Climate change the big challenge for sustainable development

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Wg2 IPCC vice-chair during AR4

SUSTAIN
SUPPORTING SCIENCE TEACHING ADVANCEMENT THROUGH INQUIRY

SUSTAIN First European Conference in Bled, Slovenia

OUTLINE

- Planetary boundaries
- Climate change science
- Climate change: complex & interdisciplinary
- Climate change as a teaching opportunity
- Conclusions: Why we need a climate literate society

GOOD PLANETS
ARE HARD TO FIND

Global Population 1800

Global Population 1960

Global Population 2050

Every hour,

10,000 people join the global population

Every hour,

1,500 hectares of forests are cut

Every hour,

1.7 Million Kg N are added to soils

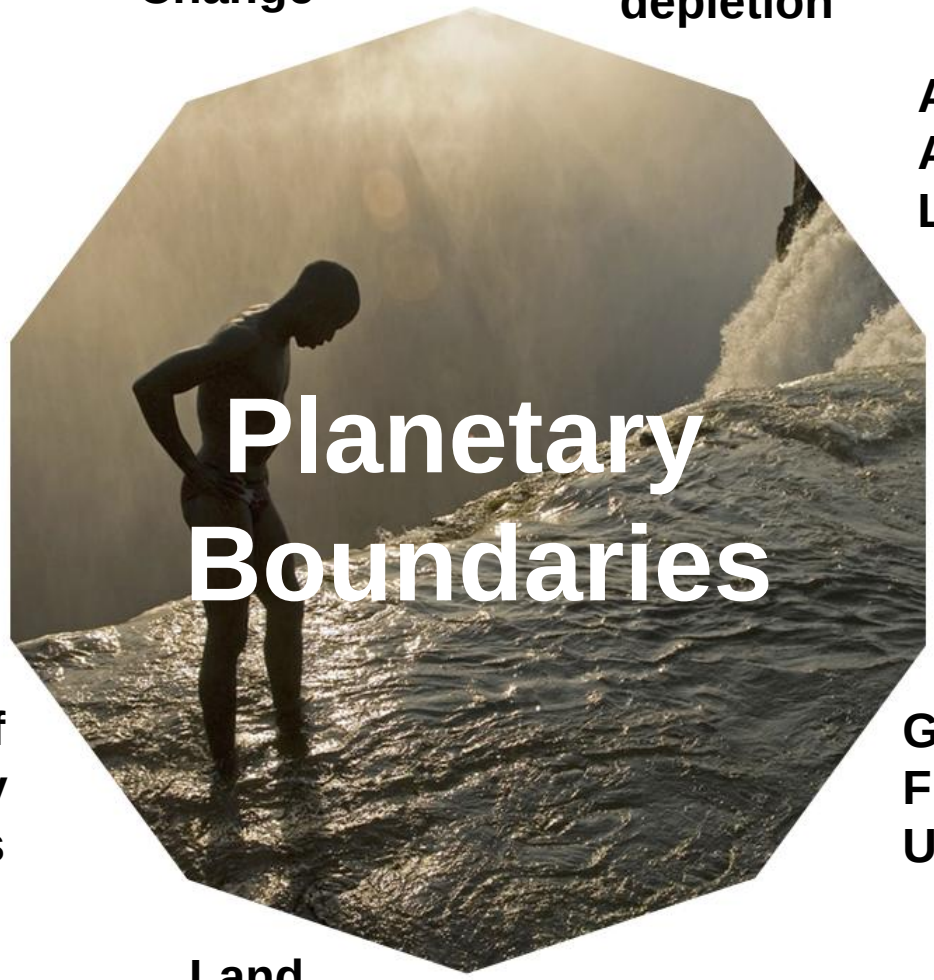
Every hour,

4 Million tons of CO_2 are emitted

Every hour,

3 species go extinct

(1000x faster than natural rates)



Climate Change

Ozone depletion

Atmospheric Aerosol Loading

Biogeochemical loading: Global N & P Cycles

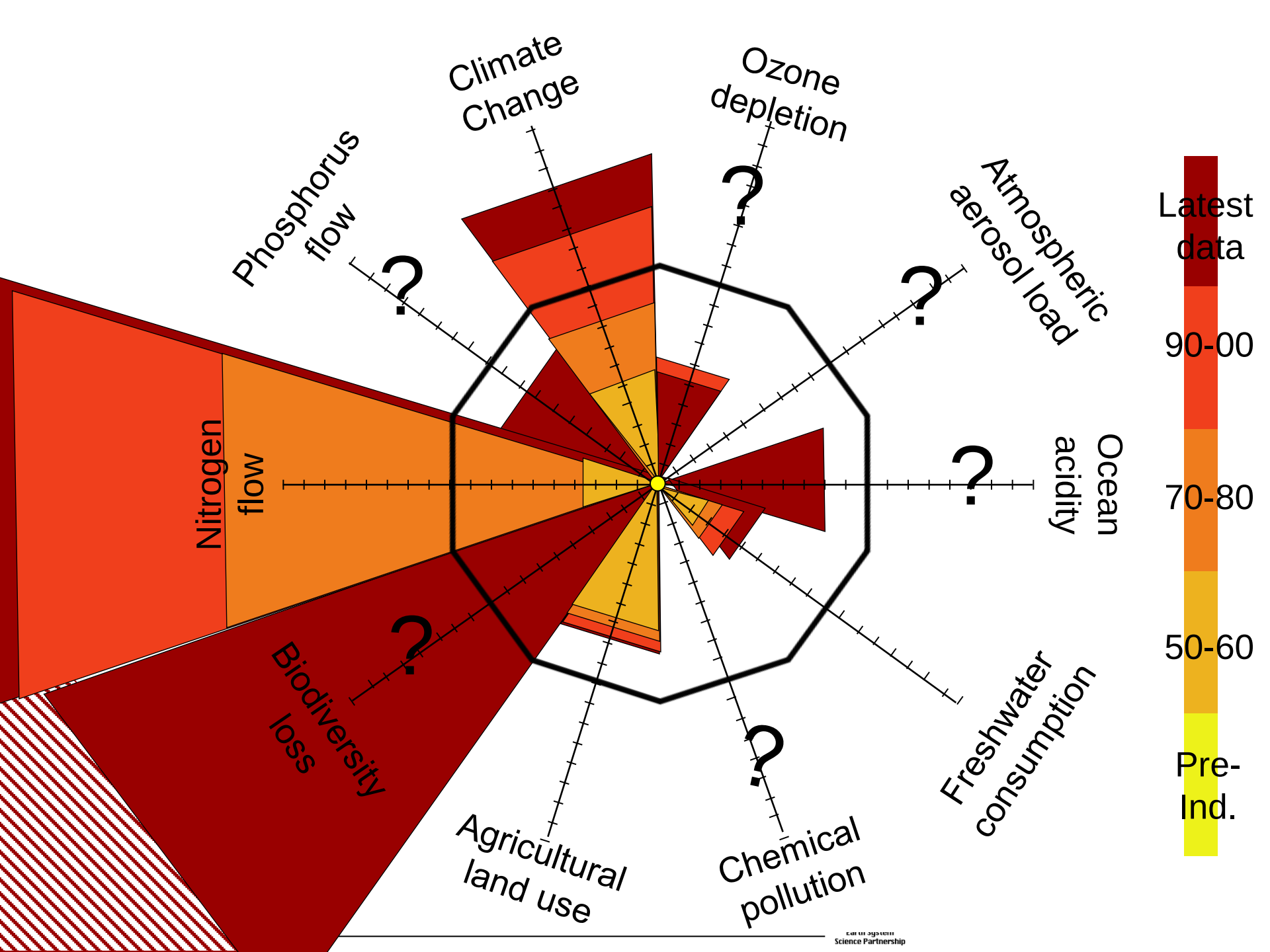
Ocean acidification

Rate of Biodiversity Loss

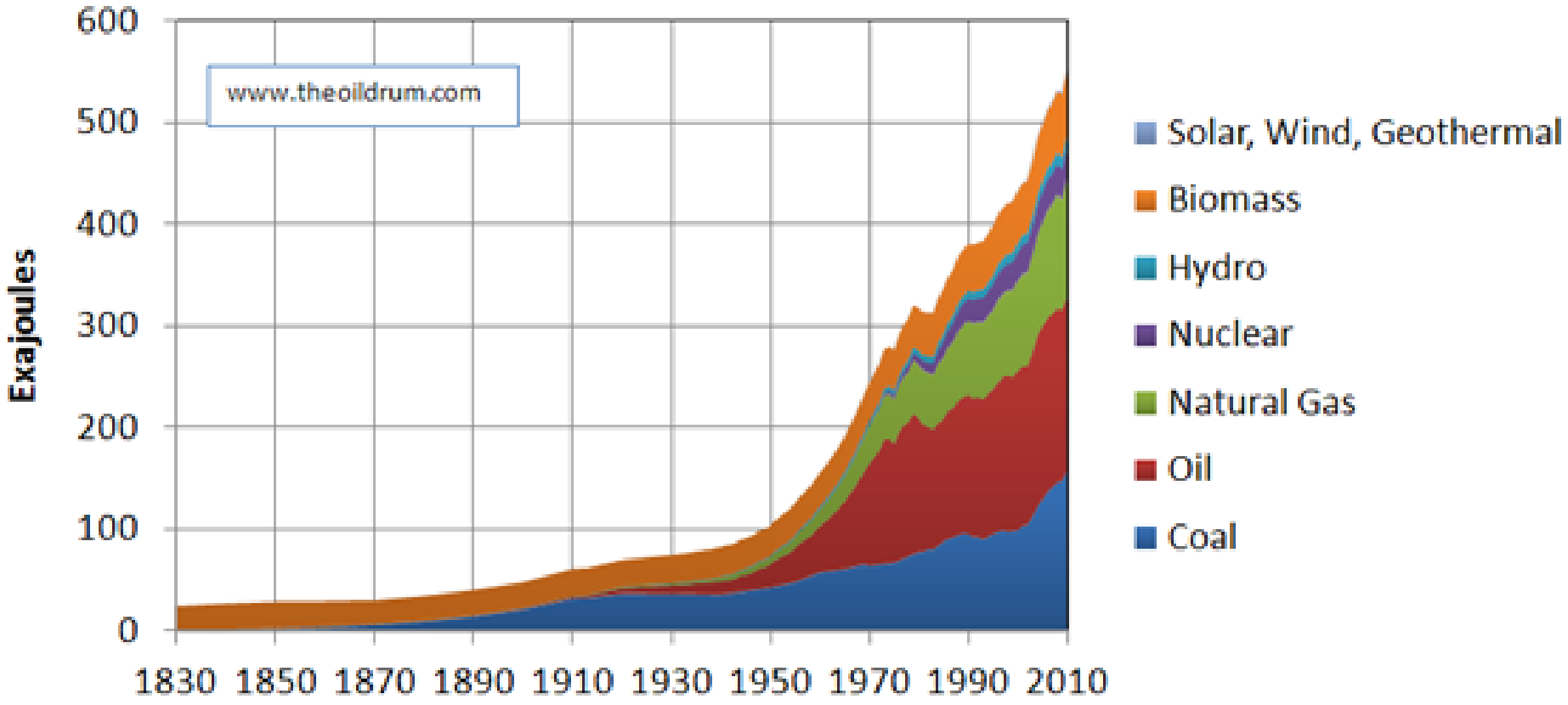
Global Freshwater Use

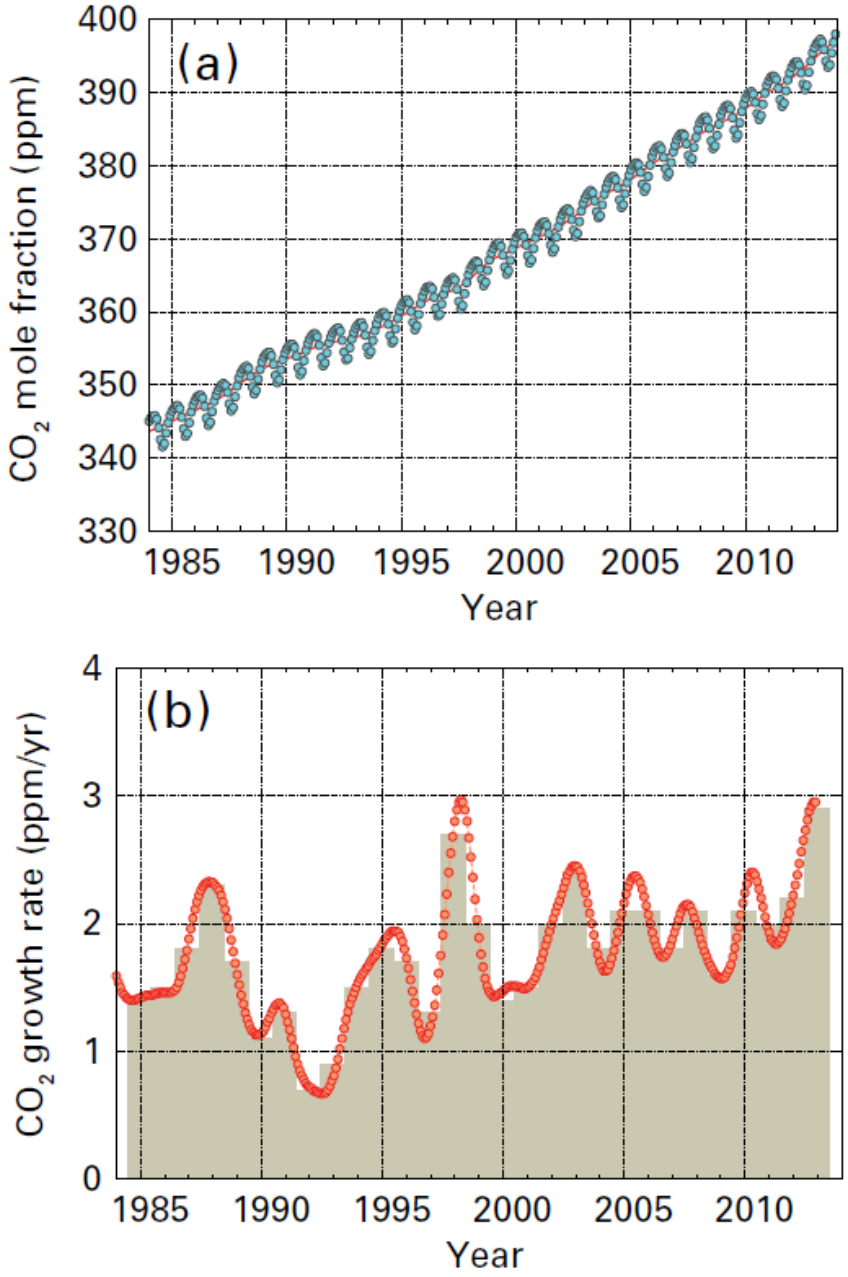
Land System Change

Chemical Pollution


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.

World primary energy consumption 1830-2010





- GHG emissions rising faster than ever (WMO, 2014)
- 2013 CO_2 concentrations **142% above preindustrial levels**

Fate of Anthropogenic CO_2 Emissions (2000-2008)

1.4 PgC y^{-1}

7.7 PgC y^{-1} +

4.1 PgC y^{-1}

45%

3.0 PgC y^{-1}

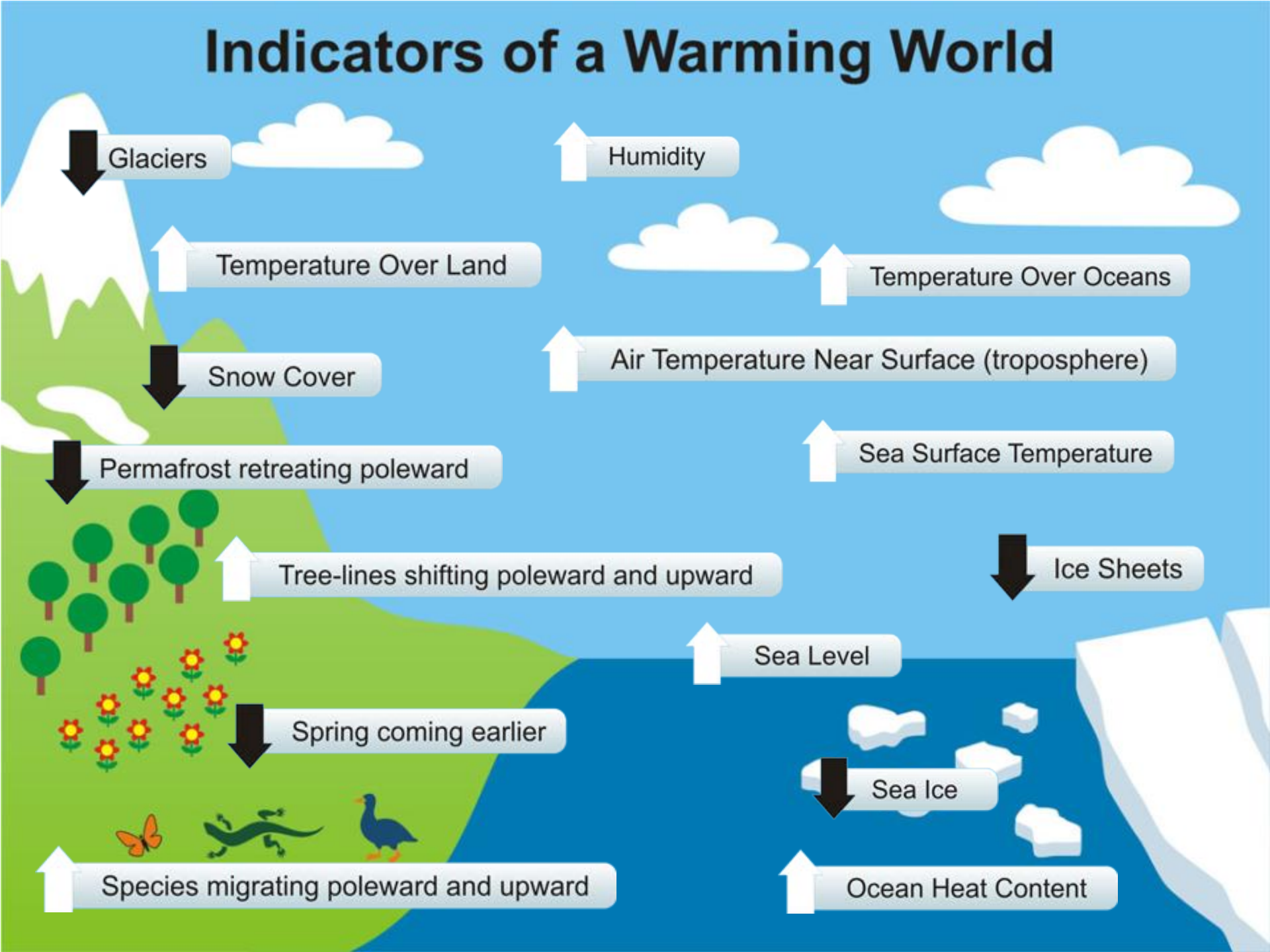
29%

26%

2.3 PgC y^{-1}

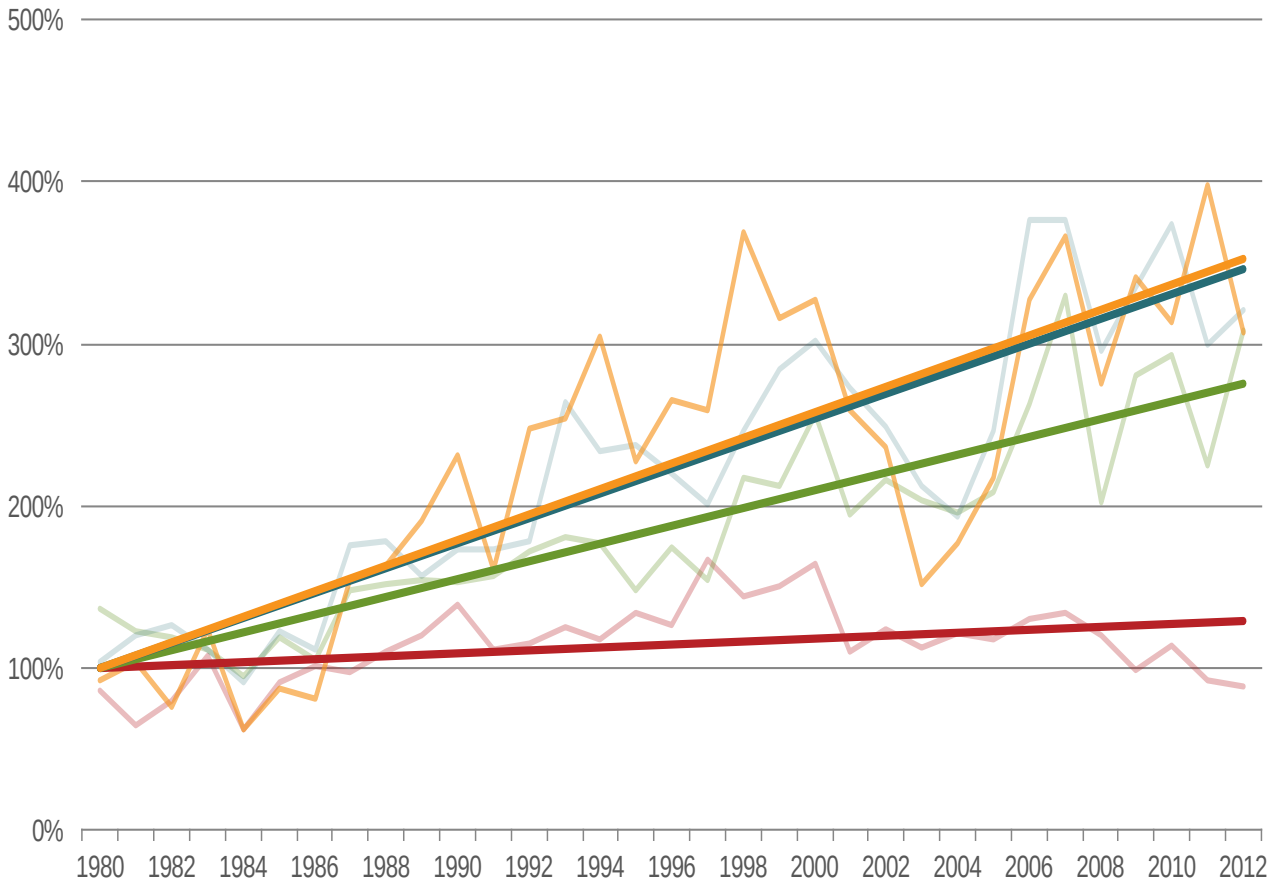
Le Quéré et al. 2009, Nature Geoscience; Canadell et al. 2007, PNAS, updated

Indicators of a Warming World



Natural catastrophes worldwide 1980 – 2012

Relative trends of different perils



Geophysical events
Earthquake, tsunami, volcanic eruption

Meteorological events
Storm

Hydrological events
Flood, mass movement

Climatological events
Extreme temperature, drought, forest fire

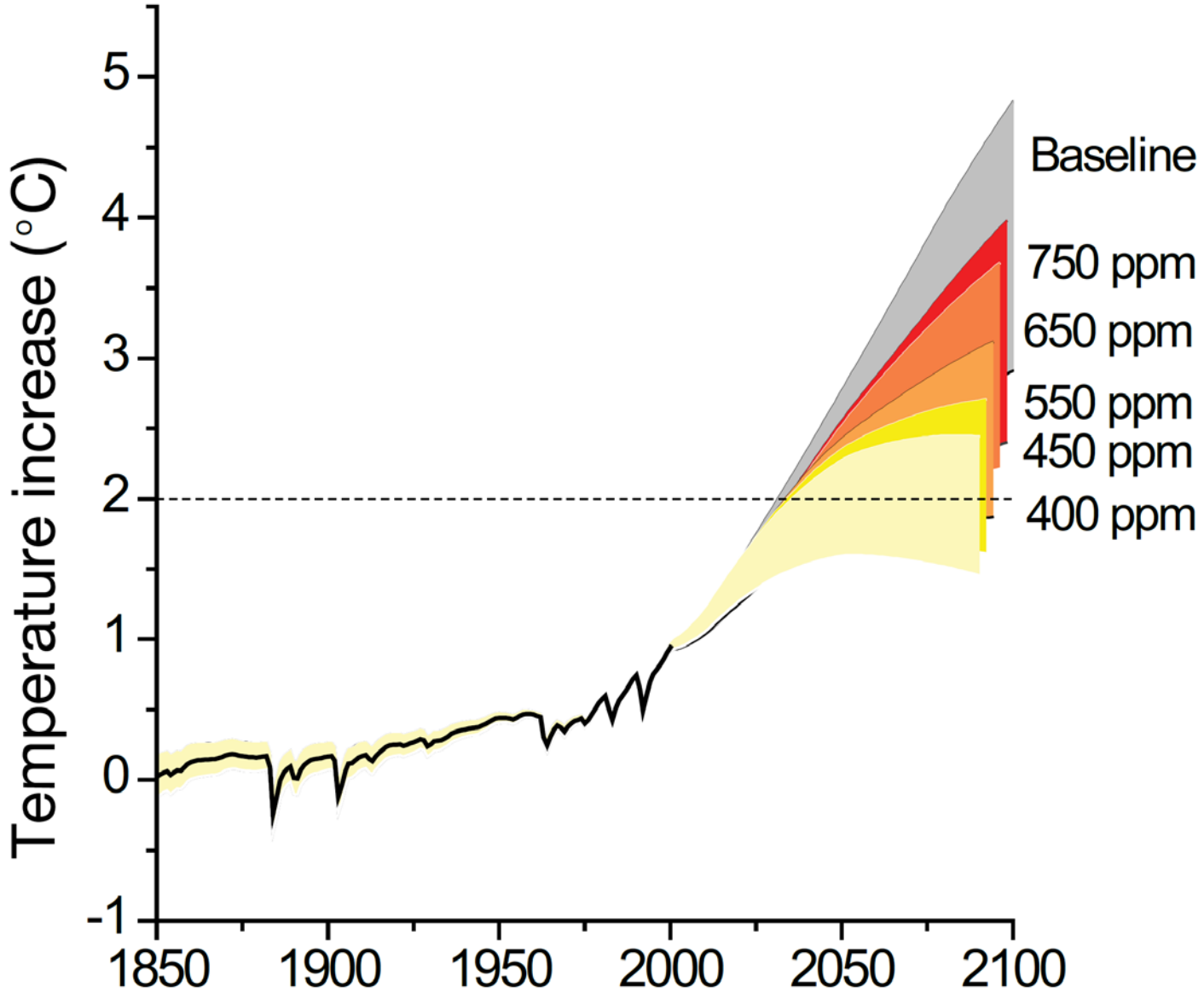
Climate Change is a Large Issue

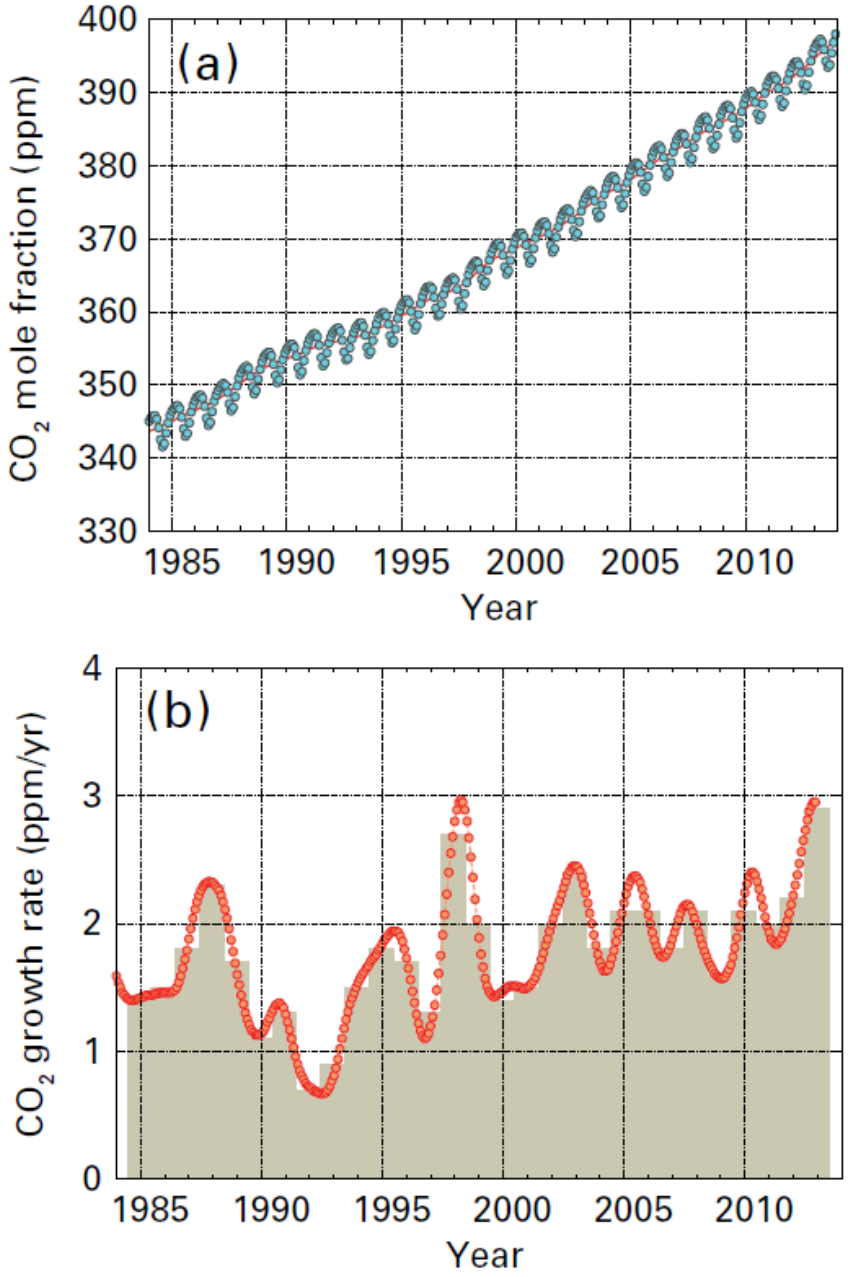
- Majority of the sciences and engineering disciplines are involved.
- Social sciences are interested.
- Business/Industry has a stake.
- Involves citizens, politicians, public policy experts, and advocates.
- **Every sector of the economy affected**.
- All aspects of our lives touched: environment, jobs, health, politics, national security, arts, religion, etc.

Human dimensions of climate change

Human interactions with the climate system:

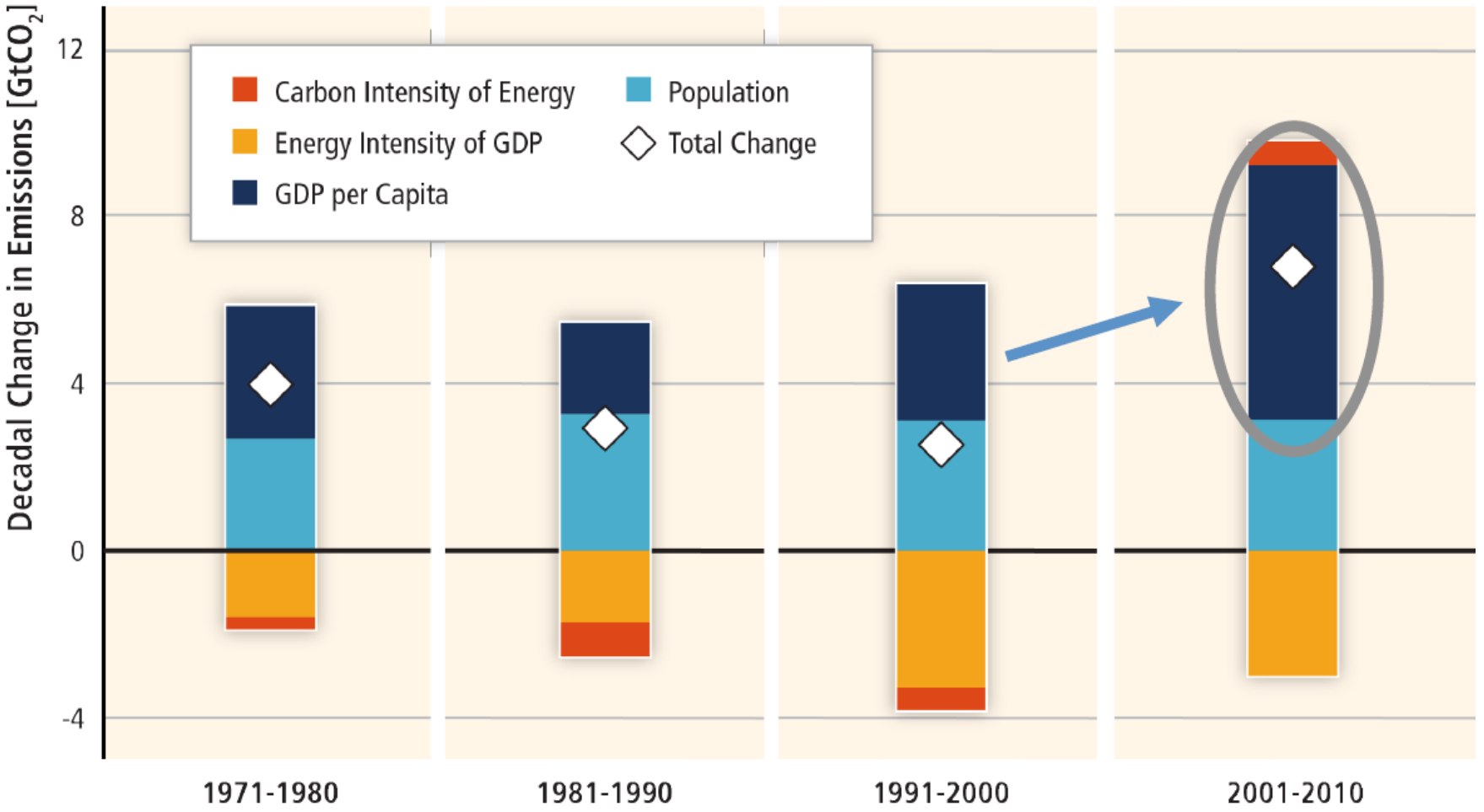
- ***Human causes*** of climate change (understanding the driving forces)
- ***Human consequences*** of climate change (vulnerabilities, resilience, etc.)
- ***Human responses*** to climate change (limiting, adapting, and informing the choices)
- ***Human understanding*** of climate change


Temperature increase (°C)
5
4
3
2
1
0
-1
1850
1900
1950
2000
2050
2100
Baseline
750 ppm
650 ppm
550 ppm
450 ppm
400 ppm

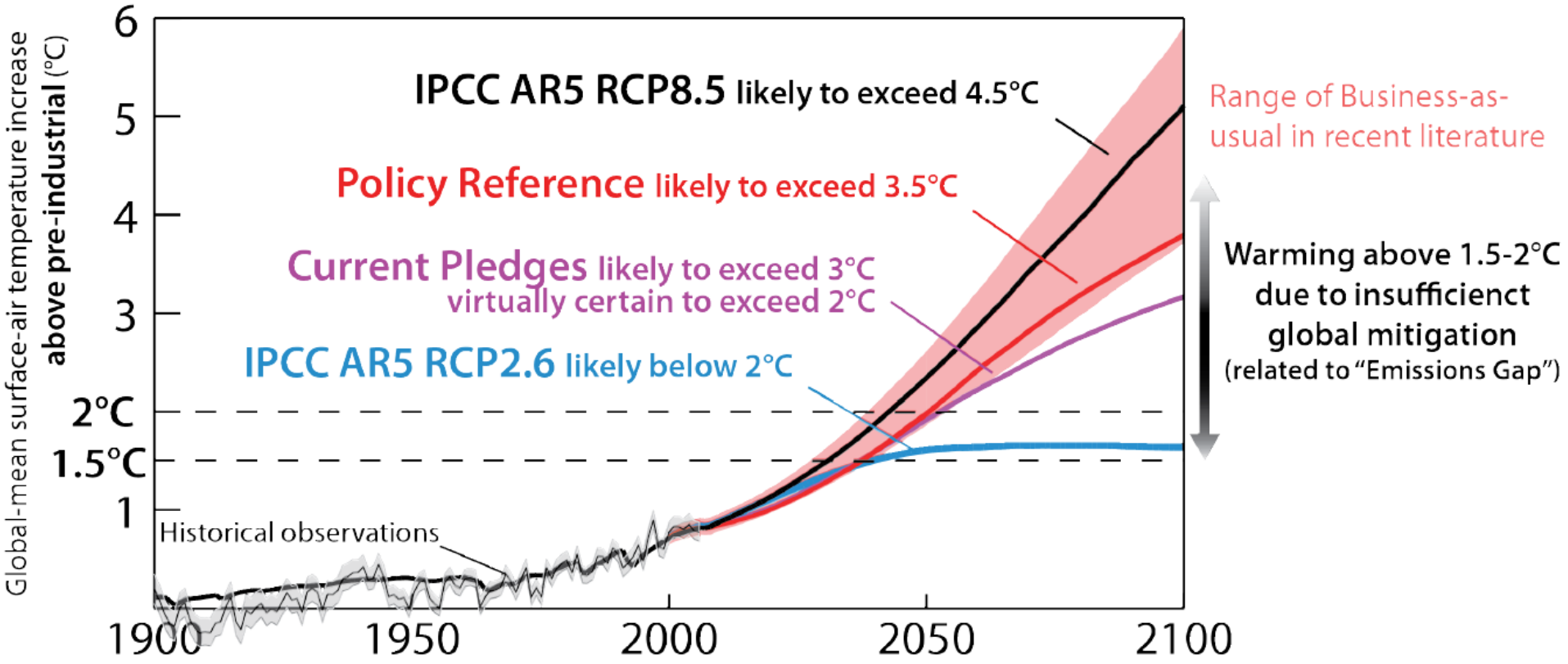


- GHG emissions rising faster than ever (WMO, 2014)
- 2013 CO_2 concentrations **142% above preindustrial levels**

GHG emissions rise with growth in GDP and population; long-standing trend of decarbonisation of energy reversed

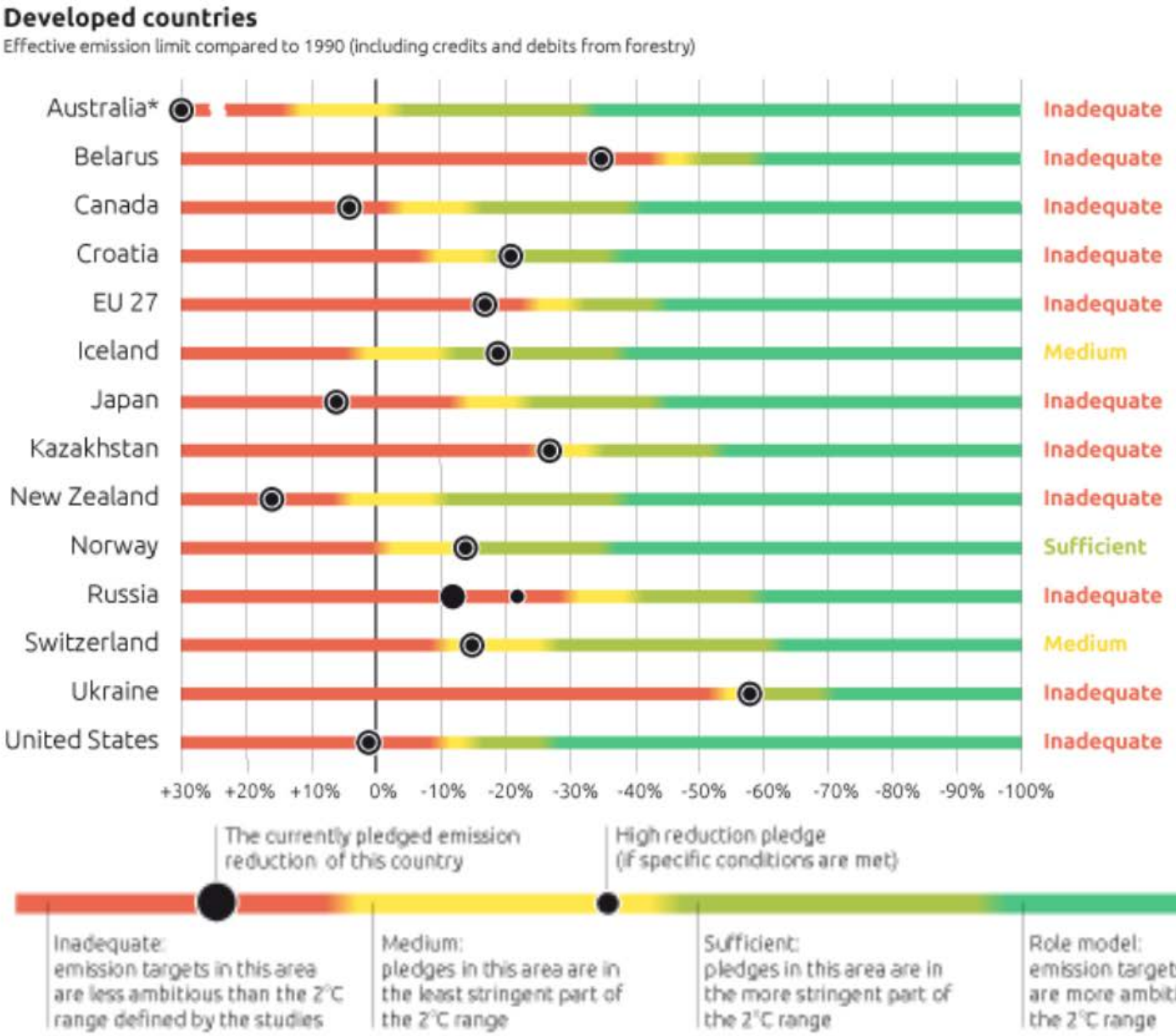


Future CO_2 concentrations



Countries‘ individual proposed efforts not sufficient !!!

Some countries propose more than others



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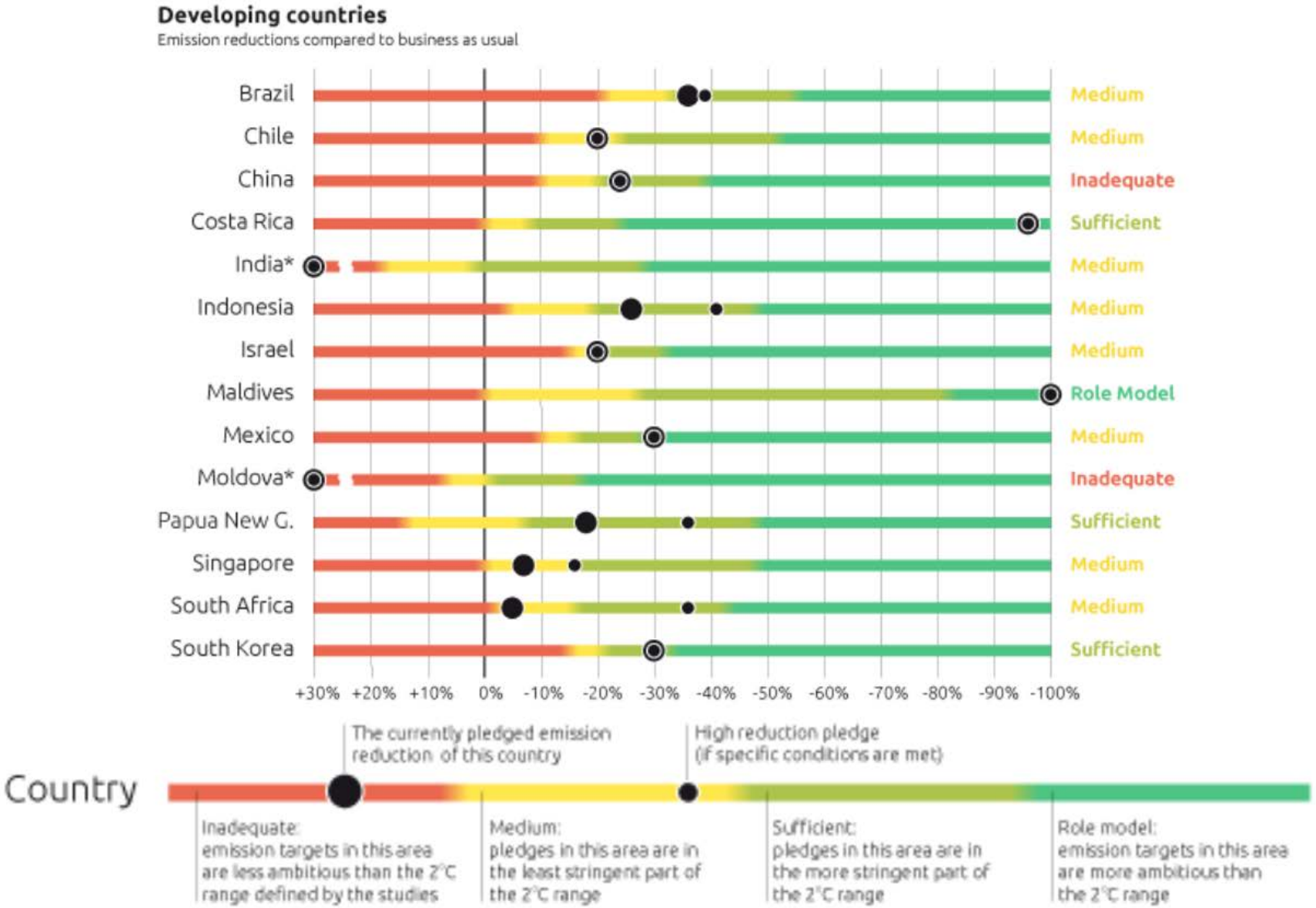
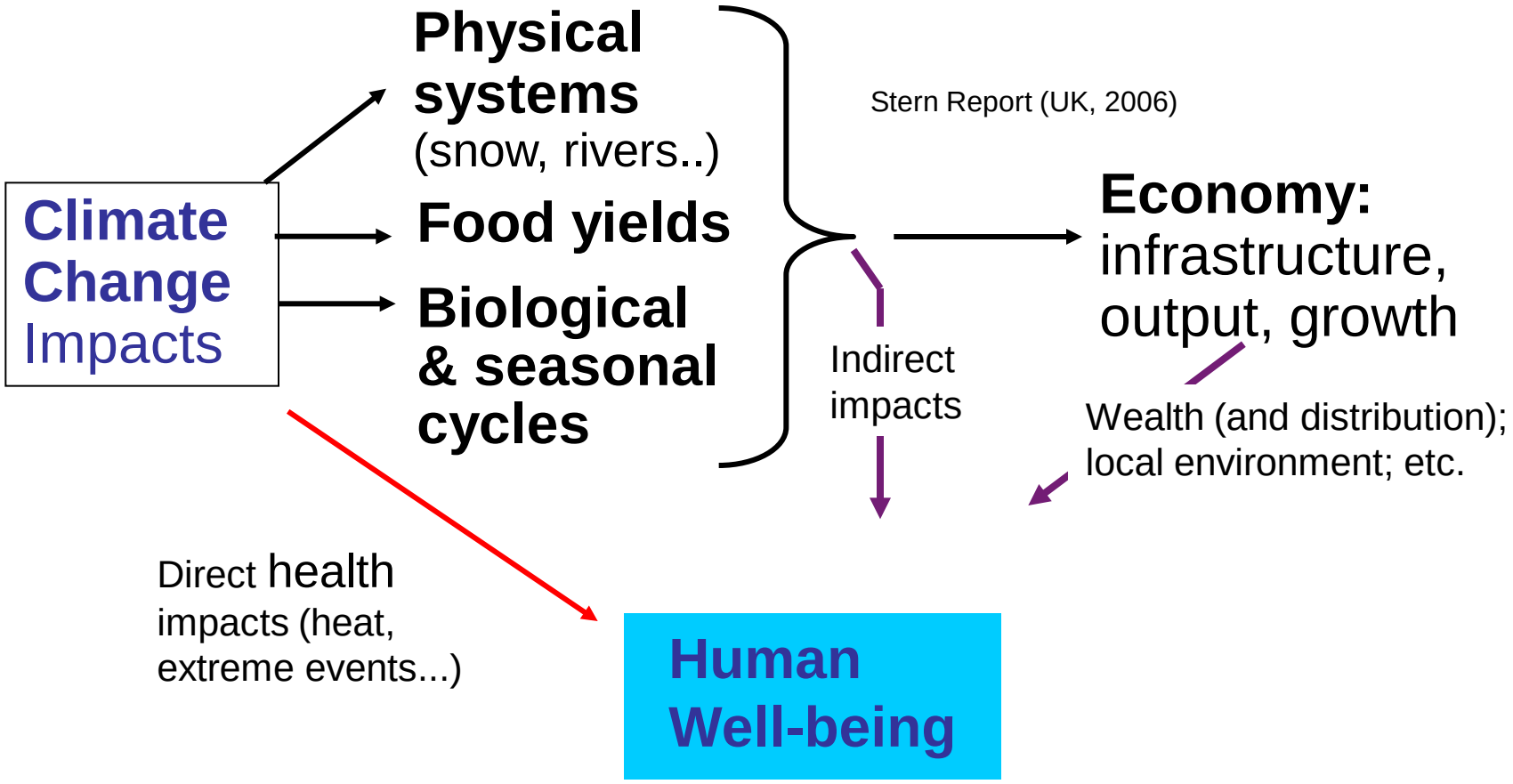


Climate Change impacts



5 human development tipping points

Reduced agricultural productivity

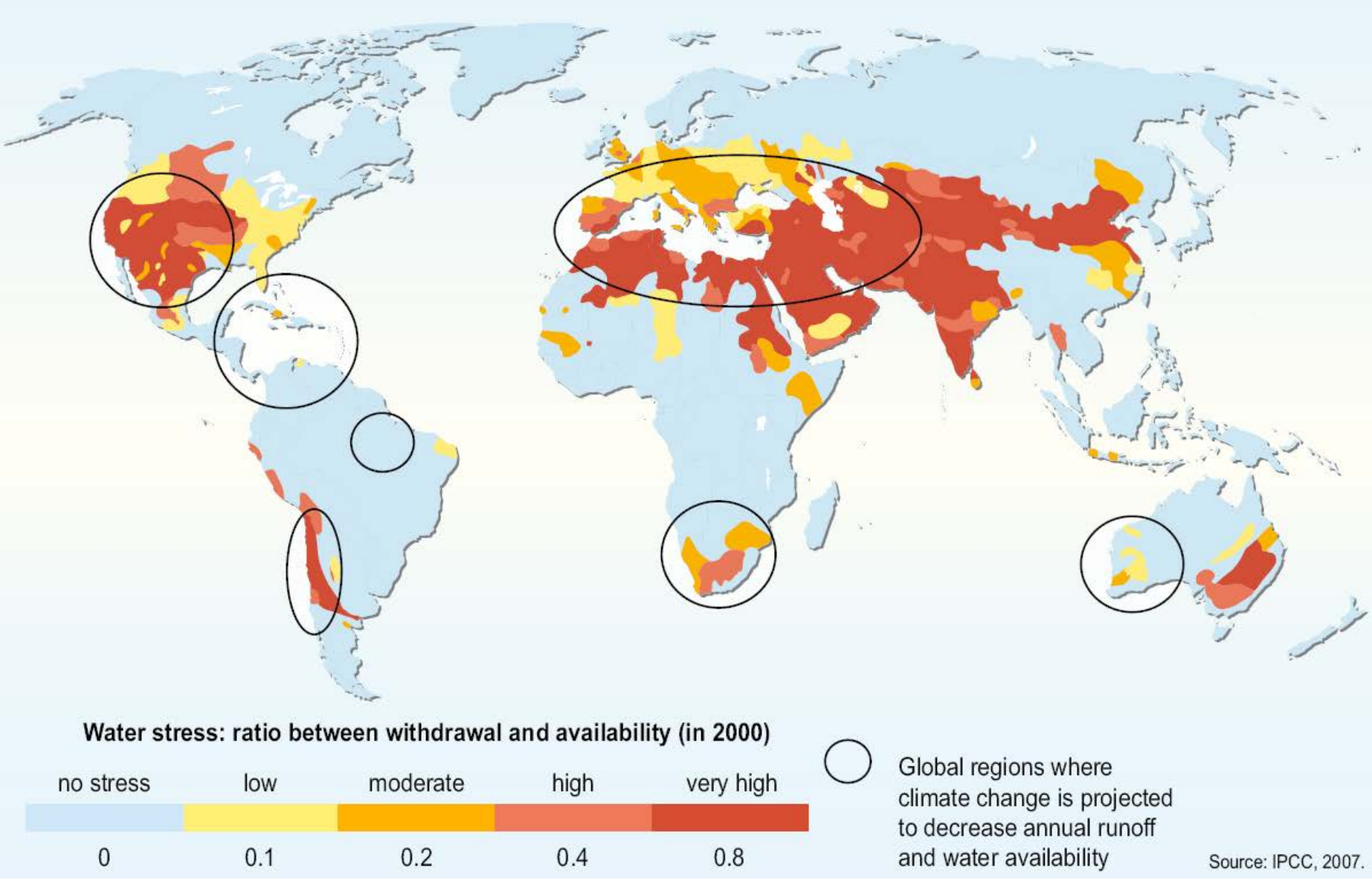
Heightened water insecurity

Increased exposure to extreme weather events

Collapse of ecosystems

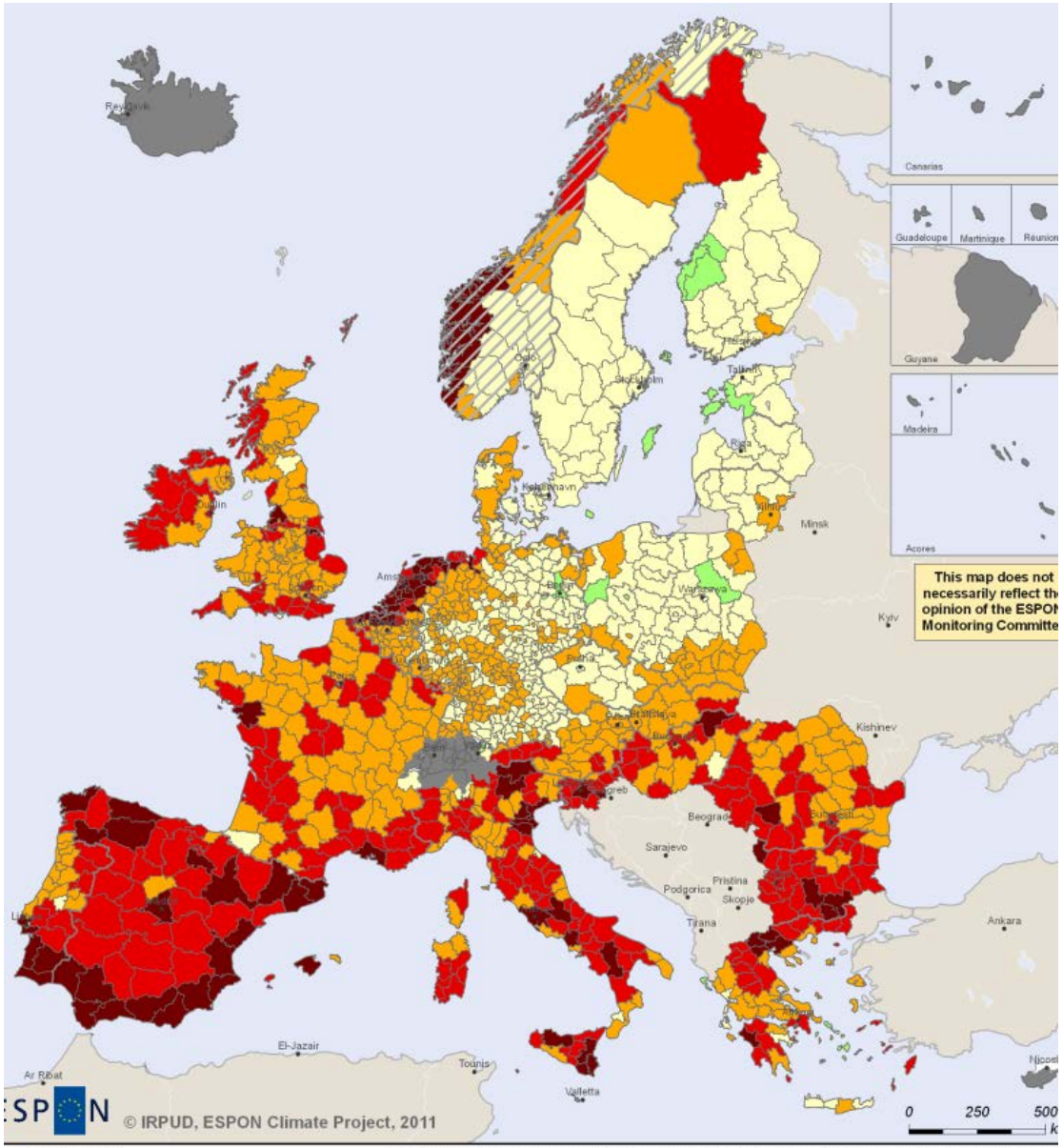
Increased health risks

Water stress and Climate Change



JRC DG Regio‘s 2020

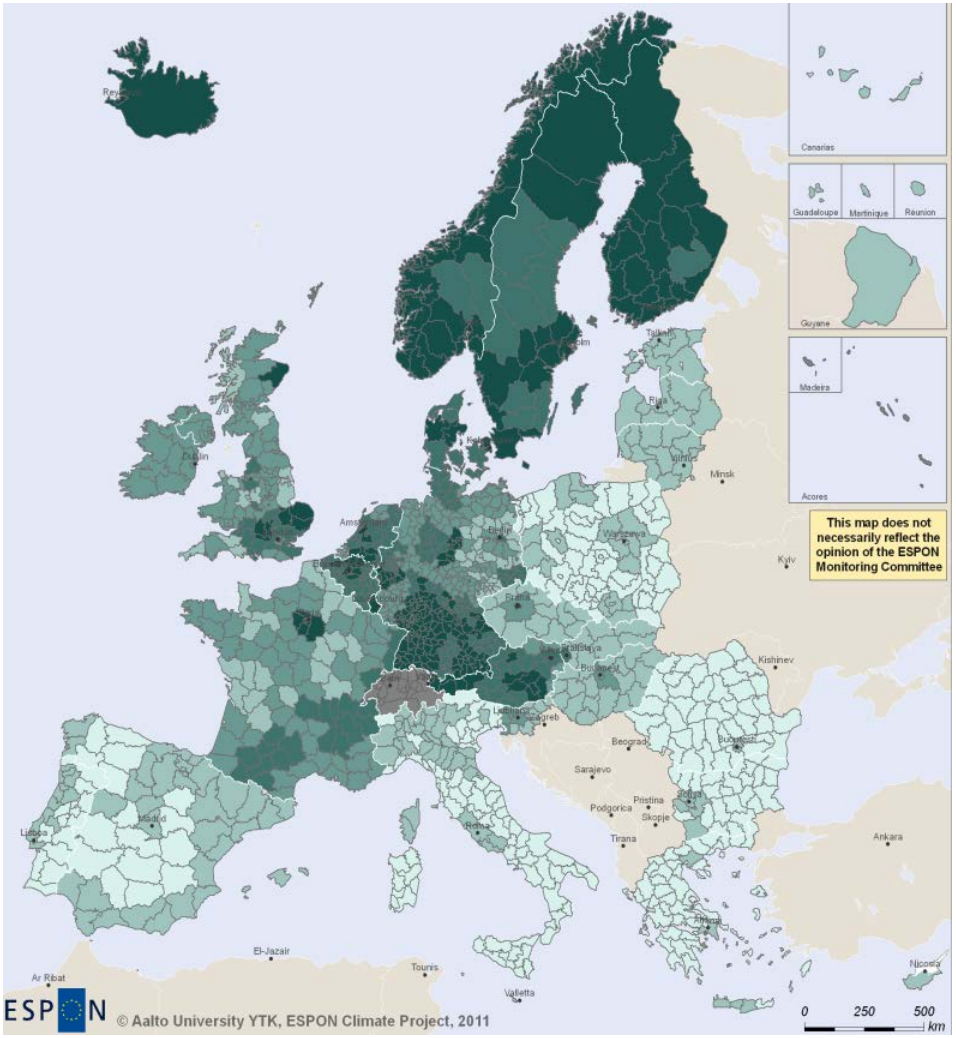
„THE CLIMATE CHANGE CHALLENGE FOR EUROPEAN REGIONS“



Adaptive capacity

"the ability or potential of a system to respond successfully to climate variability and changes" (IPCC 2007)

- Awareness
- Technology and infrastructure
- Economic resources
- Institutions



Overall capacity to adapt to climate change

- highest capacity
- high capacity
- medium capacity
- low capacity
- lowest capacity
- no data

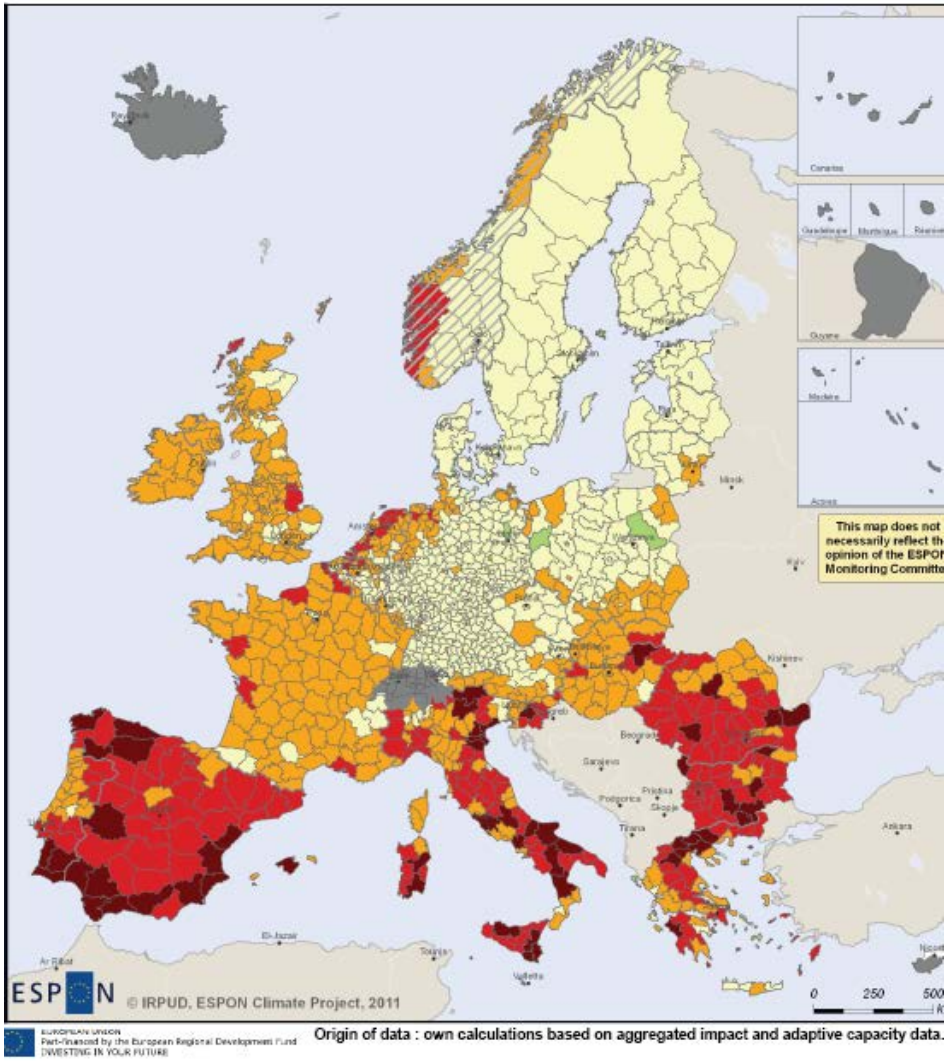
Combined adaptive capacity expressed in quintiles.

Adaptive capacity calculated as weighted combination of economic capacity (weight 0.21), infrastructure capacity (0.16), technological capacity (0.23), knowledge and awareness (0.23) and institutional capacity (0.17). Weights are based on a Delphi survey of the ESPON Monitoring Committee.

Vulnerability to climate change " is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC 2007).

- Countries which expect a high increase in impact seem to be less able to adapt
- Climate change would trigger a deepening of the existing socio-economic imbalances between the core of Europe and its periphery.

Future runs counter to territorial cohesion ?



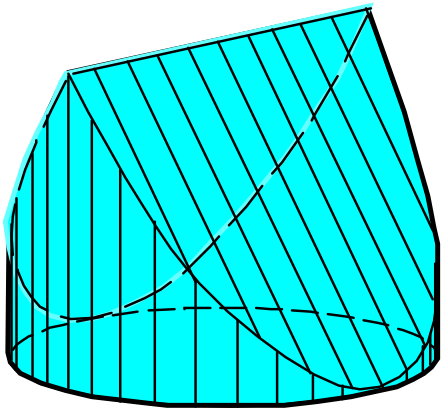
We Need A Climate Literate Society

If we want to achieve sustainable development

HOW DO INDIVIDUALS SEE THE CLIMATE CHANGE PROBLEM?

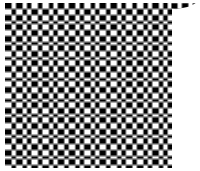
Governments

People/students



Industry

Academics



Why climate change is inherently difficult to understand

- it is not one thing (weather, water supply, ecosystem change, etc.)
- you see weather, not climate, and weather can mislead
- you can’t rely on personal experience
- climate change is very slow and swamped by variability
- changes are exponential; future rate of change > past
- hard to comprehend import of slow average change for infrequent extremes
- time lags

What happens when it is hard to understand

- people use mental models, and some mislead (e.g., air pollution)
- the battle to frame the issue [disaster is coming vs. science is uncertain]
- the need for a risk management frame that encompasses both knowledge and uncertainty

Climate change: complex & interdisciplinary

- SCIENCE
- TECHNOLOGY
- ECONOMICS
- POLITICS & POLICY

Climate change: complex & interdisciplinary

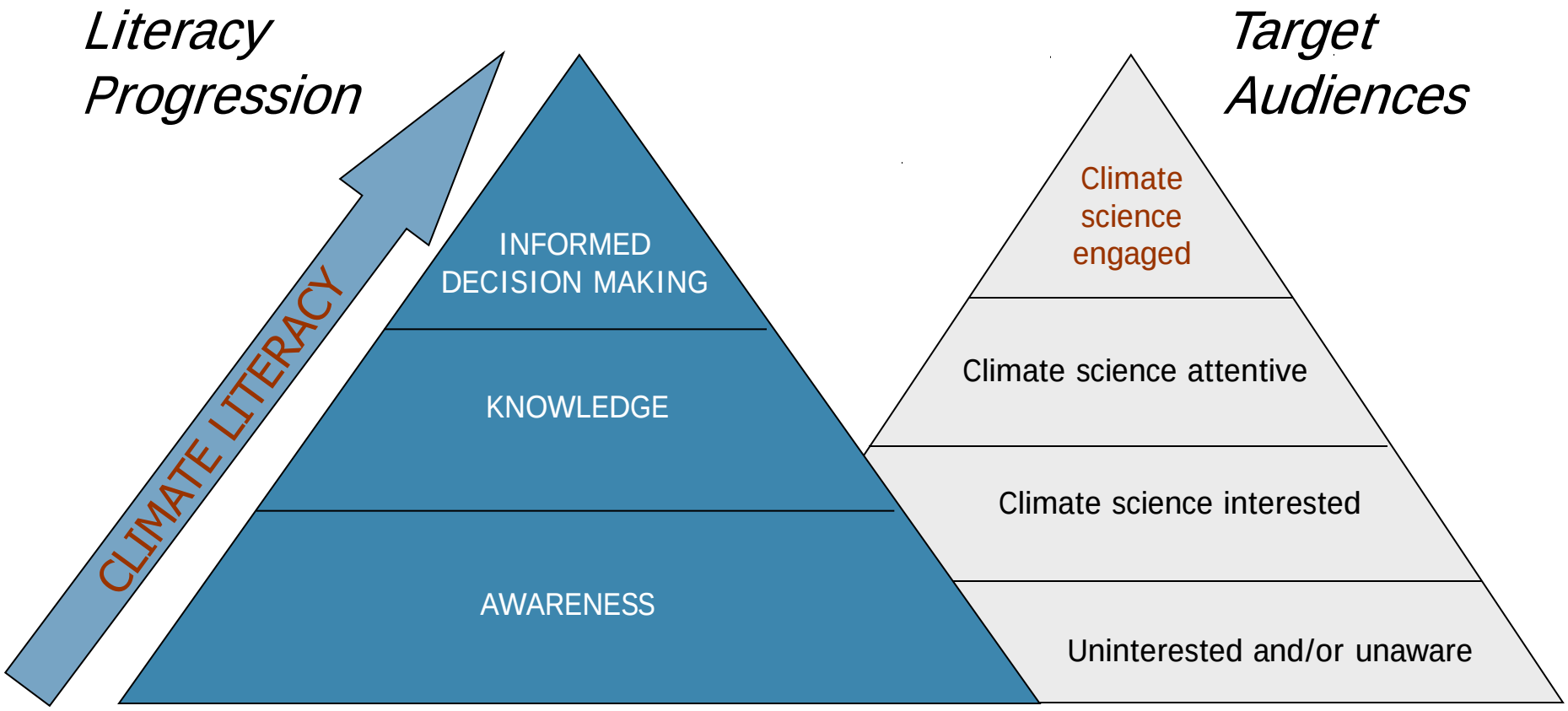
- SCIENCE
  - what climate is and how it works;
  - how global climate has been changing and why;
  - how it's likely to change in the decades ahead;
  - what the impacts are likely to be on farms, forests, fisheries, health, property, ecosystems…
- TECHNOLOGY
  - the role of humans & their technology in causing climate change;
  - technological options for mitigating climate change;
  - technological options for adapting to it.

Complex & interdisciplinary (continued)

- ECONOMICS
  - population growth & economic growth as climate-change drivers
  - costs of abatement, adaptation, and impacts
  - consequences of alternative regimes of action & inaction for economic growth, employment, trade
- POLITICS & POLICY
  - policy options and their impact on outcomes
  - actors and interests in the climate debate…and the evolution of perceptions & interests over time
  - finding a global climate-policy framework that is adequate, equitable, and attainable

Climate Literacy is

…a continuum of competency and is an ongoing process.

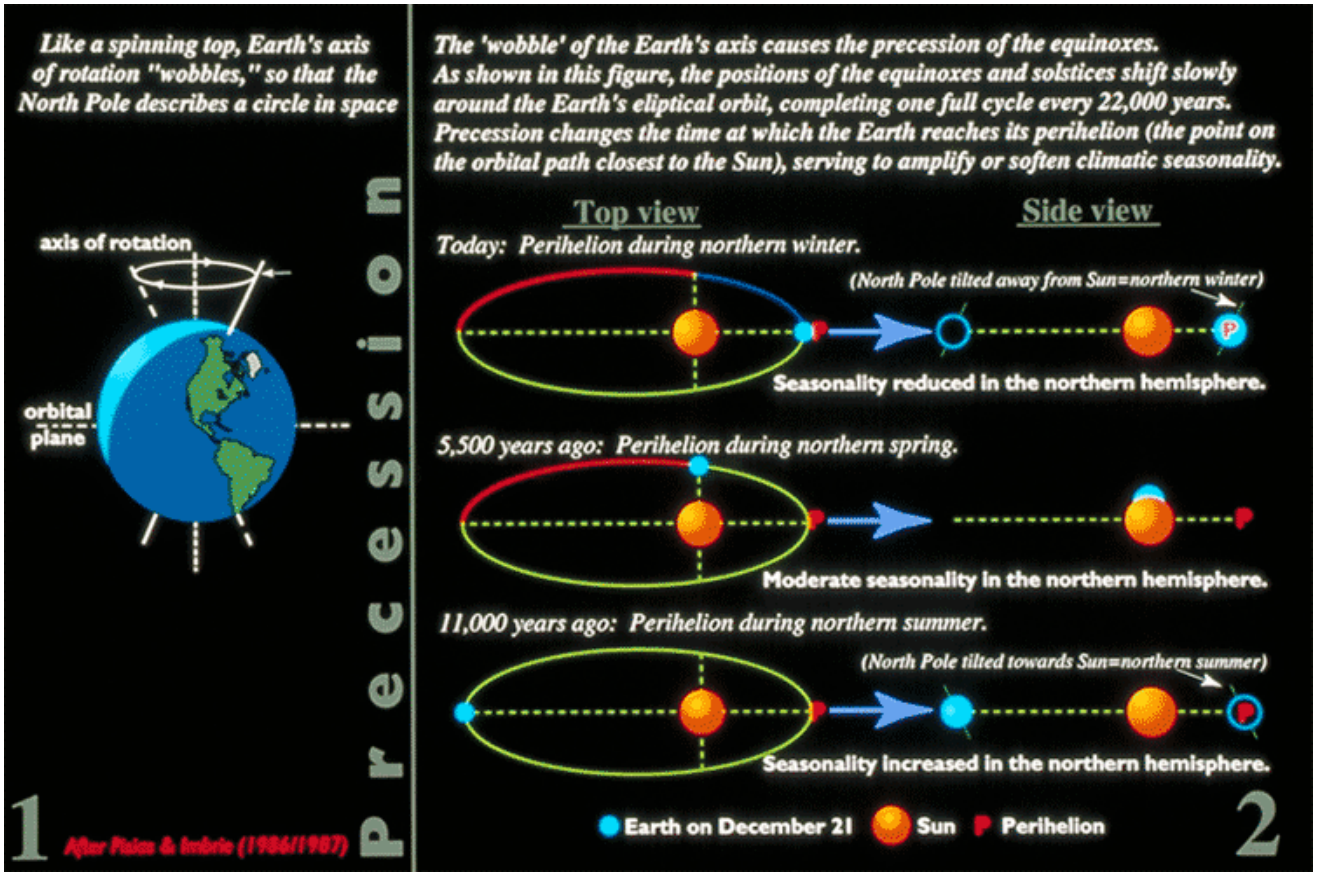


A climate literate person:

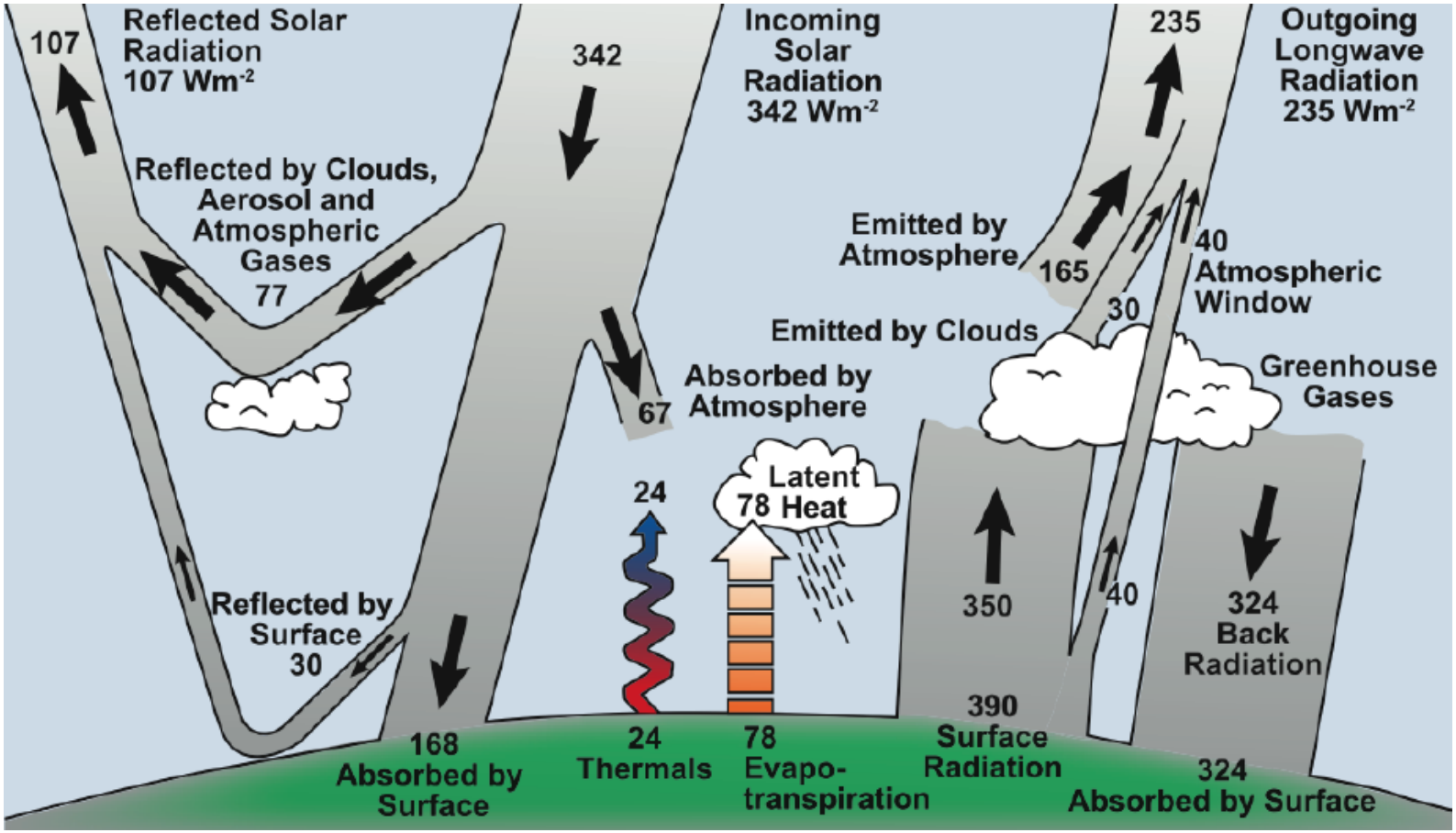
- *understands* the essential principles of Earth's climate system,
- knows how to *assess* scientifically credible information about climate,
- *communicates* about climate and climate change in a *meaningful* way, and
- is able to make *informed* and *responsible* decisions with regard to actions that may affect climate.

Climate change as a teaching opportunity

The physics & geometry of Earth's orientation to the sun



Physics: energy flows in the atmosphere



CHEMISTRY

carbon in fossil fuels and combustion

coal ≈ CH

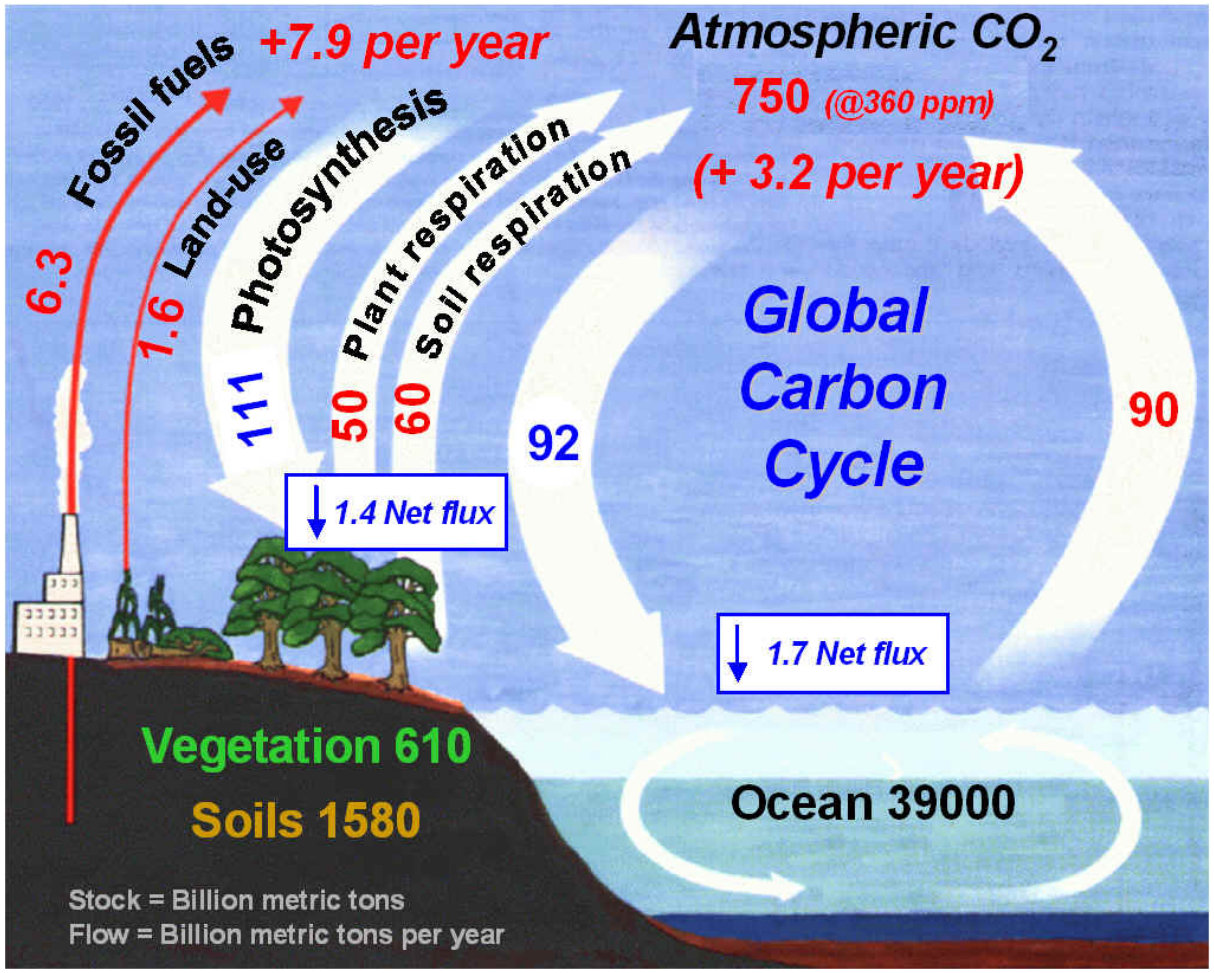
oil ≈ CH_2

natural gas ≈ CH_4 + a bit more

so, e.g., burning oil entails…

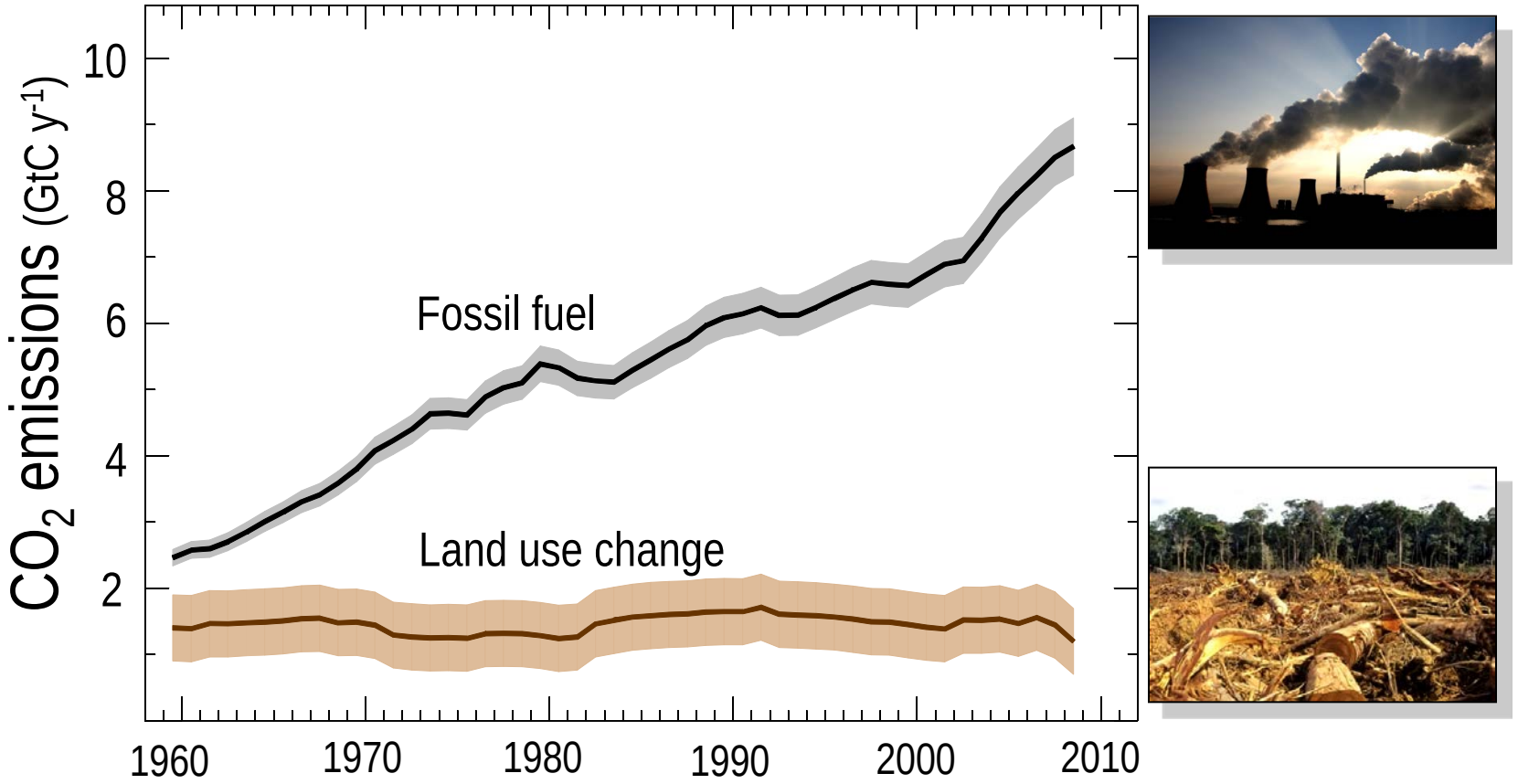
$CH_2 + 3/2\ O_2 \rightarrow CO_2 + H_2O$

Earth science: the carbon cycle



Geography: remote sensing

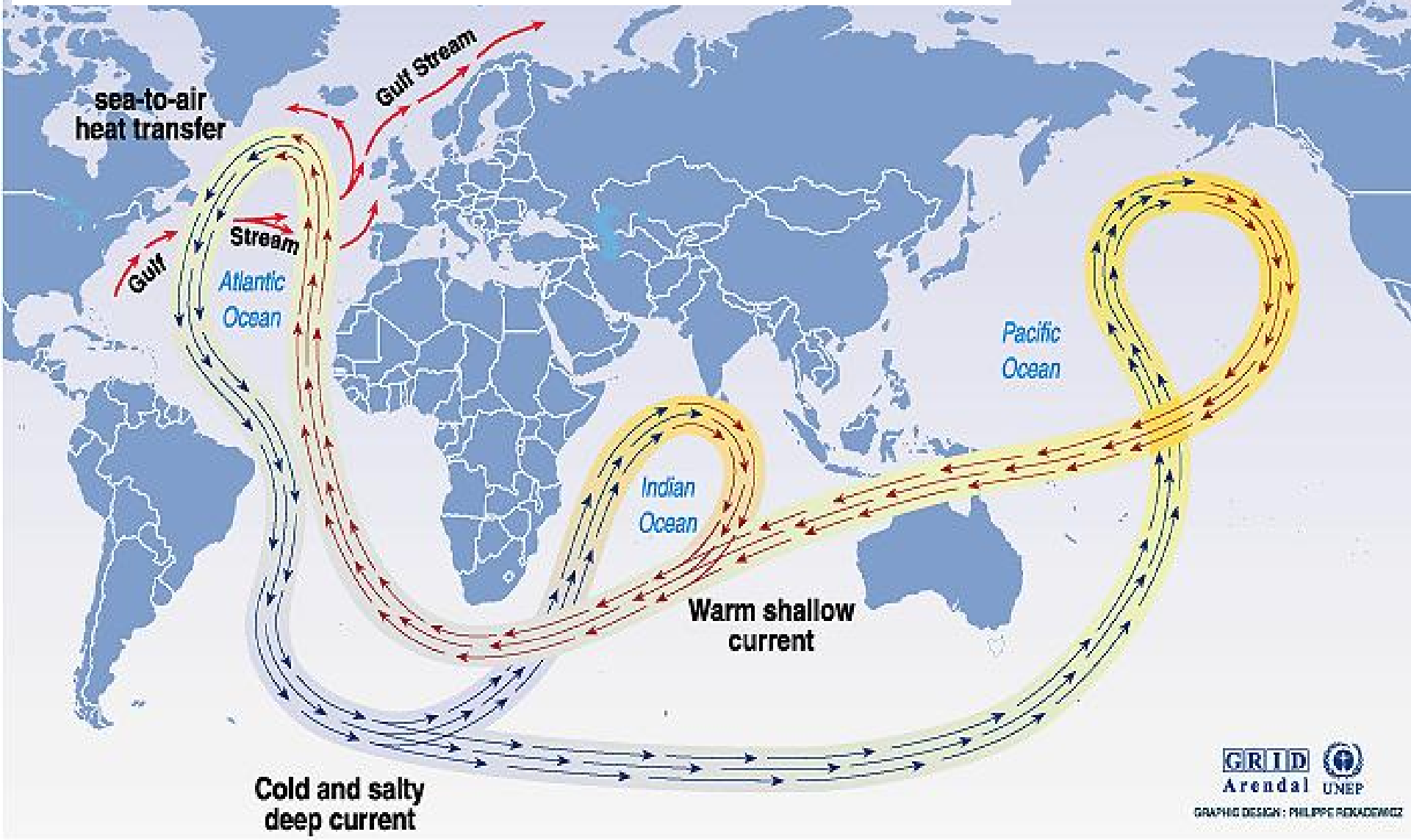
Geography: land-use & deforestation



CO_2 Emissions from Land Use Change

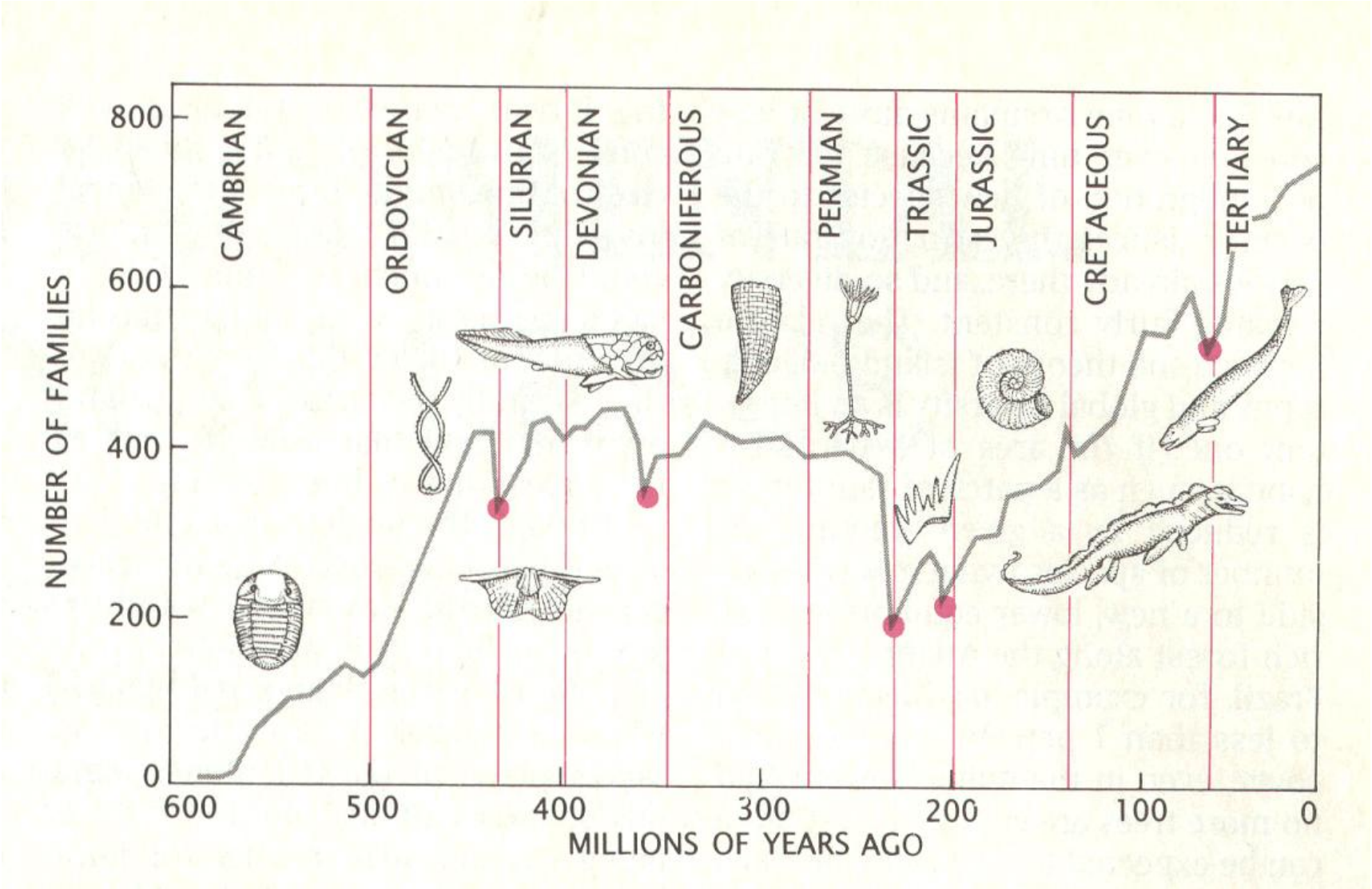
Le Quéré et al. 2009, Nature Geoscience; Data: CDIAC, FAO, Woods Hole Research Center 2009

Earth science: ocean currents

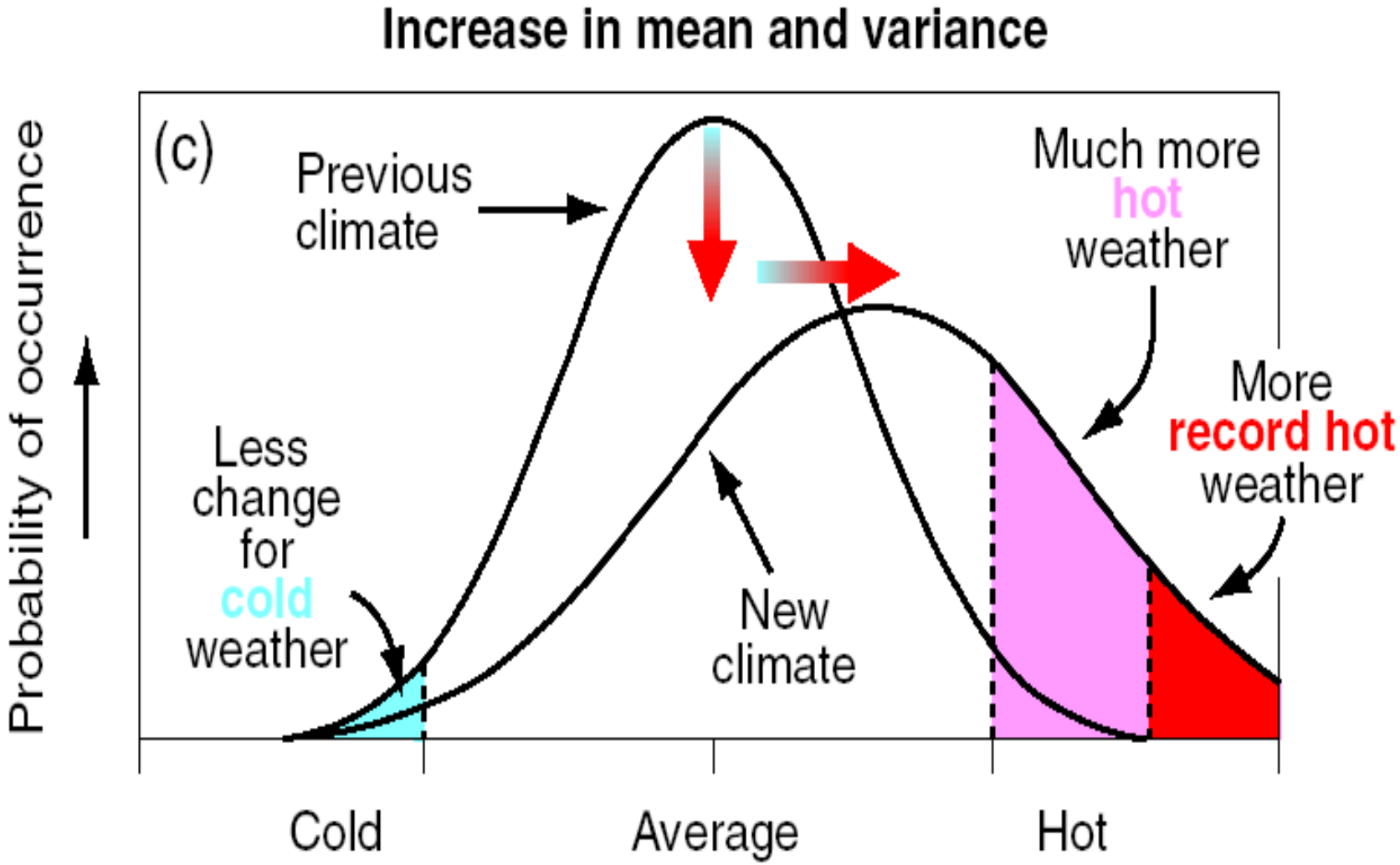


Source: Broecker, 1991, in Climate change 1995, Impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

Geology: climate & life over geologic time



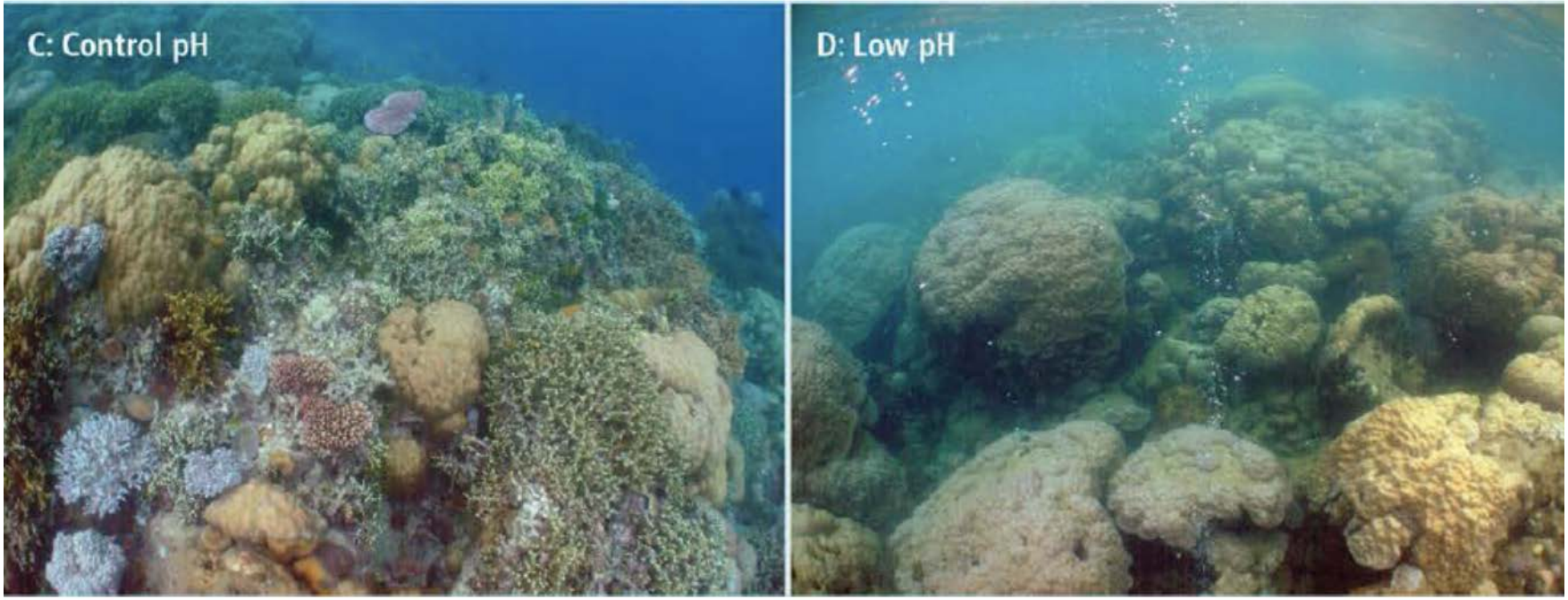
Probability and statistics of climate & weather



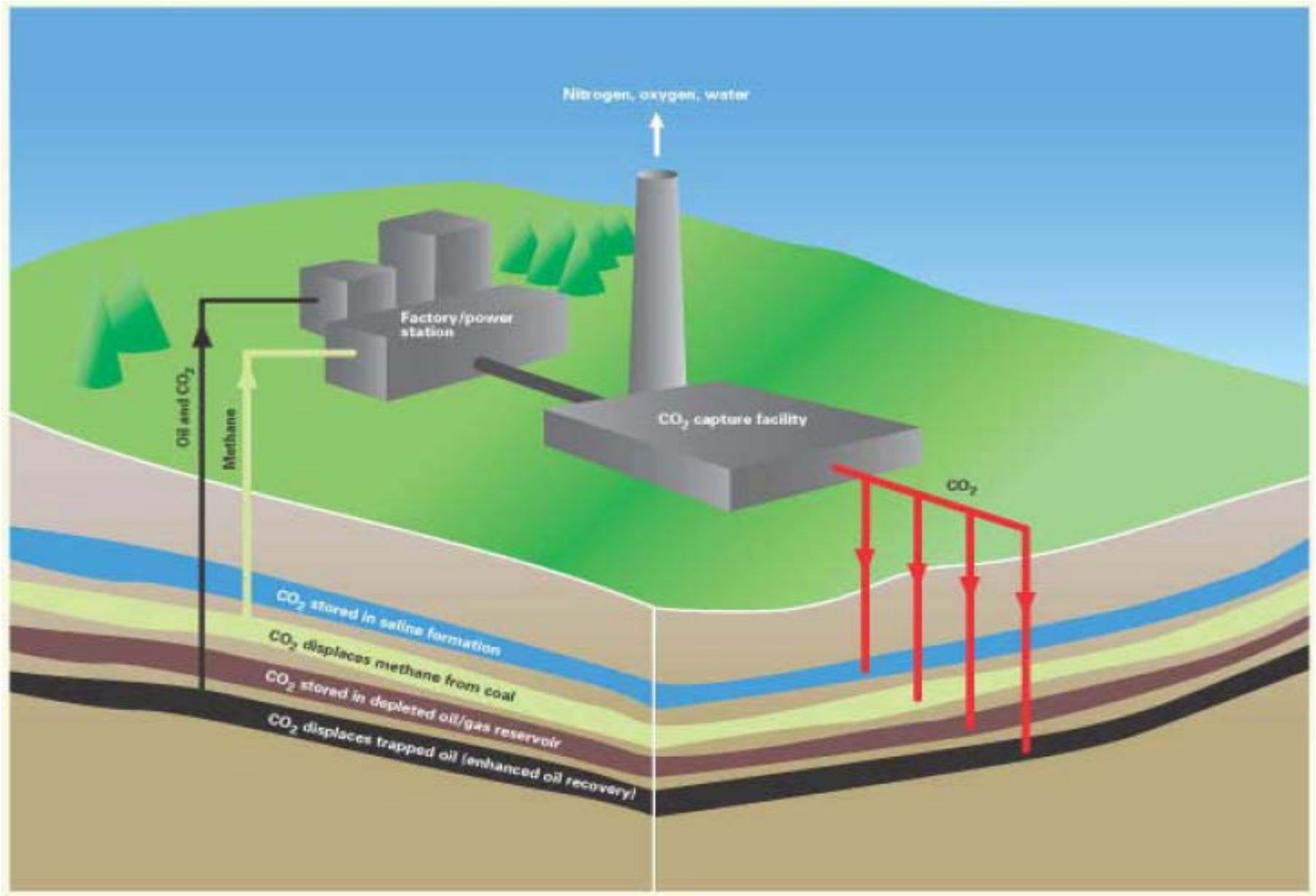
Ecology: interaction of organisms with a changing environment

Chemistry and biology

Ocean acidification

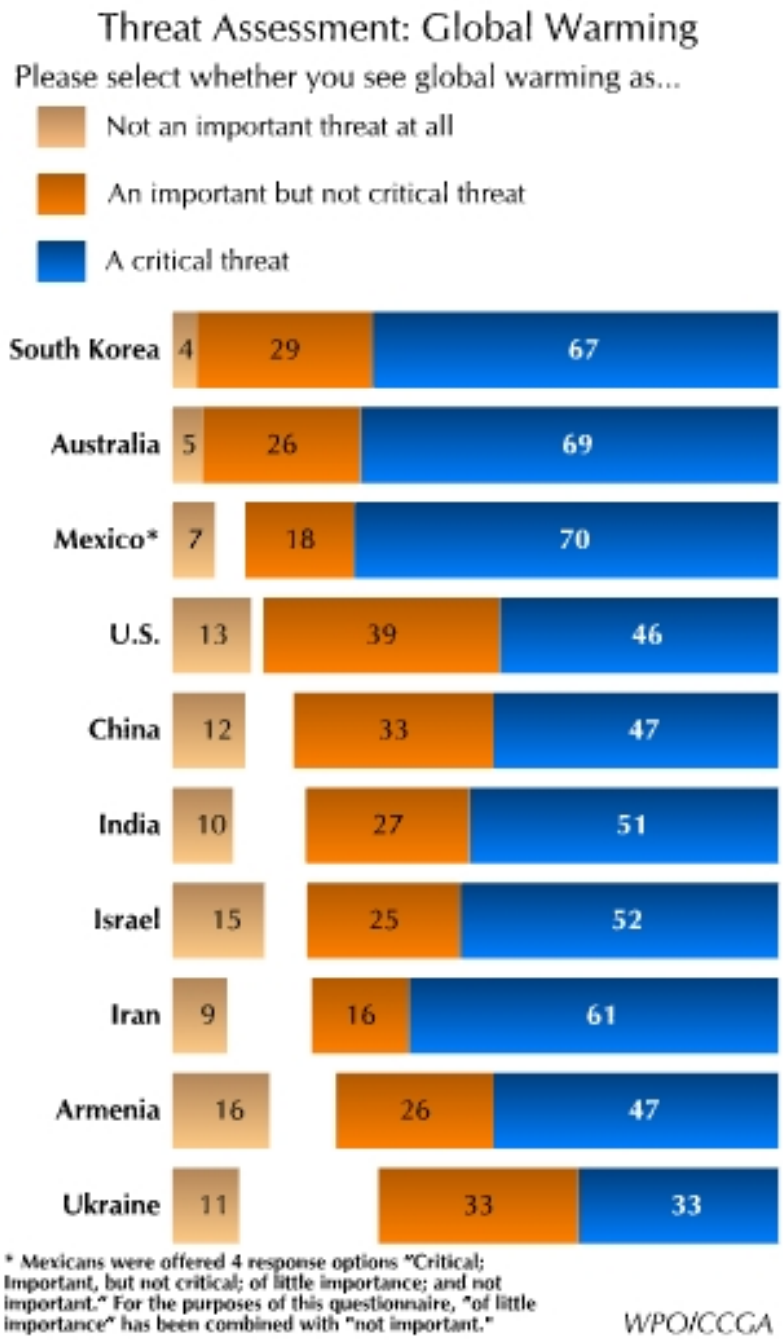


Geology: formations that can store CO_2

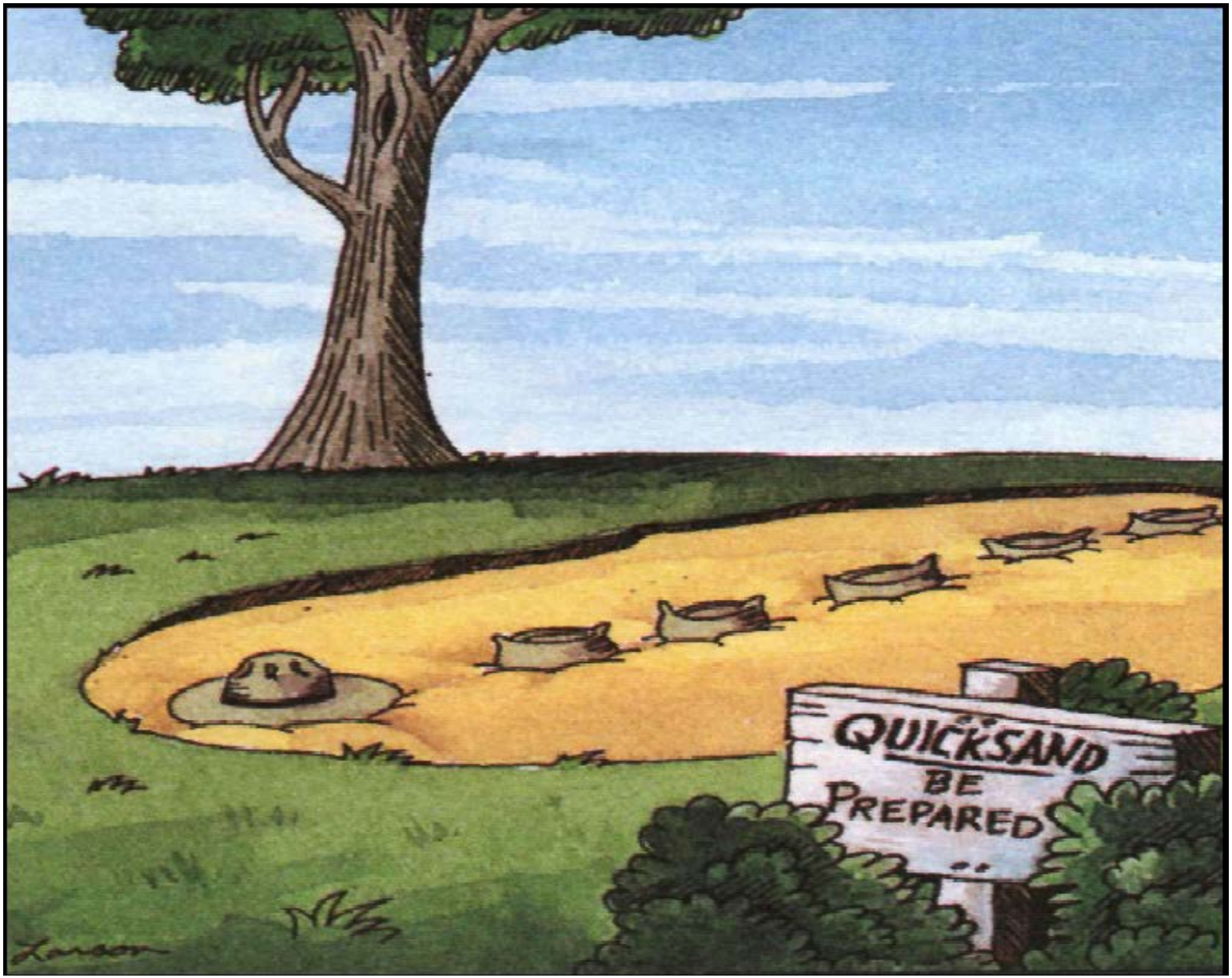


Sociology:

public-opinion polling



Political science: leadership



Climate change education needs to address:

- Climate Change Root Causes
- Climate Change Fear and Despair
- Climate Change Amplified Inequities
- Climate Change Confusion and Denial

Pedagogical implications

- Increasing CC-visibility and impact of own actions
- Developing CC-literacy (critical information literacy)
- Providing viable alternatives and energizing futures (pedagogy of hope)
- Connecting with other related educations (e.g. emergency education, development education, peace education)
- Identifying values, behaviors and systems that underlie CC, and co-creating alternative ones that may be more sustainable

How to close the gap between climate science and public climate literacy?

- Time calls for a radical change in the ways we think and act in particular in terms of education and training
- Climate change education is an integral part of the vision for education for sustainable development
- We have to improve the teaching and learning about climate change in elementary and secondary schools, on college campuses, and through lifelong learning

Improving climate literacy is more important now than ever.

What can individual scientists and teachers do?

- Read more and think more about fields and problems outside your normal area of specialization.
- Improve your communication skills for conveying the relevant essence of your understandings to members of the public and to policy makers.
- Seek out avenues for doing so.
- Spend some of your professional time and effort to working to increase the benefits of S&T for the human condition and decrease the liabilities.

There was no environmental education in 1970.

Now there are thousands of schools which offer good environmental education.


STRATEGIES FOR TAKING ACTION
REWARDS
LOOKING AFTER THE EARTH
KNOWING THAT YOU ARE DOING YOUR BEST
SAVE MONEY ON POWER AND FUEL
LOCAL HOLIDAY
SENSIBLE
HOLIDAY OVERSEAS
MODELLING
CAMERON DIAZ
LEONARDO DICAPRIO
MELISSA ETHERIDGE
CELEBRITY INSPIRATION
PLEDGES AND COMMITTMENTS
GOAL SETTING
FOCUS
GOAL
① GET CLEAR ON GOAL
② WRITE DOWN GOALS
③ GOALS MUST MEET CRITERIA
PRESENT TENSE
I am reducing my household energy by 20%
SPECIFIC
MEASURABLE
THEN
POWER BILL
$110
NOW
POWER BILL
$40
ACHEIVABLE
POSITIVE
TIME LIMIT
④ BREAKING IT DOWN
⑤ VISUALIZATION
⑥ TAKE ACTION
⑦ KEEP IT ALIVE
MENTAL HEALTH
STRESS
I CAN
WATCHING YOUR THINKING
STRESS LESS
MASSAGES
EXERCISE
Ha Ha Ha
LAUGH
MEDITATE
AEROBIC
WEIGHT TRAINING
I am strong
HOME ENERGY
$
SAVES MONEY & POWER
REDUCES CARBON FOOTPRINT
PERSONAL ENERGY INFORMATION
GIVES FEEDBACK