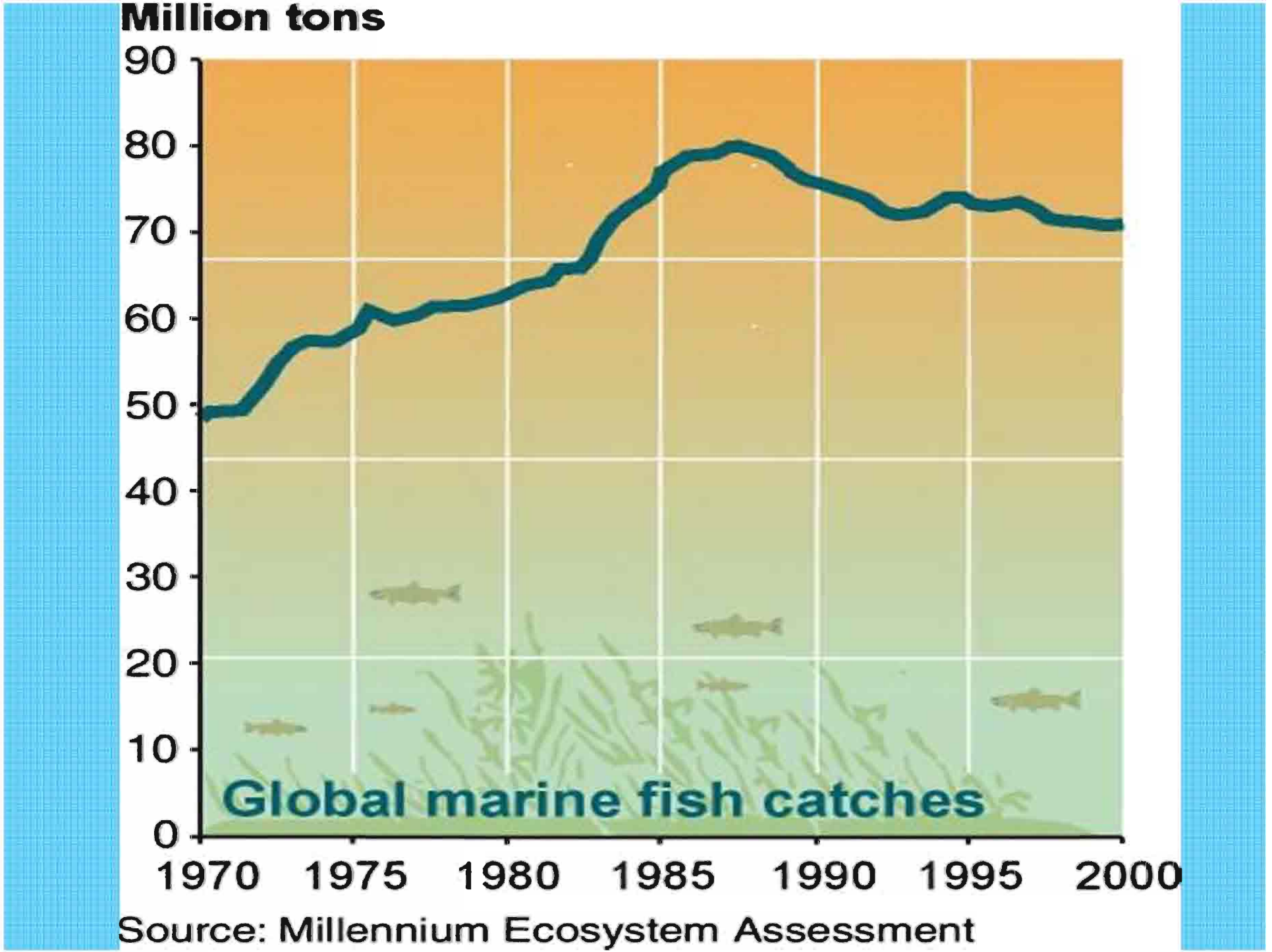
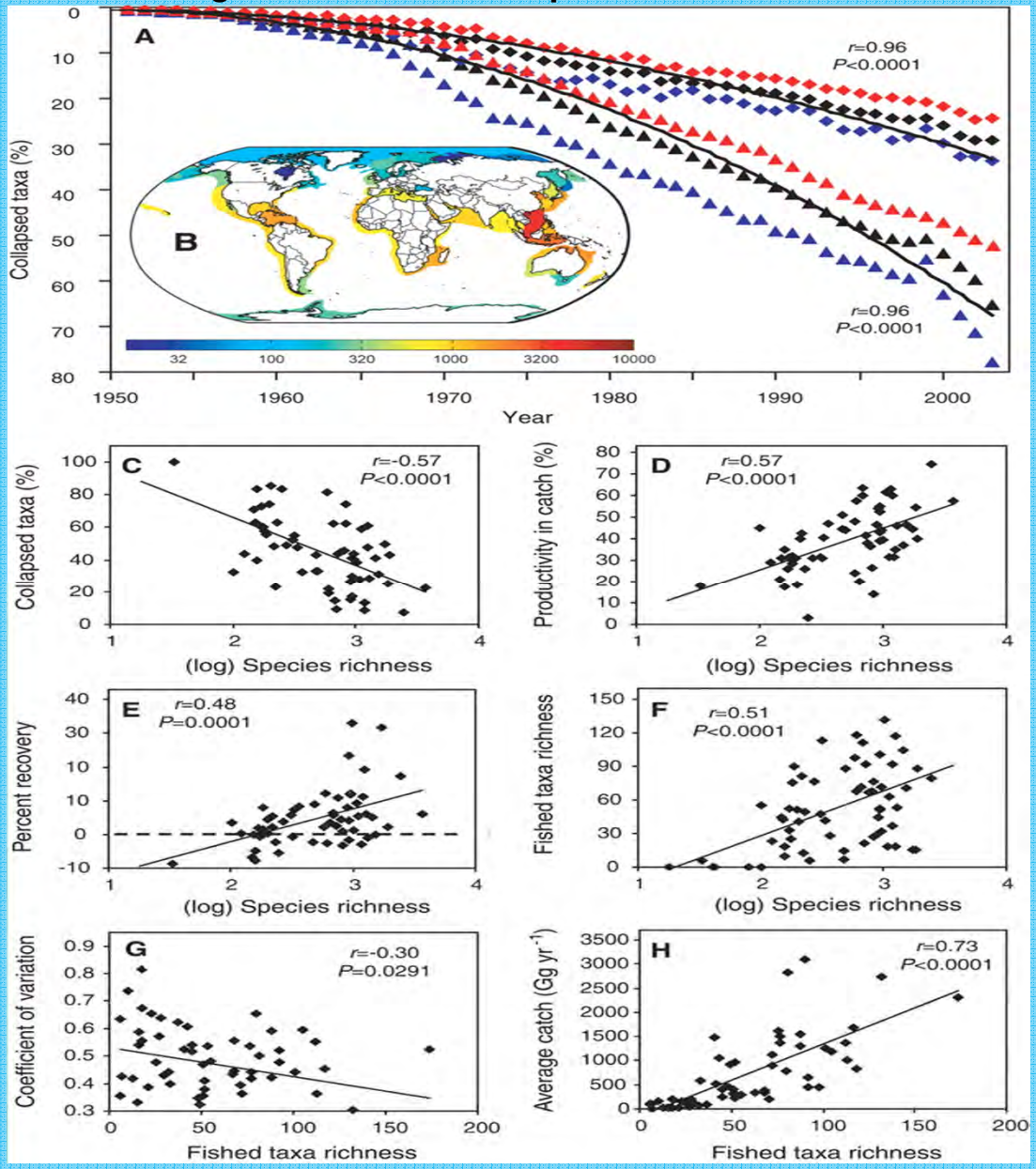

Million tons
90
80
70
60
50
40
30
20
10
0
1970
1975
1980
1985
1990
1995
2000
Global marine fish catches
Source: Millennium Ecosystem Assessment

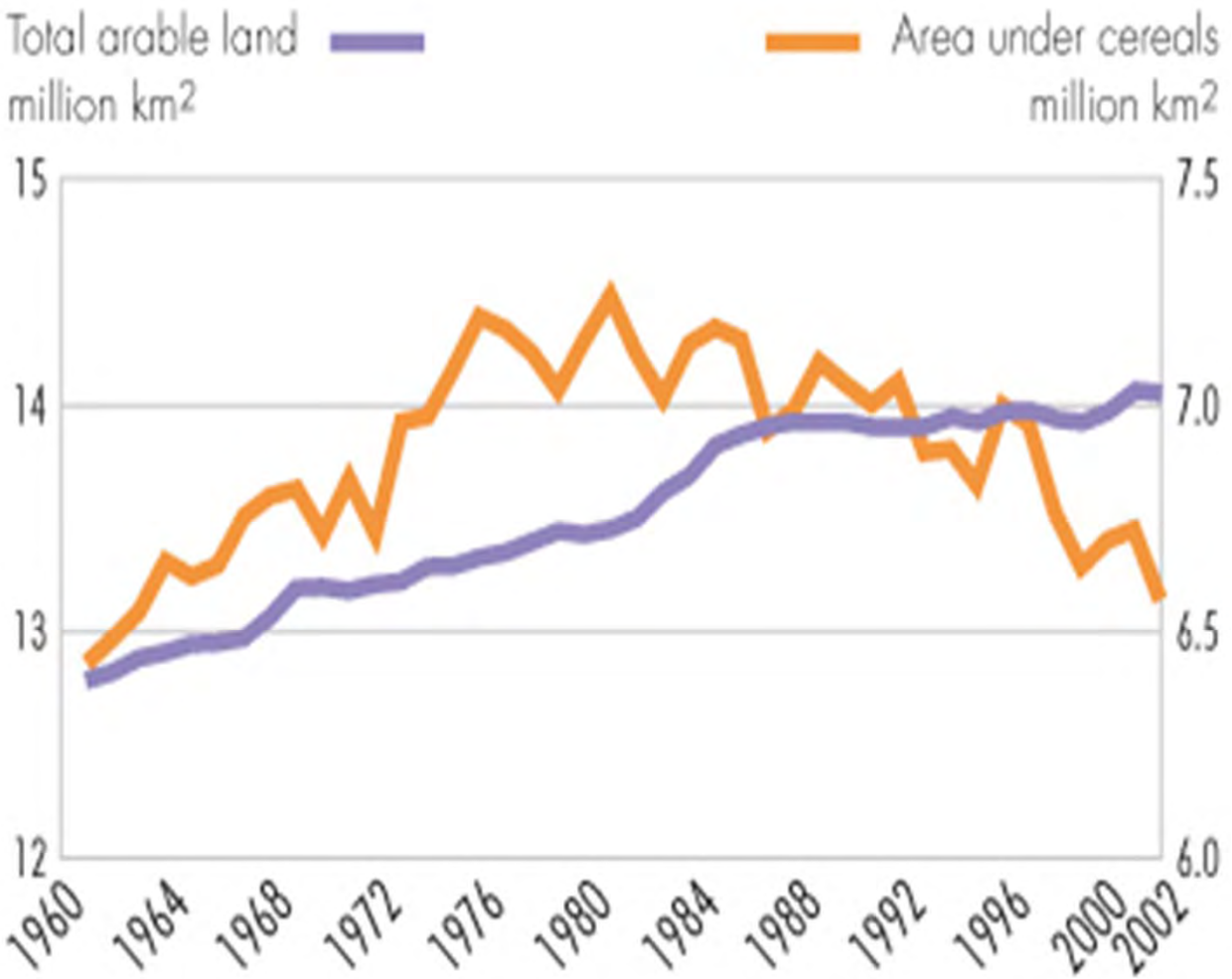
Fig. 3. Global loss of species from LMEs



B. Worm et al., Science 314, 787 -790 (2006)

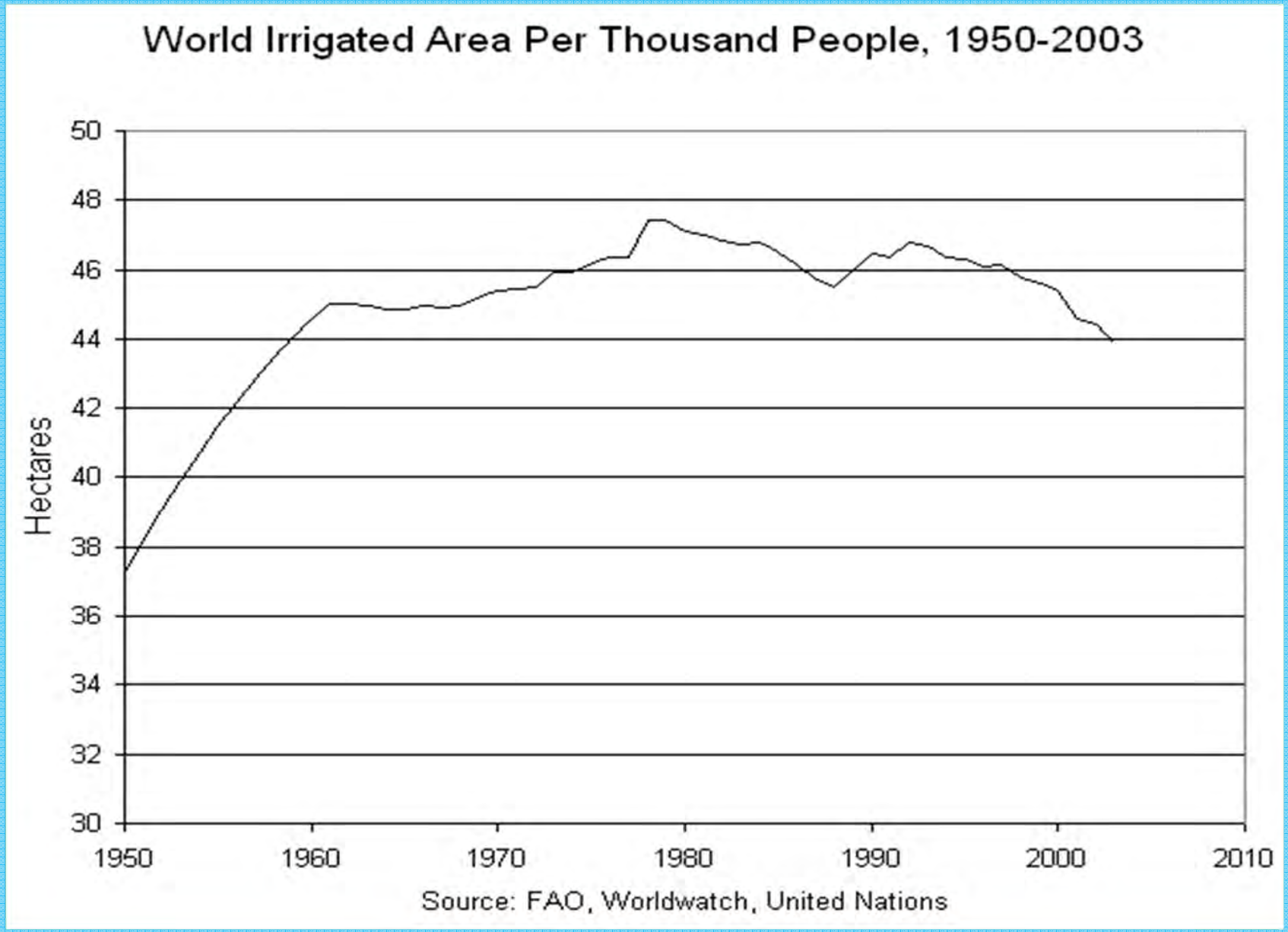
Land area is NOT increasing

Figure 3.11 Arable land and area under cereals



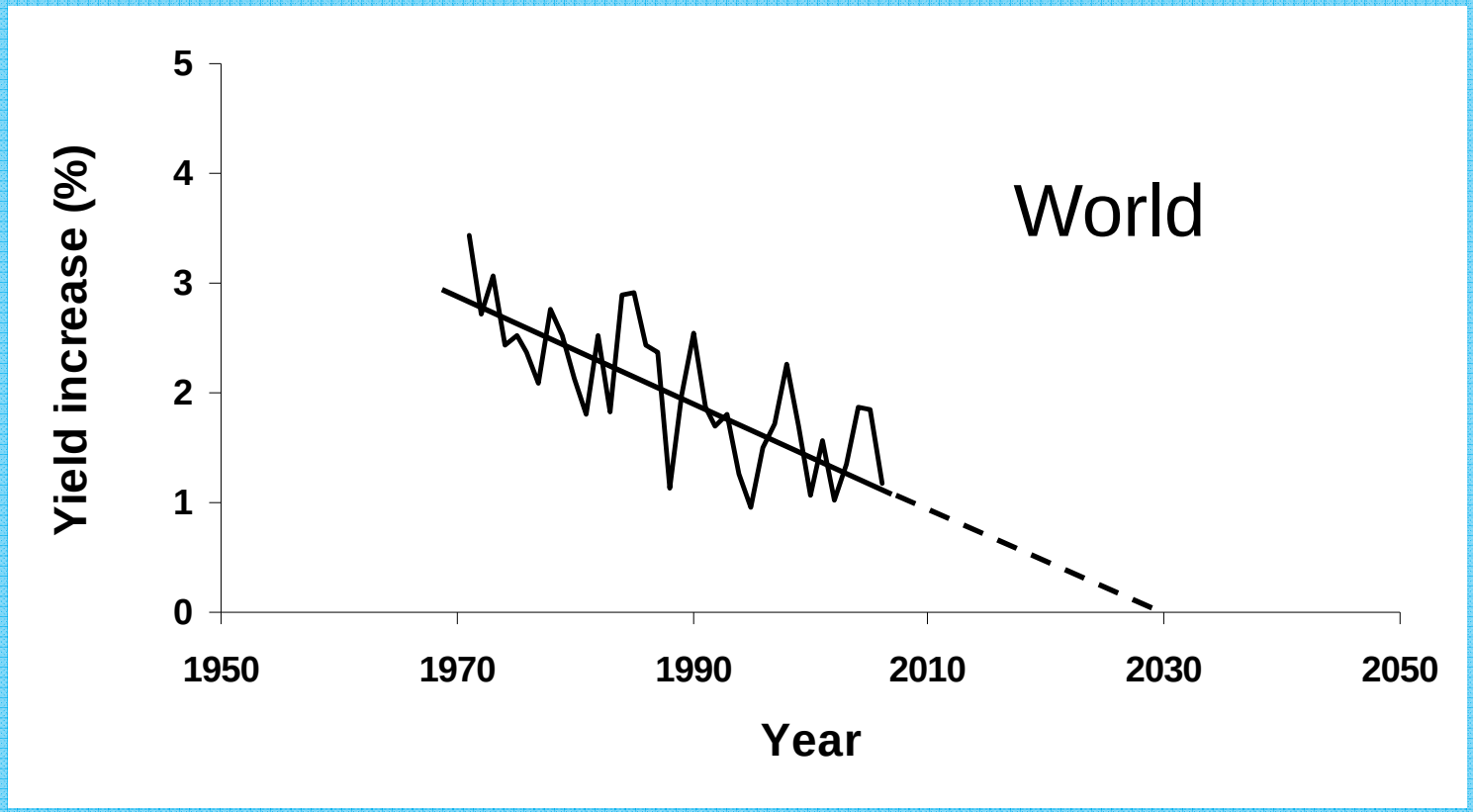
Source: FAOSTAT 2006

Irrigated Land Area is NOT Increasing



Lester Brown Plan 3.0, 2008

Food security: yield growth rate declining

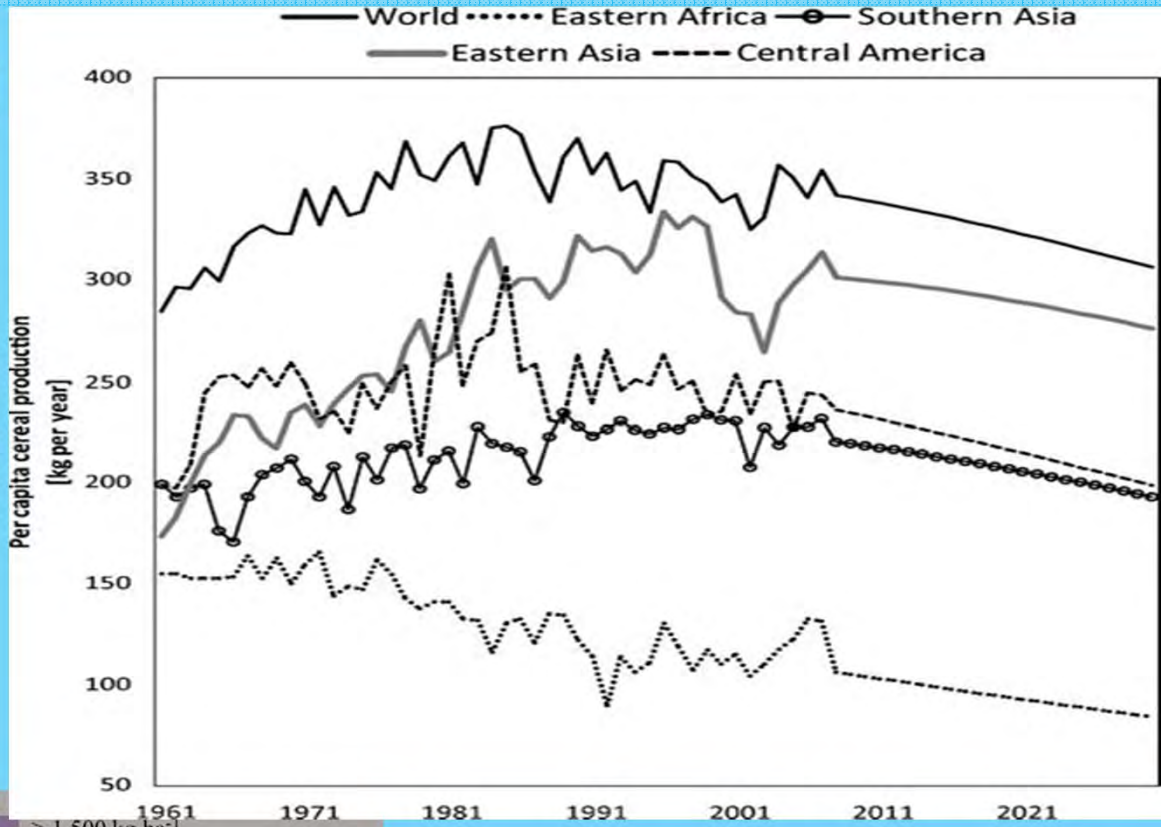


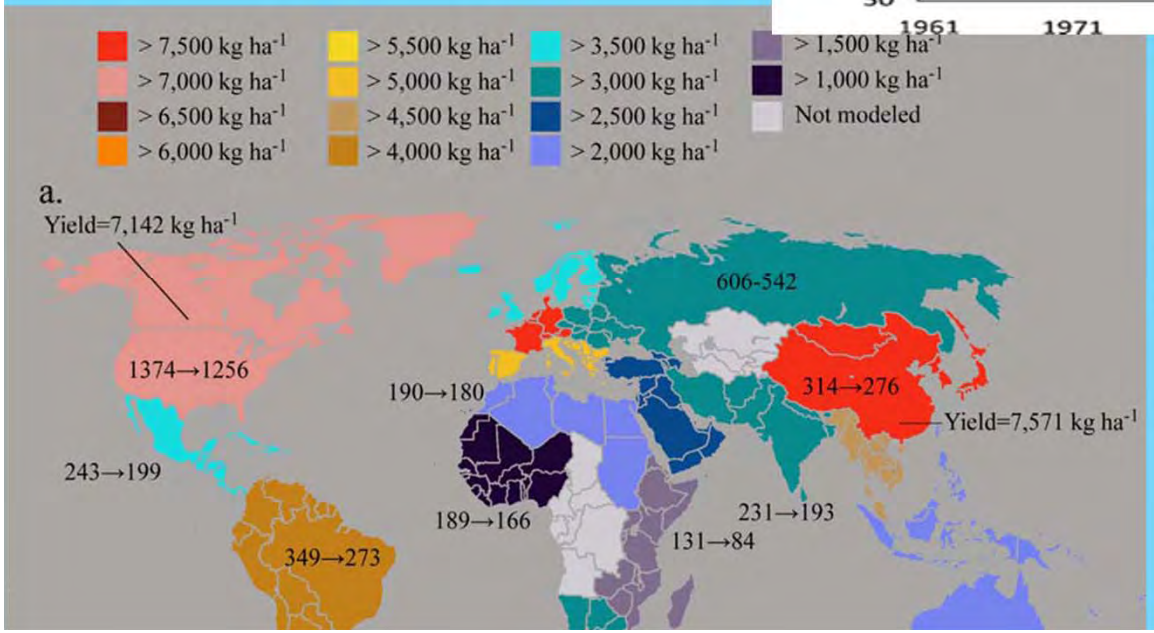
FAO wheat yield data: Analysis

From Mark Howden, CSIRO (2009)

Per Capita Agricultural Production trends.

Global 14% Per capita reduction projected by 2030



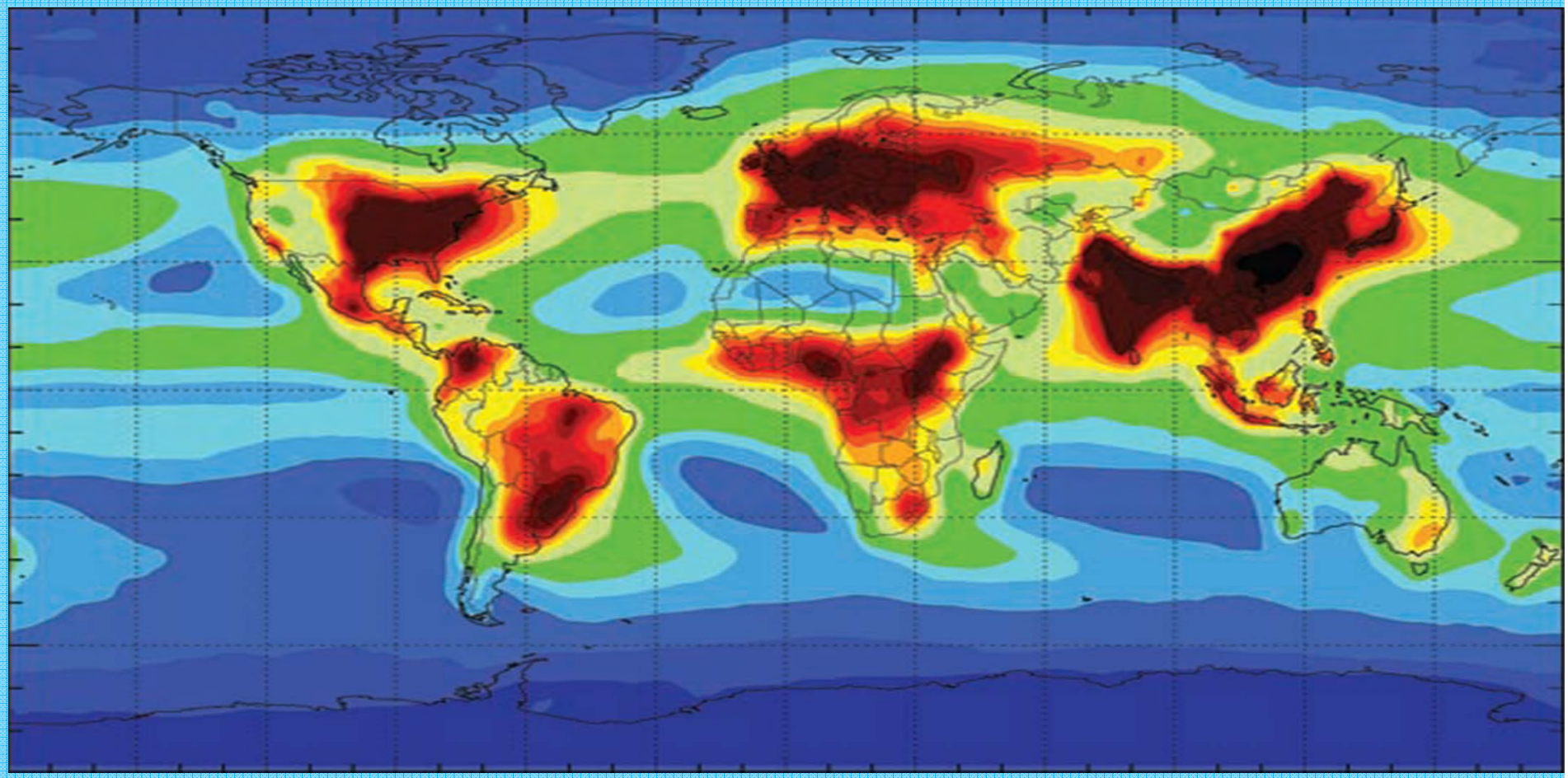


Observed 2007 – Projected 2030

Funk and Brown (2009)

Nitrogen Loading is already damaging the biosphere

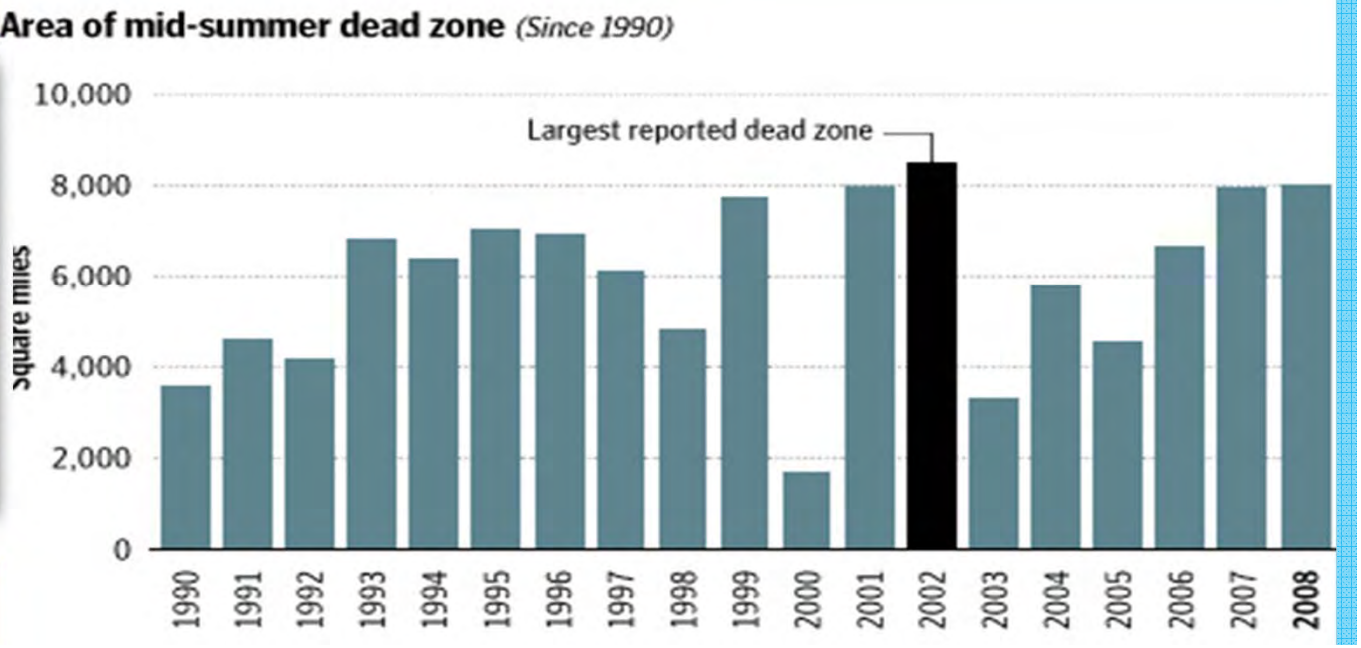
N Deposition rates (0 – 60kg/ha/yr)



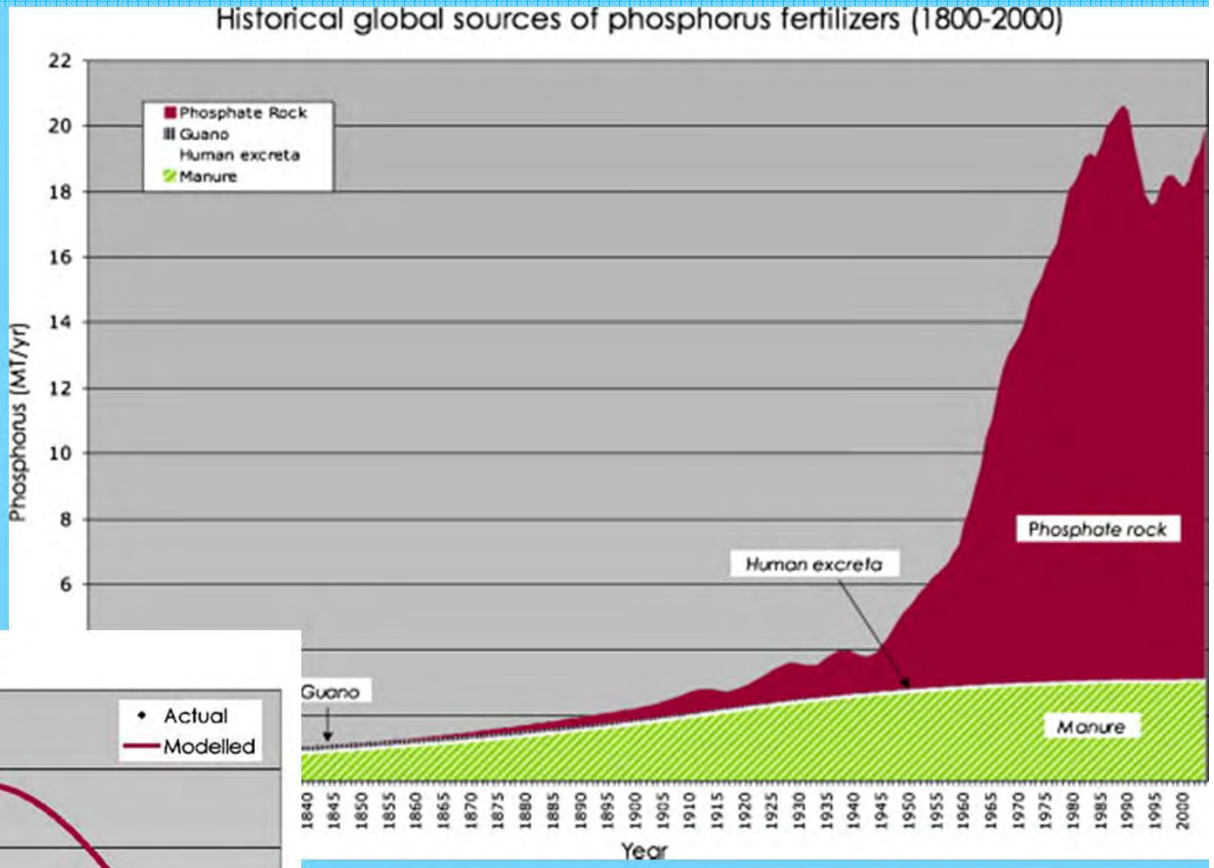
Galloway et al Science 2008

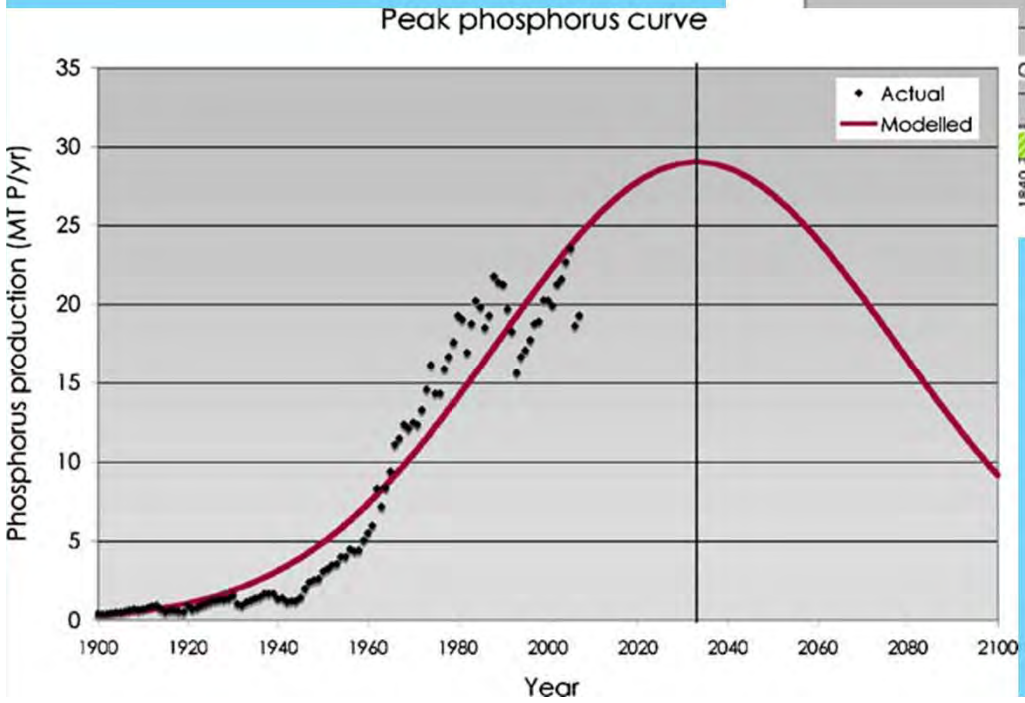
Gulf of Mexico Dead Zone

Photo: Nancy Rabalais, Louisiana Universities Marine Consortium



Future Phosphorus Limitations ?

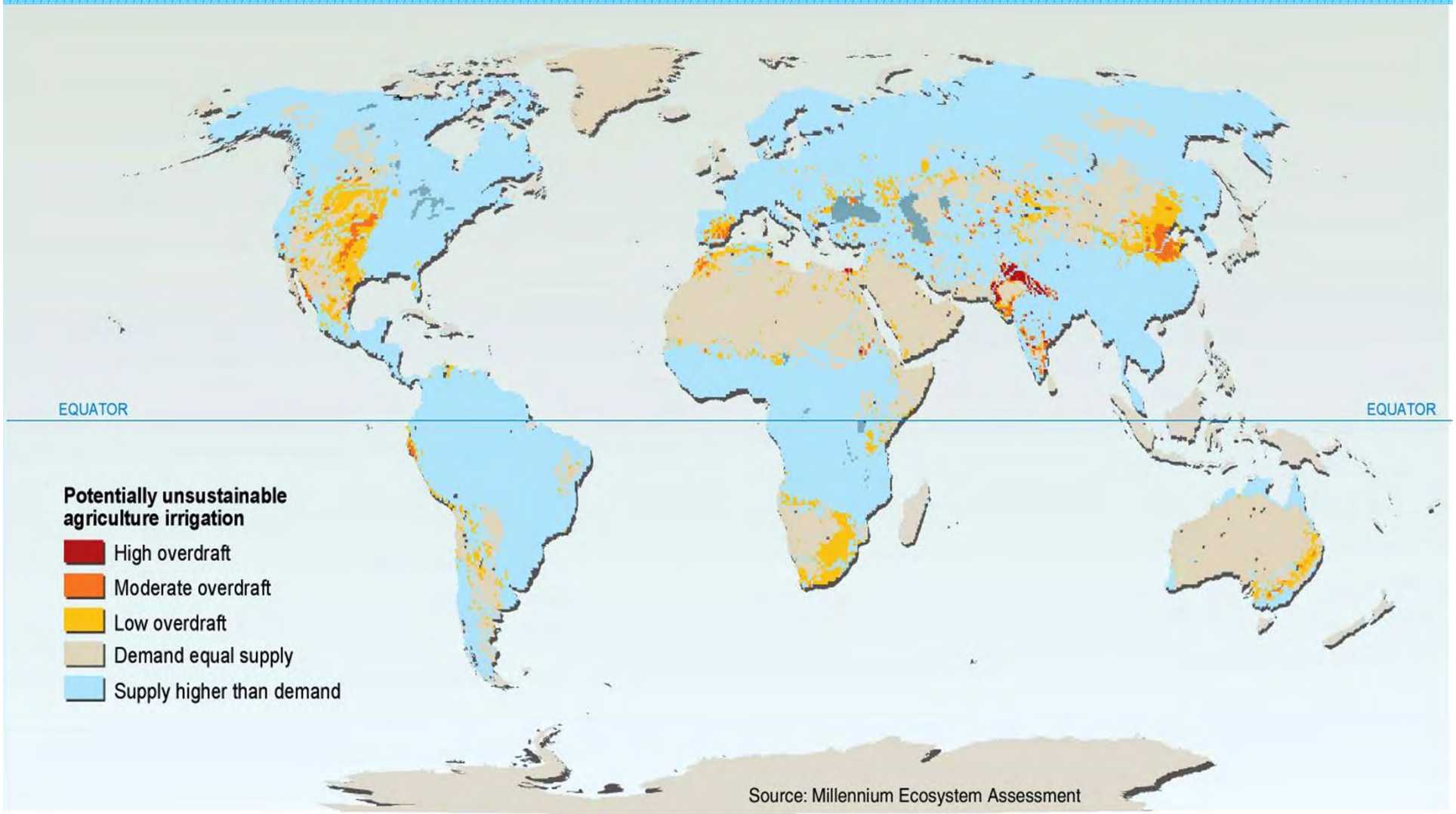




Cordell et al 2009.
Global Env Change 19: 292-305

Water

- 5 to possibly 25% of global freshwater use exceeds long-term accessible supplies (*low to medium certainty)*
- 15 - 35% of irrigation withdrawals exceed supply rates and are therefore unsustainable (*low to medium certainty)*



Unsustainable groundwater withdrawal

Depletion rate 4cm/yr

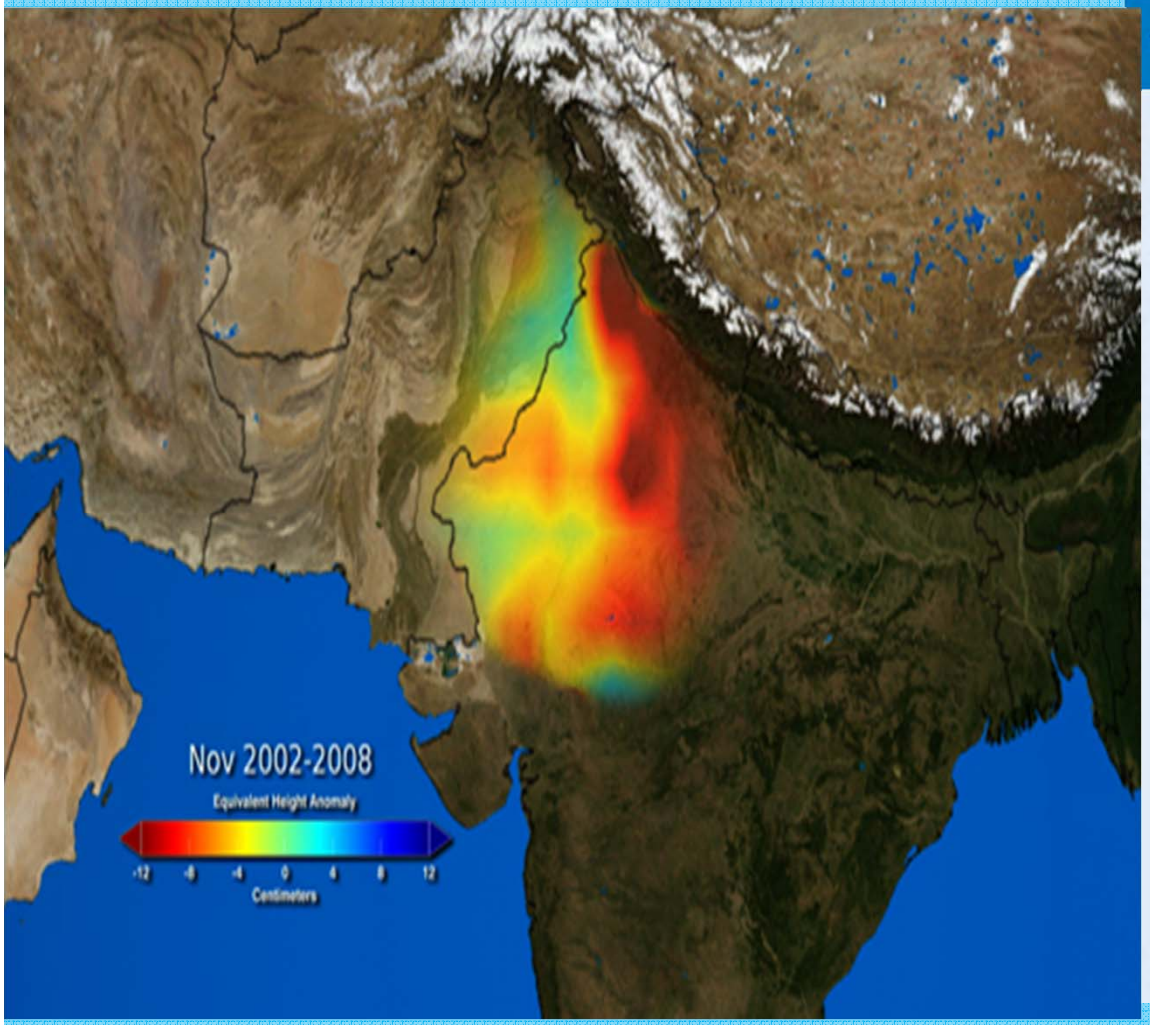
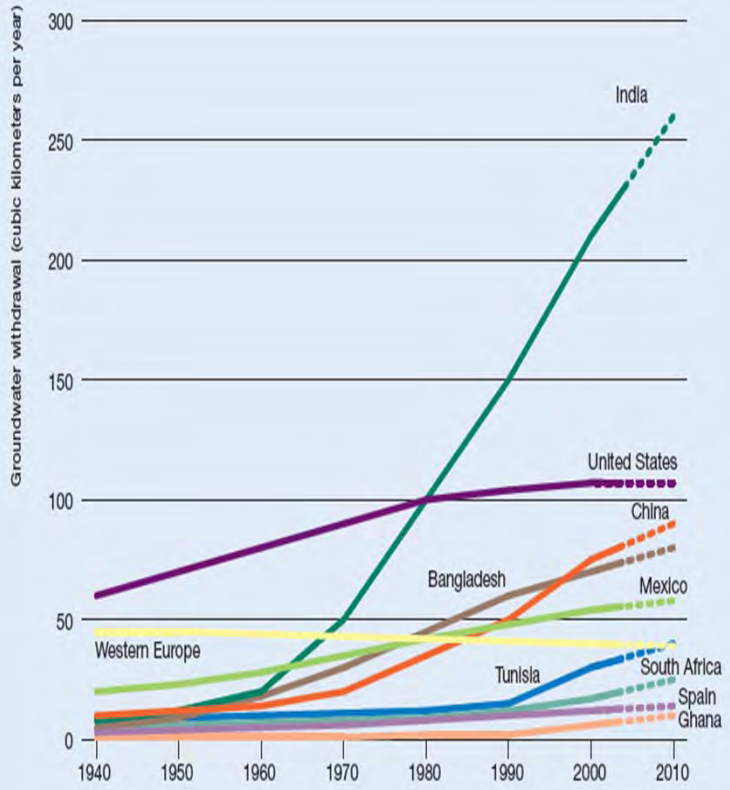


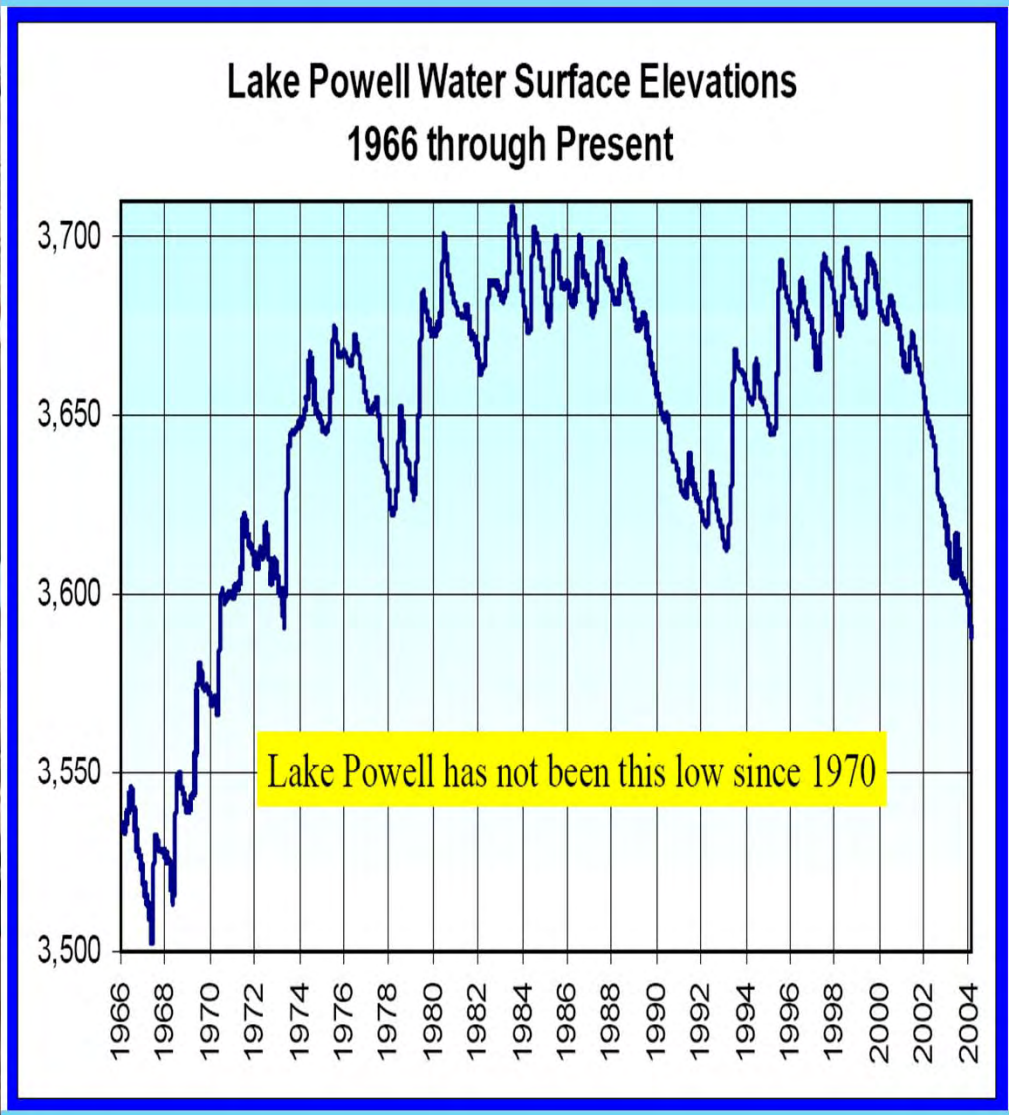
figure 10.1 | Development in groundwater withdrawal in selected countries



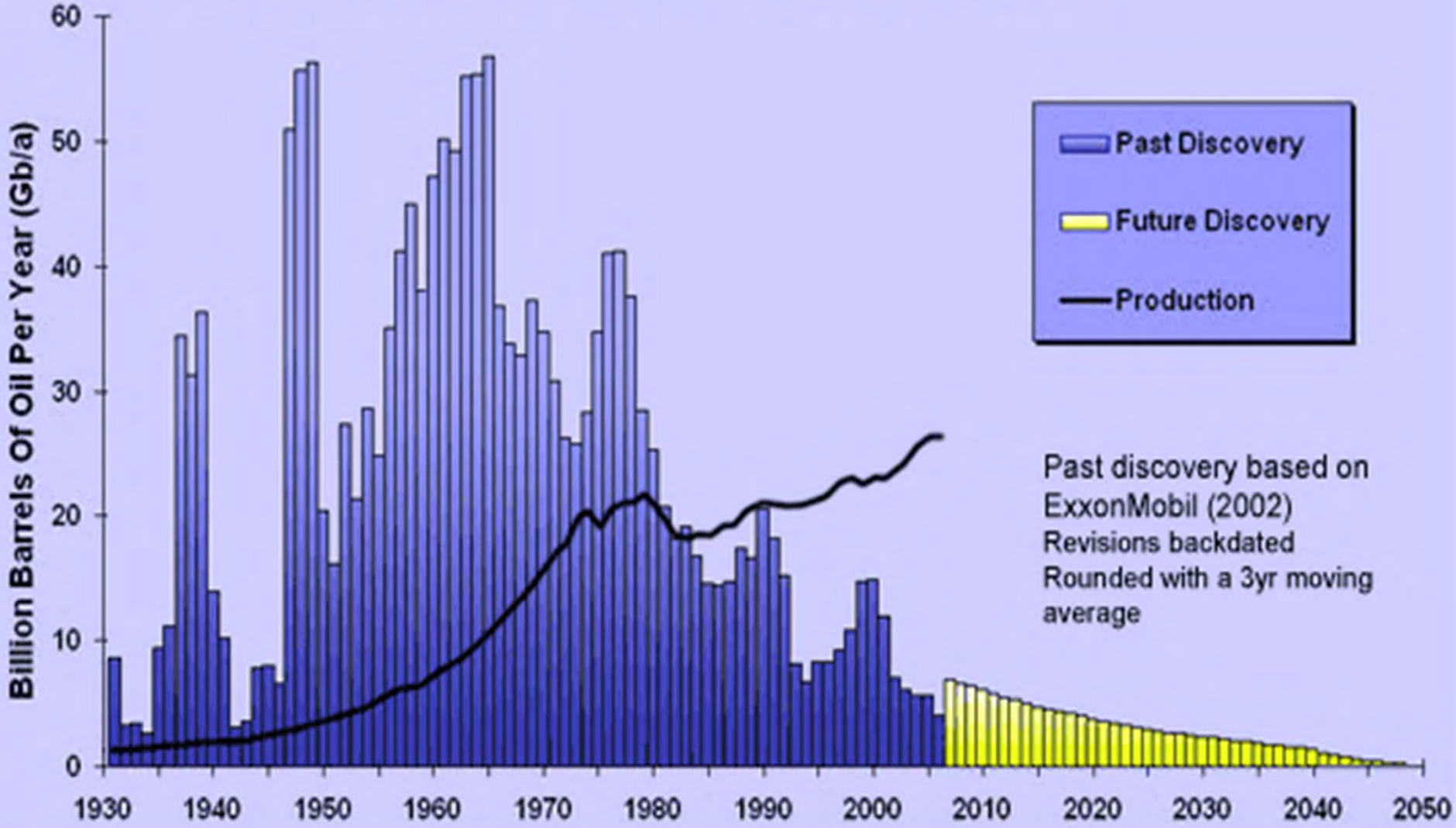
Source: Shah 2005.

Groundwater withdrawals as % of recharge, 2002-2008.
Rodell et al Nature 2009

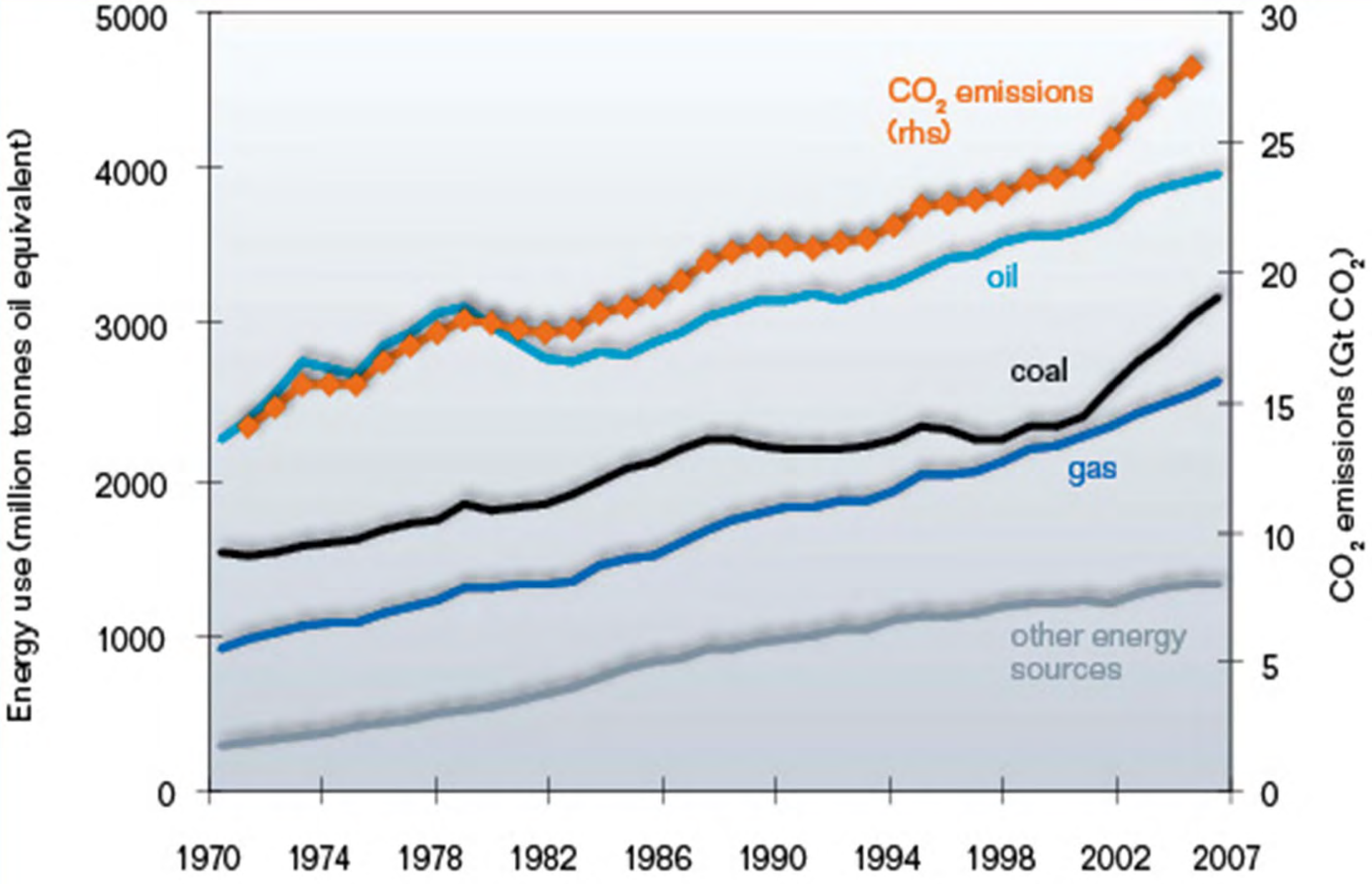
Lake Powell, AZ
Colorado River Basin



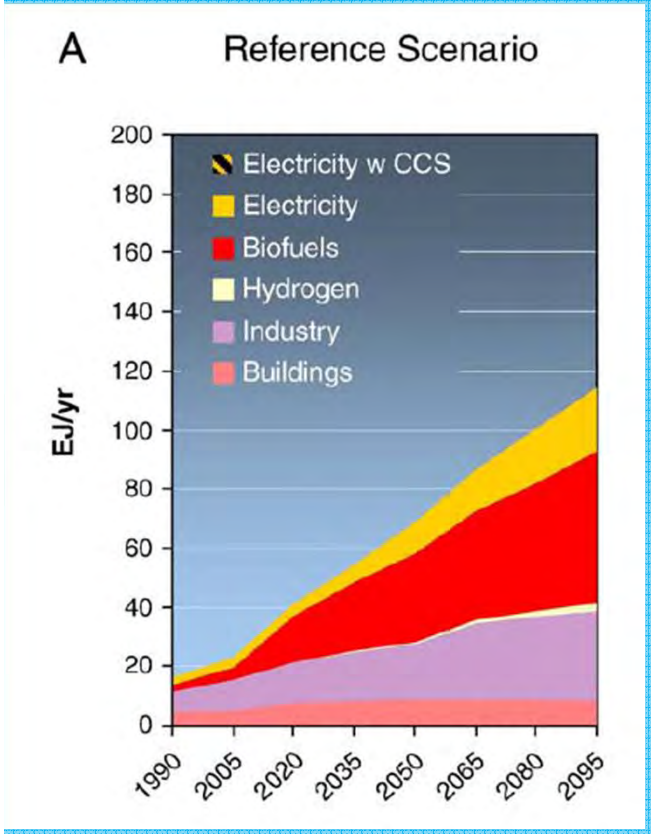
THE GROWING GAP
Regular Conventional Oil: Discovery & Production



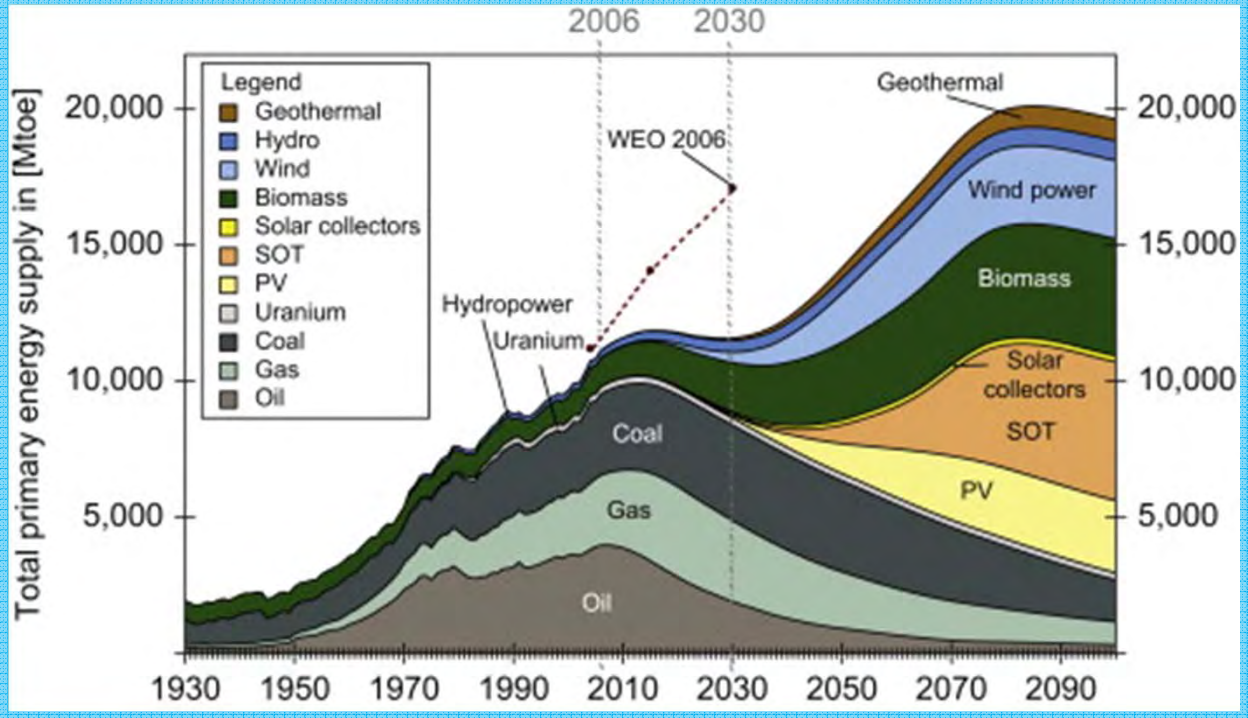
Global Energy Consumption



Aggressive Biofuel Projections by energy and economics sectors

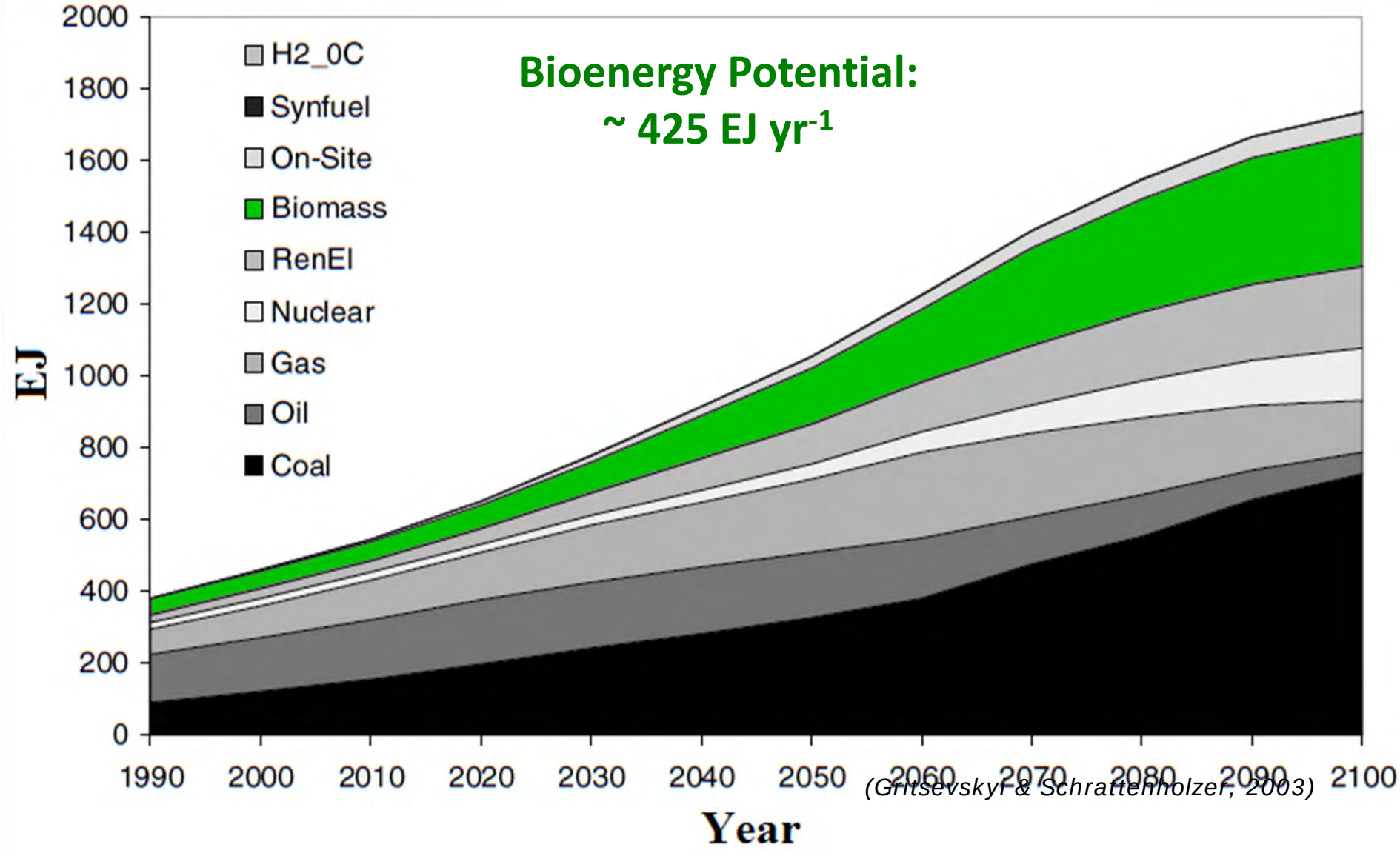


Calvin et al Energy Economics (2009)



Zerta et al 2008

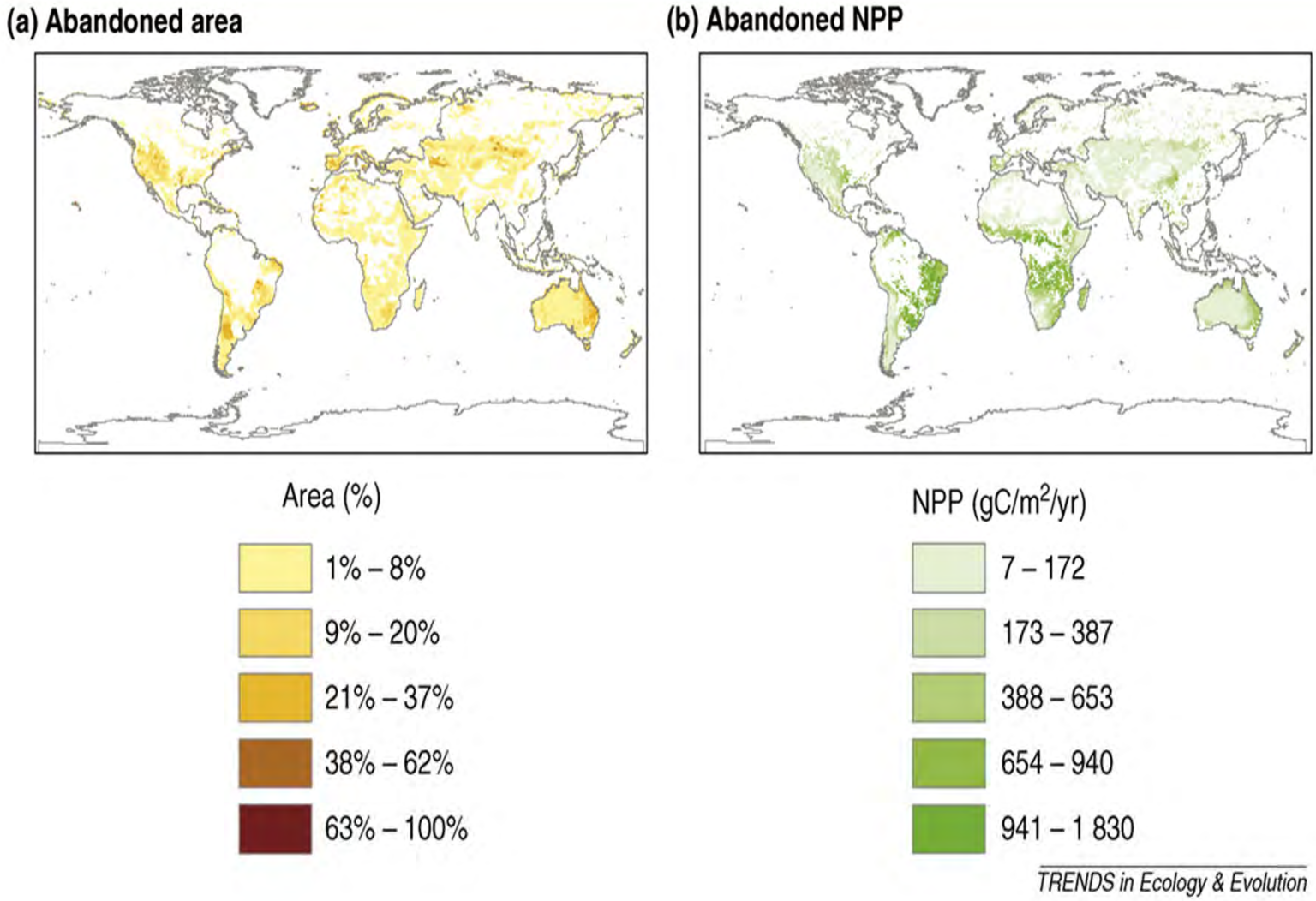
Future Bioenergy Potential (estimated by economists)



(Gritsevskyi & Schrattenholzer, 2003)

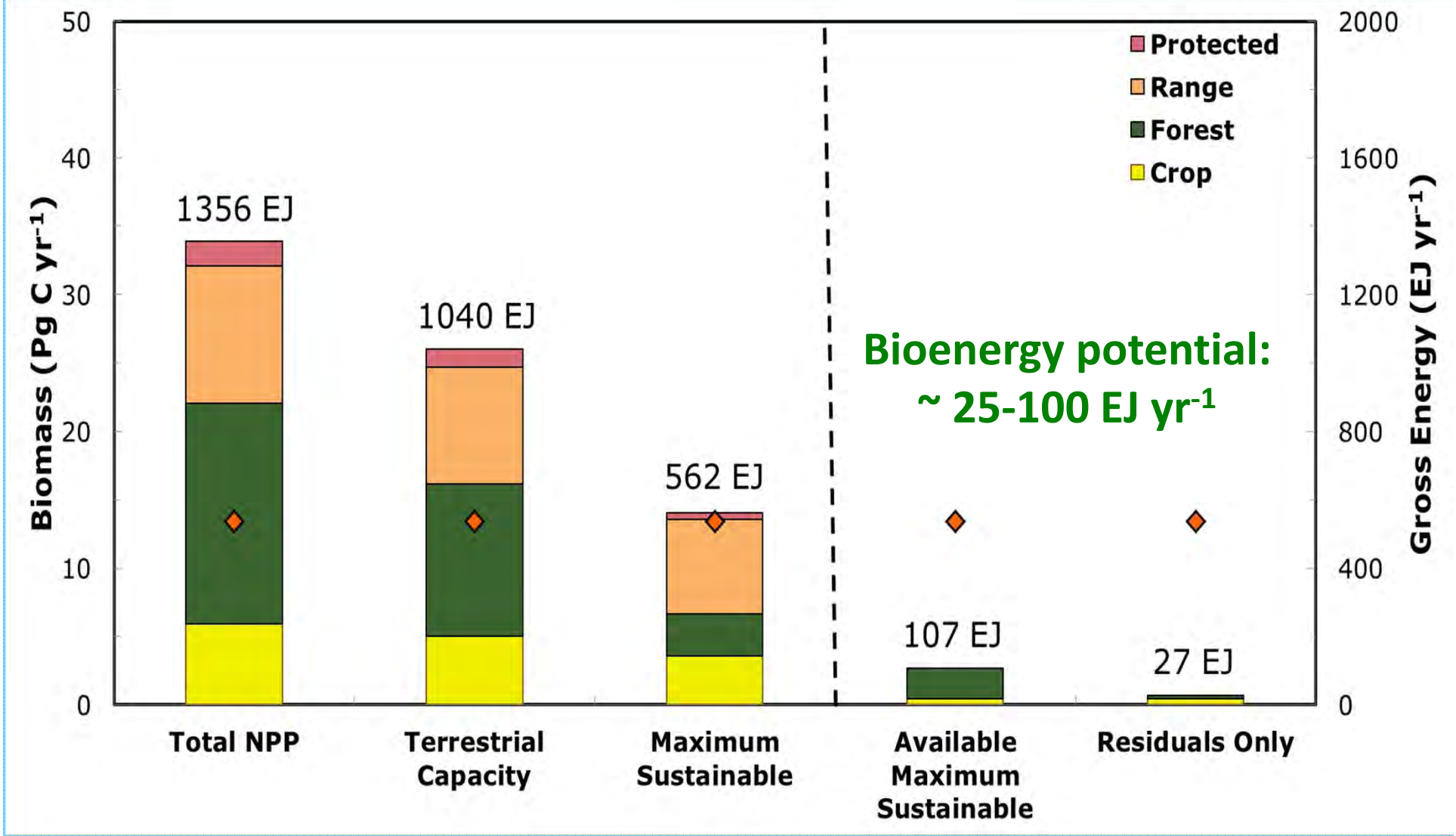
Bioenergy Potential from "Abandoned Area"

(5% of 2006 global energy)



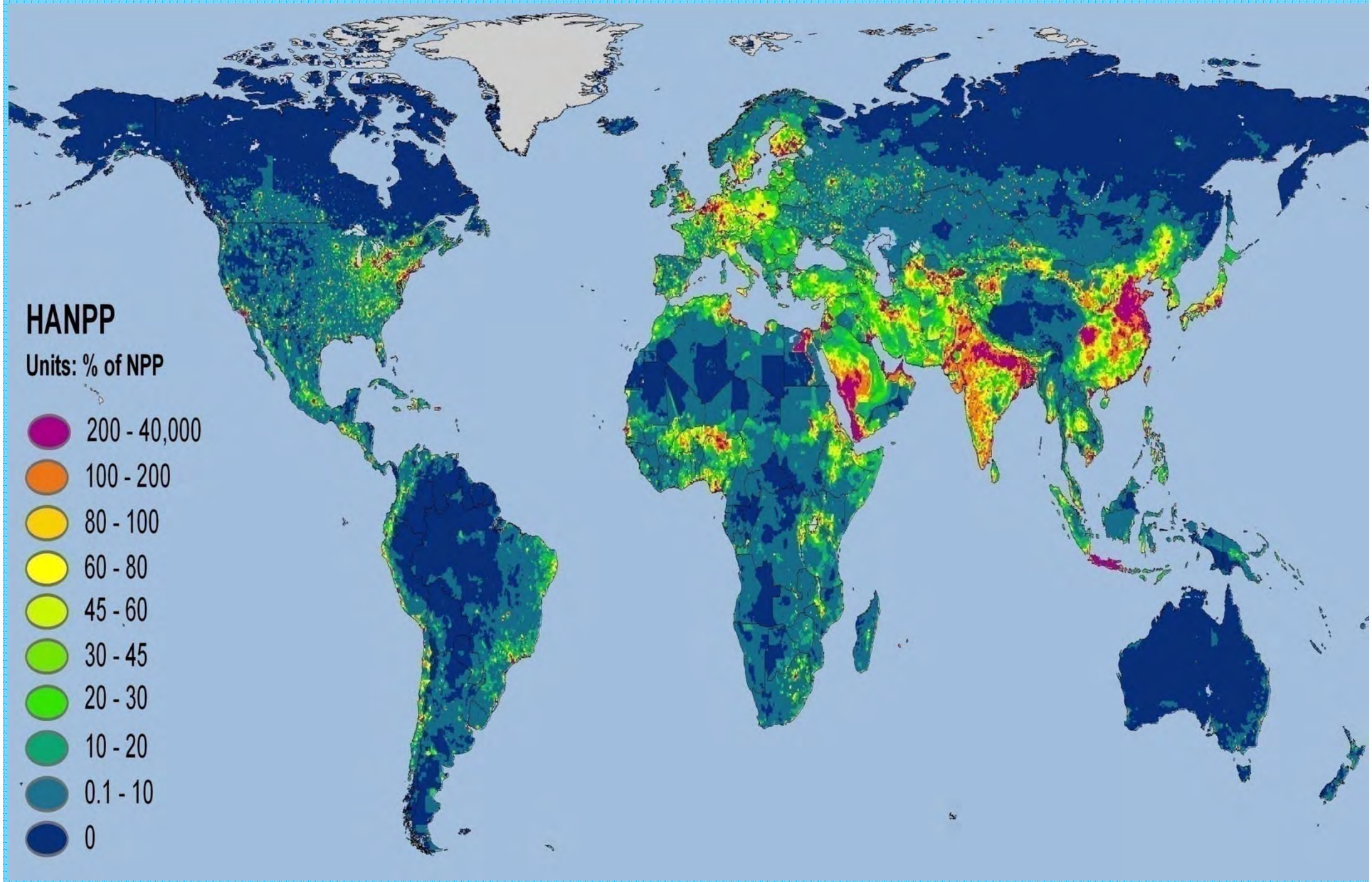
C. Field et al Trends in Ecology and Evolution, 2008

Capacity for Bioenergy Production (estimated by ecologists)



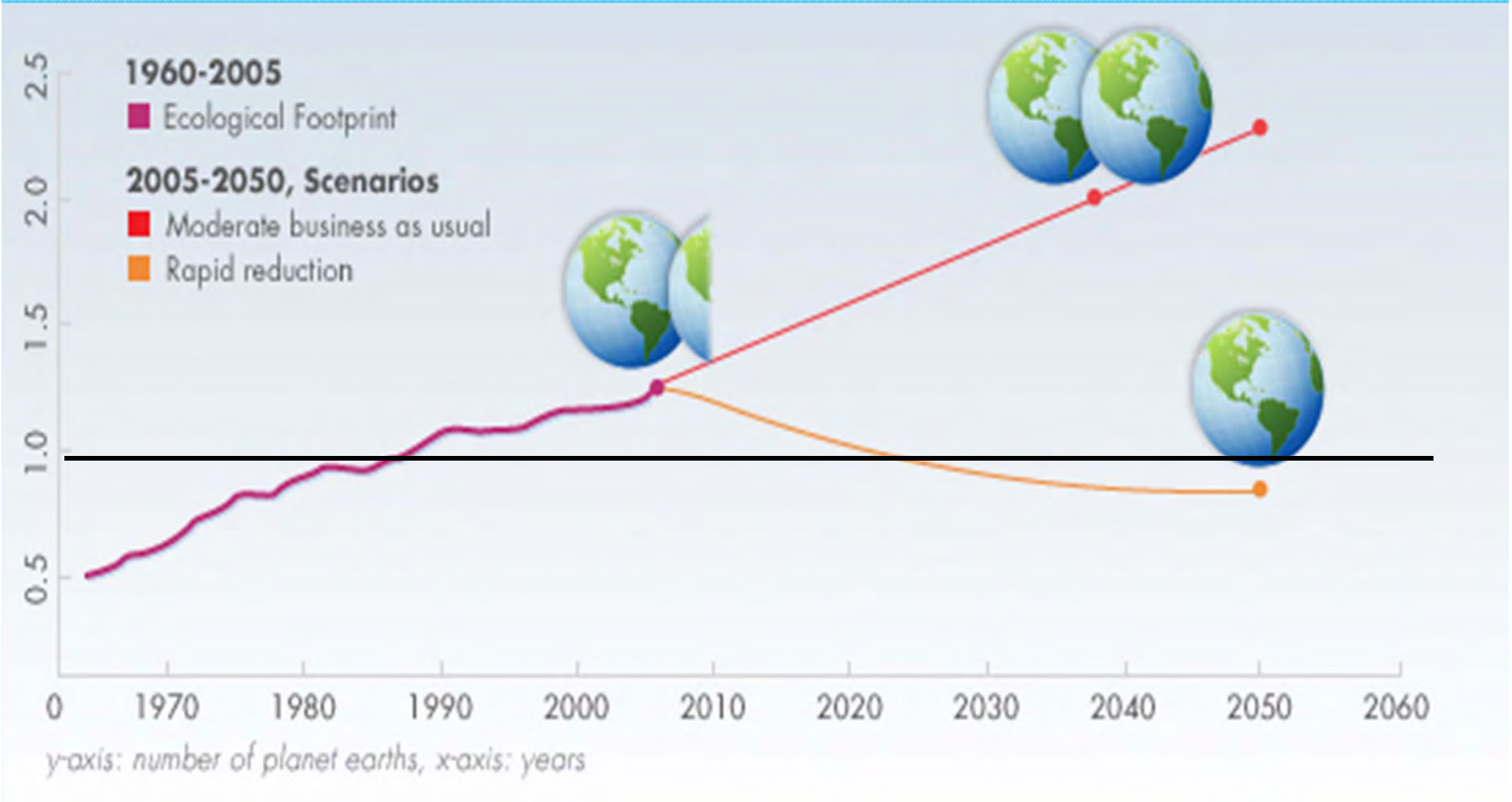
Smith and Running, in prep

HUMAN APPROPRIATION OF NET PRIMARY PRODUCTION



NASA Visible Earth, Imhoff et al 2004

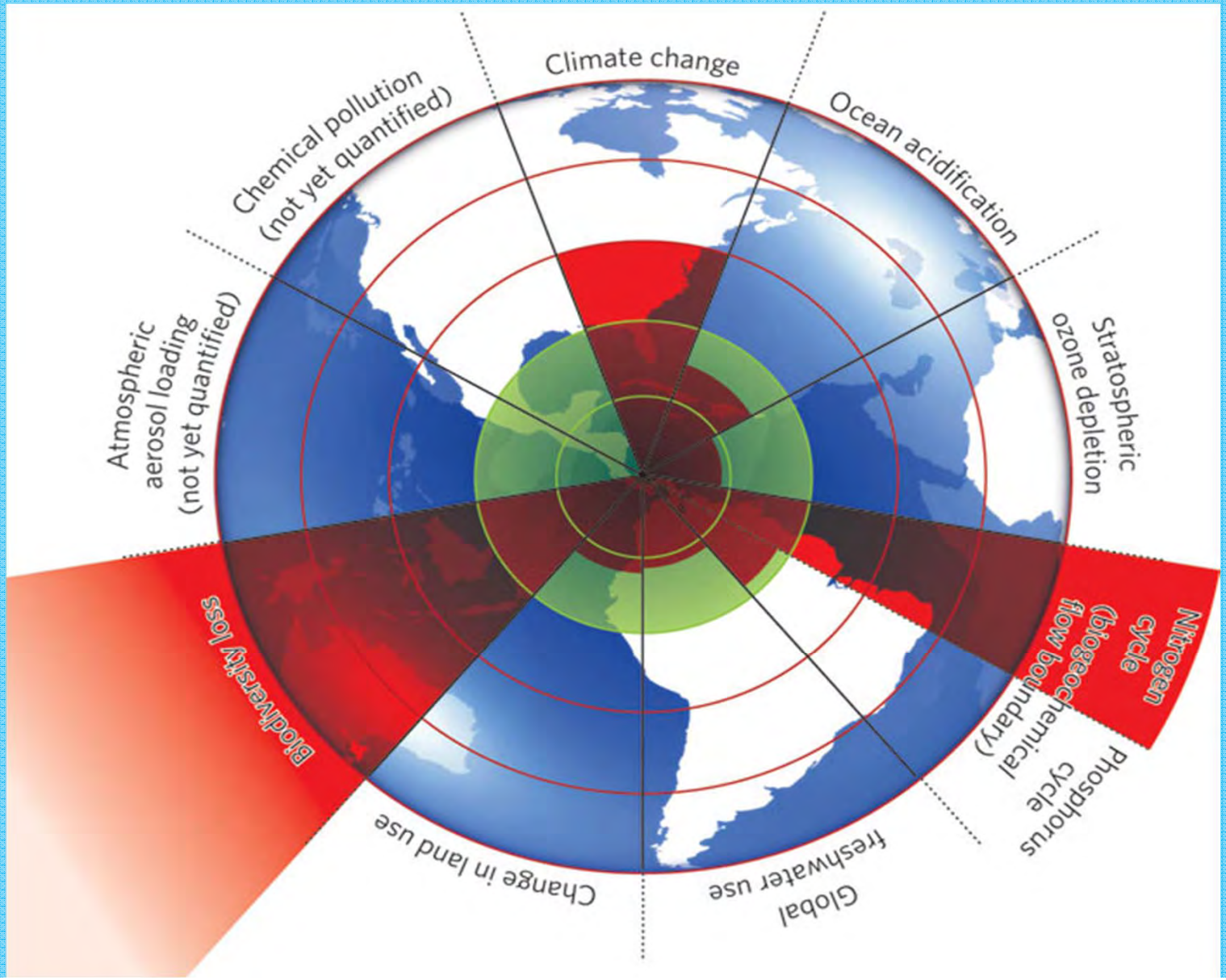
Human Ecological Footprint



For all humans to live like Americans would take 7 Earths

PLANETARY BOUNDARIES

Rockstrom et al. *Nature* 2009



APRIL 6, 2009

Hey G-20, Can You Spare a Dime? 4 Countries' Woes

Sticker Shock: Inside the College Financial Aid Game

Brain Injuries: How A Simple Accident Can Turn Fatal

TIME

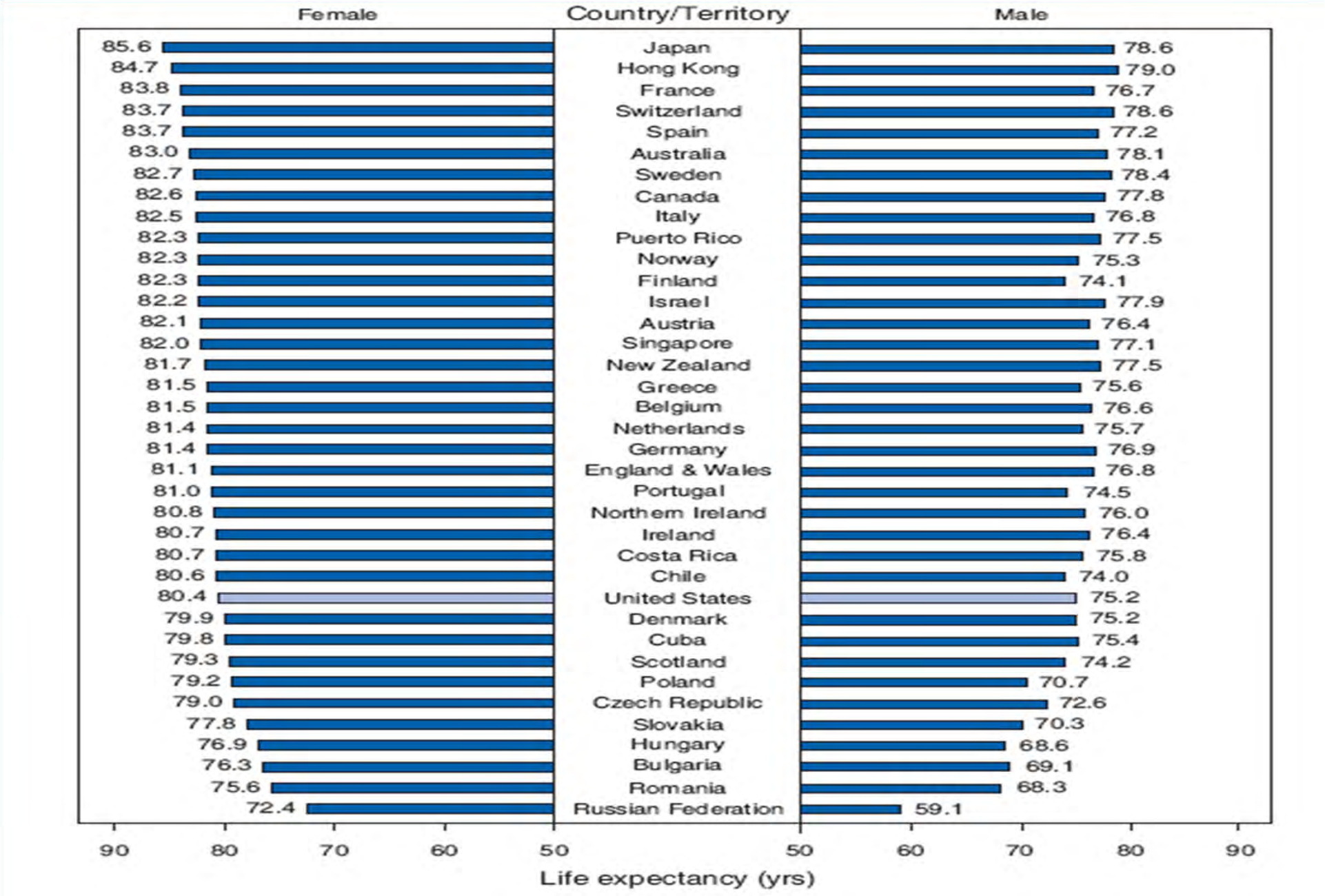
The End of Excess

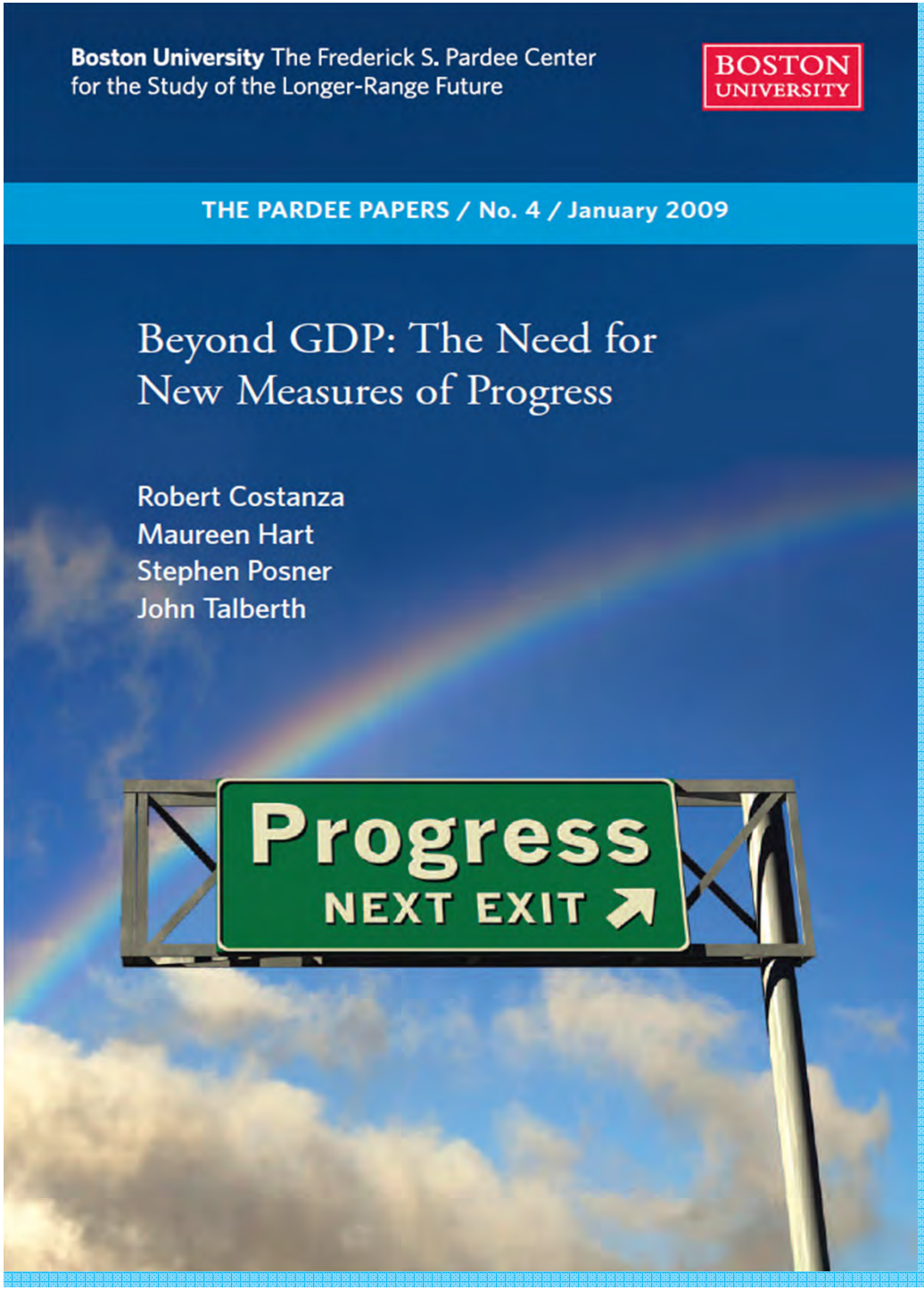
Why this crisis is good for America

BY KURT ANDERSEN

www.time.com

LIFE EXPECTANCY





Gross Domestic Product (GDP) measures everything….. "Except that which makes life worthwhile. "

Robert F. Kennedy, 1968

2008

EE

Managing Without Growth

Slower by Design, Not Disaster

Peter A. Victor

Advances in Ecological Economics

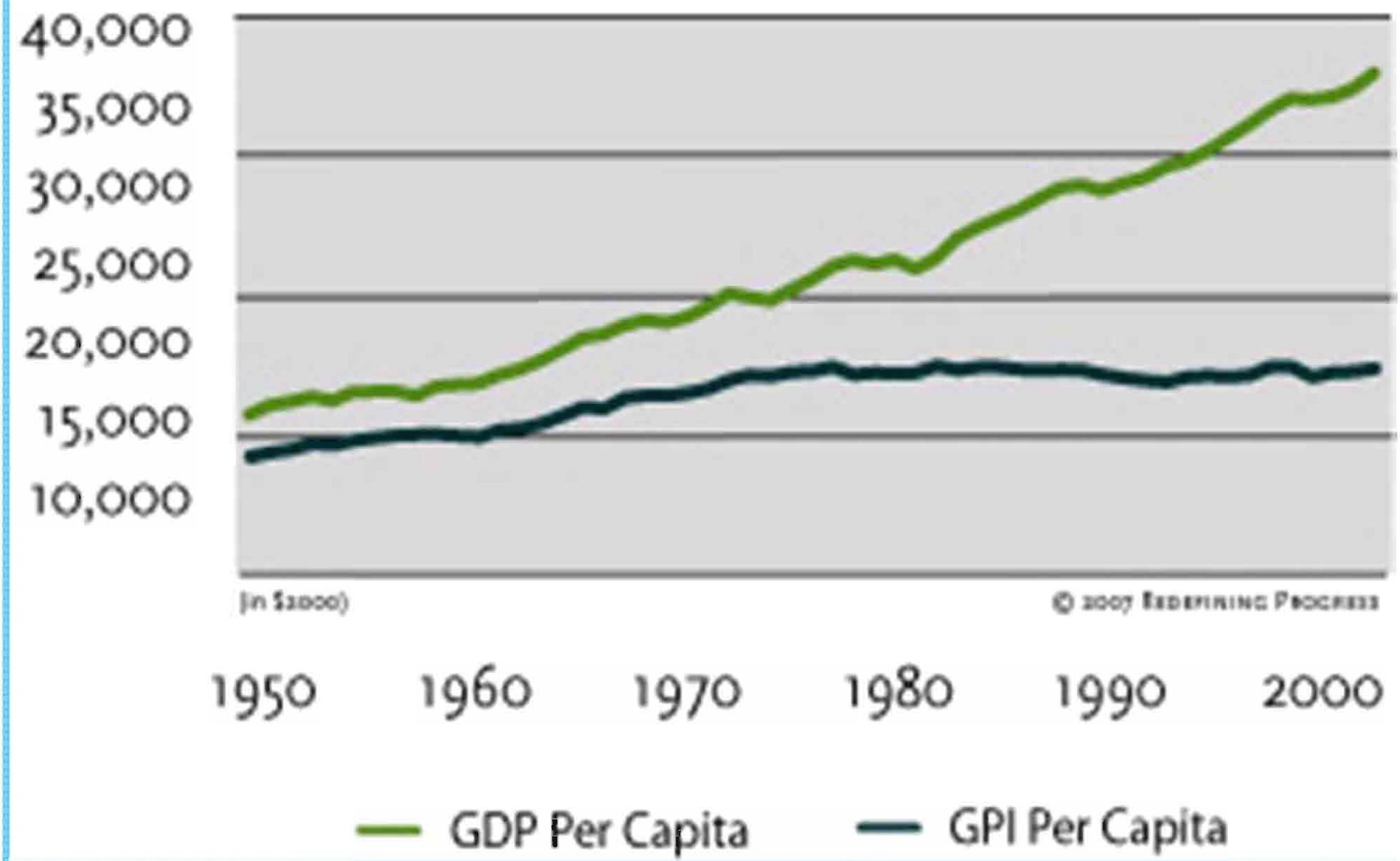
SERIES EDITOR: JEROEN C.J.M. VAN DEN BERGH

ICTAM VII Seventh International Congress on Traditional Asian Medicine, Thimphu, 7-11 September 2009

Gross National Happiness as a Larger Context for Healing and Global Change

Dasho Karma Ura
dasho.k.ura@gmail.com
President, Centre for Bhutan Studies, Thimphu, Bhutan

Gross Production vs. Genuine Progress, 1950-2004



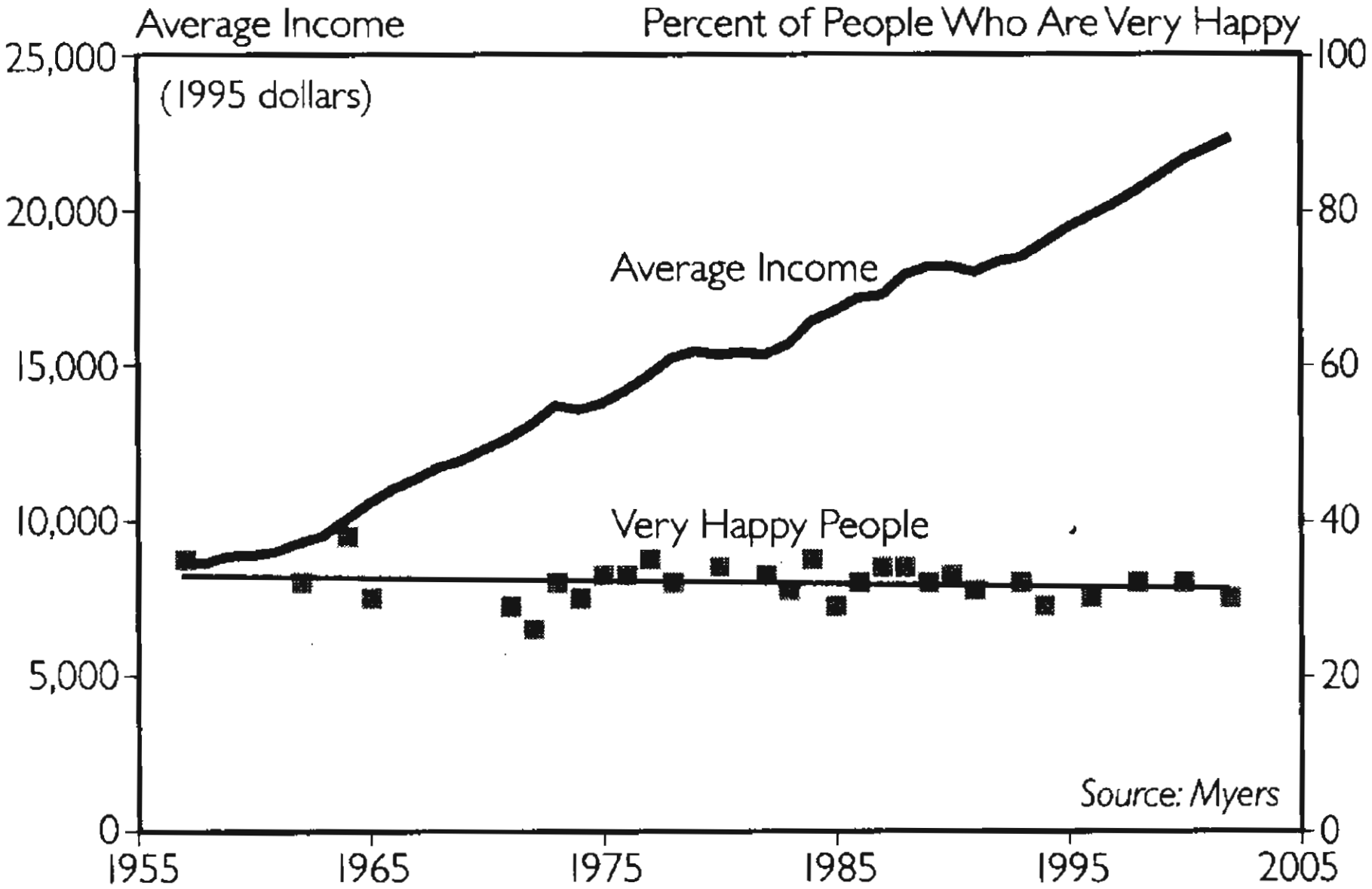
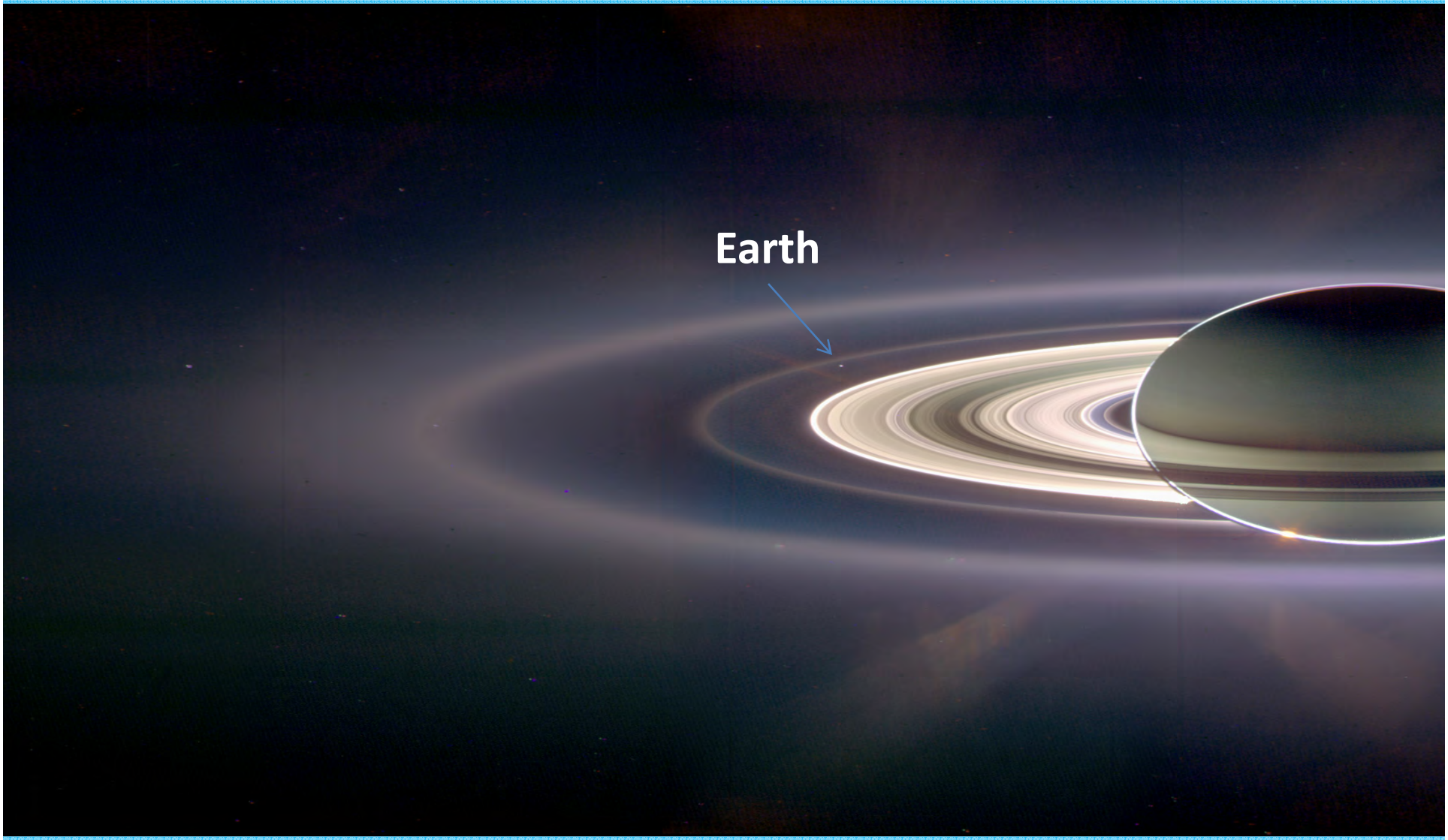


Figure 8–1. Average Income and Happiness in the United States, 1957–2002

Earth from 1 billion km away

(most remote picture of Earth ever taken)

Cassini spacecraft, Sept 15 2006



From NASA Earth Observatory