IGBP Earth System Science for Global Sustainability: Connecting Regional to Global.

Sybil P. Seitzinger

Executive Director, IGBP

Stockholm, Sweden

Integrated Earth-System Approach

Integrated Earth-System Approach

Land

Integrated Earth-System Approach

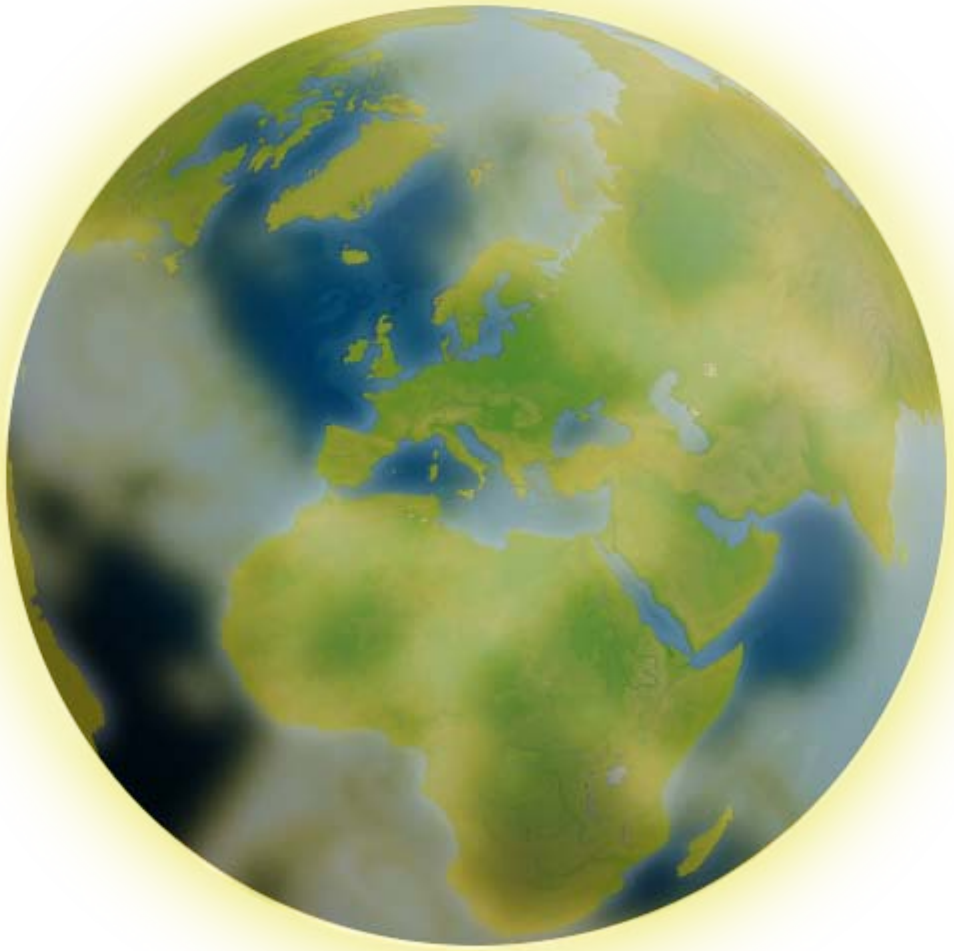
Ocean

Integrated Earth-System Approach

Atmosphere

Integrated Earth-System Approach

Land-
Atmosphere

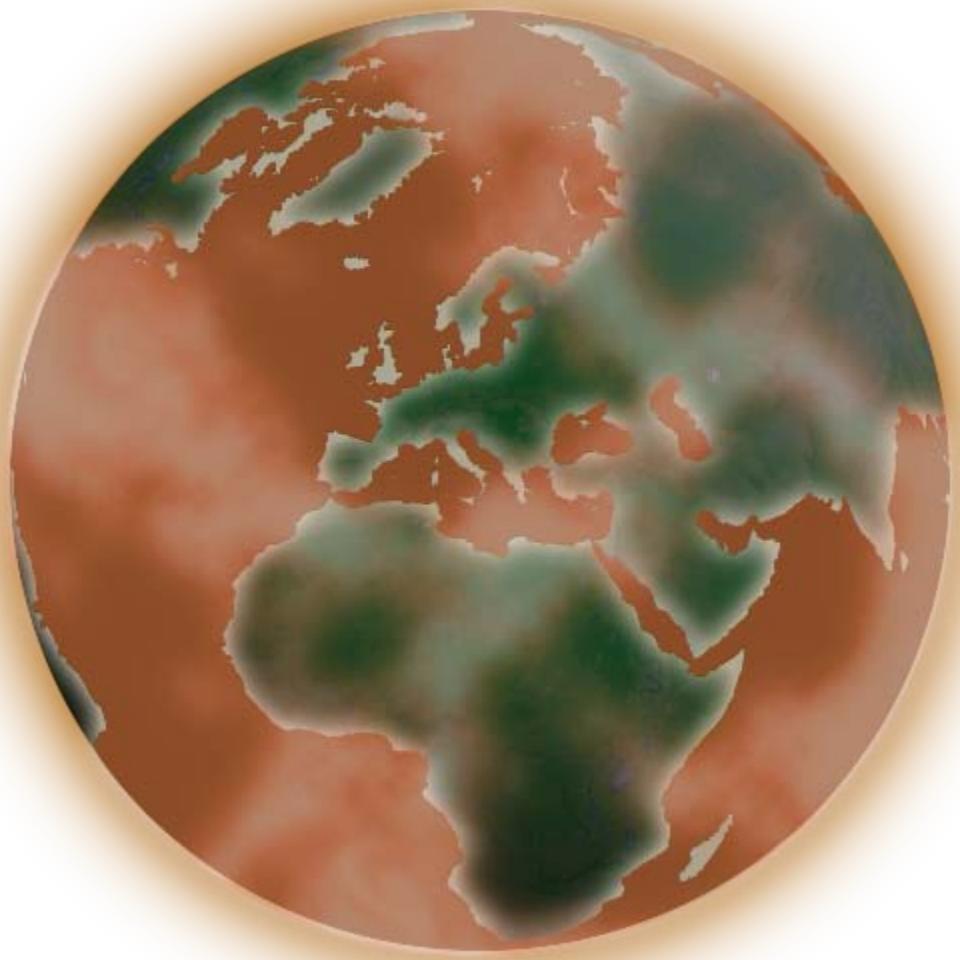


Integrated Earth-System Approach

Land-Ocean

Integrated Earth-System Approach

Ocean-
Atmosphere

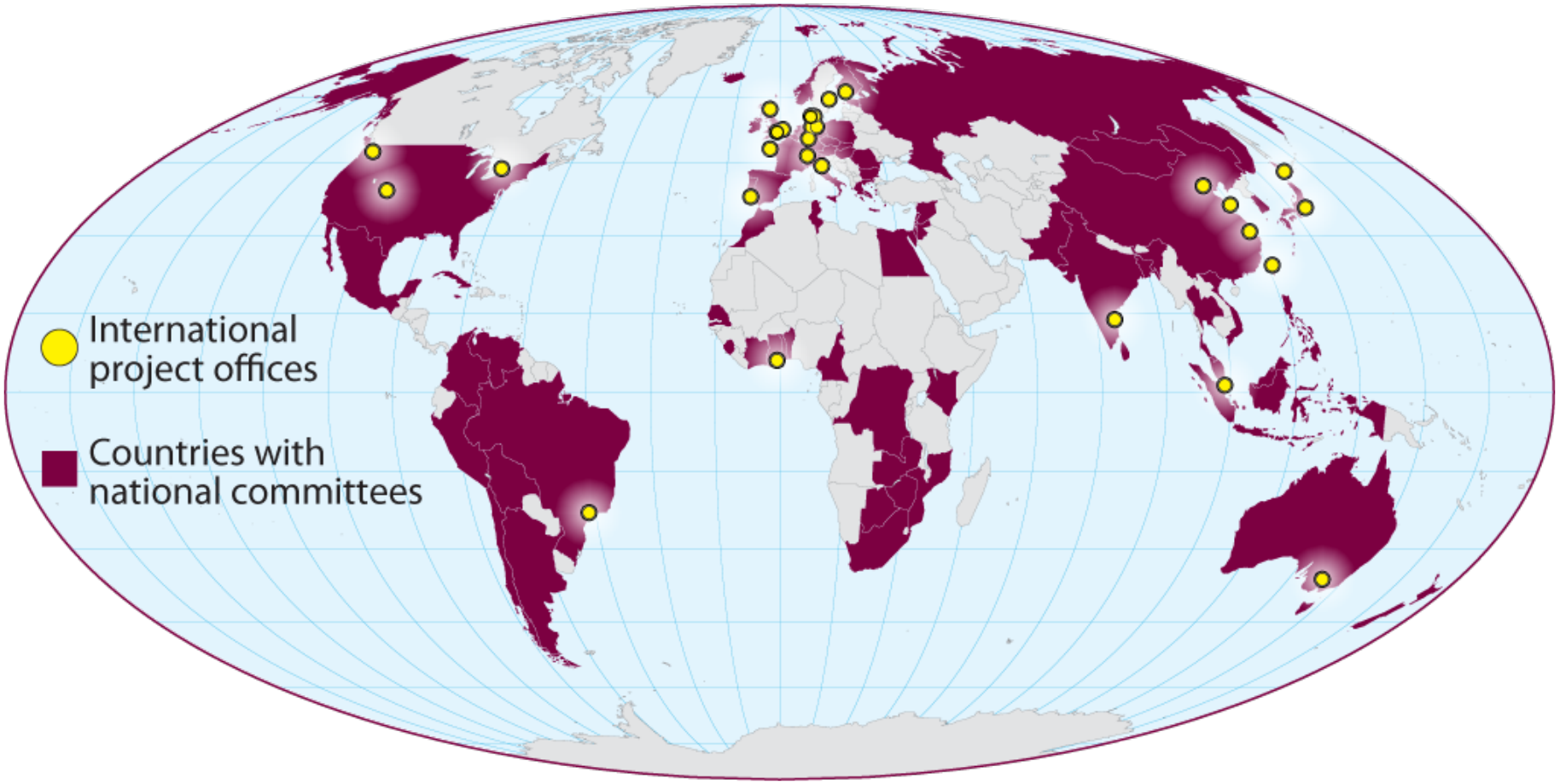


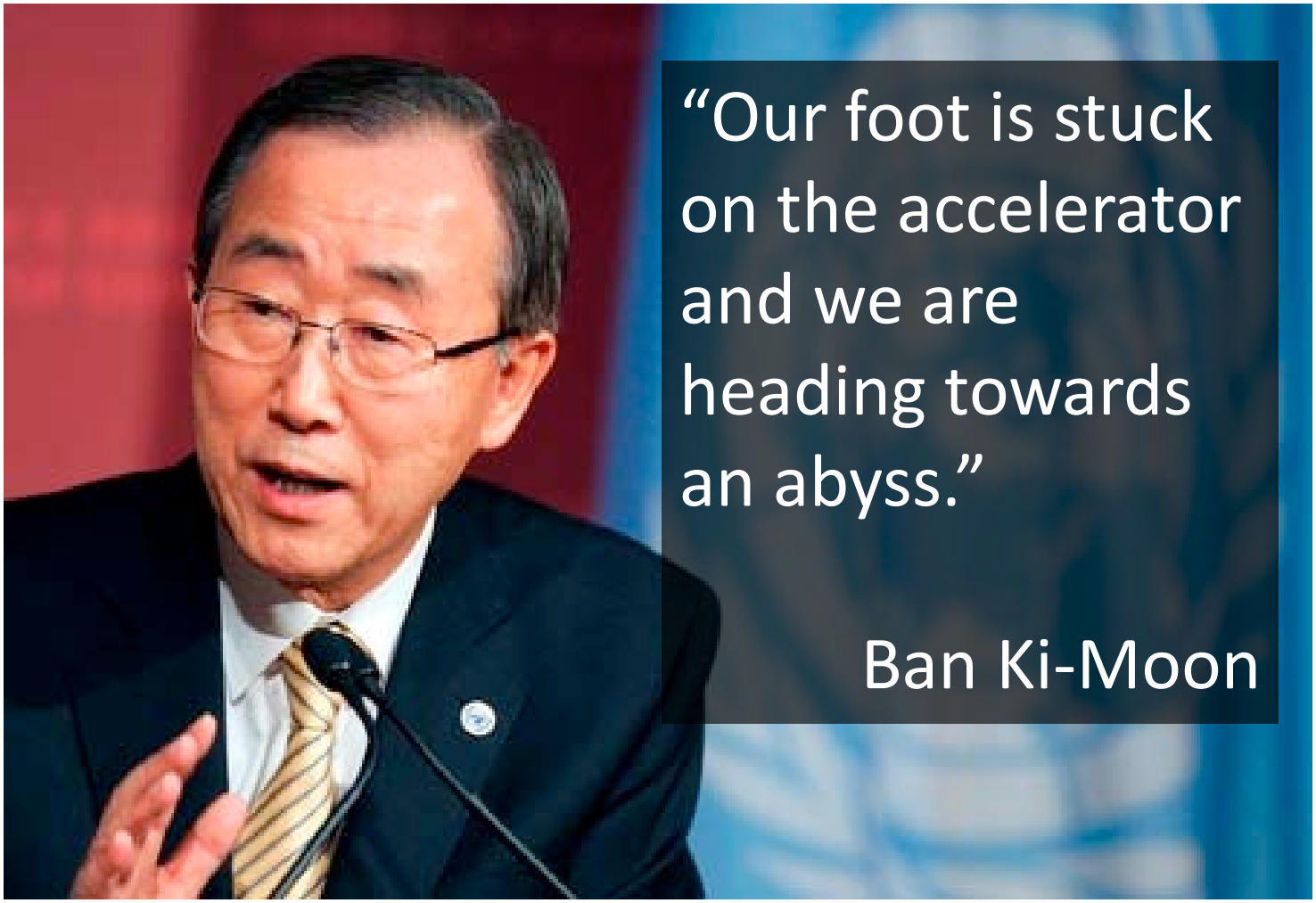
Integrated Earth-System Approach

Integration-
Synthesis

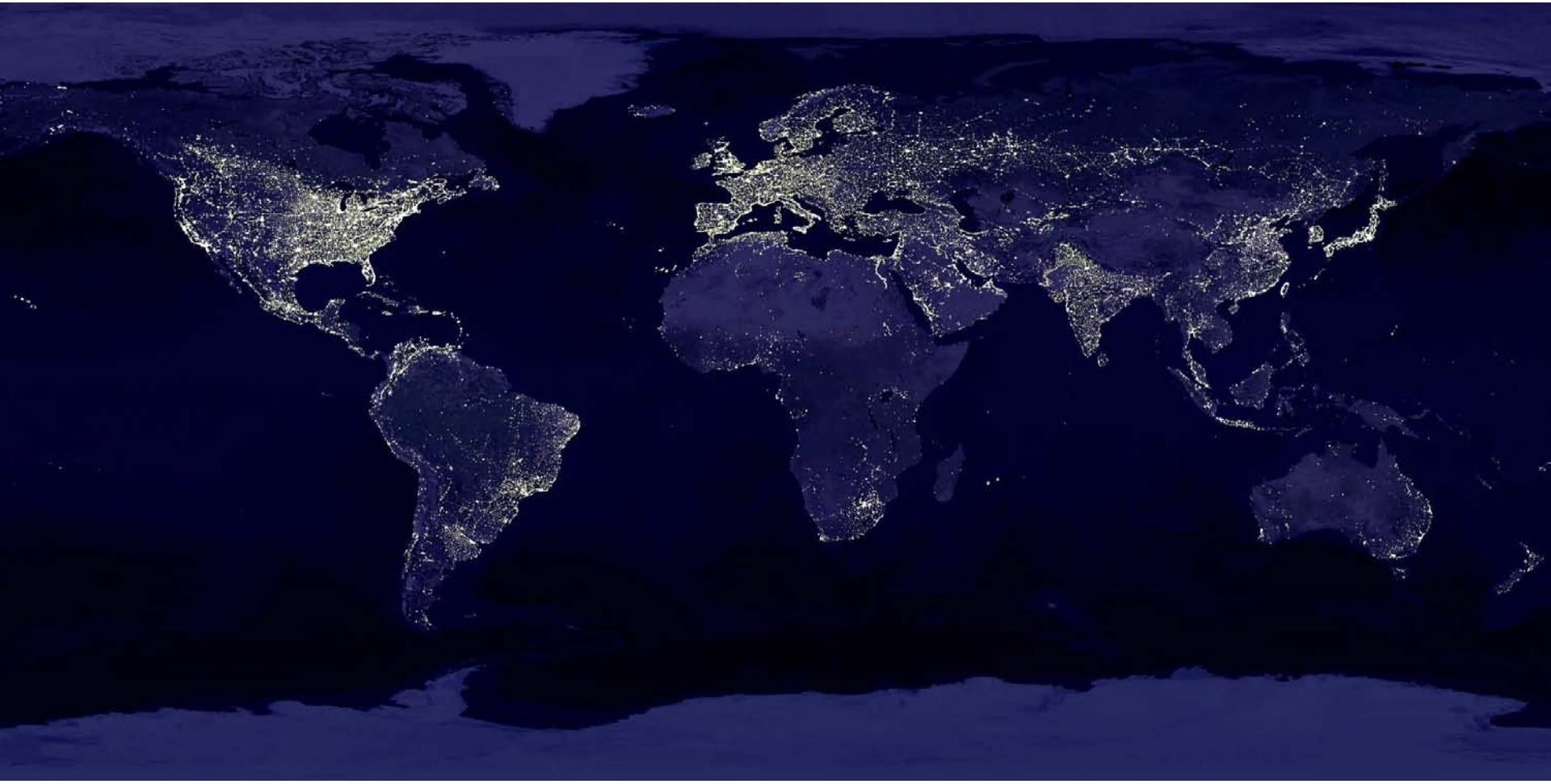
Integrated Earth-System Approach

National Committees and IPOs

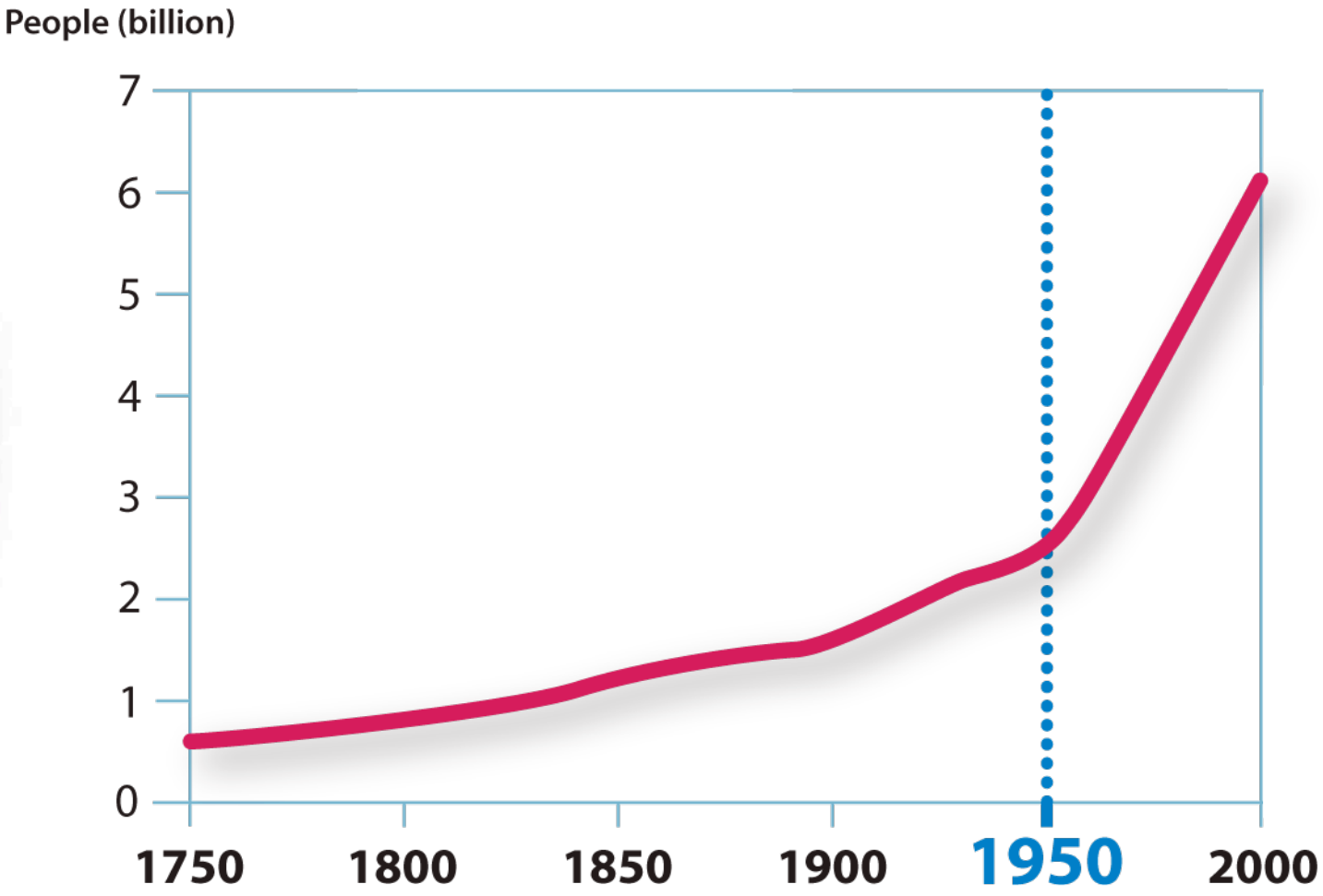



“Our foot is stuck on the accelerator and we are heading towards an abyss.”
Ban Ki-Moon

The Great Acceleration – a planet under pressure



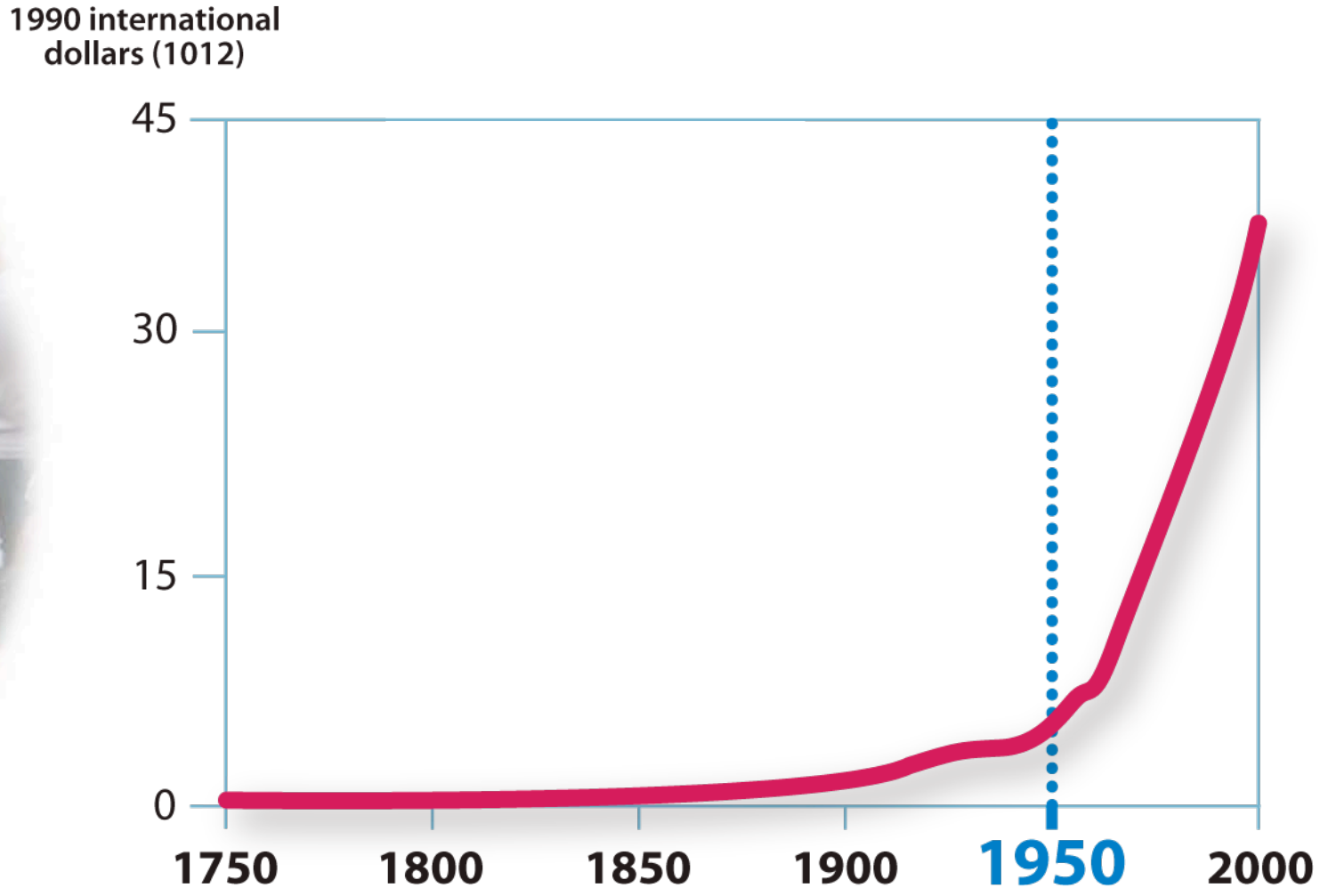
Population



US Bureau of the Census (2000) International database

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

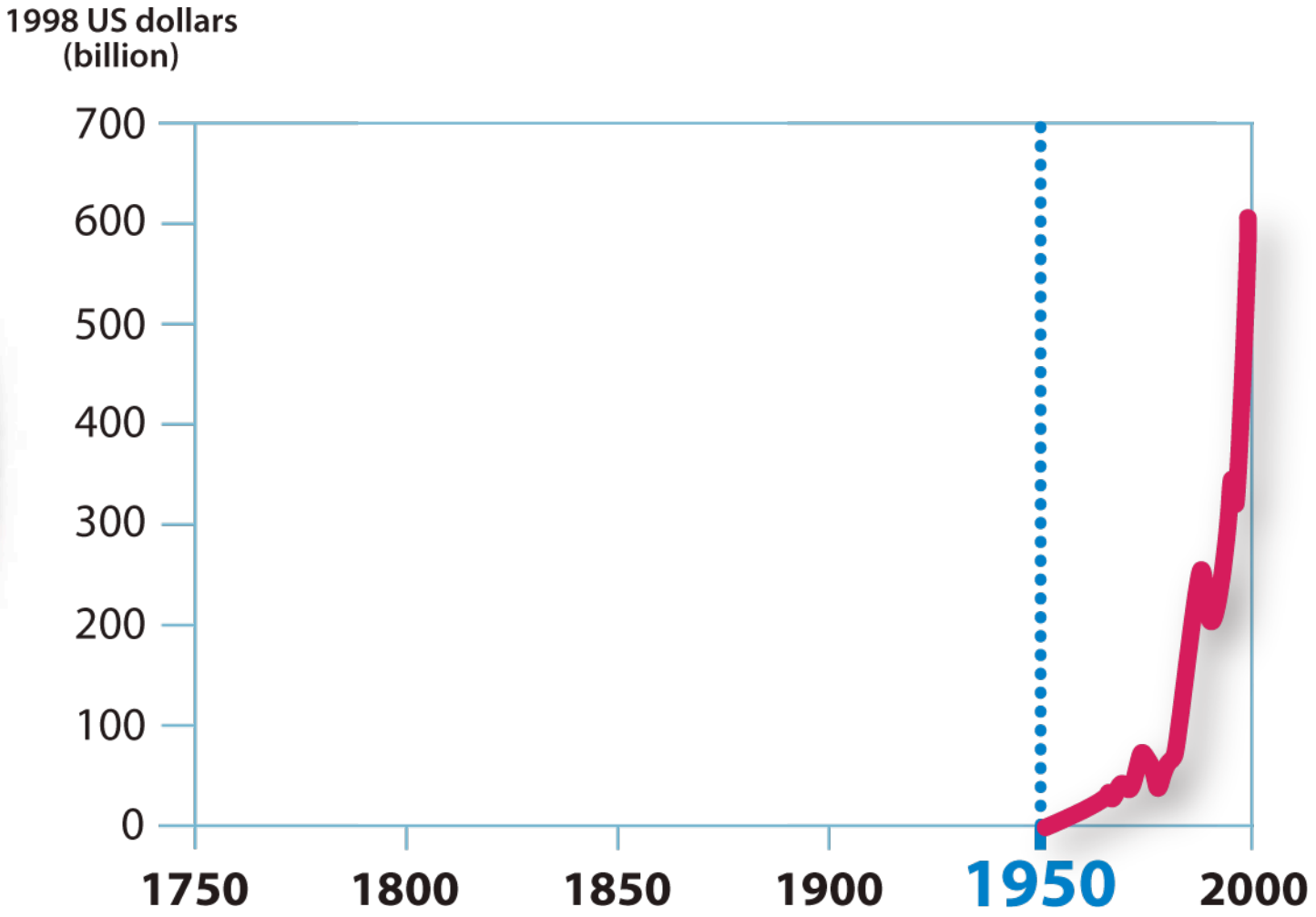
Total real GDP



Nordhaus (1997) The economics of new goods. University of Chicago Press

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

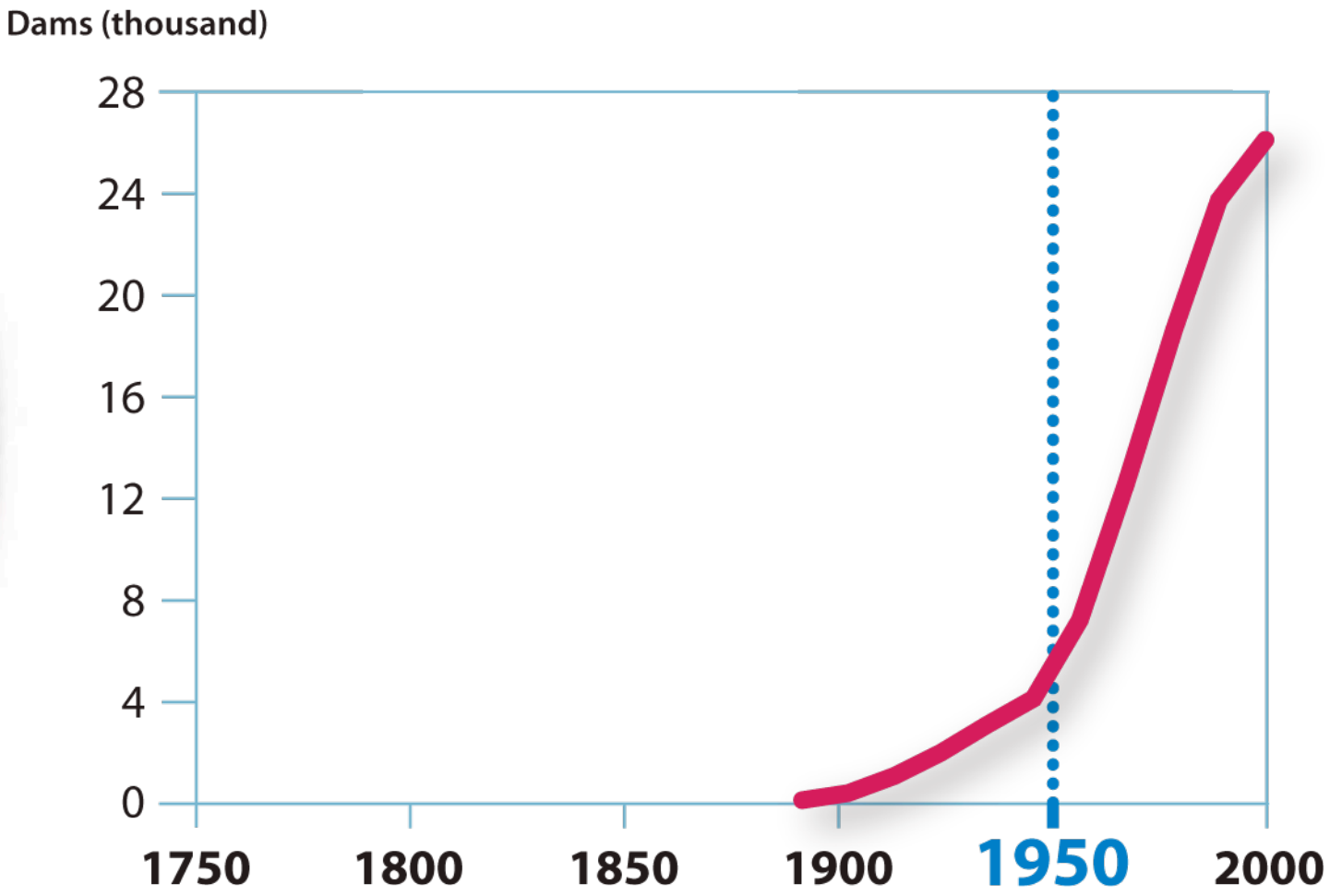
Foreign direct investment



World Bank (2002) data and statistics

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

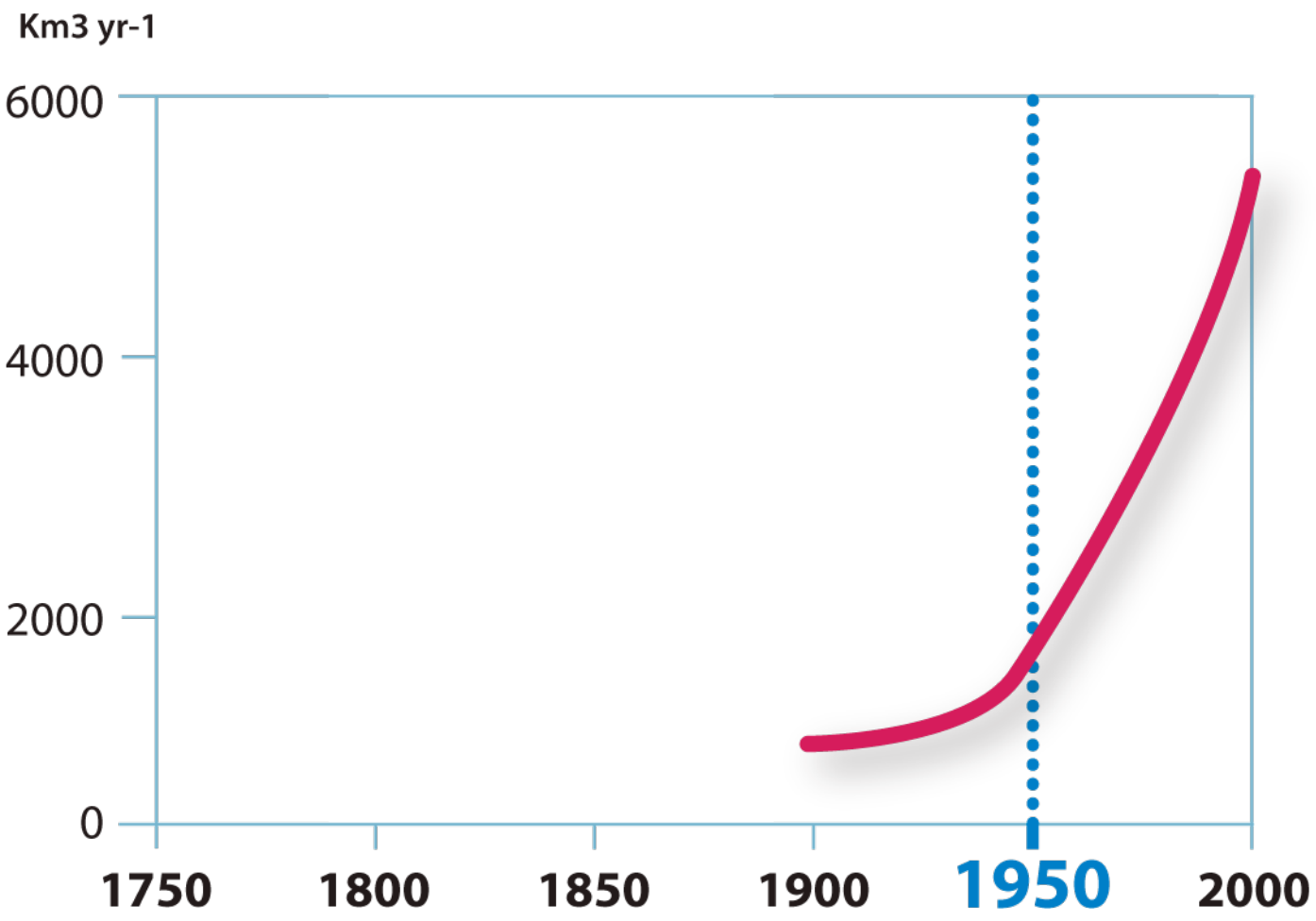
Damming of rivers



World Commission on Dams (2000)

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

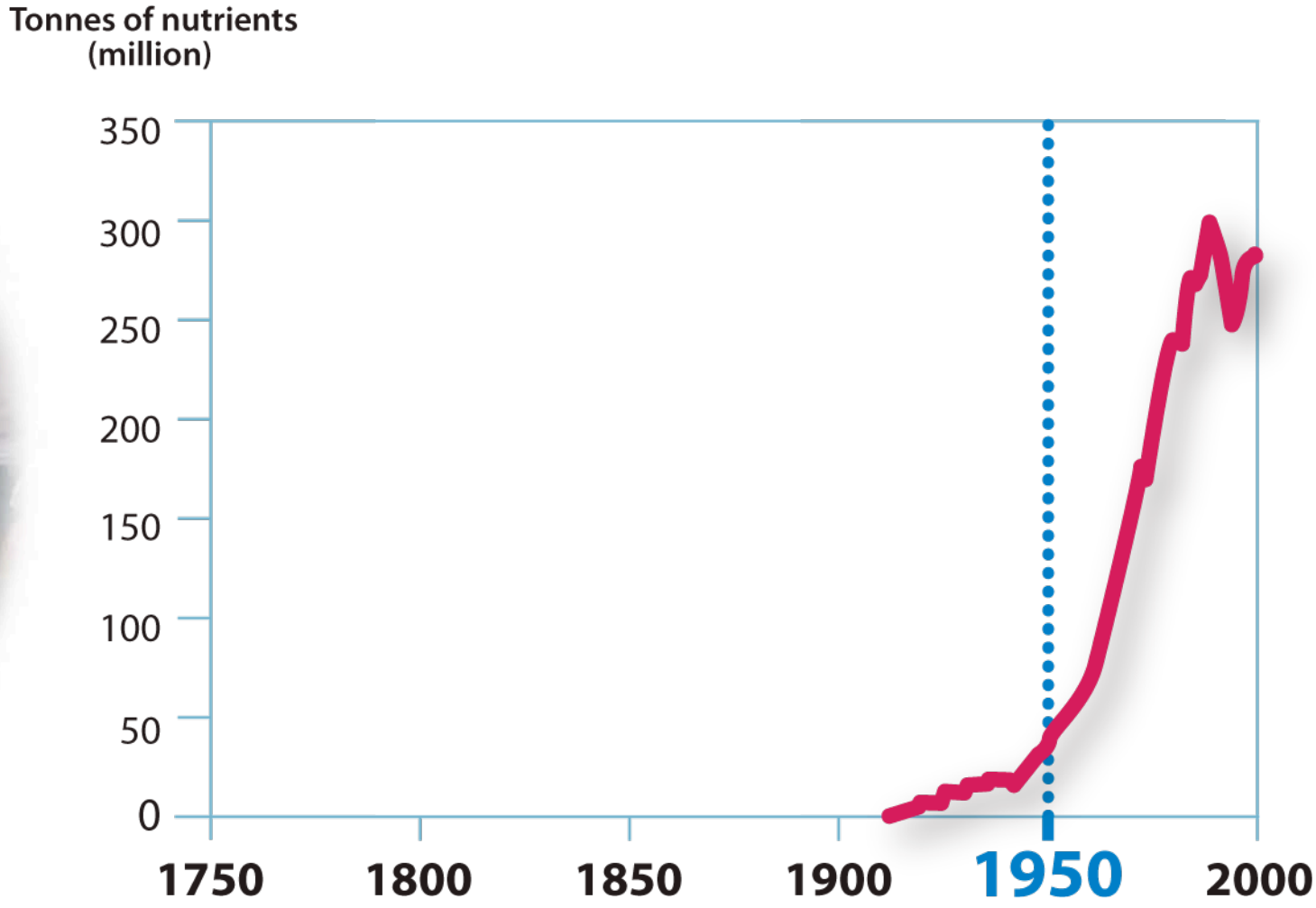
Water use



Shiklomanov (1990) Global Water Resources

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

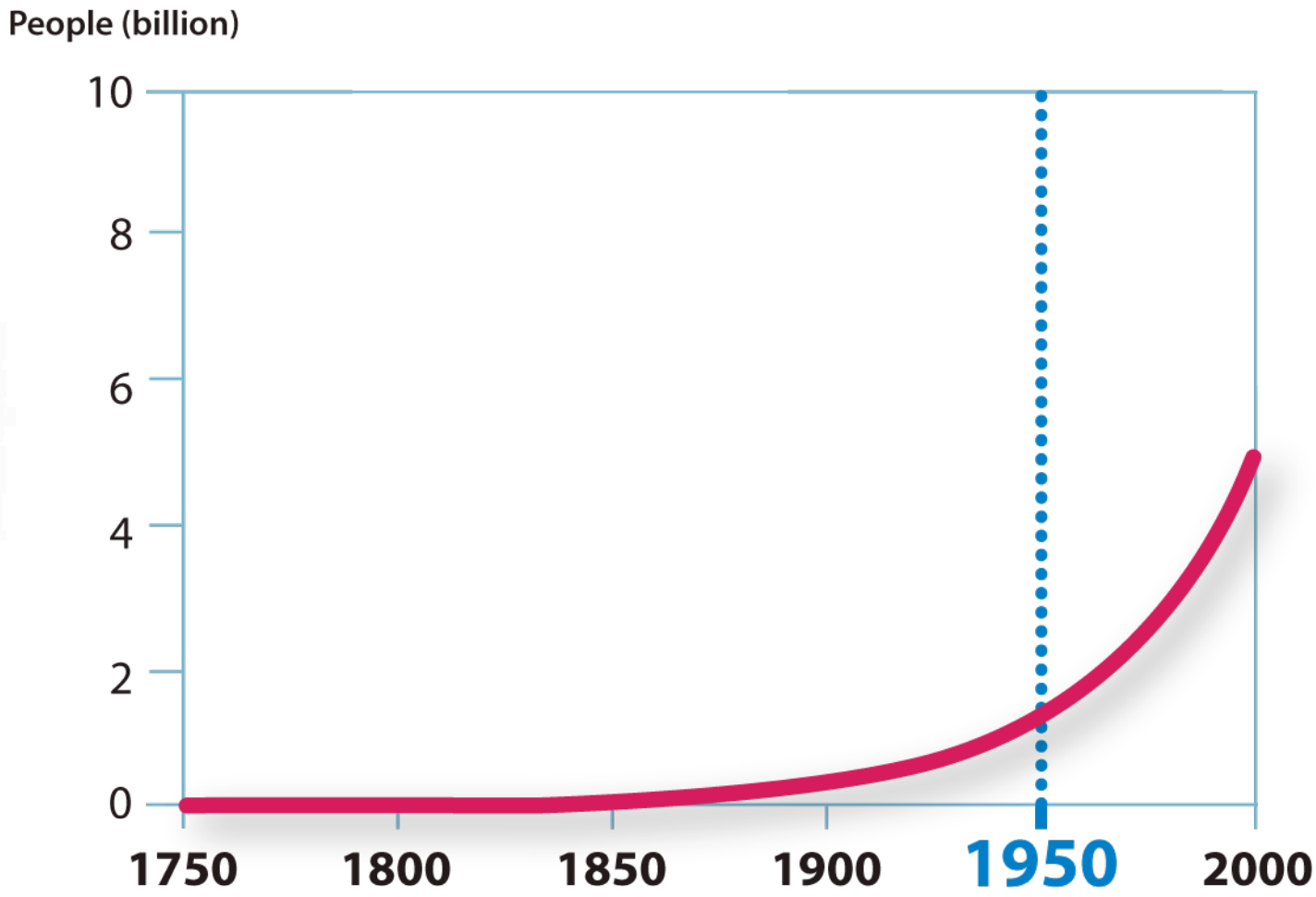
Fertiliser consumption



International Fertilizer Industry Association (2002)

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

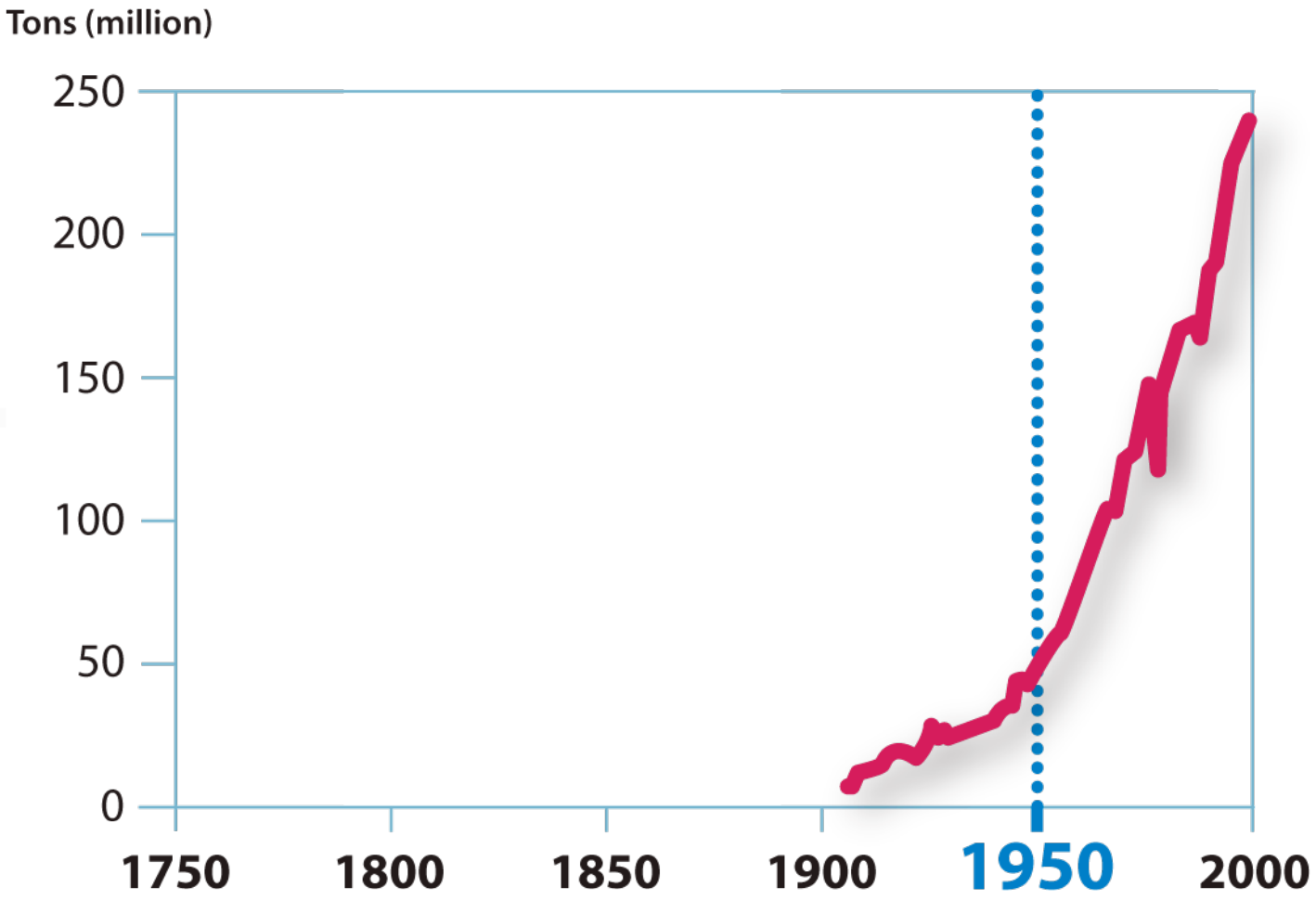
Urban population



The State of the World's Cities (2001)

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

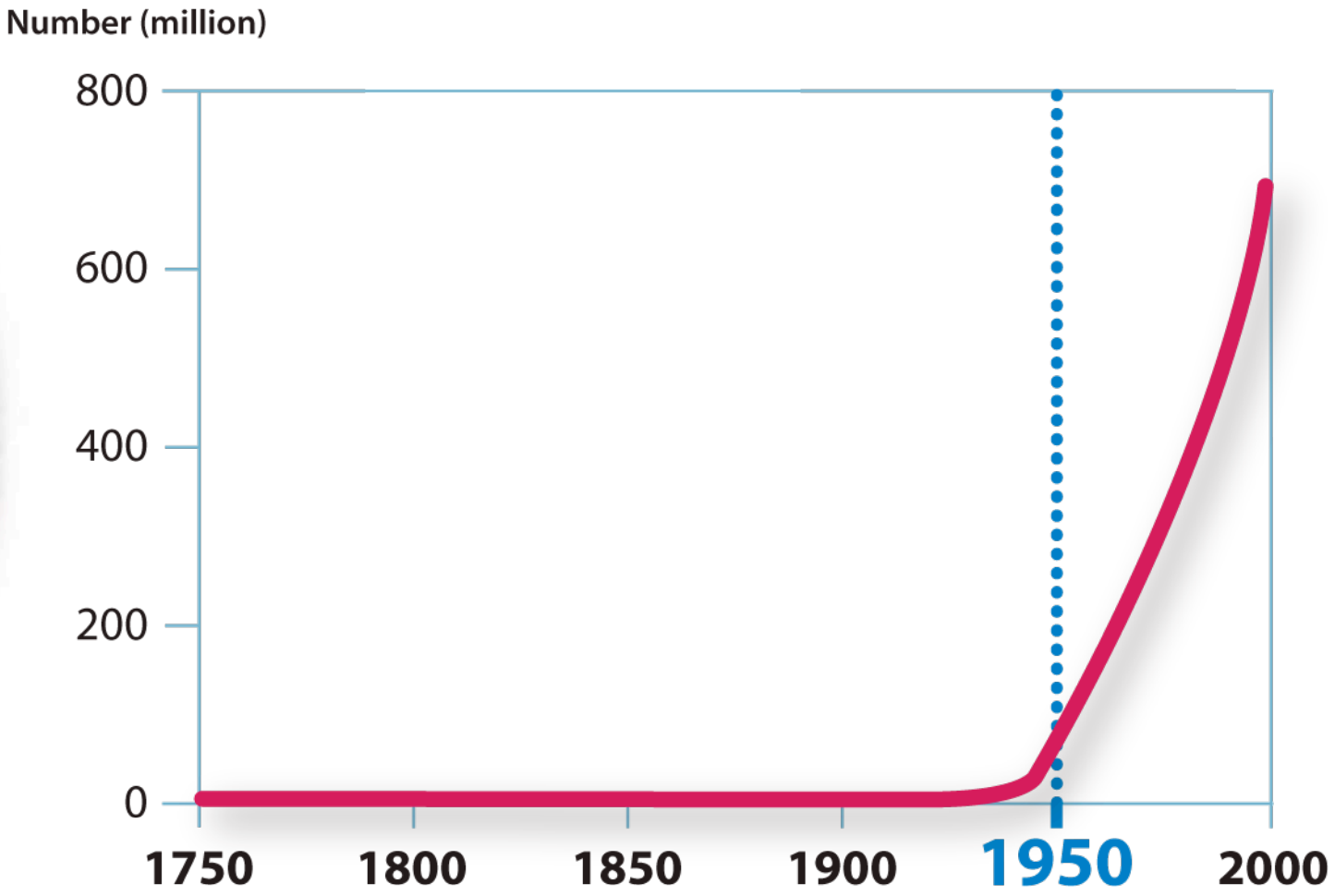
Paper consumption



Pulp and paper international (1993)

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

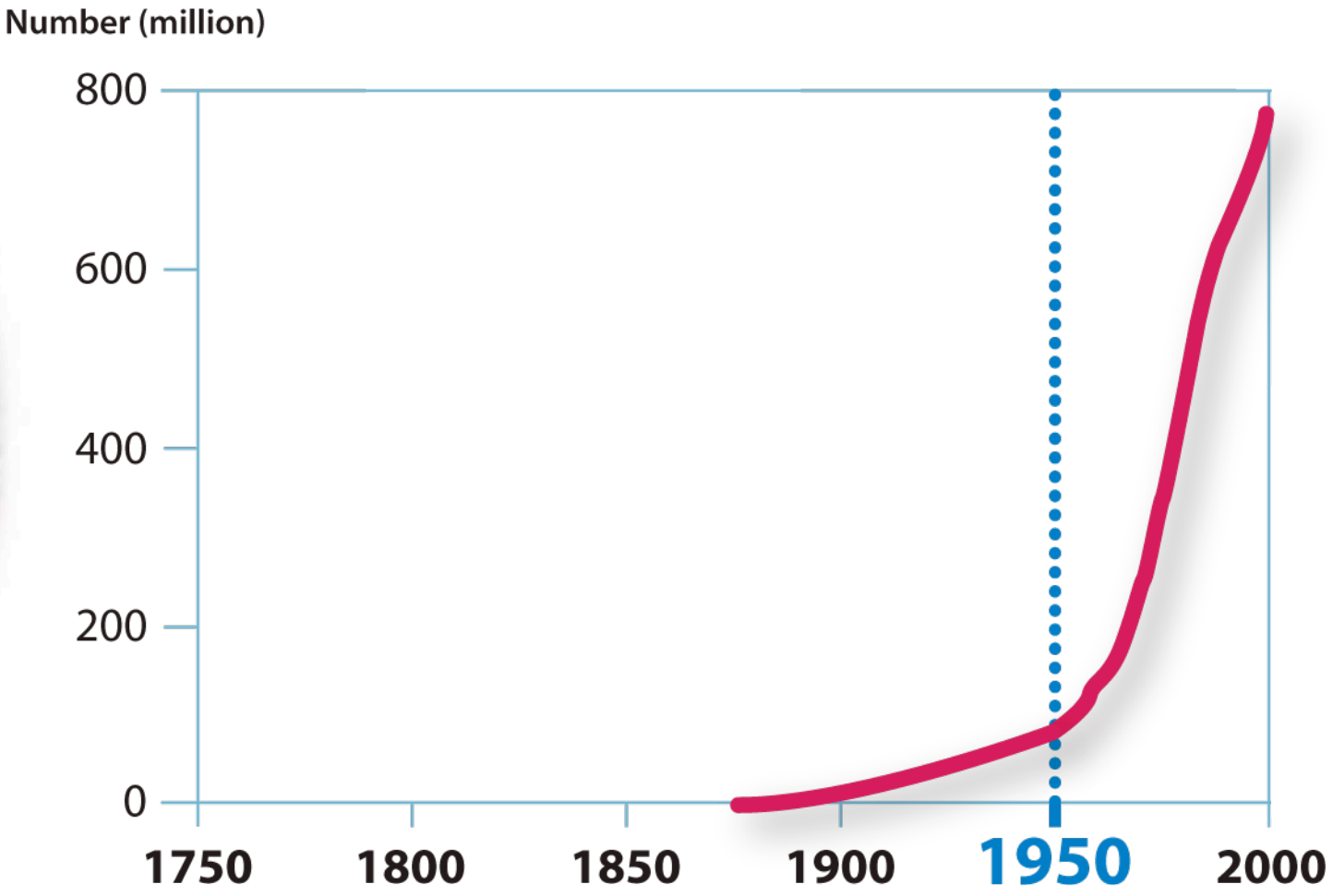
Motor vehicles



Global environmental outlook (2000)

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

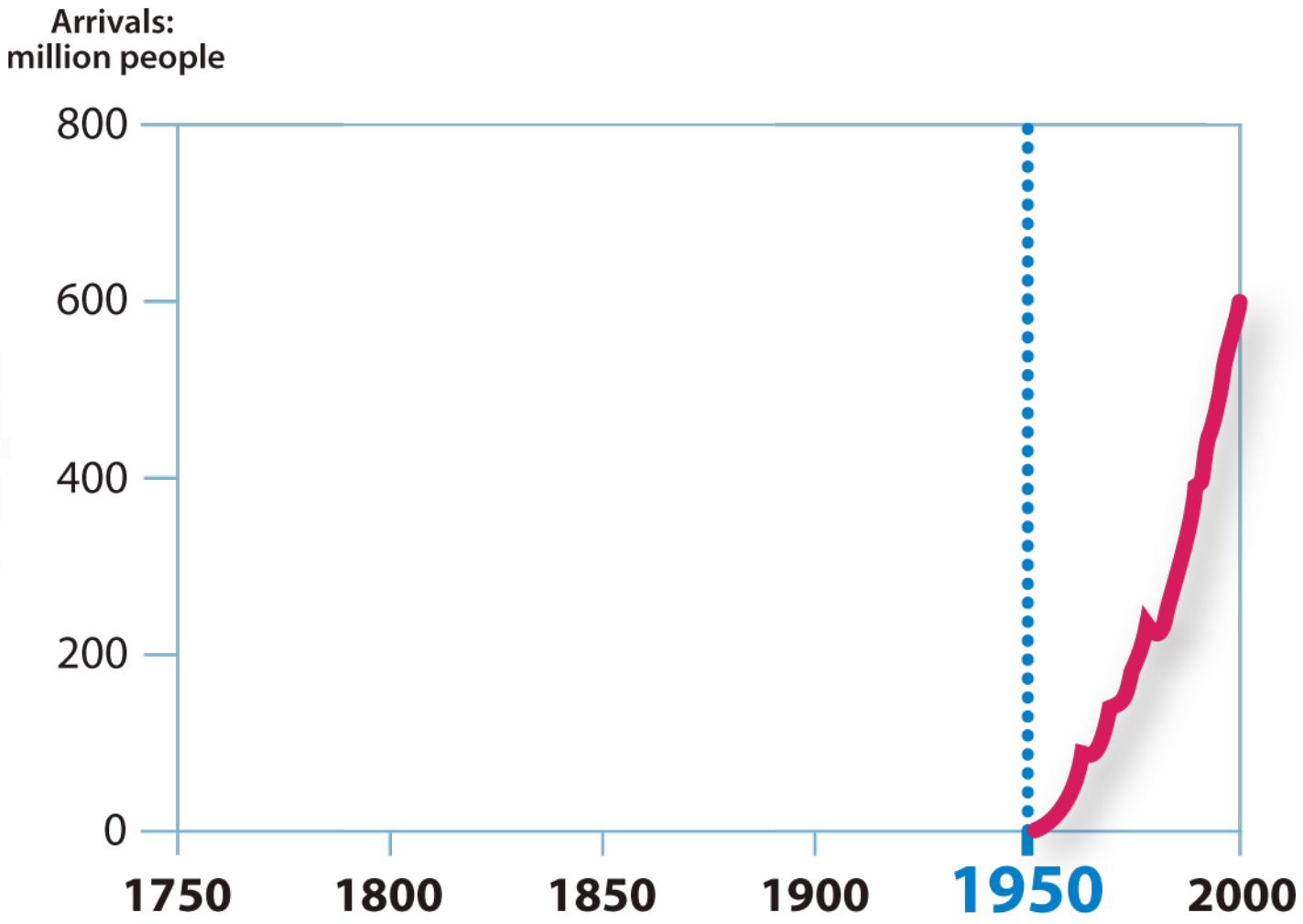
Telephones



Canning (2001) A database of world infrastructure stocks, 1950-95 World Bank

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

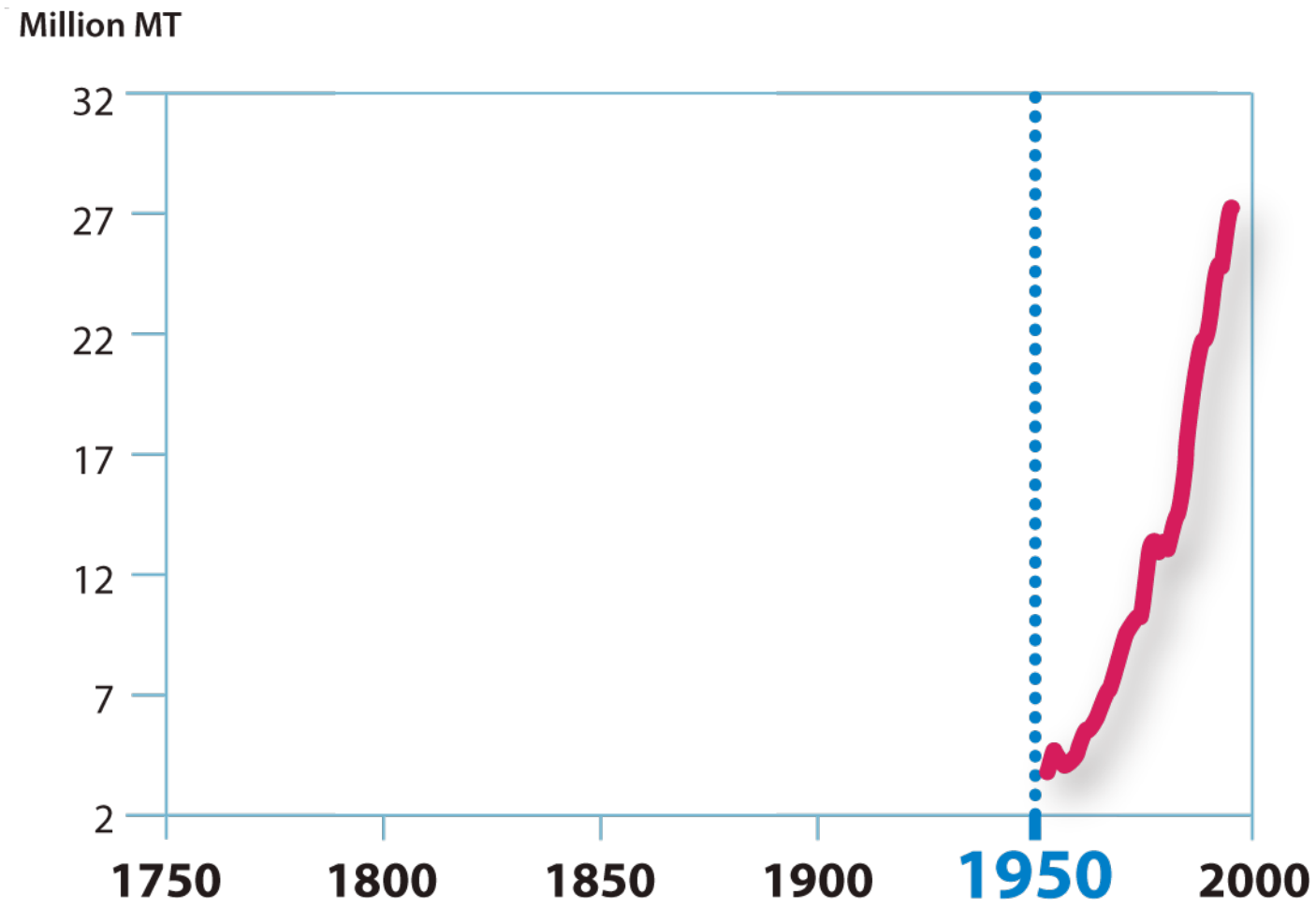
International tourism



World Tourism Organization (2001) Tourism industry trends

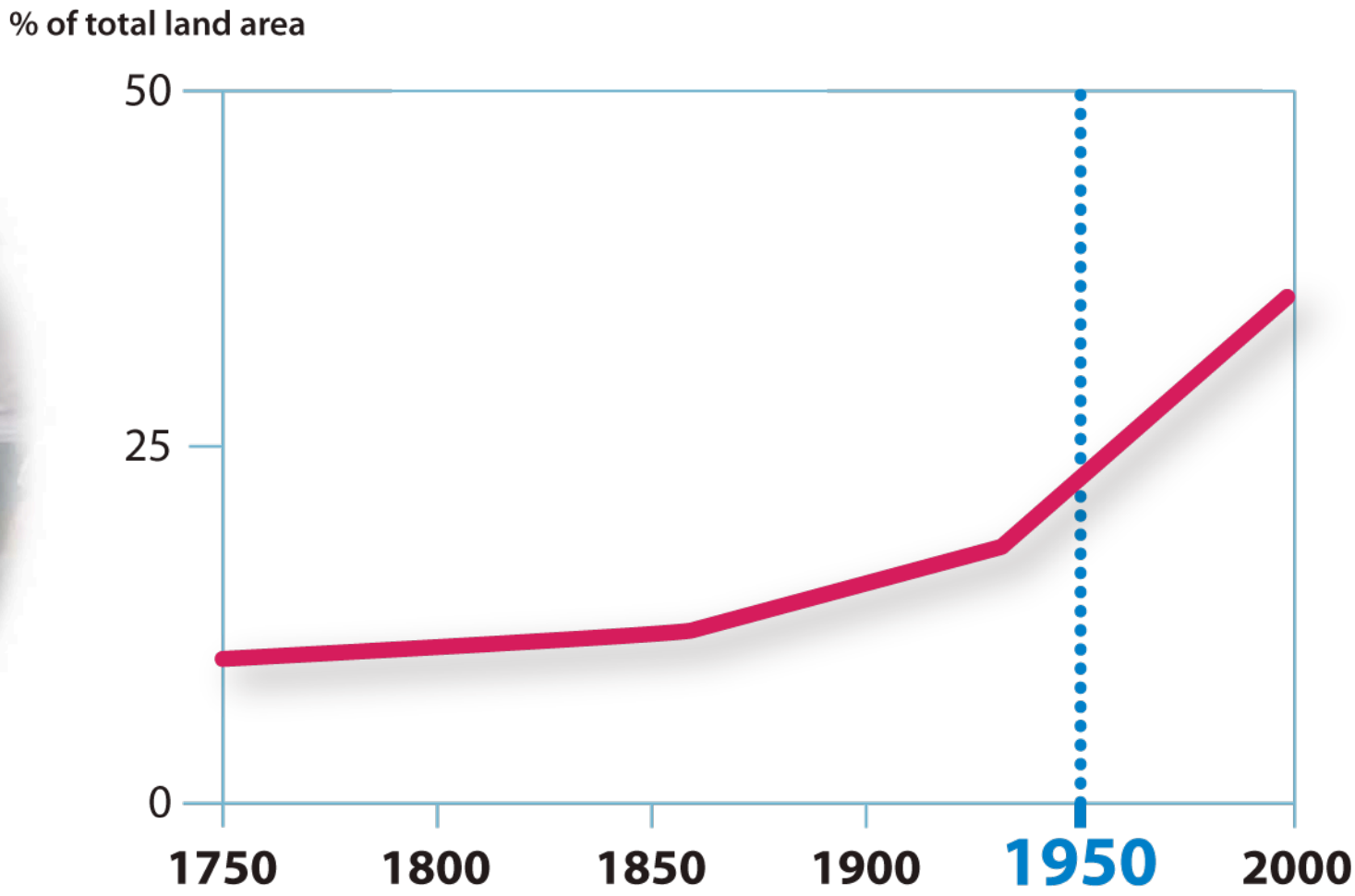
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Shrimp farm production



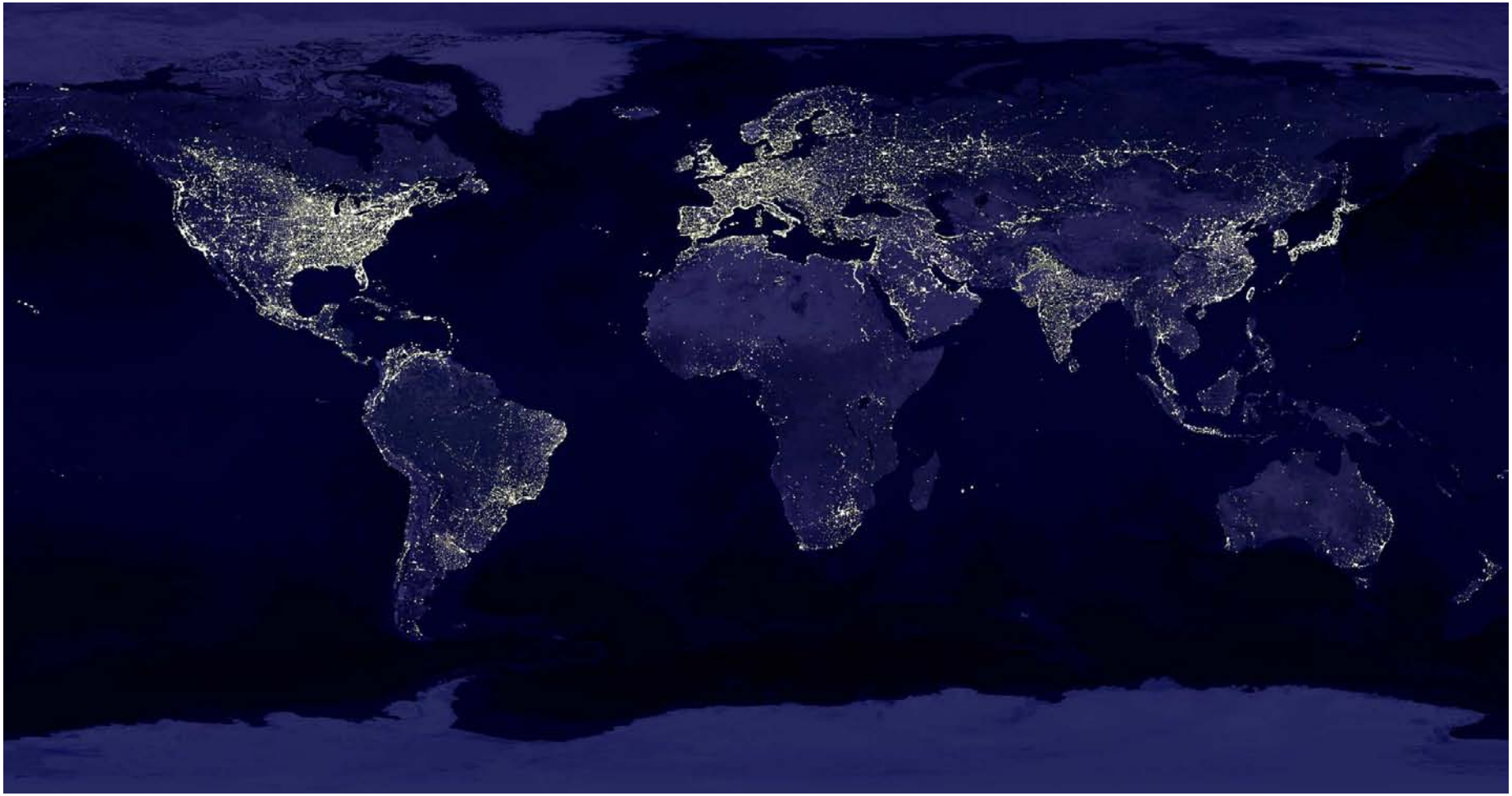
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Domesticated land

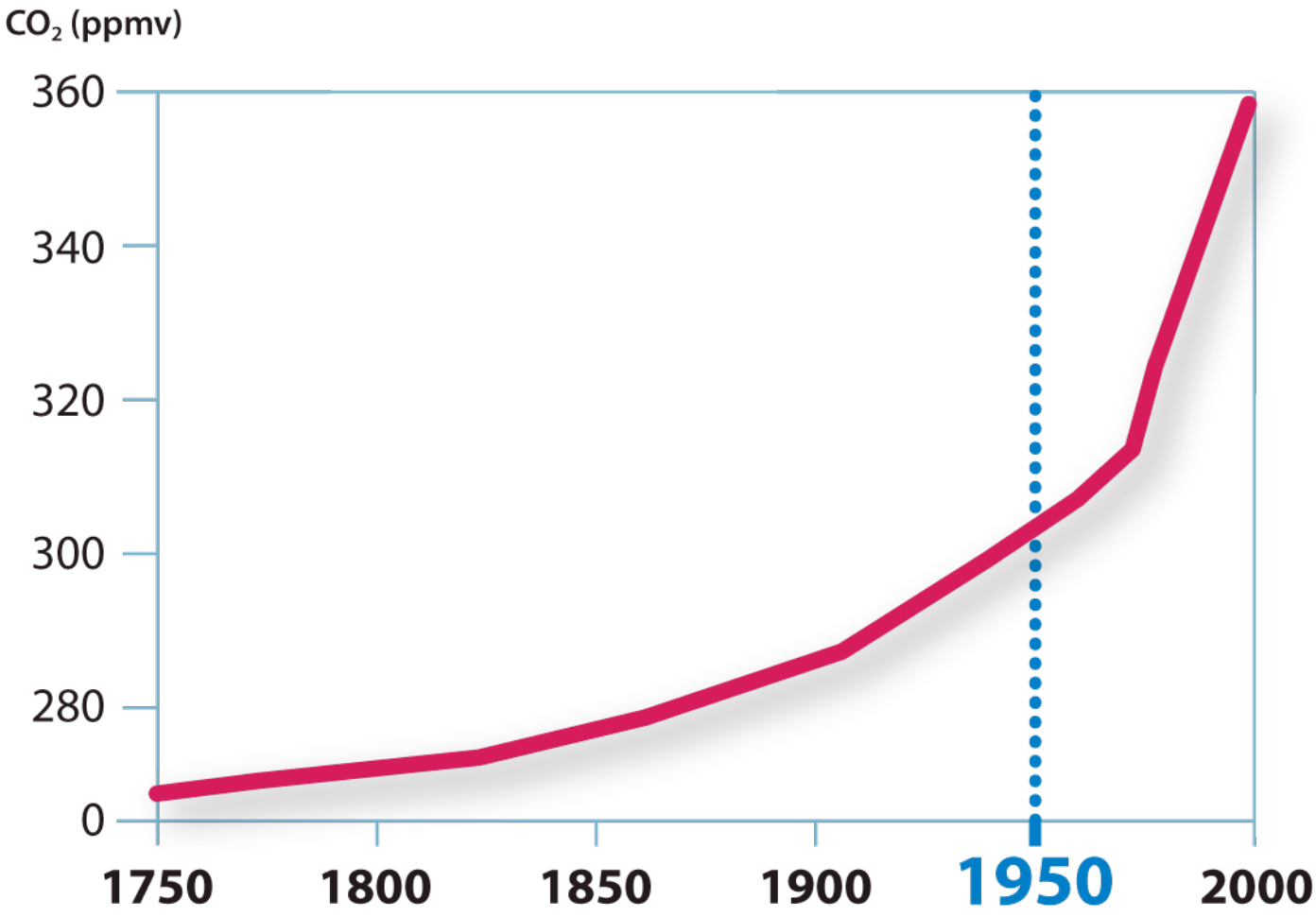


IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Planetary response



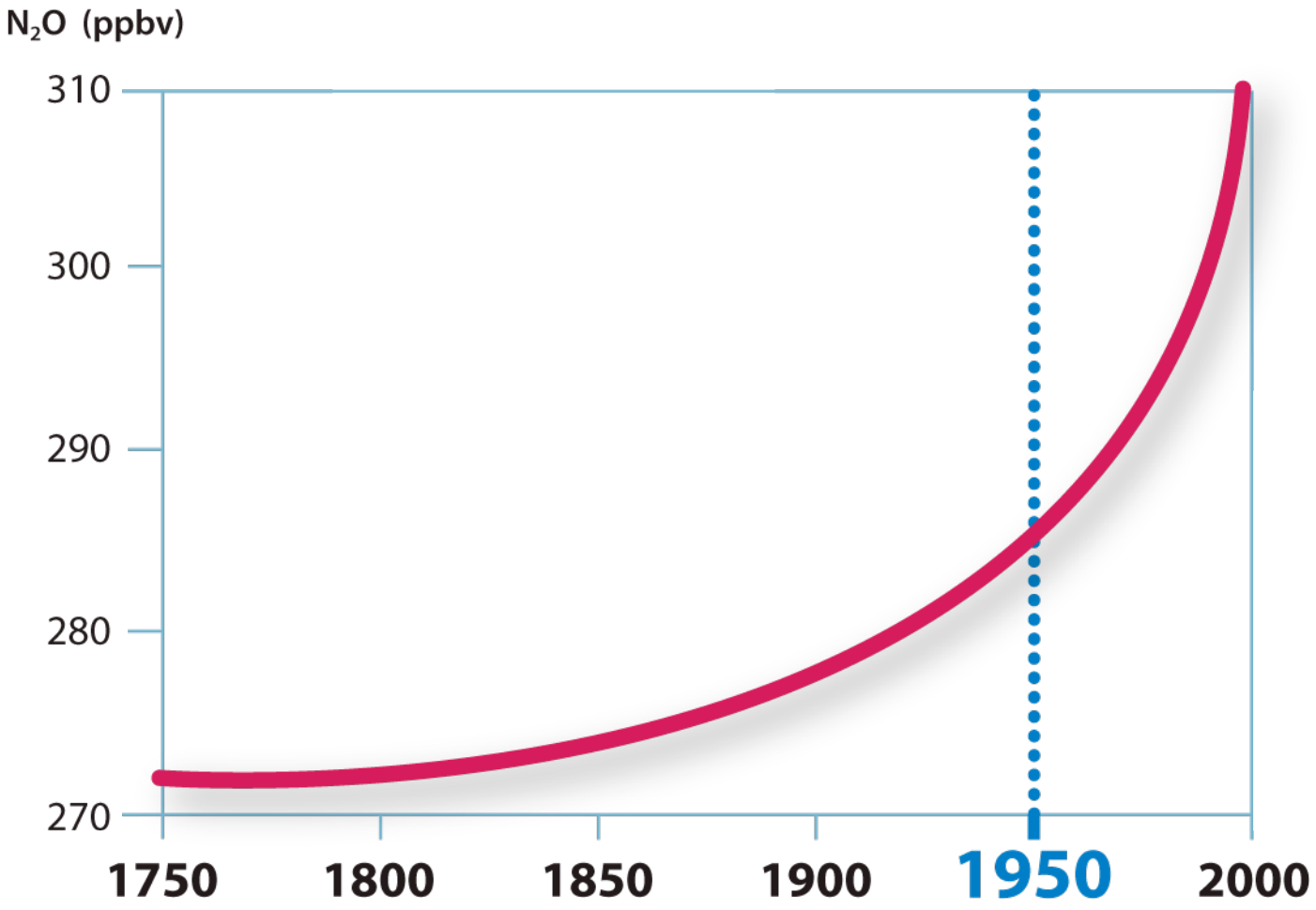
Atmospheric CO_2 concentration



Etheridge et al. Geophys Res 101: 4115-4128

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

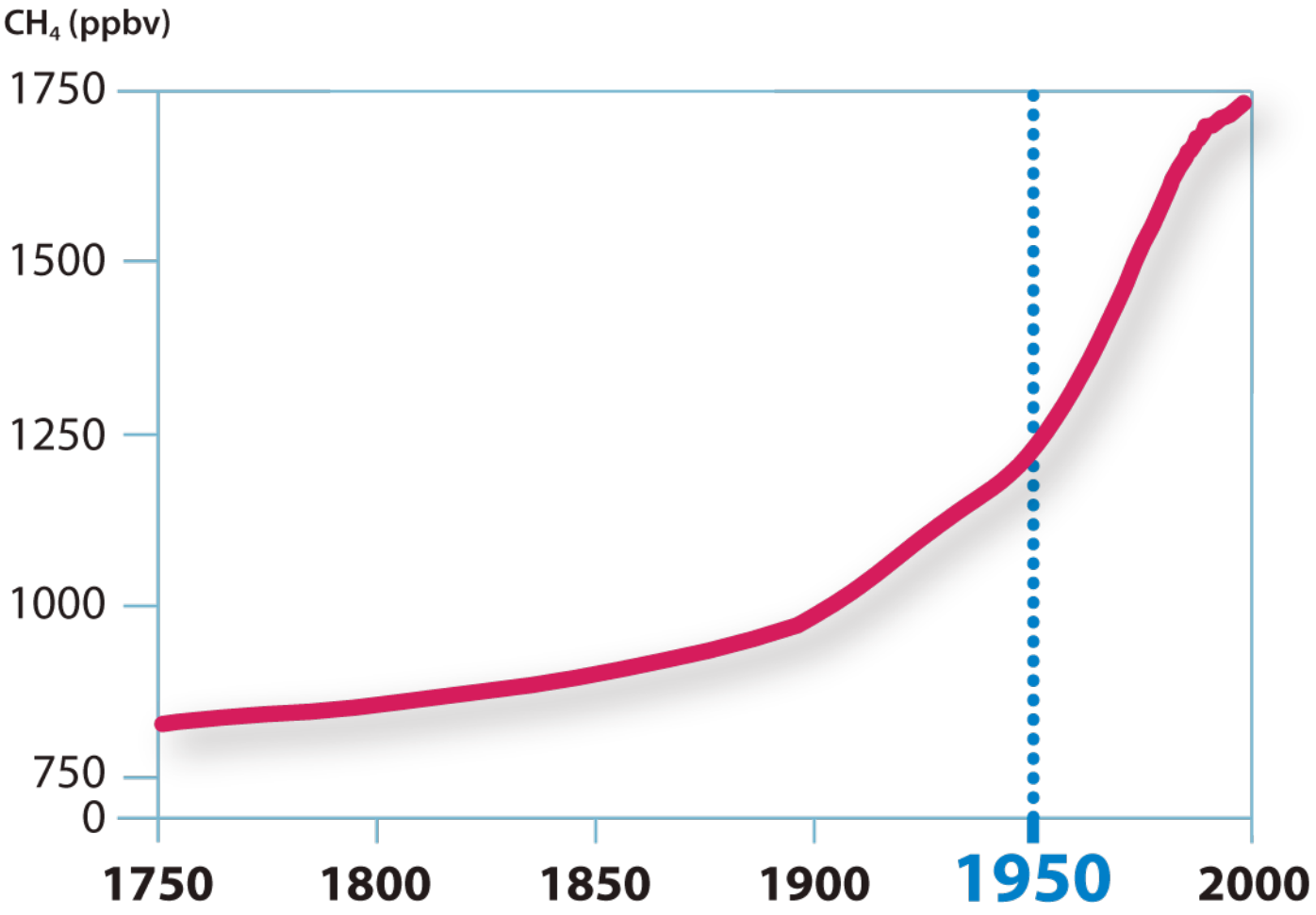
Atmospheric N_2O concentration



Machida et al Geophys Res Lett 22:2921-2925

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

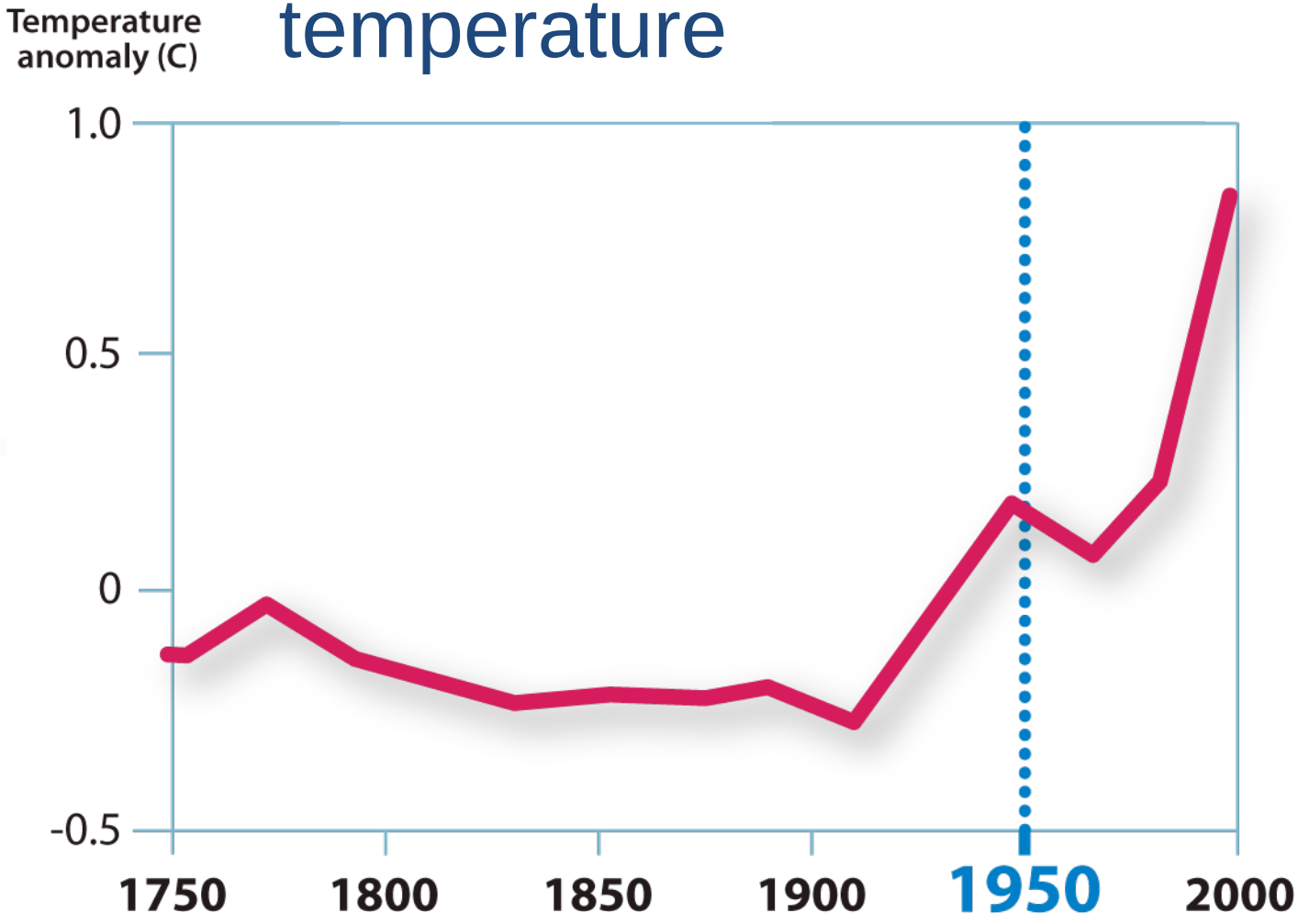
Atmospheric CH_4 concentration



Blunier et al J Geophy Res 20: 2219-2222

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

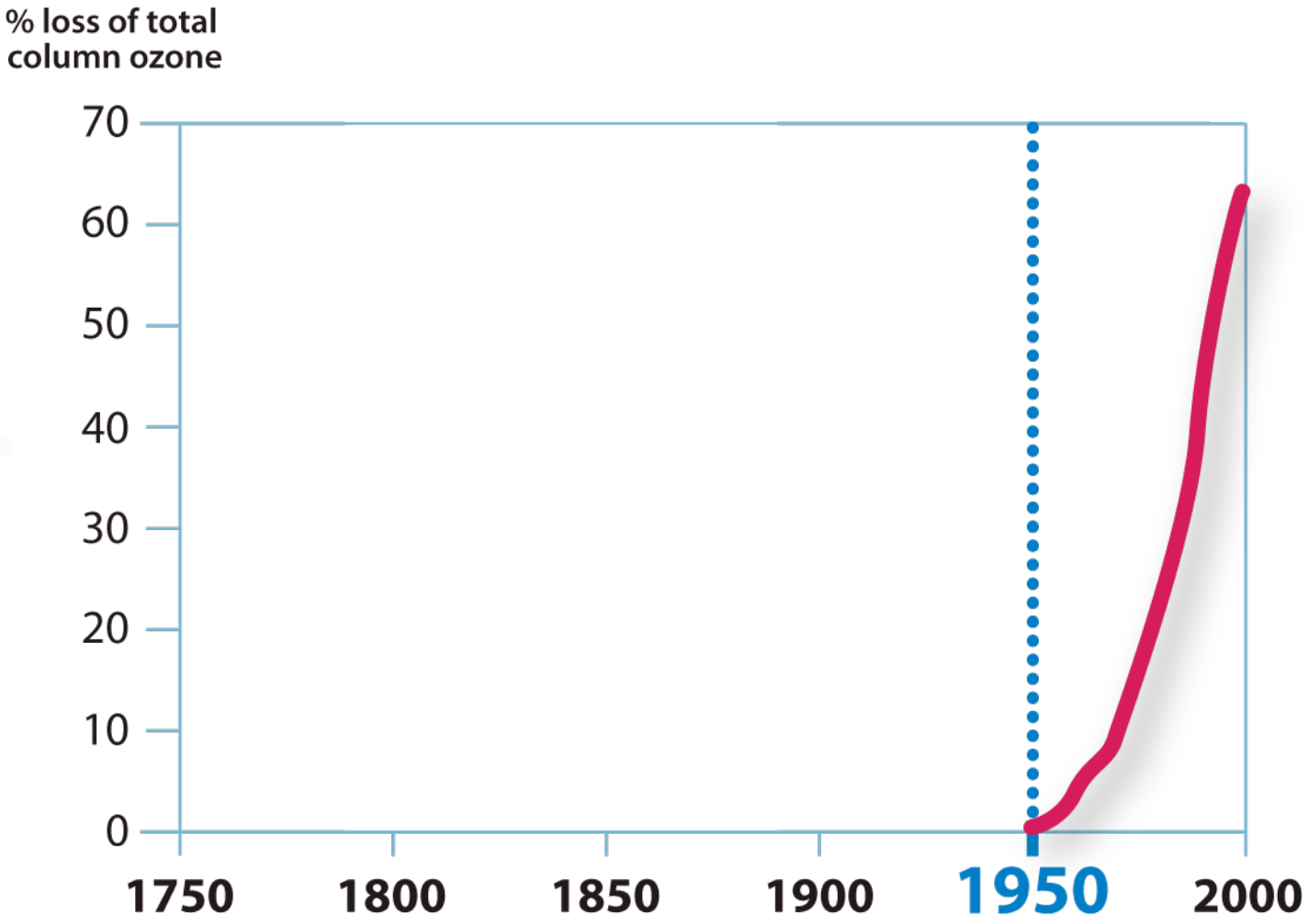
Northern hemisphere average surface temperature



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

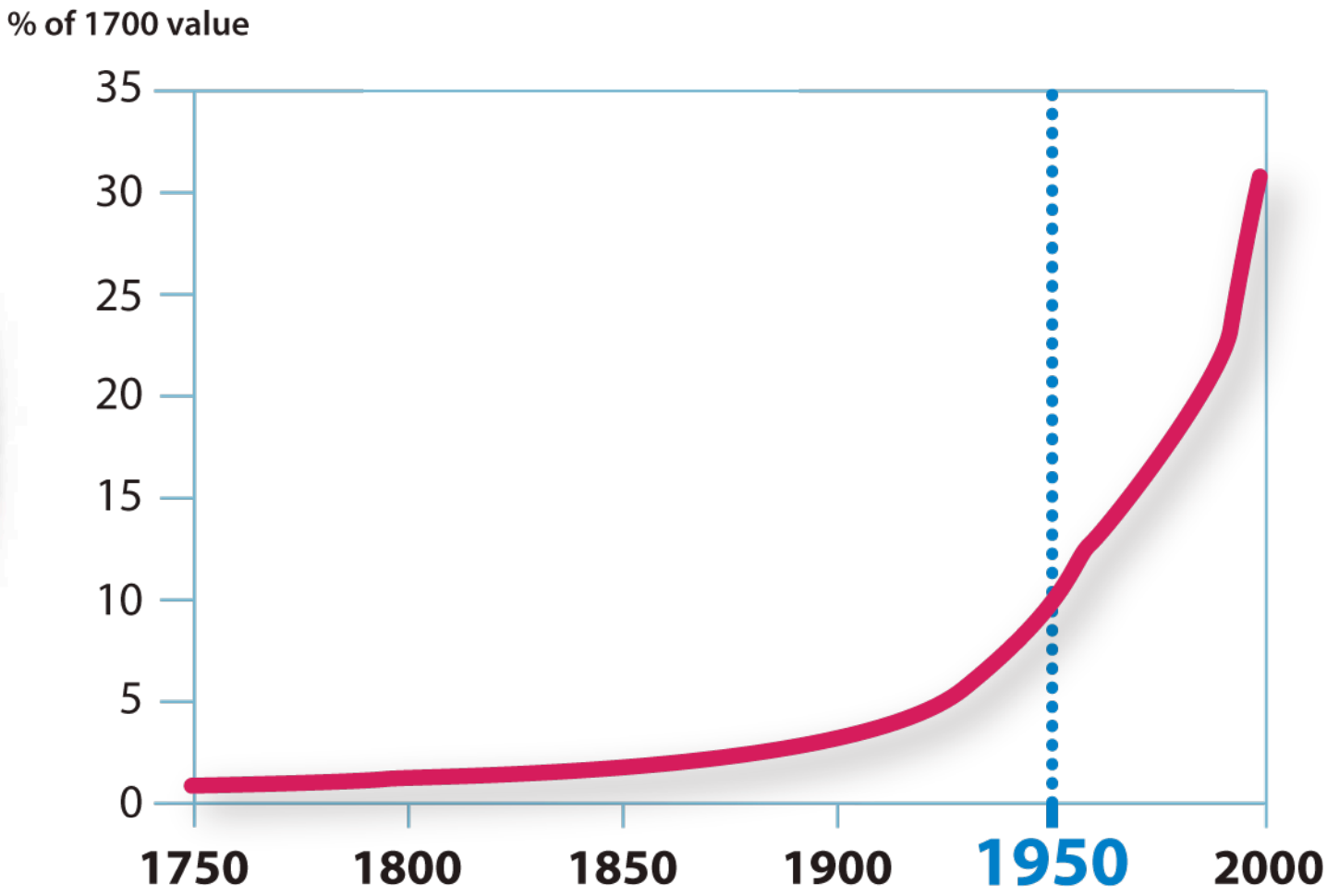
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Ozone depletion



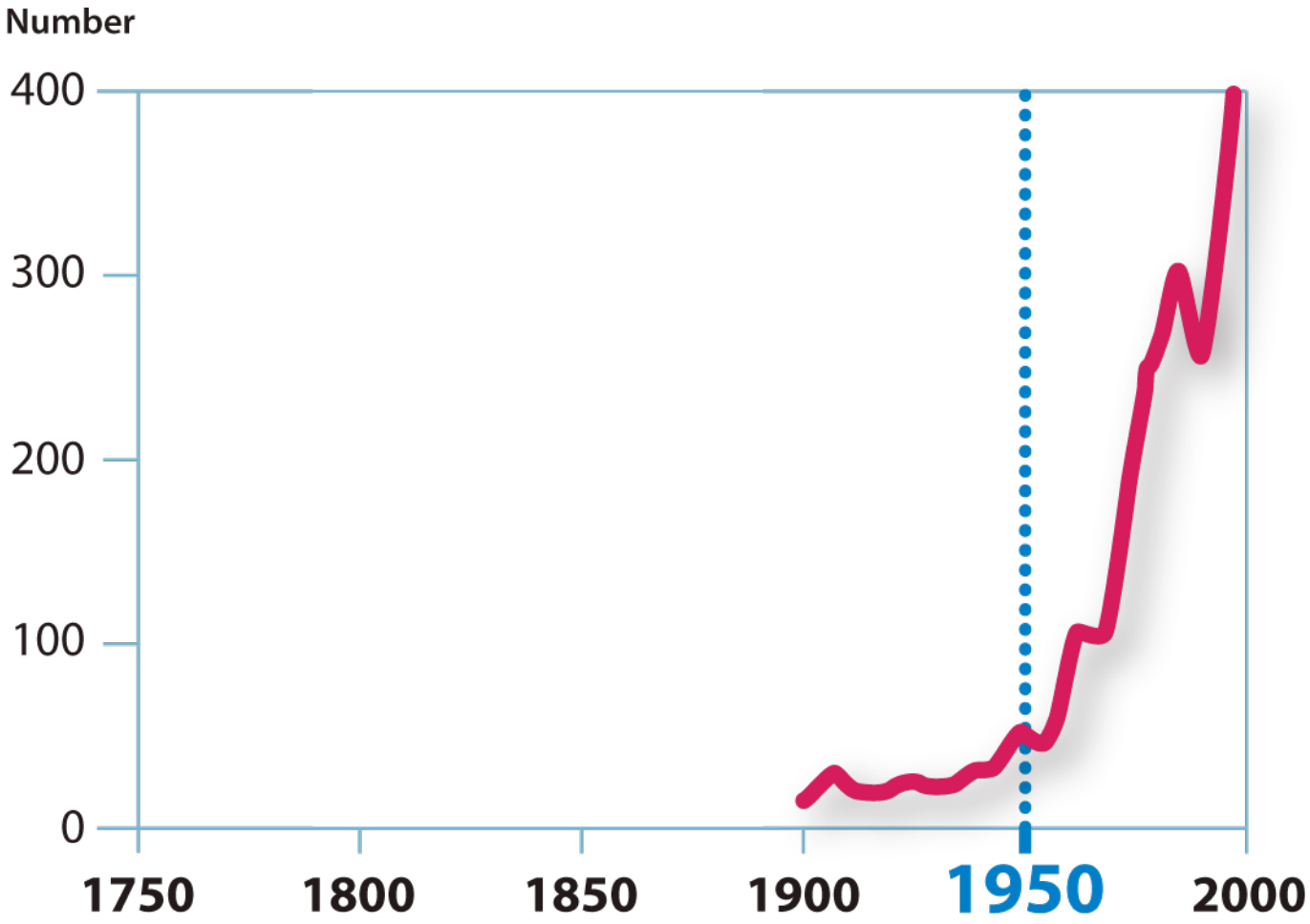
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Tropical rainforest and woodland loss



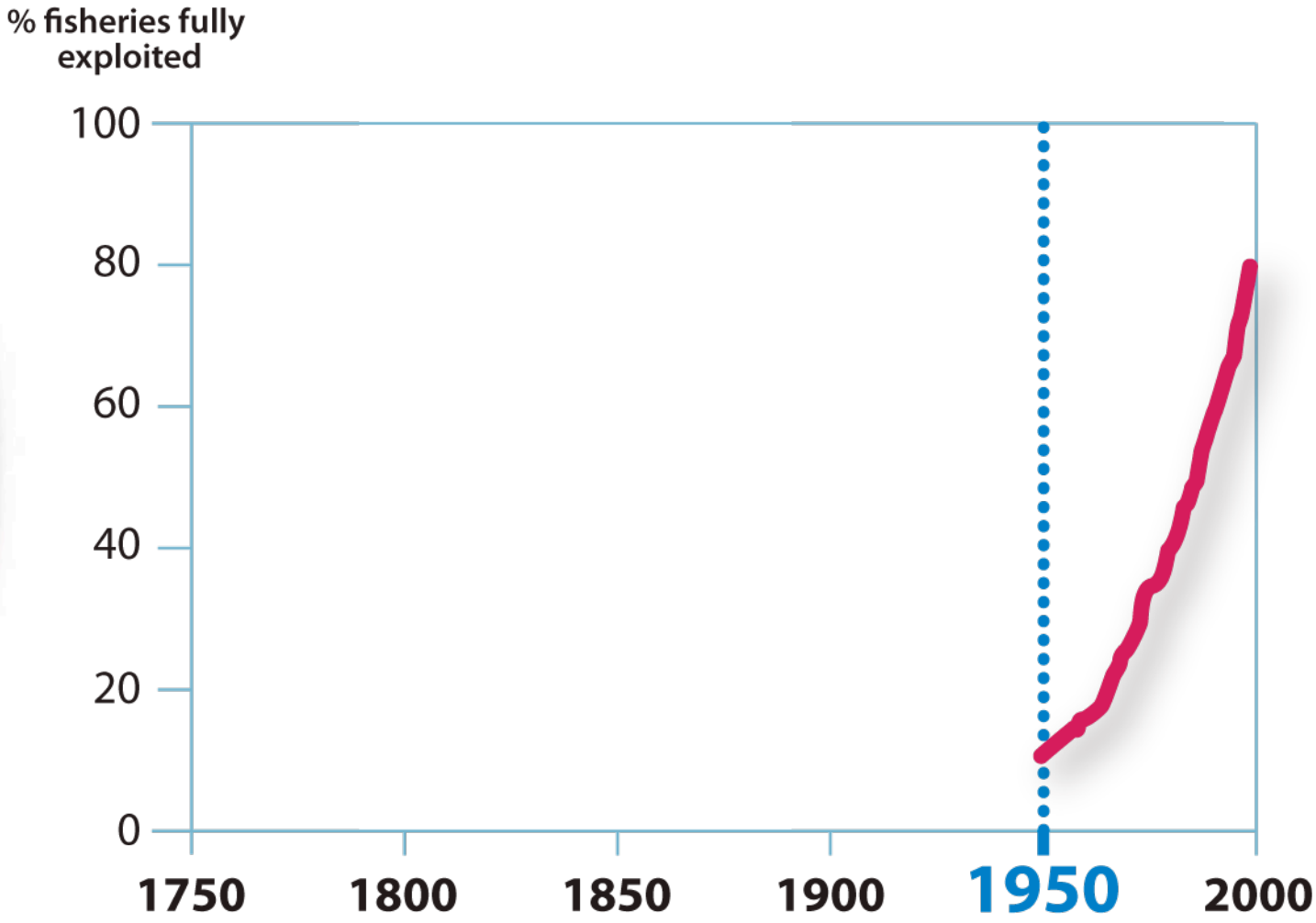
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Natural climatic disasters



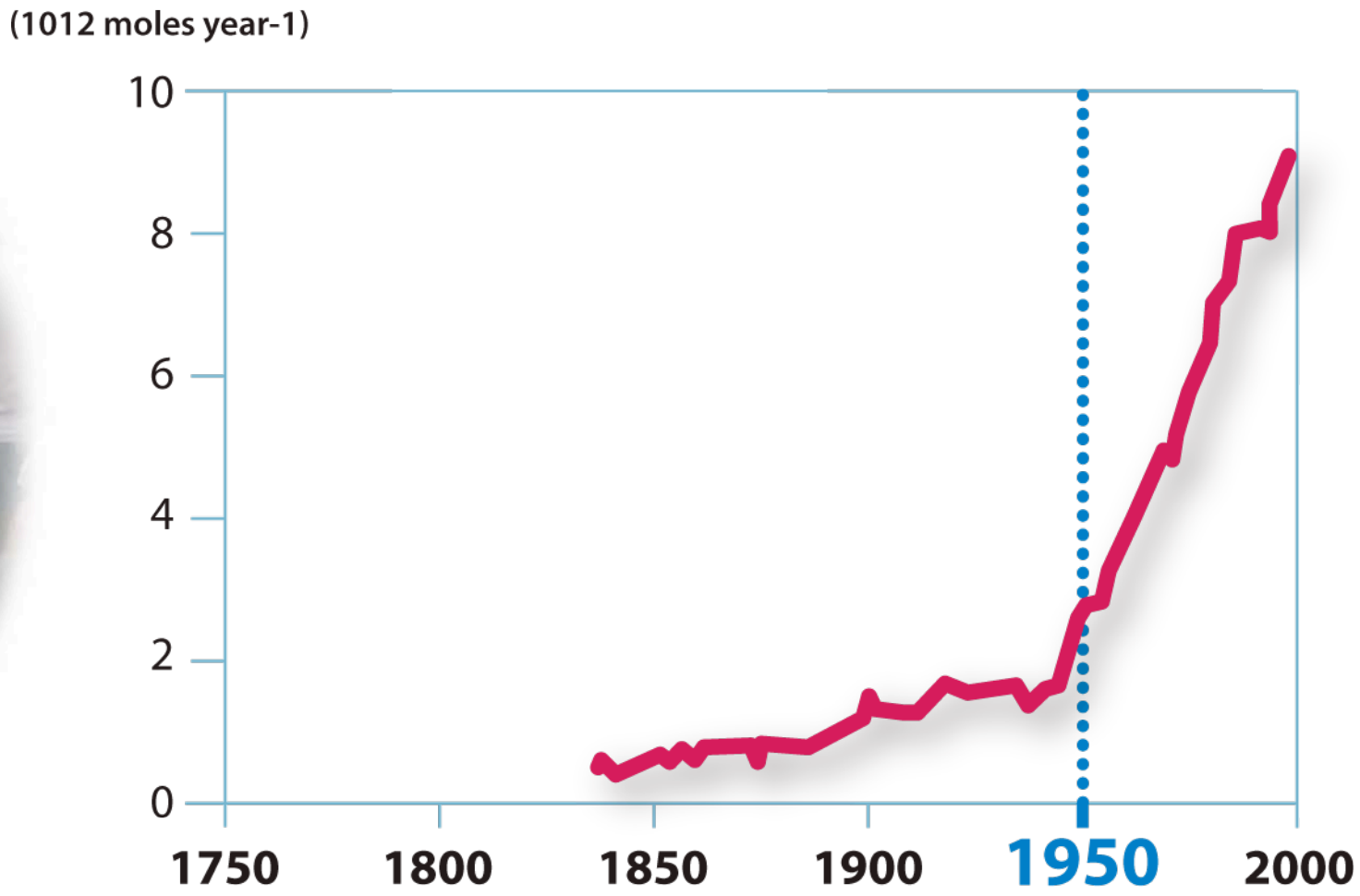
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Fisheries exploitation



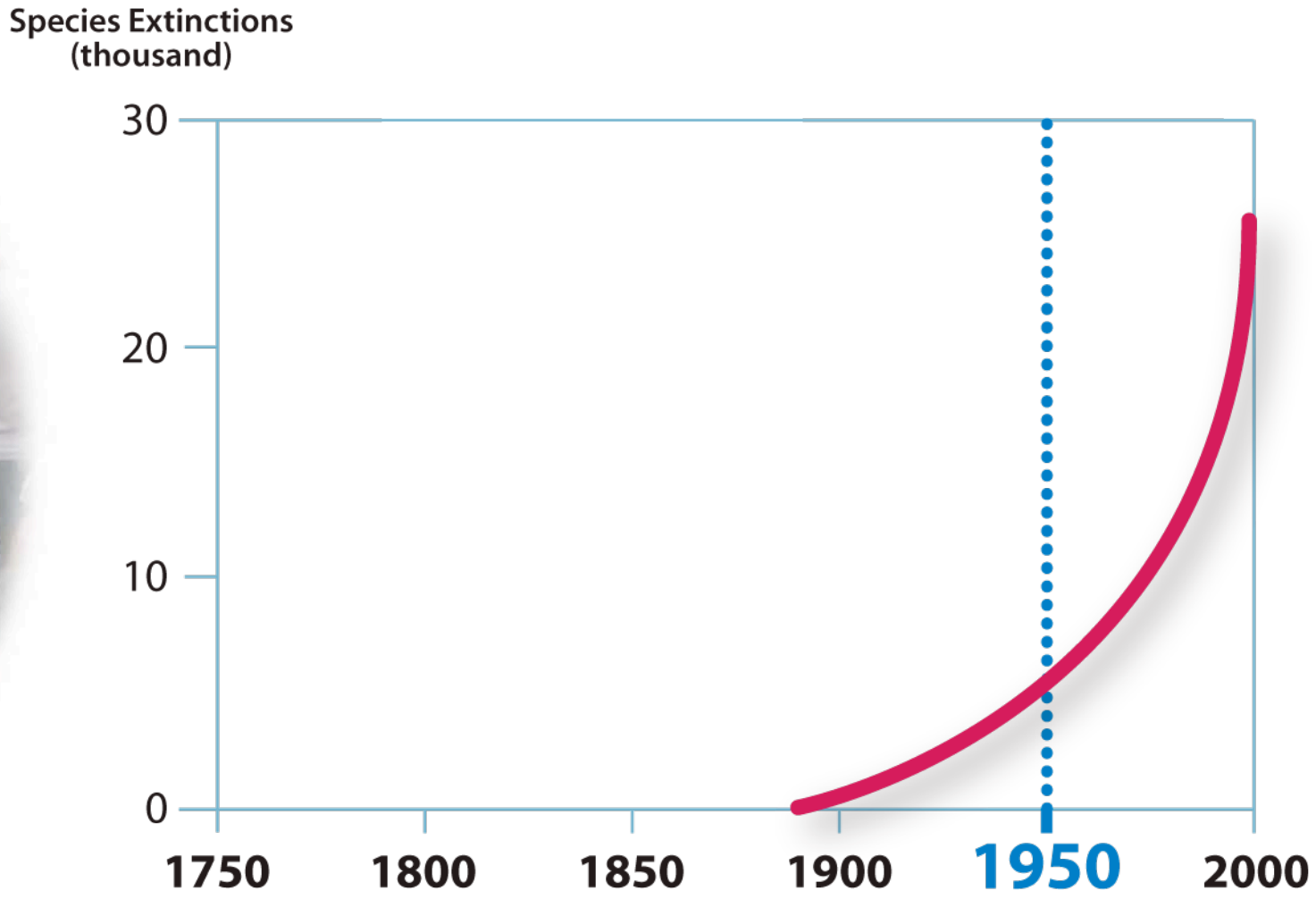
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Coastal zone nitrogen flux



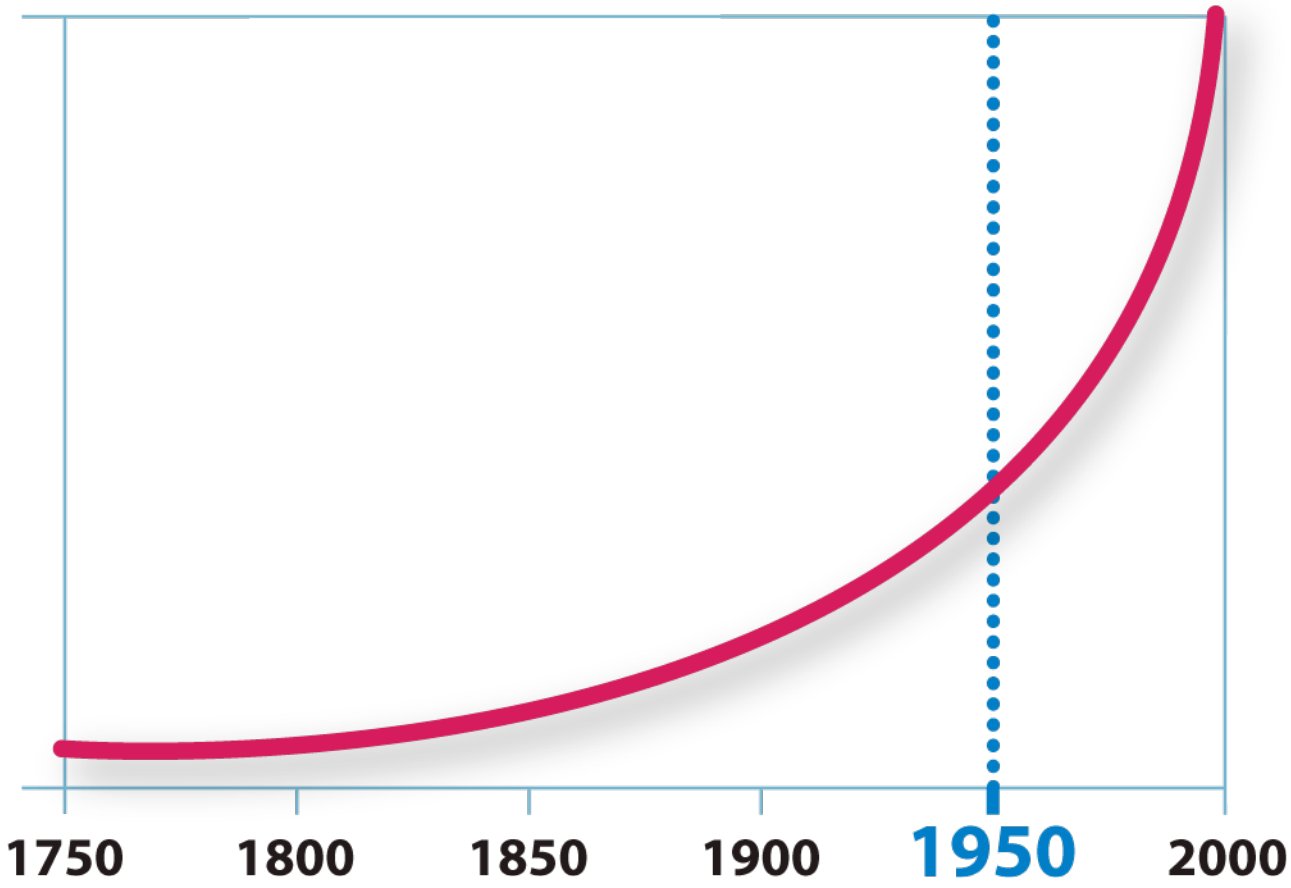
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Biodiversity loss



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

Great acceleration



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

IGBP Strategic Vision

To provide essential scientific **leadership** and knowledge of the **Earth system** to help guide society onto a **sustainable** pathway during rapid global change

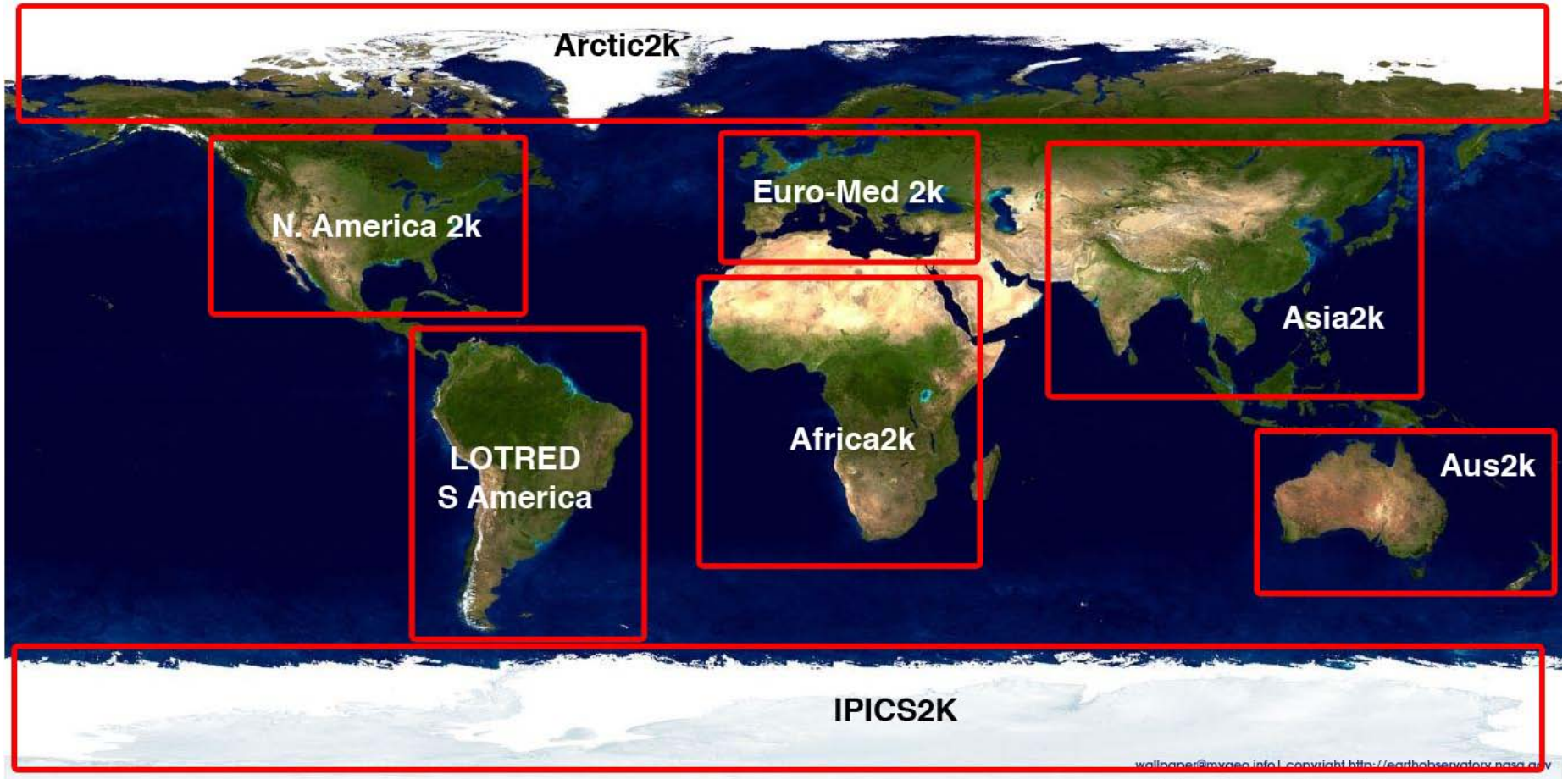
IGBP Strategic Vision

Fundamentals of the Earth system
Impacts of environmental disturbances
Bio-geophysical and social diversity
Resource management
Mitigation and adaptation

Three Pillars

- research and synthesis
- science-policy interface
- communication and education

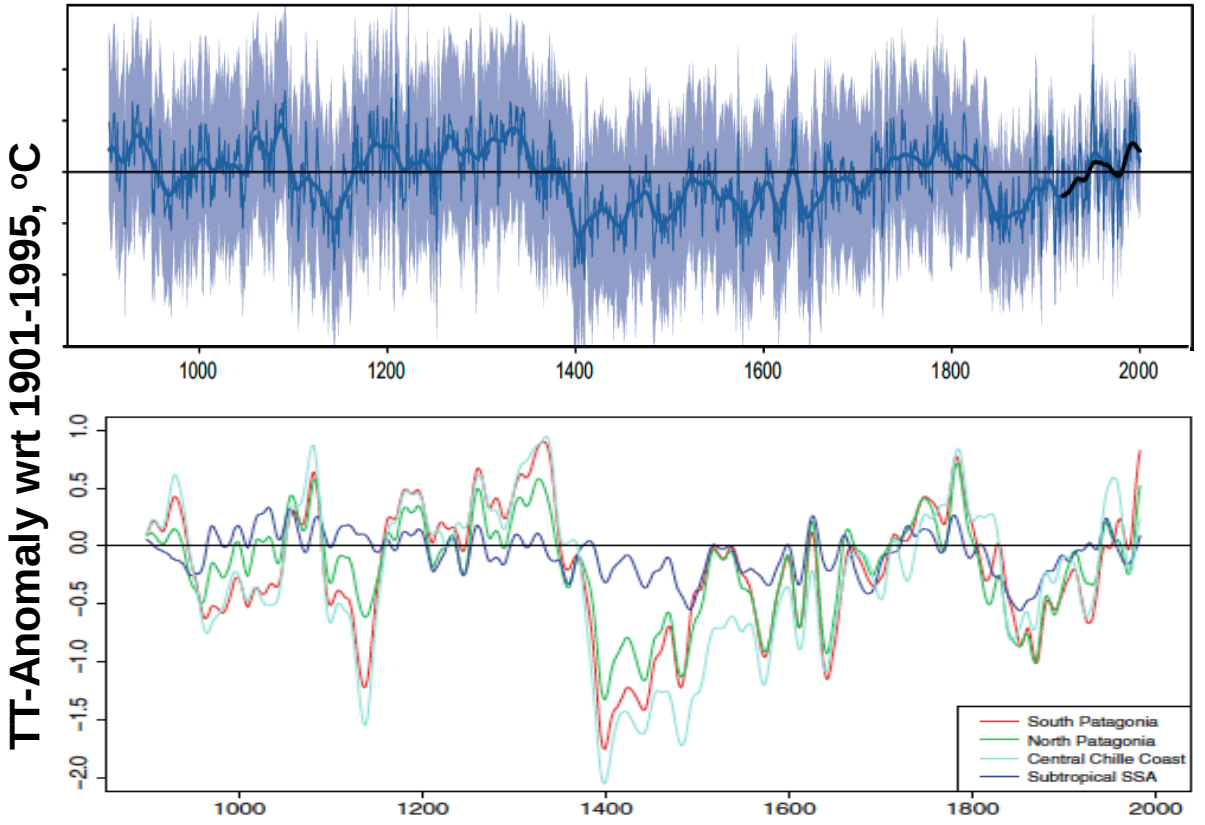
2000 year regional climate reconstruction



PAGES
PAST GLOBAL CHANGES

Past climate in South America

Villalba et al. 2009 Palaeo-3 (special issue)

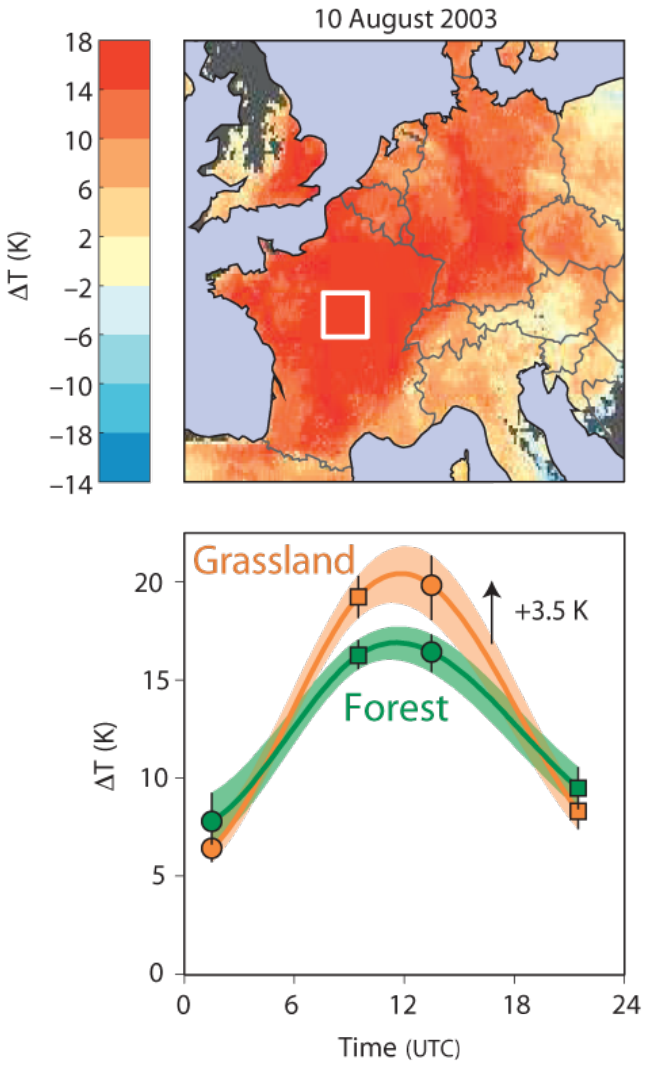


Neukom et al., 2010, Climate Dynamics

PAGES
PAST GLOBAL CHANGES

Land cover affects climate

- Europe heat waves 2003-2006
  - dry, warm conditions
- Grasslands contribute extreme heating
  - soil-moisture depletion
- Implications future
  - forests help ammeliorate
  - prolonged/severe heat waves



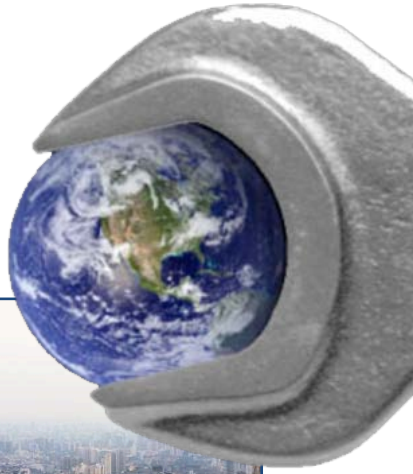
Teuling et al. 2010 Nature Geoscience

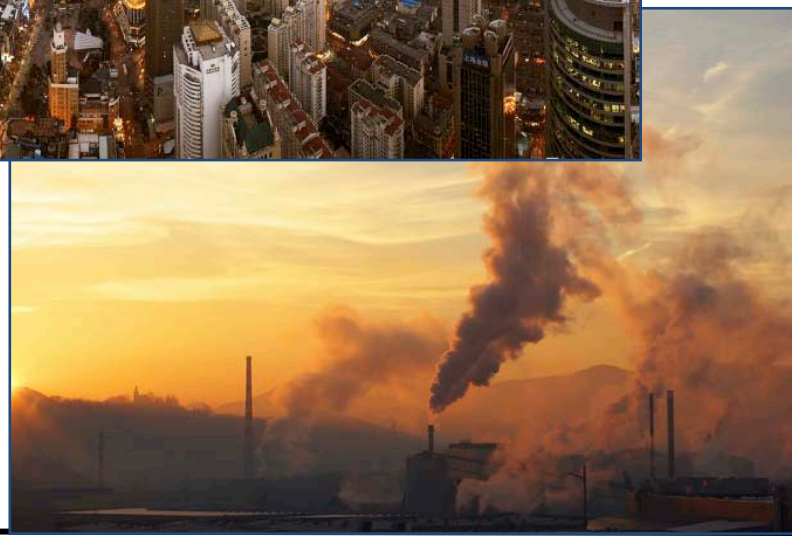
IGBP Synthesis

Bringing together biogeochemists,
with biodiversity,
social scientists,
economists,
policy makers, ...

IGBP Synthesis Topics

- Least Developed Countries
- Cryosphere
- Geoengineering impacts
- Megacities and coasts
- N and climate
- LULCC and climate
- Air pollution and climate
- Adaptation
- Changing nutrient loads

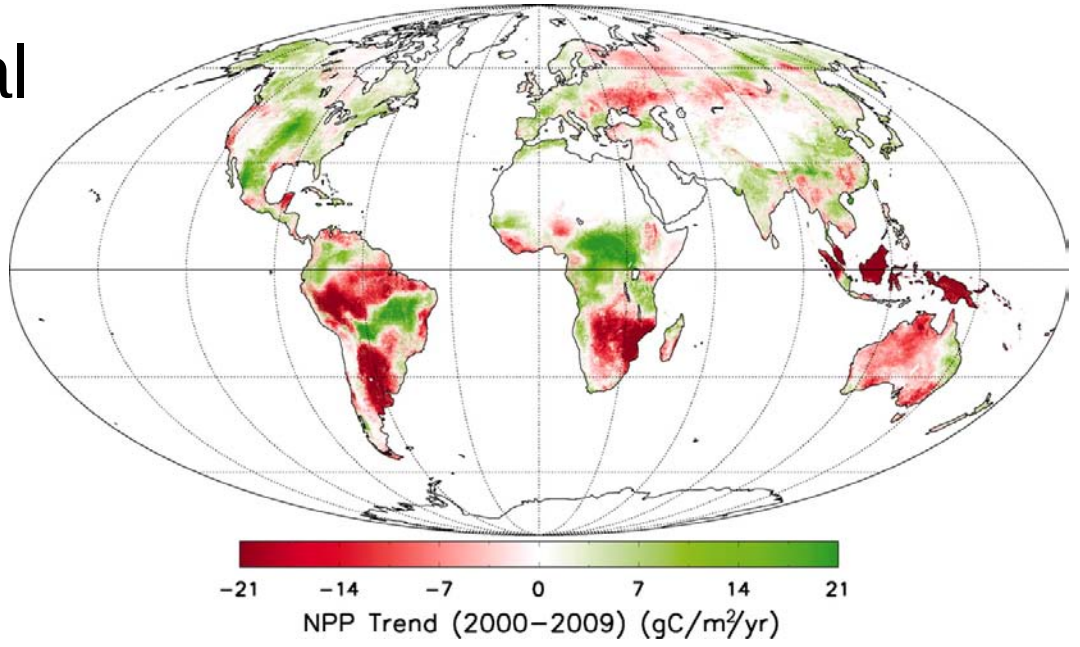




Primary production trends

- Global NPP decrease
- SH decrease – drought
- Implications terrestrial C sink
- Space-based and *in situ* observations

Terrestrial NPP trends (2000 – 2009)



M. Zhao et al., 2010 Science

Land Systems, Global Change and Sustainability

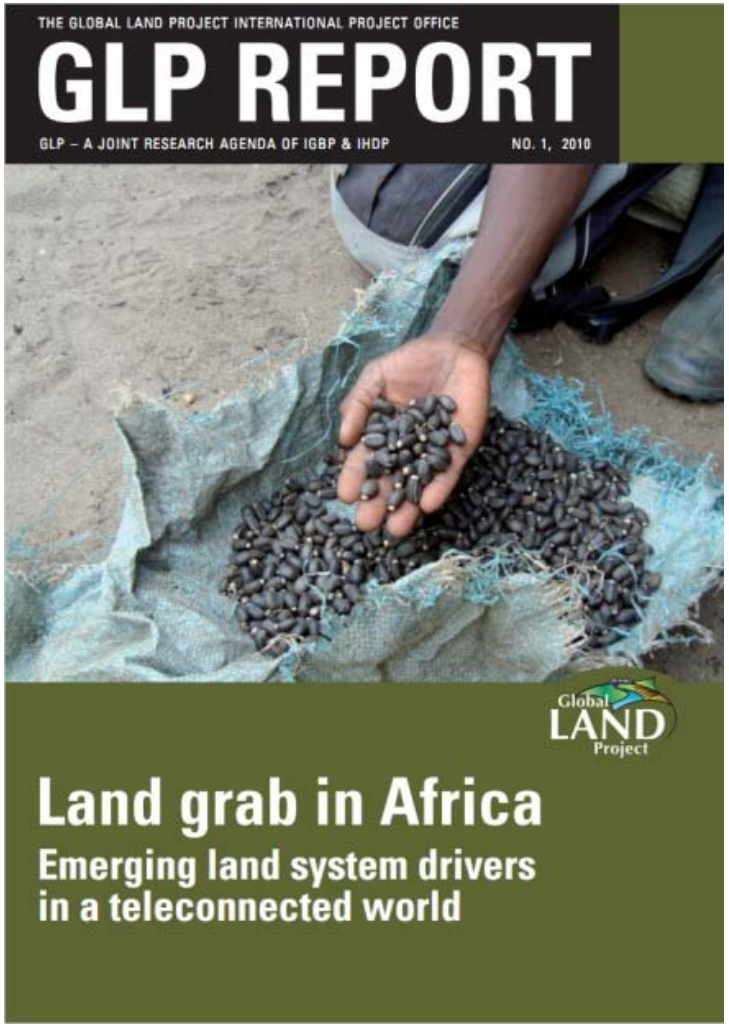
Open Science Conference

Arizona State University (ASU),
October 17-19th 2010

Science-policy interaction

Land Grab in Africa

- Magnitude of land deals
- Throughout Africa
- Teleconnections and land-scarcity



Friis and Reenberg, 2010

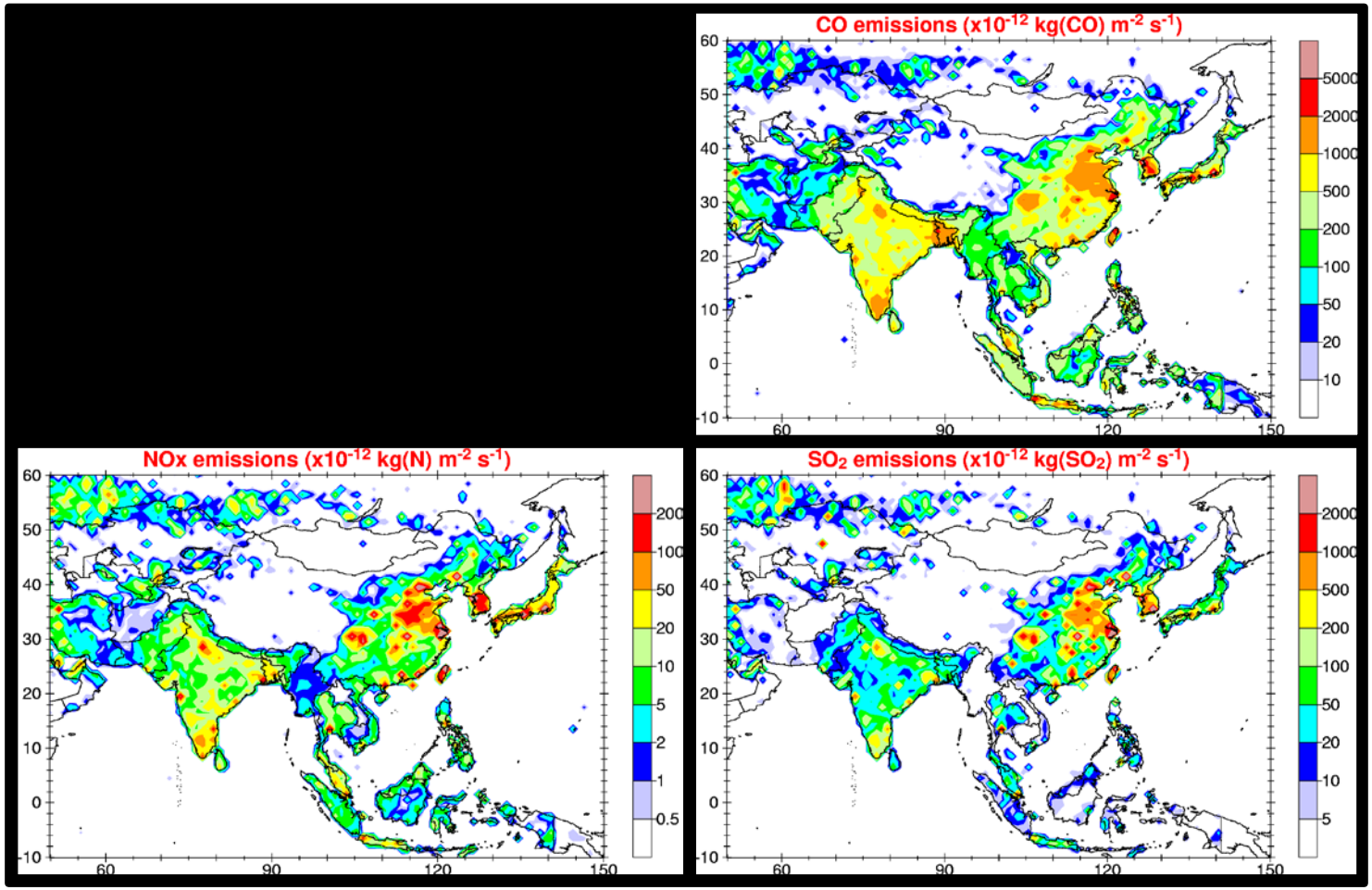
Sustainability in urbanizing planet

Urbanization and Built Environments

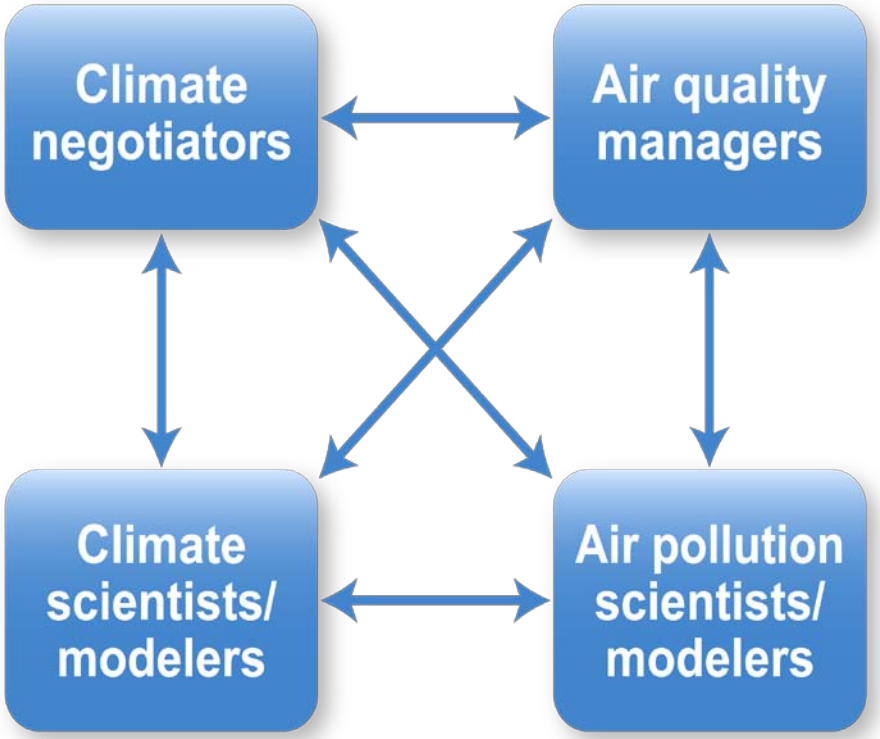
- If 3.2 billion additional people by 2100
- Mostly in cities of 1 million
- Require 3200 cities of 1 million over 89 years
- 89 years = 32485 days
- 3200 cities over 32485 days
- **~ 1 new city of 1 million every 10 days**

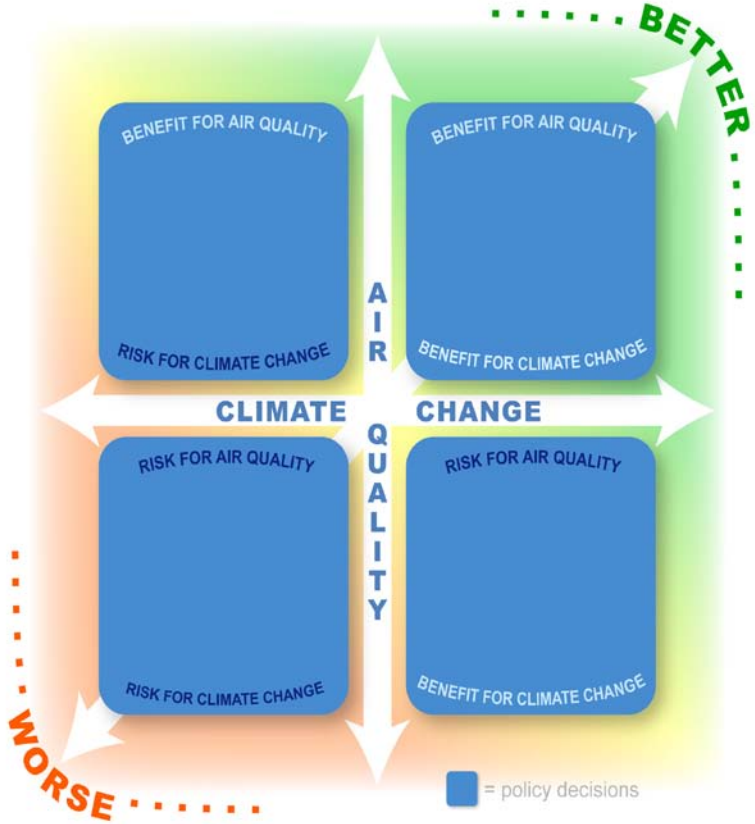
Karen Seto 2011

Report on Atmospheric Chemistry in Megacities: Asia Chapter



Air Pollution & Climate:





Air Pollution & Climate:

2nd Workshop

Air Pollution and Climate: A Science-Policy Dialogue

With a focus on Asia

7 – 10 November 2011

Taipei, Taiwan

Sponsored by the Taiwan Environmental Protection Agency

OBJECTIVES

Create a science-policy dialogue

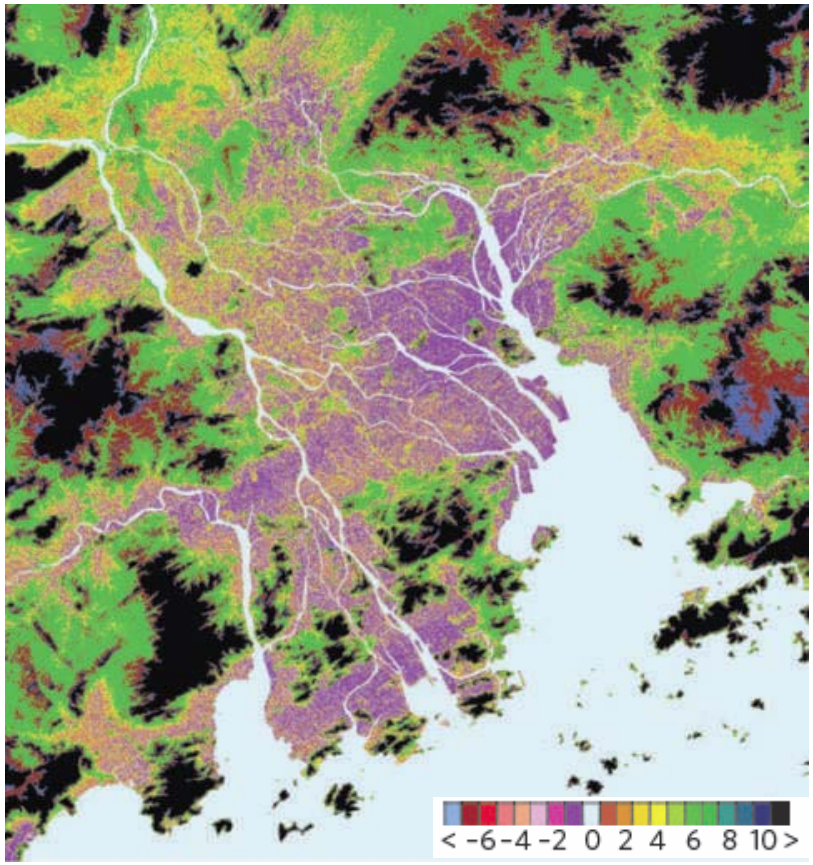
Define the air pollution and climate change challenge in Asia

Develop a strategy for a multidisciplinary programme for Asia

For more information contact megan@igacproject.org

Coastal vulnerability, Freshwater security

- 24 of 33 deltas sinking
- Multiple stresses
  - urbanization
  - water, mineral mining
  - land use/hydrology
  - sea level rise
- Future projections



Syvitski et al. 2009
Nature Geoscience

Coastal vulnerability End-to-end

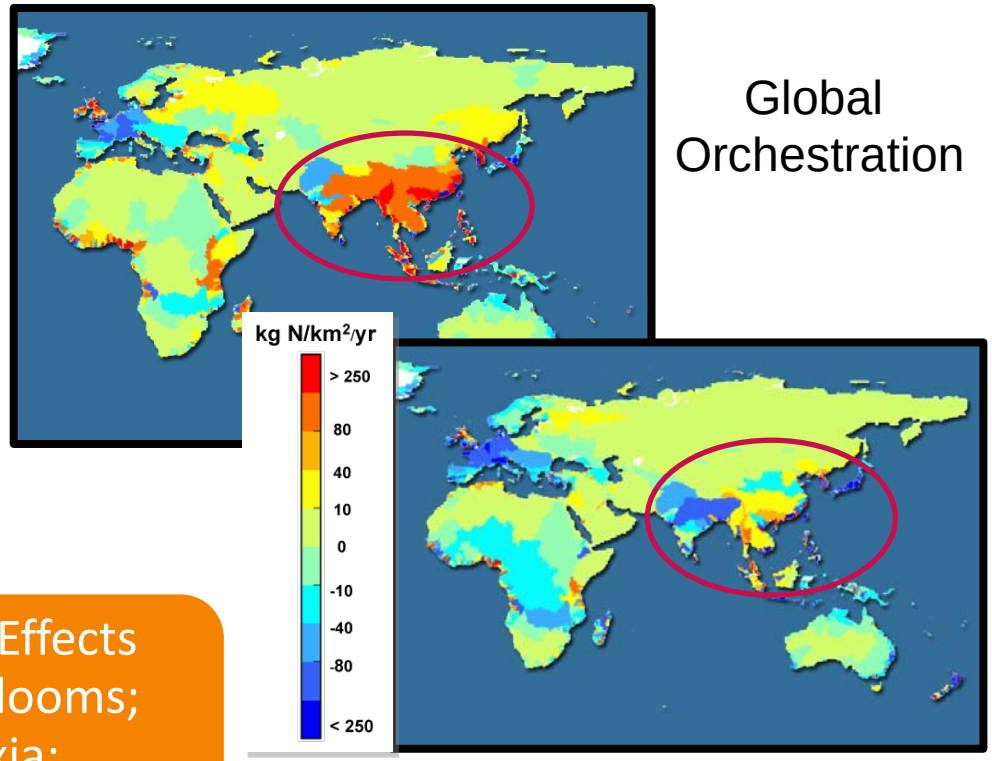
Policy Options & Costs

Nutrient Sources from Food and Energy

Nutrient Export at River Mouth

Coastal Effects (algae blooms; anoxia; fisheries; etc.)

Change in DIN Export 2000-2030



Global Orchestration

Adapting Mosaic

Seitzinger *et al*. 2005, Mayorga *et al*. 2010
Seitzinger *et al.* 2010

Coastal Systems, Global Change and Sustainability”

Open Science Conference

12-15 September 2011, Yantai, China

- Social-ecological systems and scales
- Vulnerability and resilience
- Adaptive capacity and mechanisms
- Earth observation and monitoring
- Modelling and scenario building
- Science-practice-policy interface
- Coastal governance
- Coastal urbanization

GEC and sustainable development: needs of least developed countries

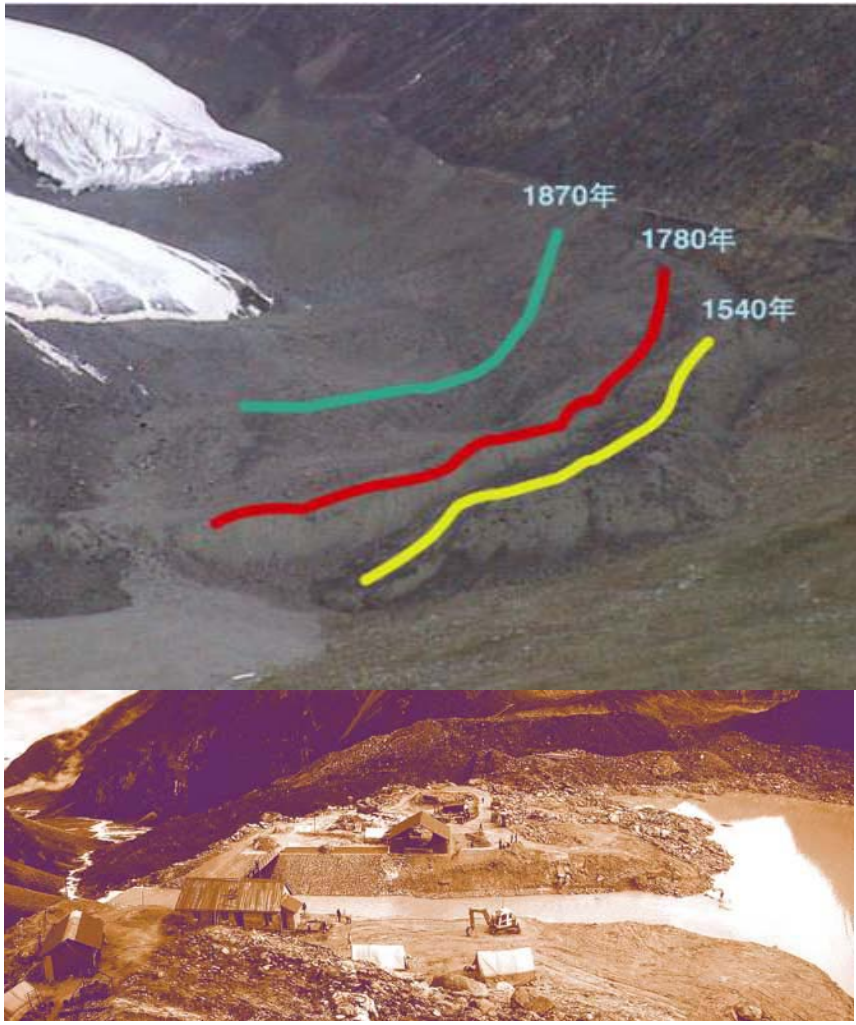
- Natural hazards and disasters
  - scenarios socio-economic consequences
- Ecosystems and water
- Indigenous knowledge
  - transferability
  - climate change

Lead: Pauline Dube, Bostwana

Freshwater security

Changes in the cryosphere of arid Central Asia

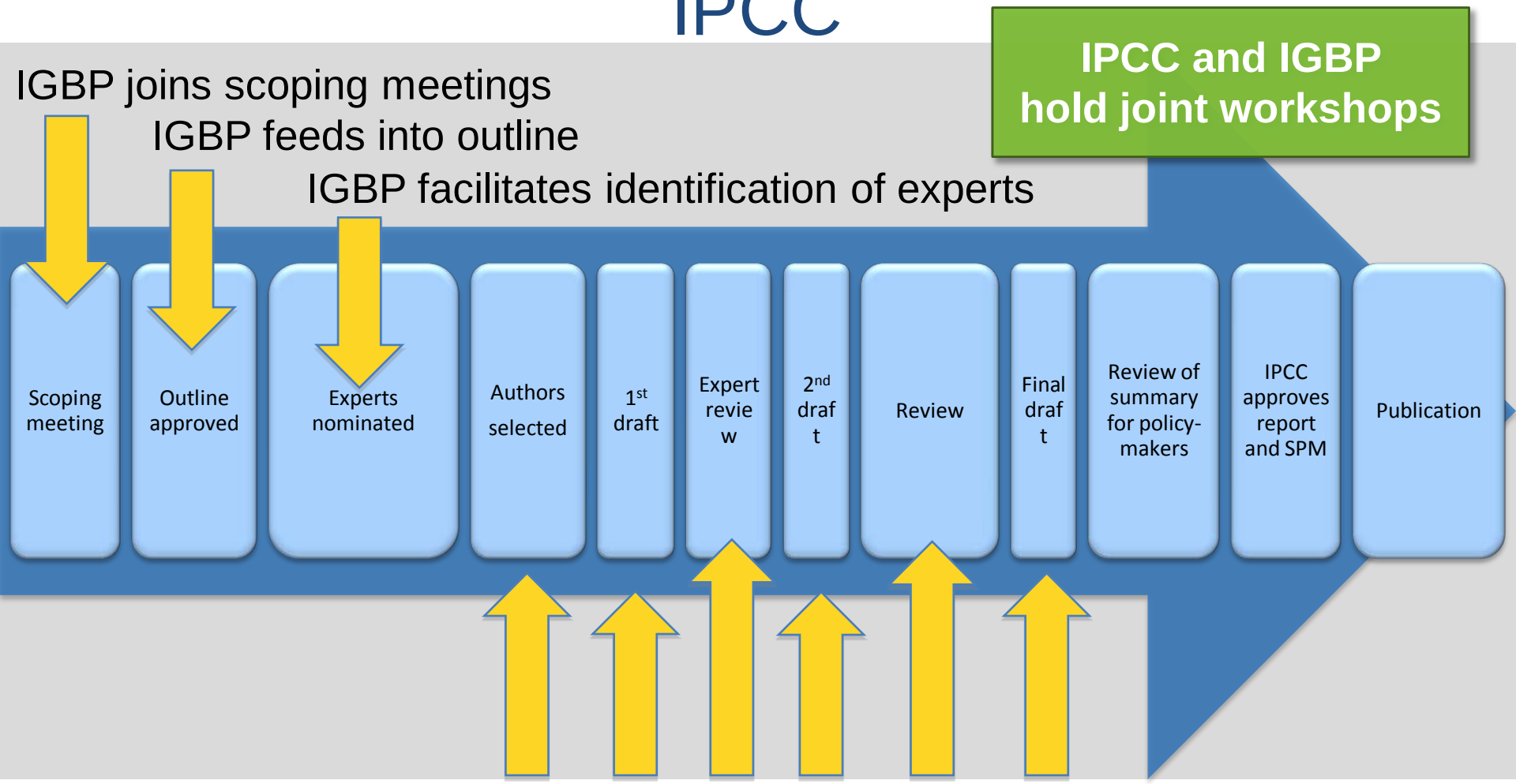
- Water availability, management
- Hazards
- Vulnerability, adaptation strategy
- Peer-reviewed publications
- Reports for policy-makers



Three Pillars

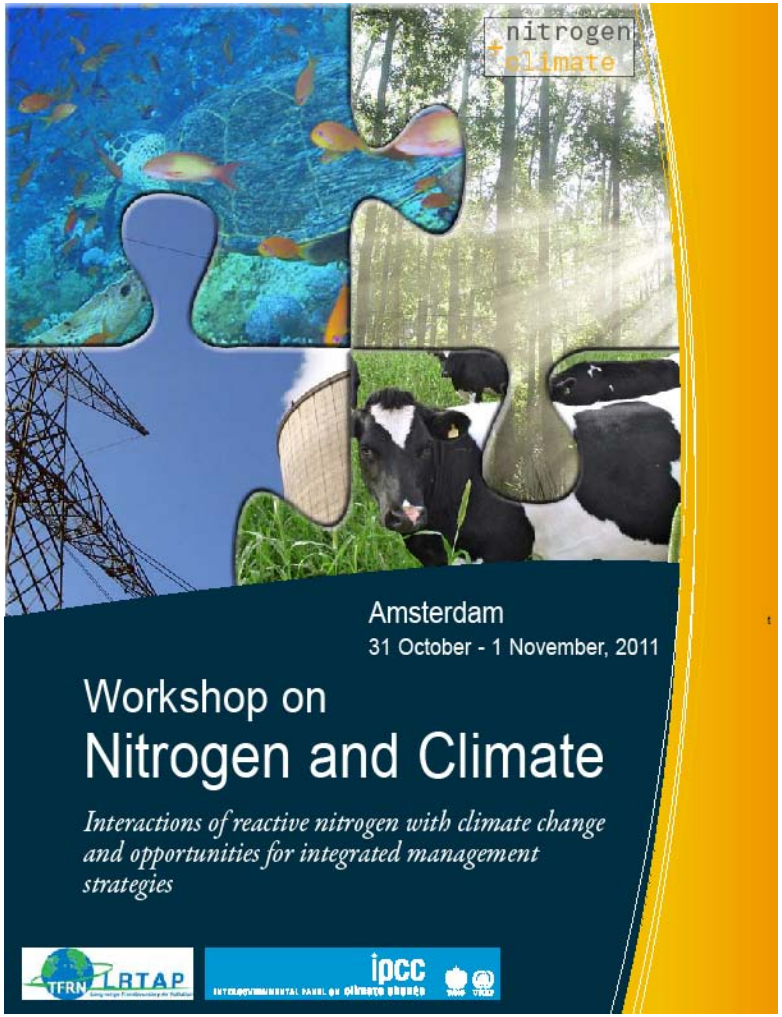
- research and synthesis
- **science-policy interface**
- communication and education

Intergovernmental Panel on Climate Change IPCC



Nitrogen and Climate

- IGBP co-sponsors workshops
  - with IPCC
- Latest scientific findings
  - emerging issues



Key scientific findings, priorities, uncertainties

Feeding into UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA)

UN High-Level Global Sustainability Panel

- Interconnected challenges: interconnected solutions
- Overcome inertia
- Foundation for beyond Millennium Development Goals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TOWARDS
SOLUTIONS
www.planetunderpressure2012.net
GLOBAL CHANGE
IGBP International Geosphere-Biosphere Programme
DIVERSITAS
IHDP
WCRP World Climate Research Programme
ICSU International Council for Science
And their Earth System Science Partnership

PLANET UNDER PRESSURE 2012 MARCH 26-29 LONDON

NEW KNOWLEDGE TOWARDS SOLUTIONS

State of the planet

Trans-disciplinary research

Focus on solutions

Scientific leadership for Rio +20

www.planetunderpressure2012.net

GLOBAL CHANGE IGBP International Geosphere-Biosphere Programme

DIVERSITAS

IHDP

WCRP World Climate Research Programme

ICSU International Council for Science

And their Earth System Science Partnership

IGBP

To provide essential scientific **leadership** and knowledge of the **Earth system** to help guide society onto a **sustainable** pathway during rapid global change

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Thank you!

Arctic Coastal Change

- Physical, ecological, human dimensions, governance
- Socio-ecological approach to coastal change in the Arctic
- Monitoring, detecting, modeling, projecting Arctic coastal change
- Adaptation and governance
- >10 countries