Terrestrial Impacts, Feedbacks & Human Adaptation

Chris Field

Carnegie Institution: Department of Global Ecology
www.global-ecology.org

- Where are we headed?
- Impacts of changes that have already occurred
- Impacts of future changes
- Feedbacks from the unmanaged carbon cycle

Terrestrial Impacts, Feedbacks & Human Adaptation

- Paul Kirshen, Tufts University:
  "Sea level rise and coastal flooding"
- David Lobell, Lawrence Livermore National Laboratory:
  "Warming and the global harvest"
- Ted Schuur, University of Florida:
  "Permafrost carbon and climate feedbacks"

North America: Key messages

- A wide range of impacts of climate change are now clearly documented
- Risks from future impacts concentrated on extreme events
- Vulnerable people and activities in almost every region
- Opportunities for improving adaptation

Future risk areas

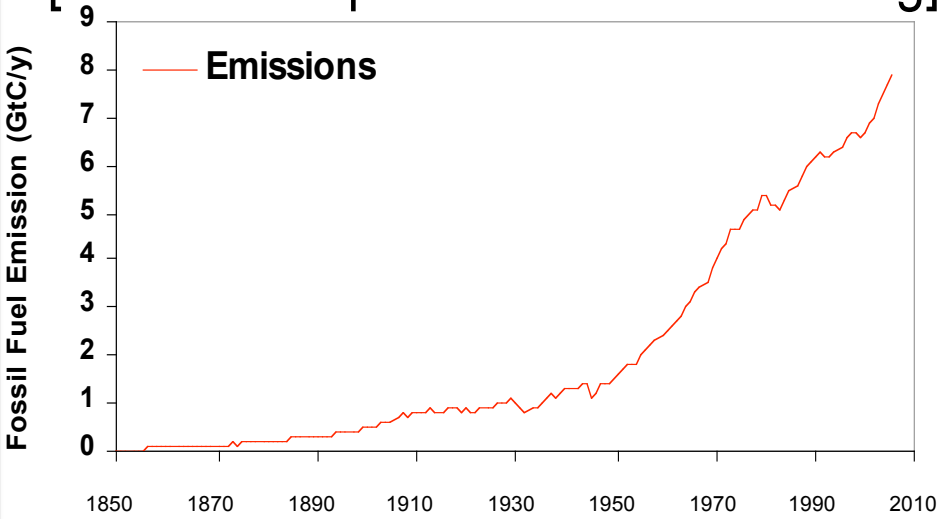
- Increasing frequency of severe hurricanes
- More frequent and more severe heat waves
- Rising sea level
- Public health challenges
- Decreasing water availability (& quality)
- More frequent and larger wildfires
- Challenges to agriculture and forestry
- International trade and security

IPCC AR4 WG2, North America

Anthropogenic C Emissions: Fossil Fuel

2006 Fossil Fuel: 8.4 Pg C

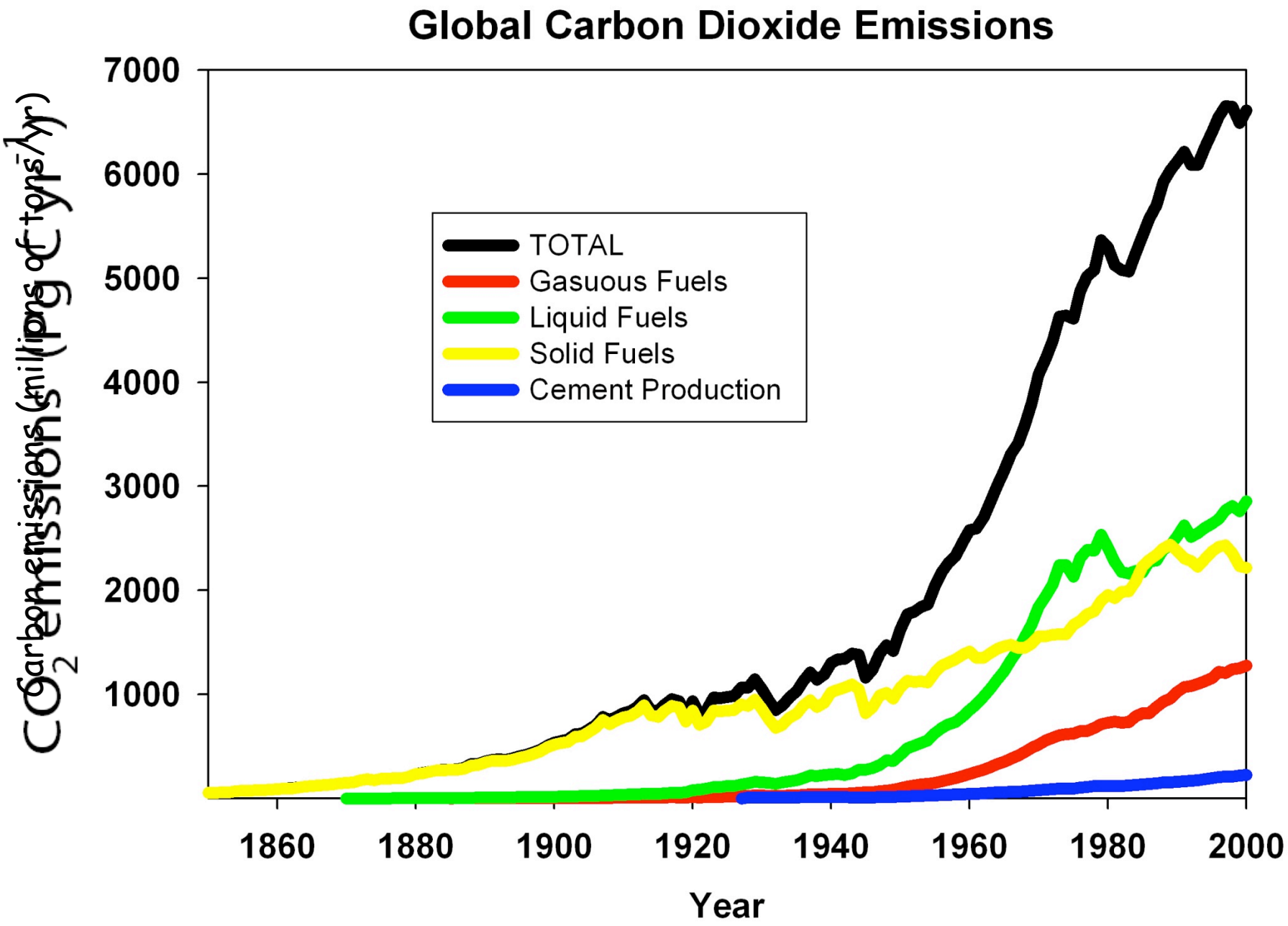
[Total Anthrop.Emis.:8.4+1.5 = 9.9 Pg]

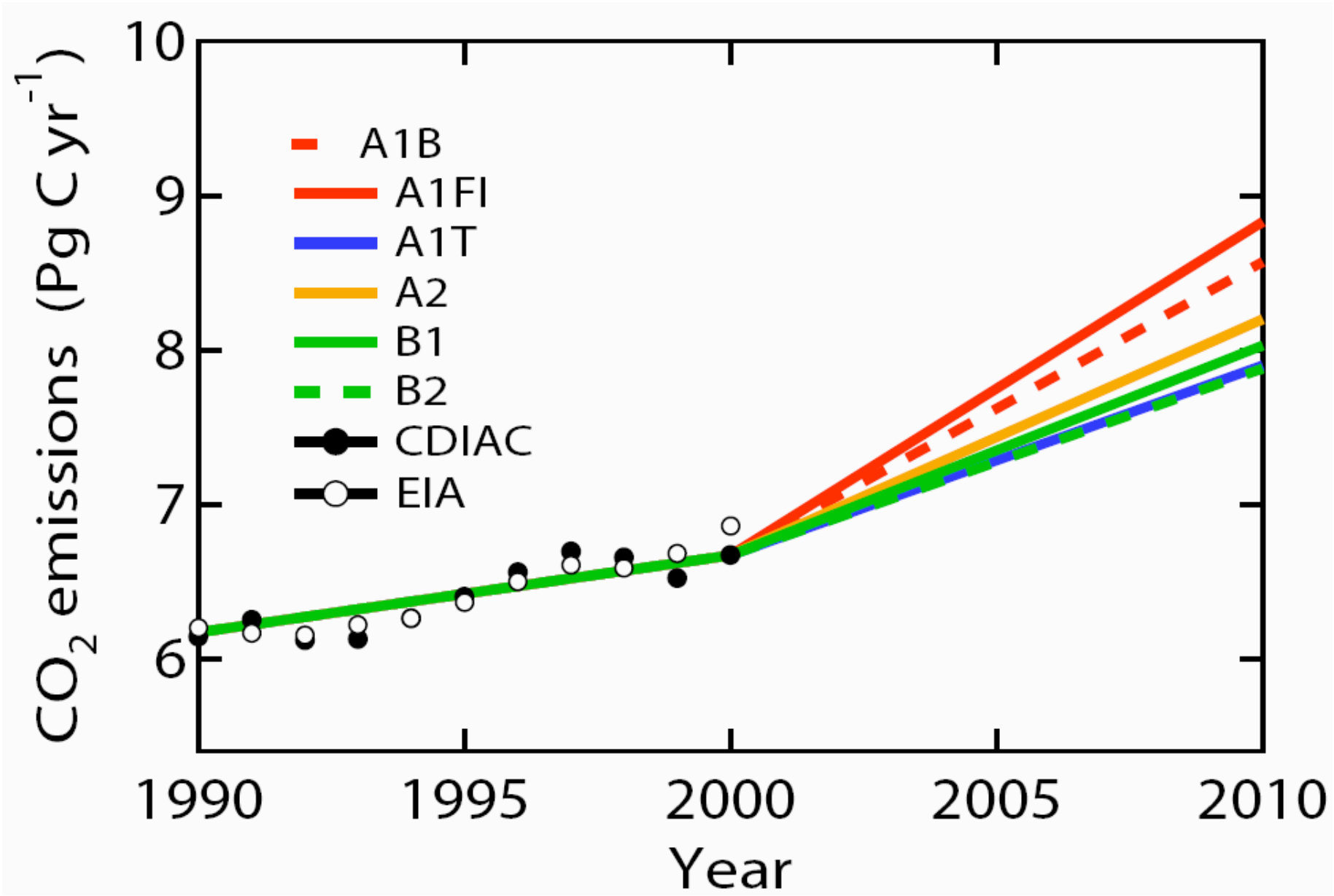


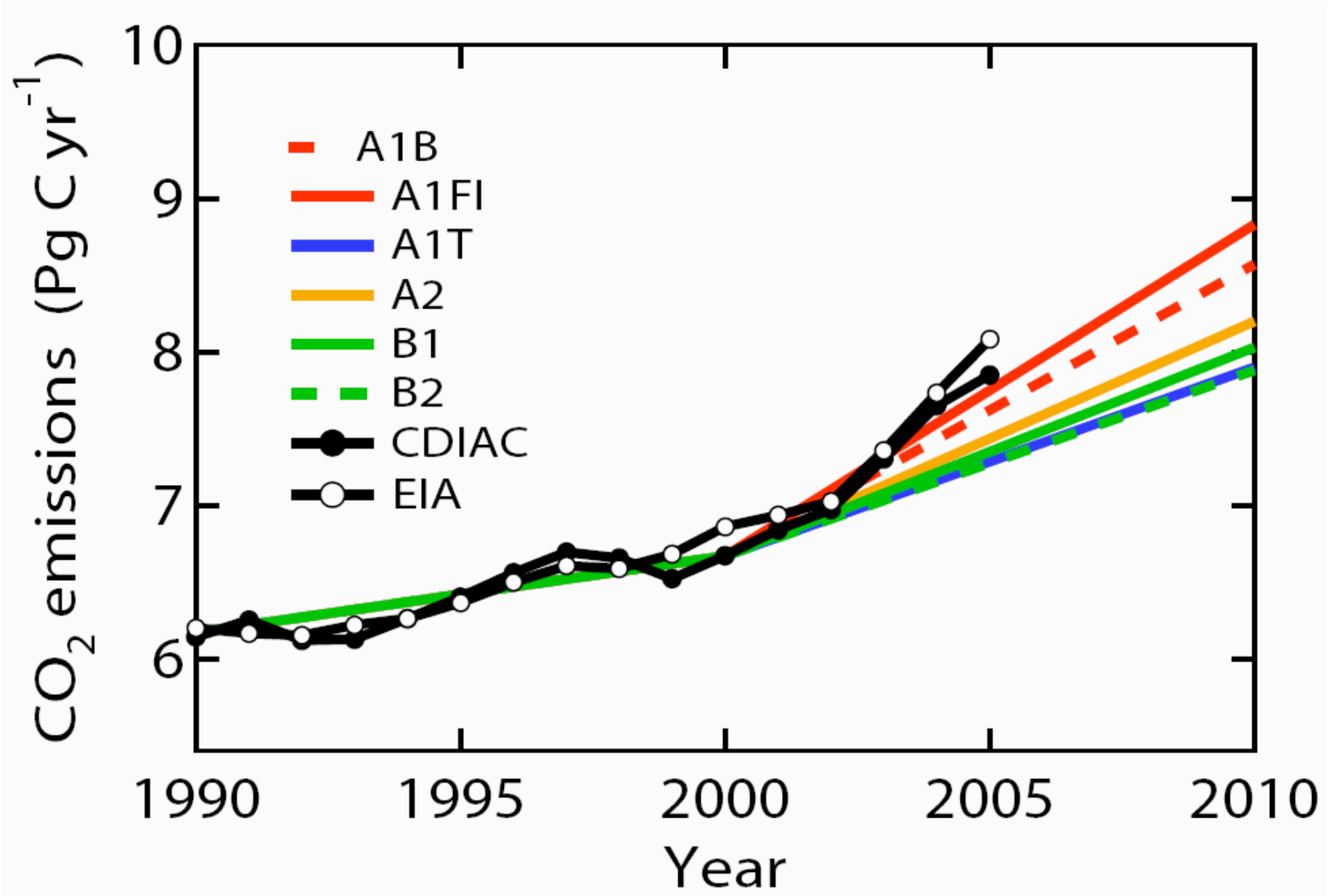
1990 - 1999: 1.3% y^{-1}

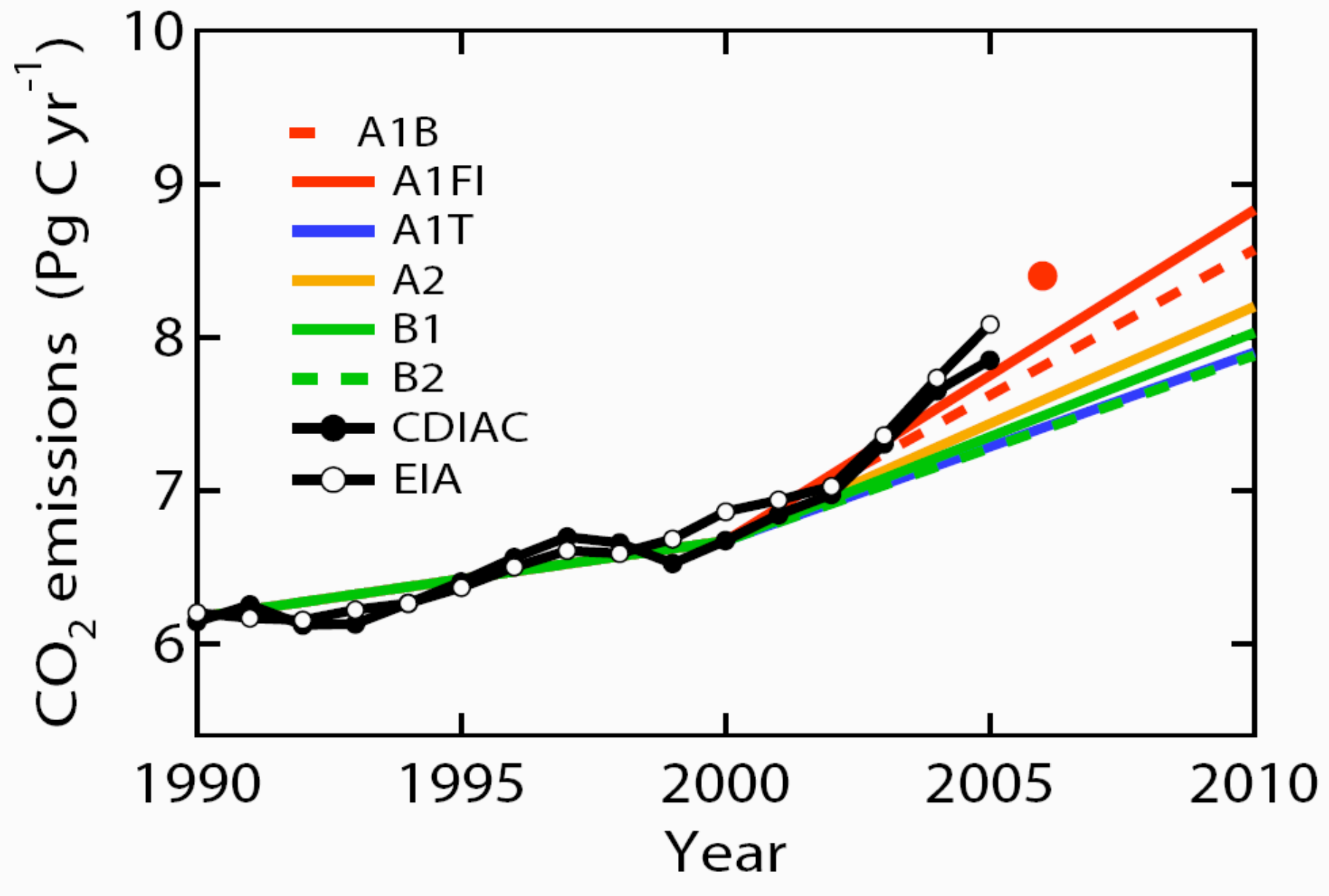
2000 - 2006: 3.3% y^{-1}

Raupach et al. 2007, PNAS; Canadell et al 2007, PNAS


Global Carbon Dioxide Emissions
7000
6000
5000
4000
3000
2000
1000
TOTAL
Gasuous Fuels
Liquid Fuels
Solid Fuels
Cement Production
1860
1880
1900
1920
1940
1960
1980
2000
Year


10
9
8
7
6
CO_2 emissions (Pg C yr^{-1})
A1B
A1FI
A1T
A2
B1
B2
CDIAC
EIA
1990
1995
2000
2005
2010
Year


10
9
8
7
6
CO_2 emissions (Pg C yr^{-1})
A1B
A1FI
A1T
A2
B1
B2
CDIAC
EIA
1990
1995
2000
2005
2010
Year


10
9
8
7
6
CO_2 emissions (Pg C yr^{-1})
A1B
A1FI
A1T
A2
B1
B2
CDIAC
EIA
1990
1995
2000
2005
2010
Year

Finding the mechanism

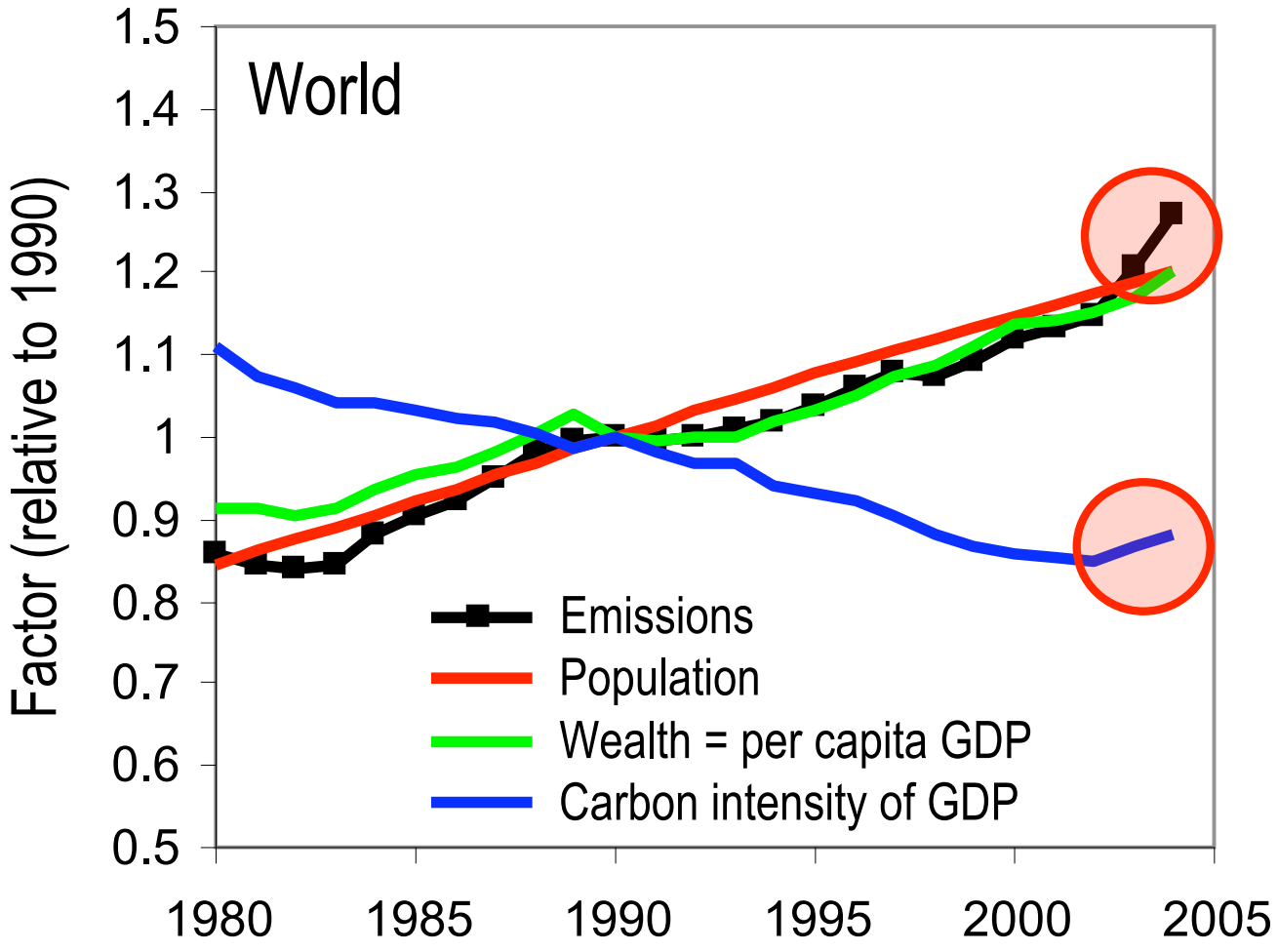
$$CO_2 = \left(\frac{CO_2}{GDP}\right) x \left(\frac{GDP}{P}\right) xP$$

Carbon intensity Of economic activity

Per capita GDP

Population size

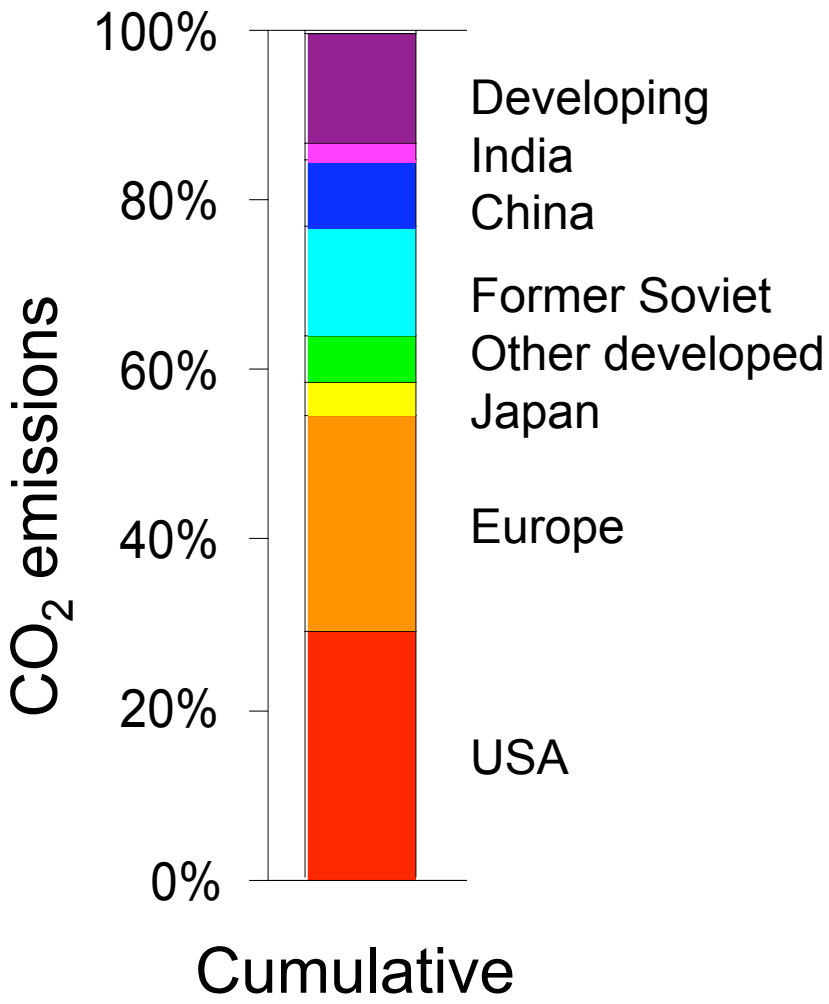
Anthropogenic C Emissions: Carbon Intensity of GDP



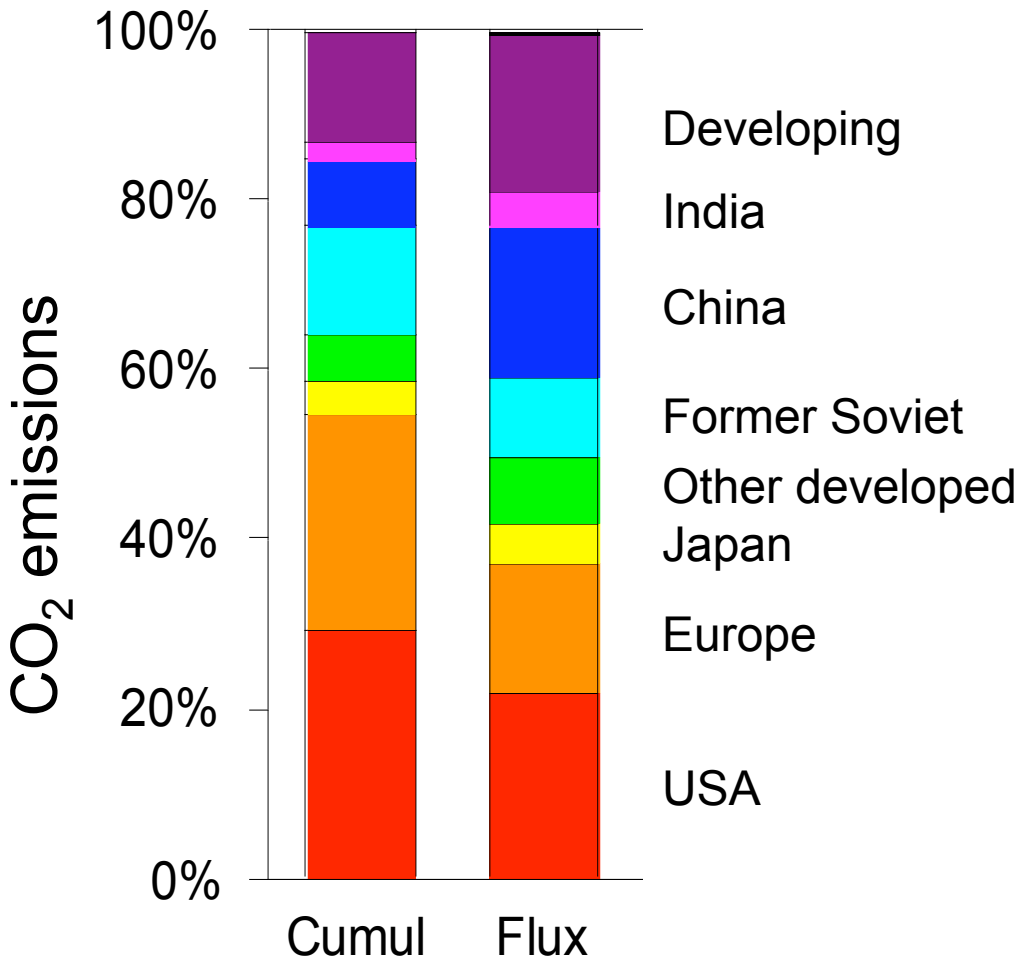
Raupach et al 2007, PNAS

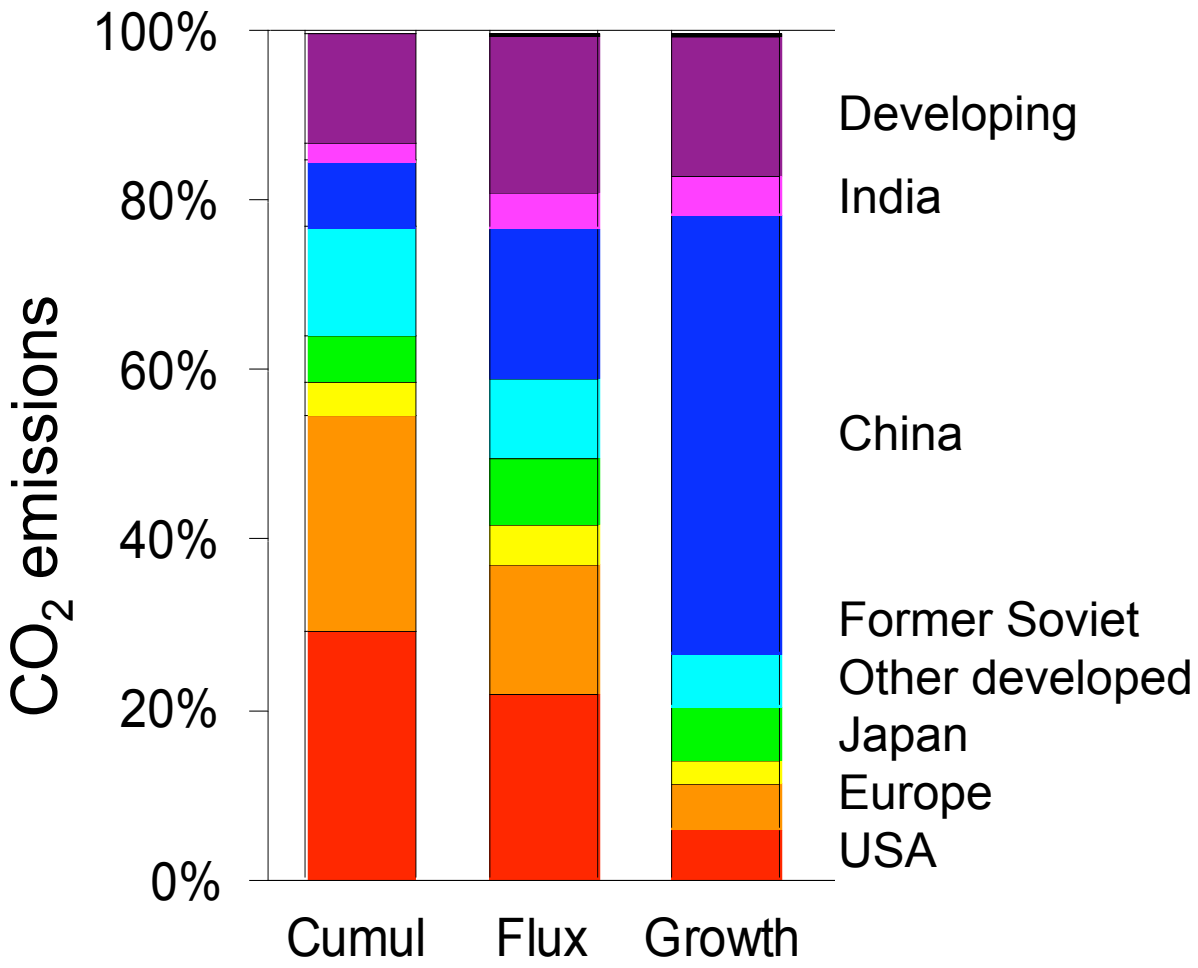
Global Carbon Project

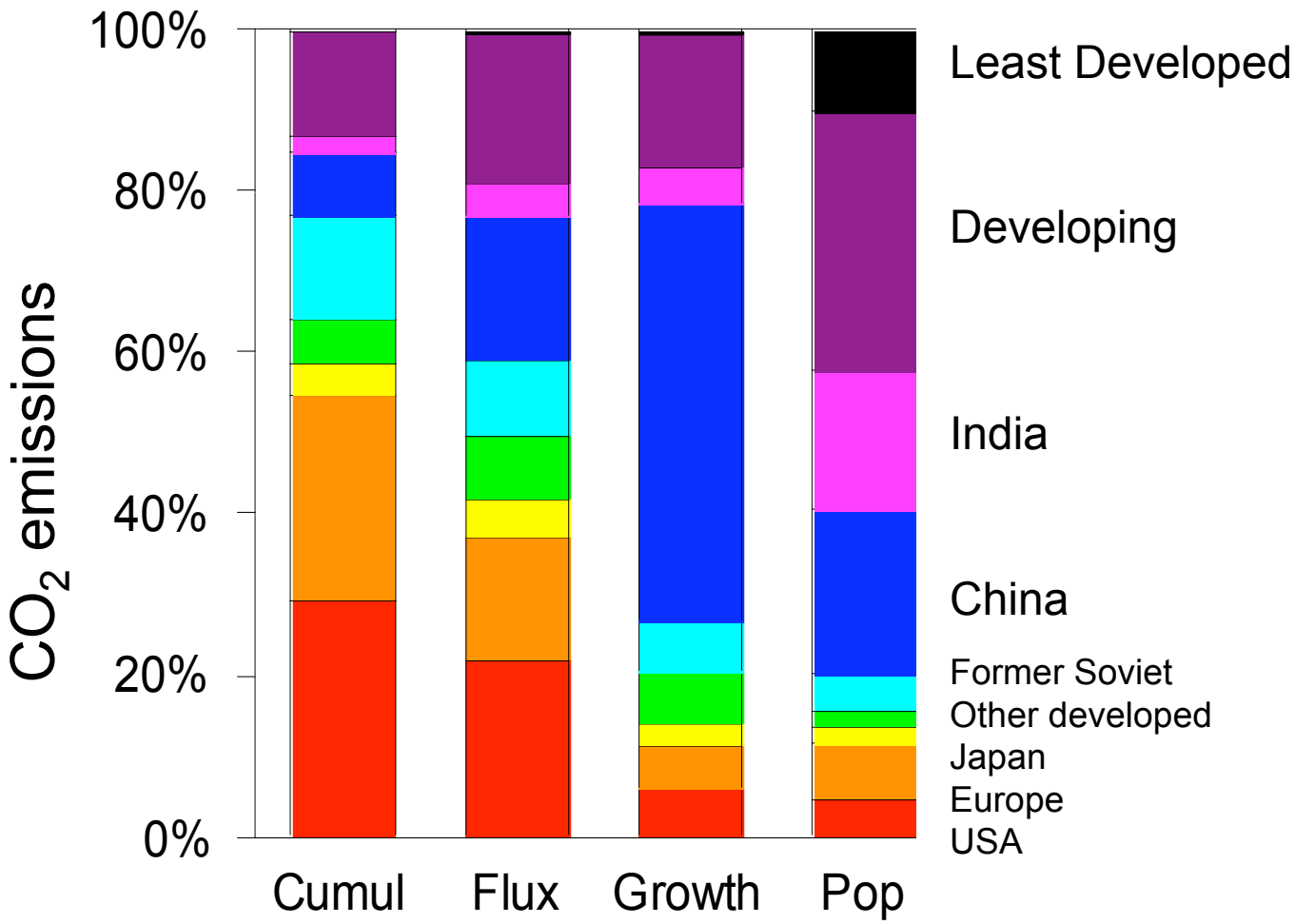
Dramatic contrast – history versus future

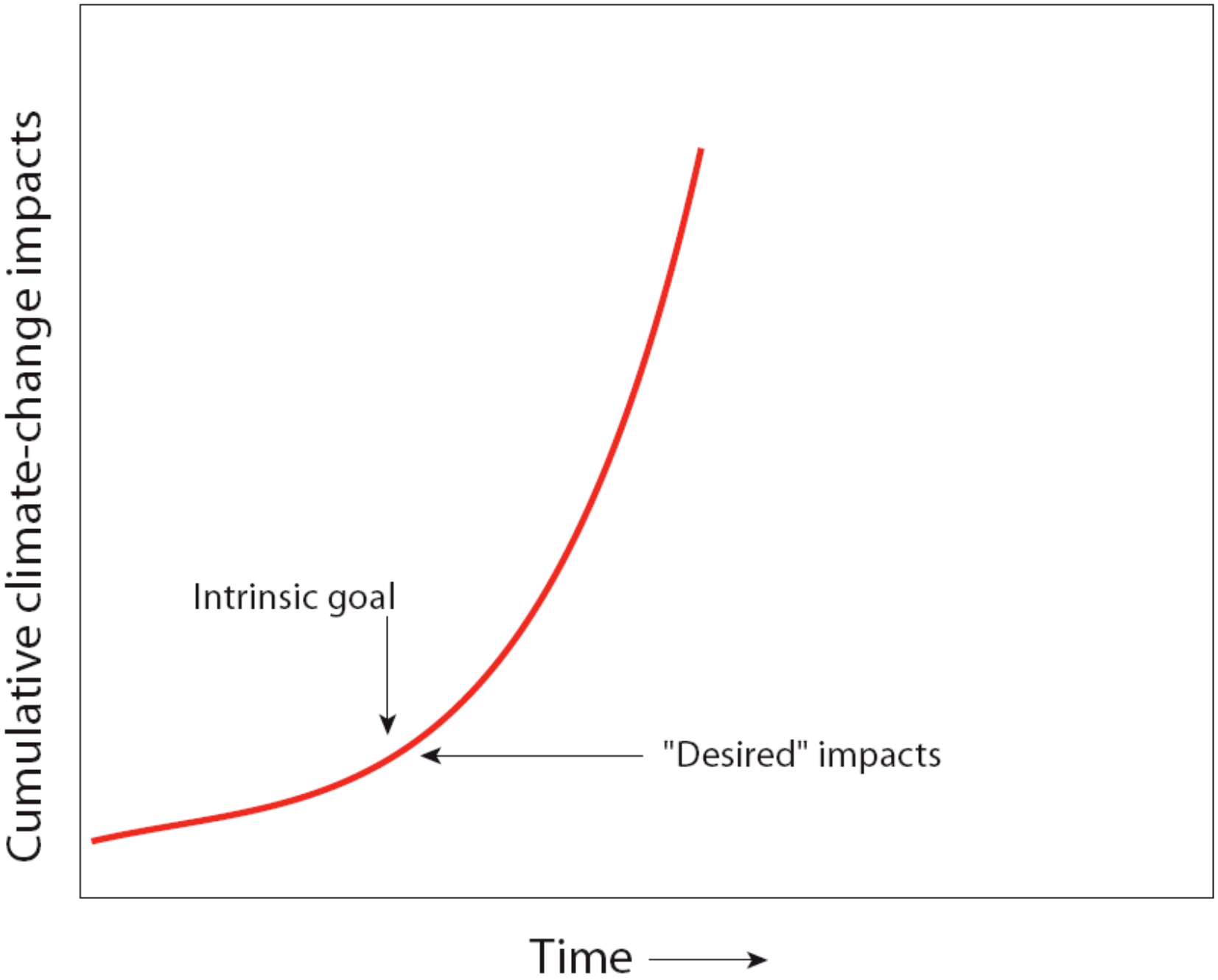


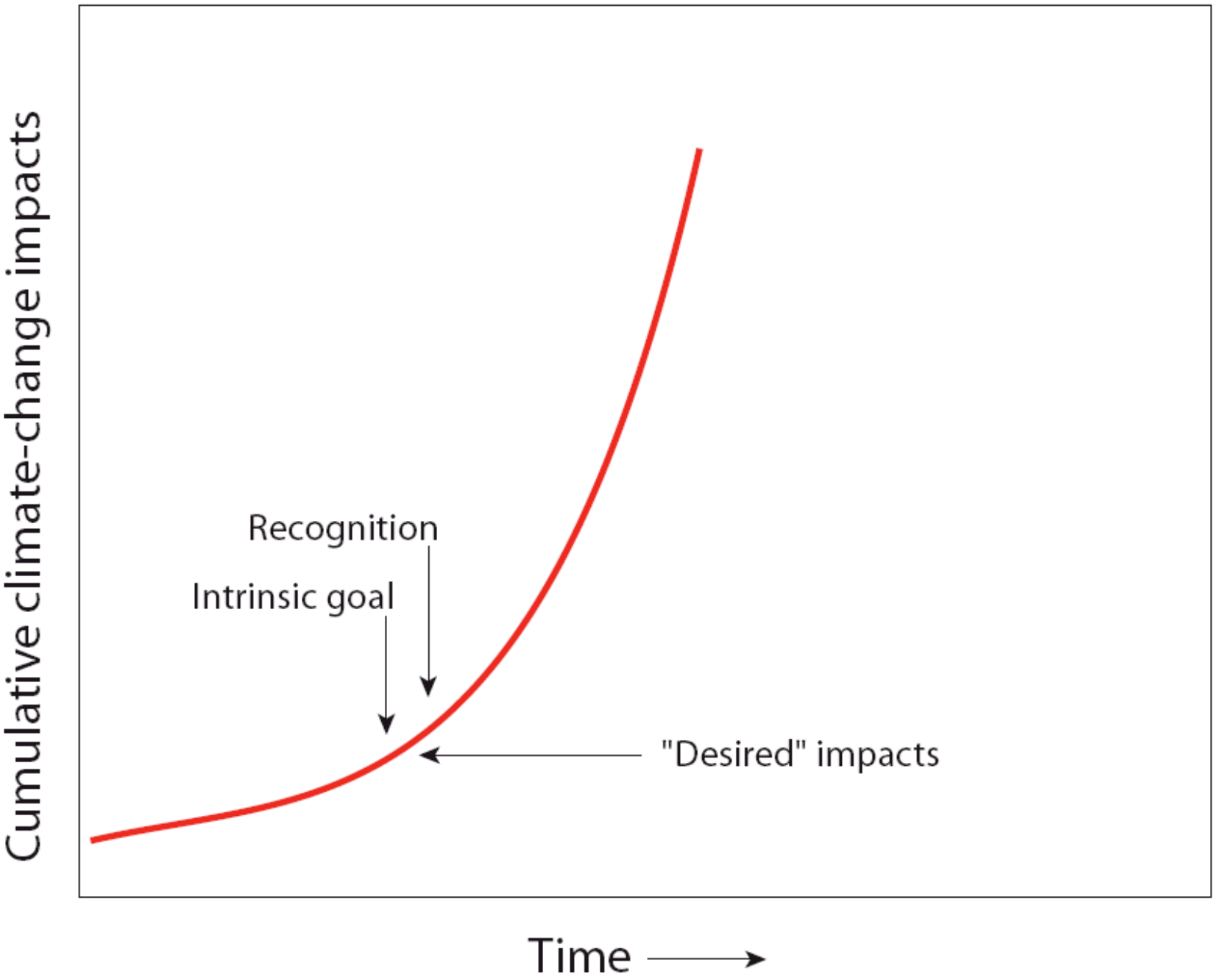
Raupach et al. PNAS 2007

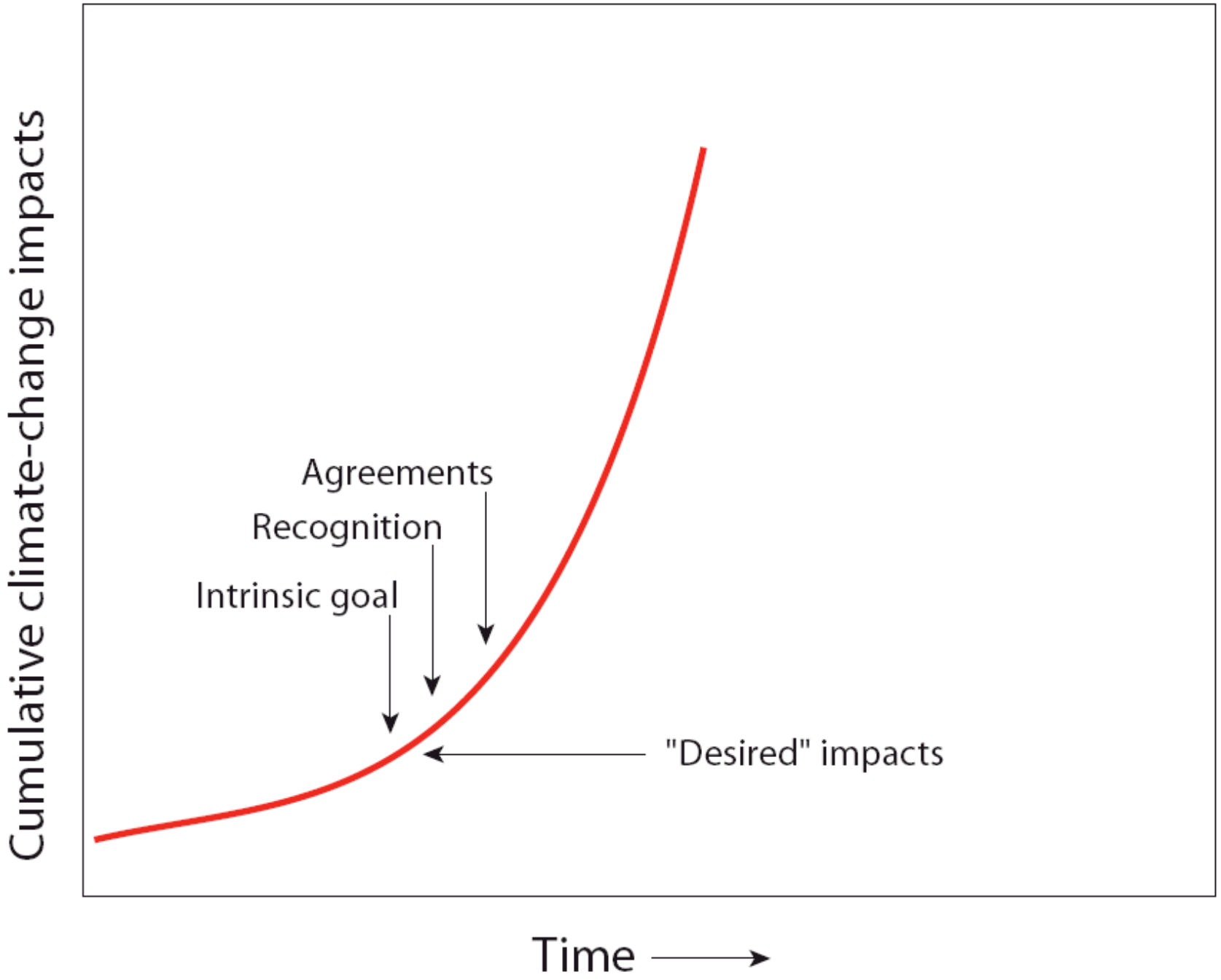

100%
80%
60%
40%
20%
0%
CO_2 emissions
Cumul
Flux
Developing
India
China
Former Soviet
Other developed
Japan
Europe
USA

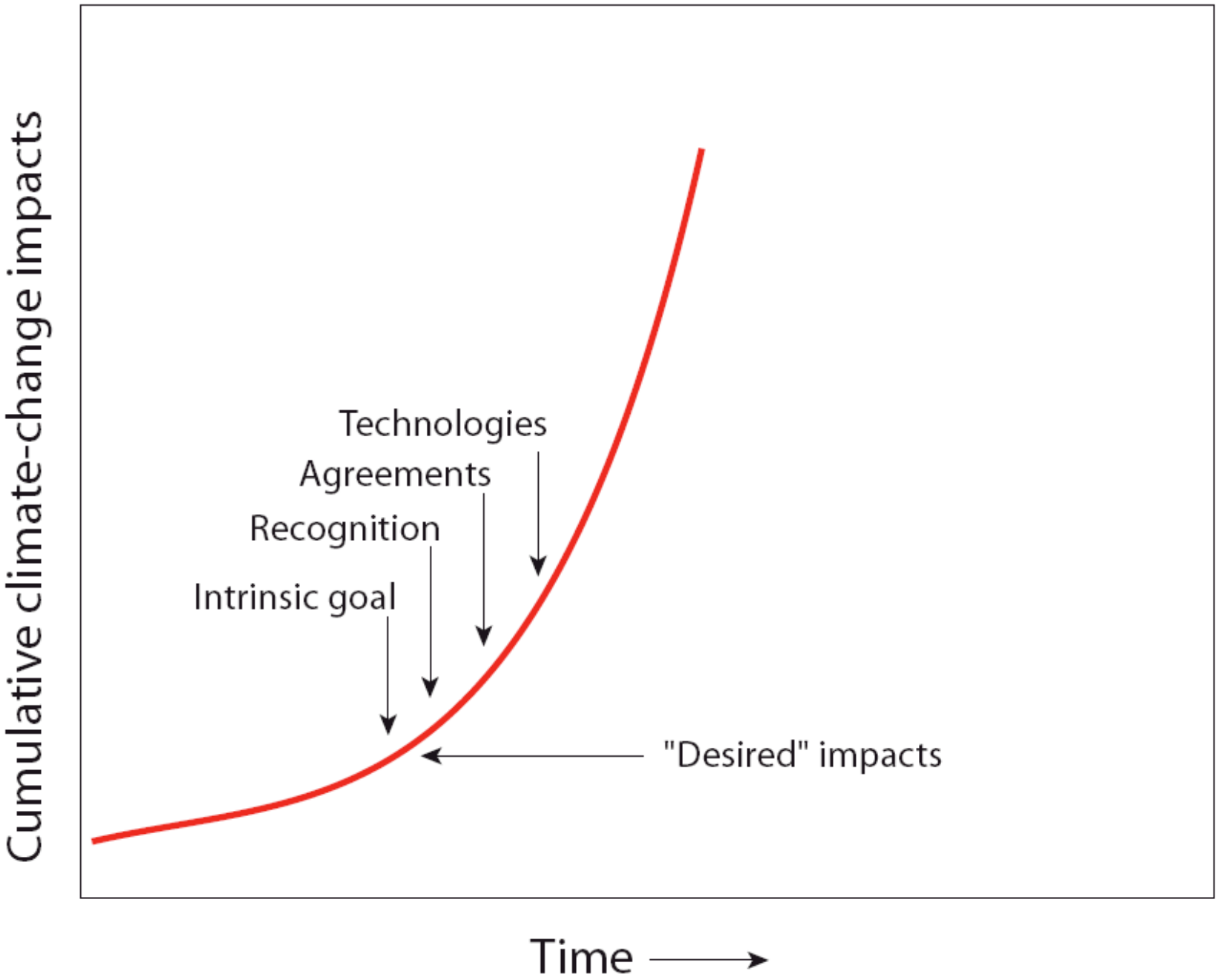

100%
80%
60%
40%
20%
0%
CO_2 emissions
Cumul
Flux
Growth
Developing
India
China
Former Soviet
Other developed
Japan
Europe
USA

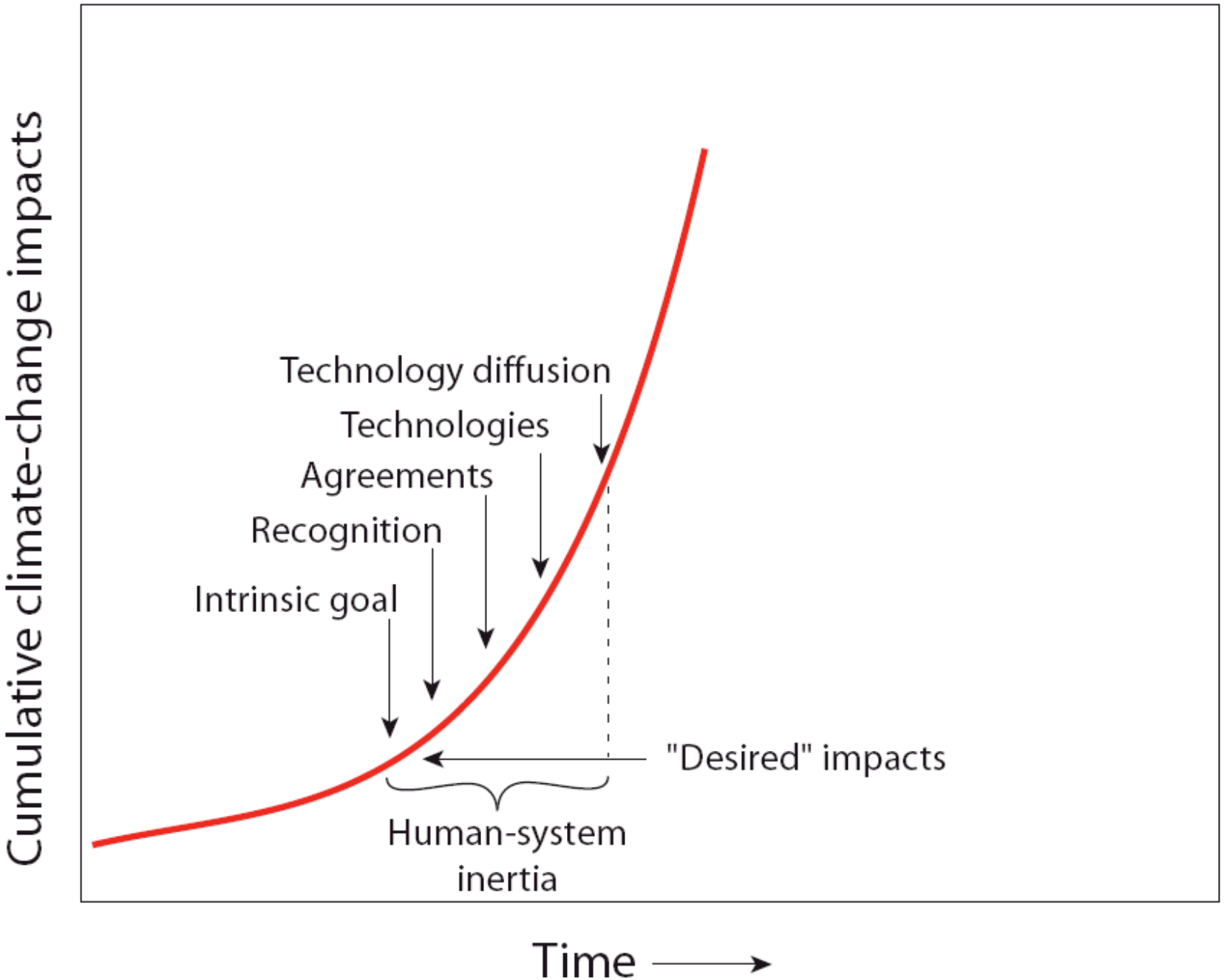

100%
80%
60%
40%
20%
0%
CO_2 emissions
Cumul
Flux
Growth
Pop
Least Developed
Developing
India
China
Former Soviet
Other developed
Japan
Europe
USA

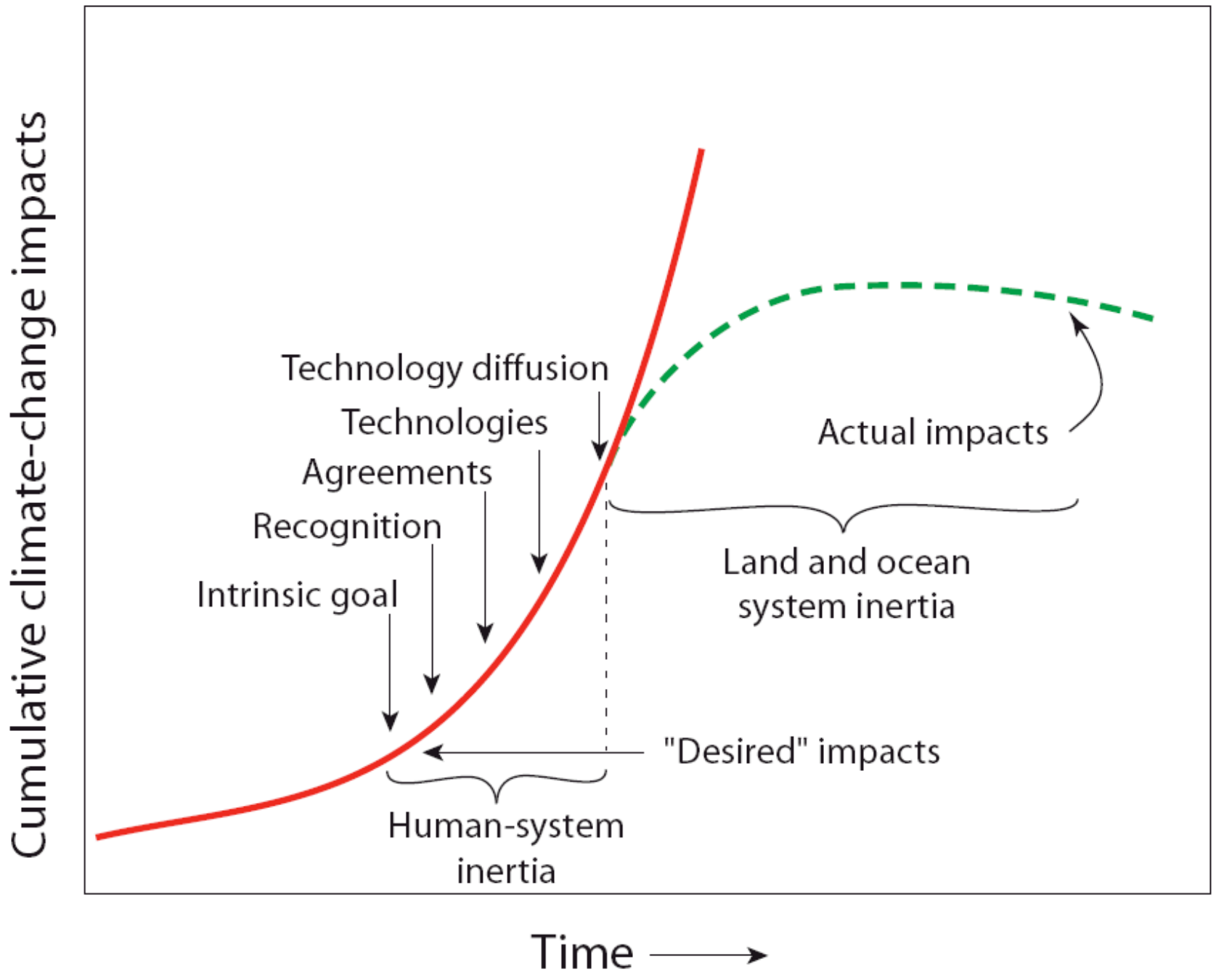

Cumulative climate-change impacts
Intrinsic goal
"Desired" impacts
Time

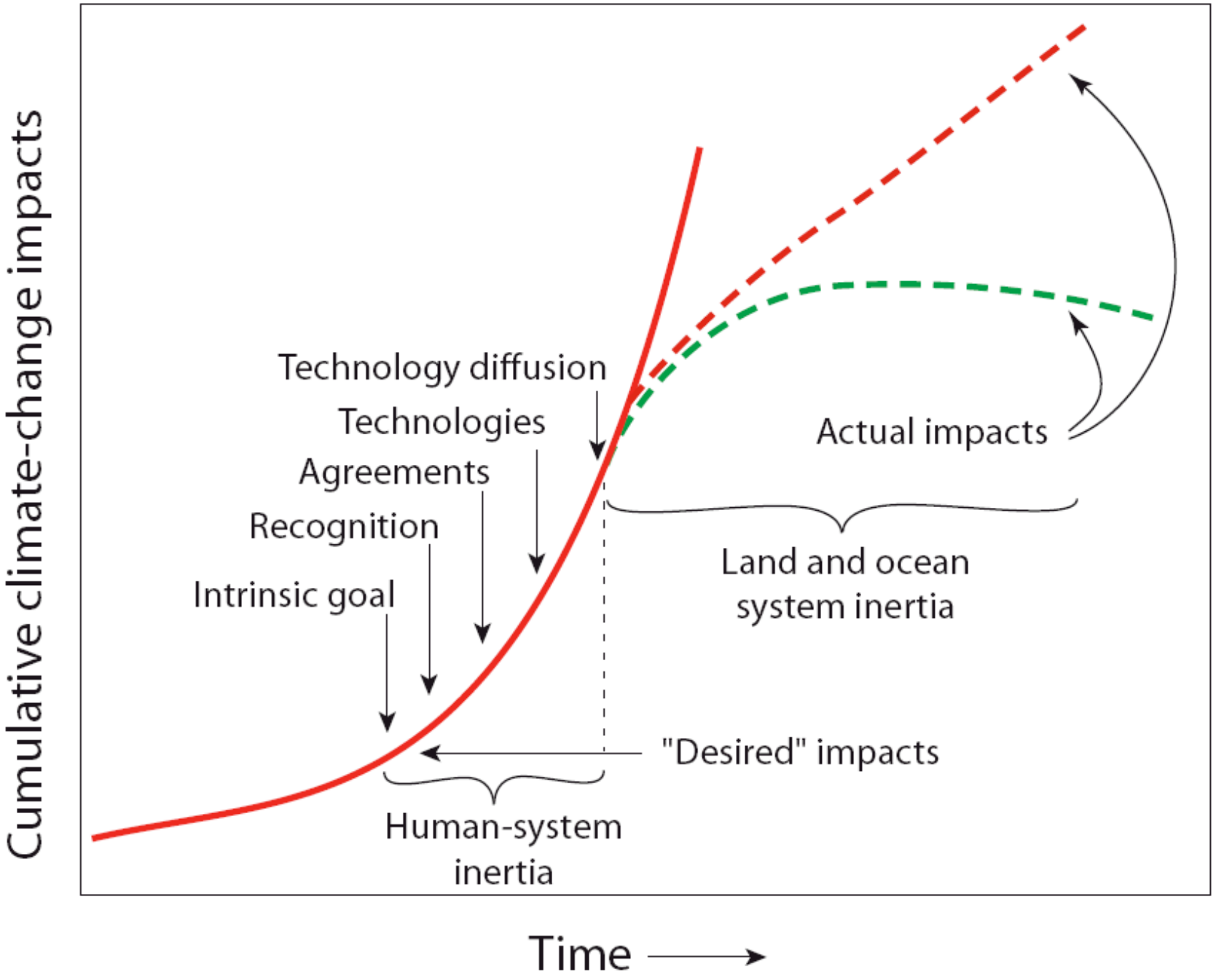

Cumulative climate-change impacts
Recognition
Intrinsic goal
"Desired" impacts
Time


Cumulative climate-change impacts
Agreements
Recognition
Intrinsic goal
"Desired" impacts
Time

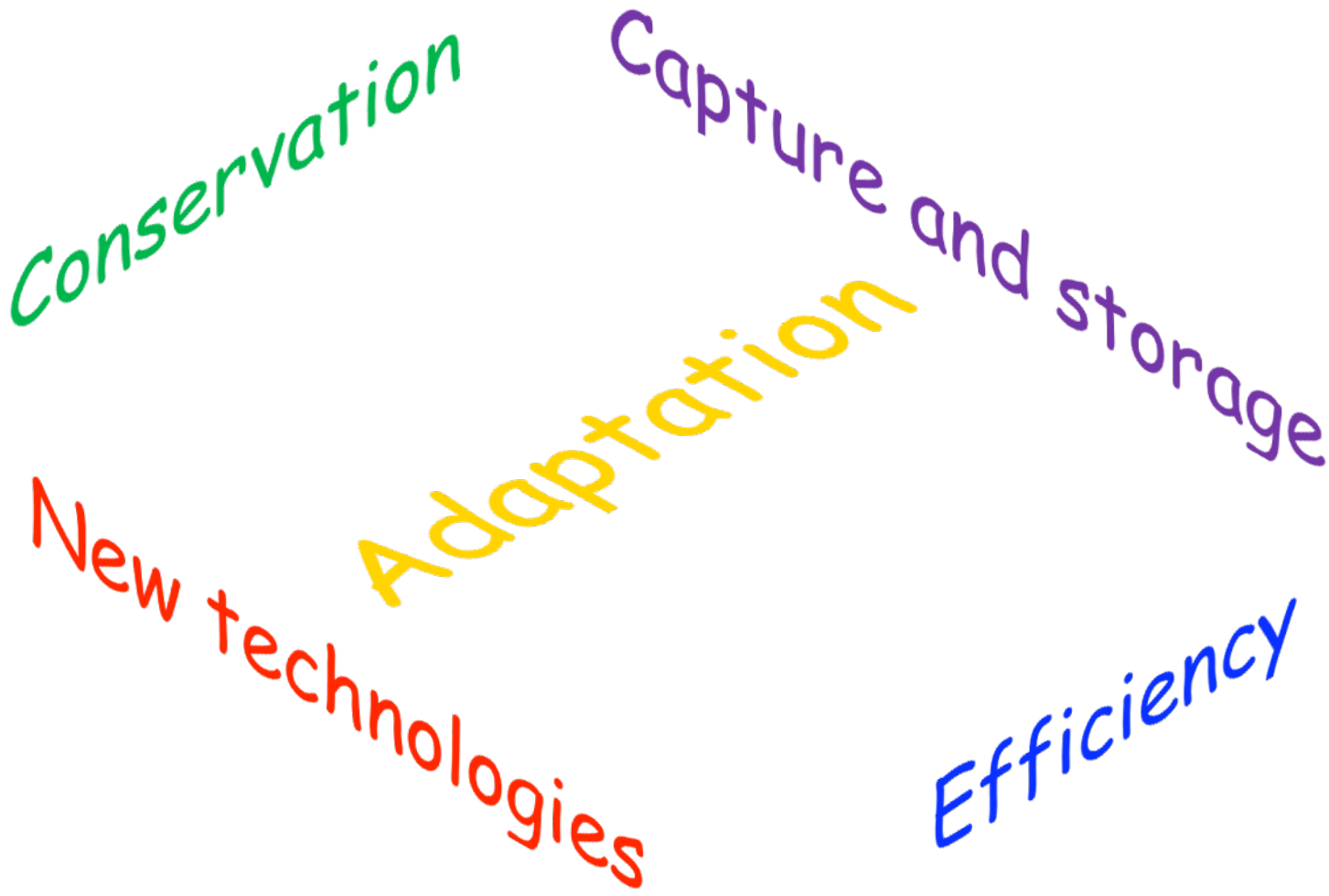

Cumulative climate-change impacts
Technologies
Agreements
Recognition
Intrinsic goal
"Desired" impacts
Time


Cumulative climate-change impacts
Technology diffusion
Technologies
Agreements
Recognition
Intrinsic goal
"Desired" impacts
Human-system inertia
Time


Cumulative climate-change impacts
Technology diffusion
Technologies
Agreements
Recognition
Intrinsic goal
Actual impacts
Land and ocean
system inertia
"Desired" impacts
Human-system
inertia
Time


Cumulative climate-change impacts
Technology diffusion
Technologies
Agreements
Recognition
Intrinsic goal
Actual impacts
Land and ocean
system inertia
"Desired" impacts
Human-system
inertia
Time

- How do we compress the time to keep impacts in the acceptable range?
- How do we minimize the risk of strong amplification by unmanaged processes?
- How do we grow the economy while decreasing CO_2 emissions?
- How do we encourage meaningful adaptation?


Conservation
Capture and storage
Adaptation
New technologies
Efficiency