Mitigation and Adaptation Studies

Class 18: Knowing the Hazards: Climate Hazards, Public Health, Food-Water-Energy Nexus

Class 19: Foresight

Contents:

- Preliminaries
- Climate Change and Sea Level Hazards
  - Observing the Planet
  - Detecting Changes
  - Assessing Knowledge
  - Understanding the Processes and Causes
  - Having Foresight
- Public Health
- Food-Water-Energy Nexus

Climate Change and Sea Level Hazards

Hazards:

Changes in means:
- air temperature
- precipitation
- wind field/circulation
- evapotranspiration
- humidity
- soil moisture
- permafrost
- sea and lake levels
- inundation
- river runoff
- desertification
- ice and snow cover

Changes in extremes:
- Storms (hurricanes, typhoons, tornados, thunderstorms)
- Floods
- Droughts
- Heat Waves
- Ice storms and snow fall

Changes in dynamics and chemistry:
- ocean circulation
- atmospheric circulation
- ocean temperature
- ocean acidification
- soil, air and water chemistry

Changes in biosphere:
- ecosystem health and services
- migration
- invasive species
- extinction

Questions:
- How well do we know the past and current changes?
- How well do we understand the processes and causes?
- *How are the hazards potentially going to impact human and non-human systems?*
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Processes

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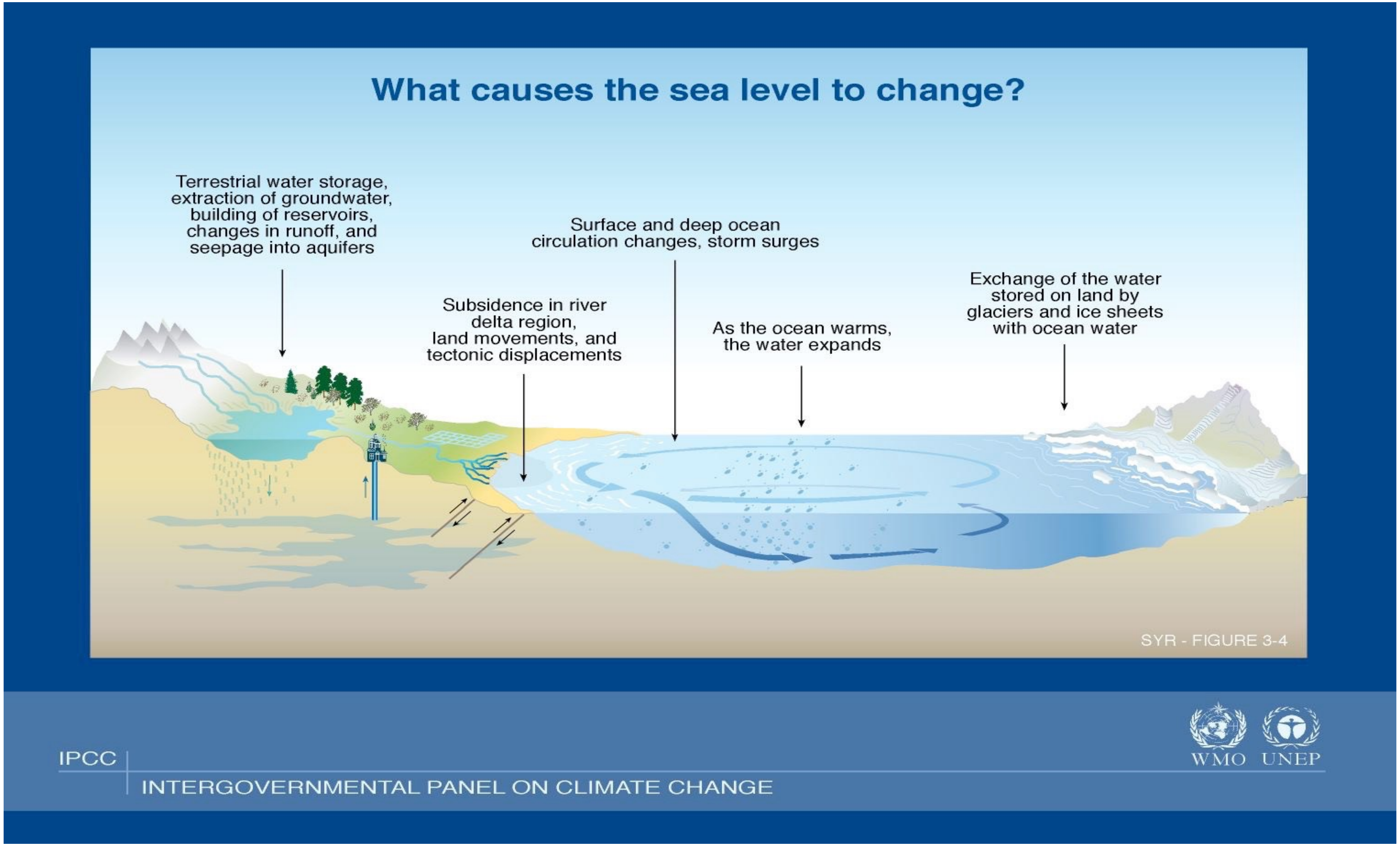
Understanding the Processes

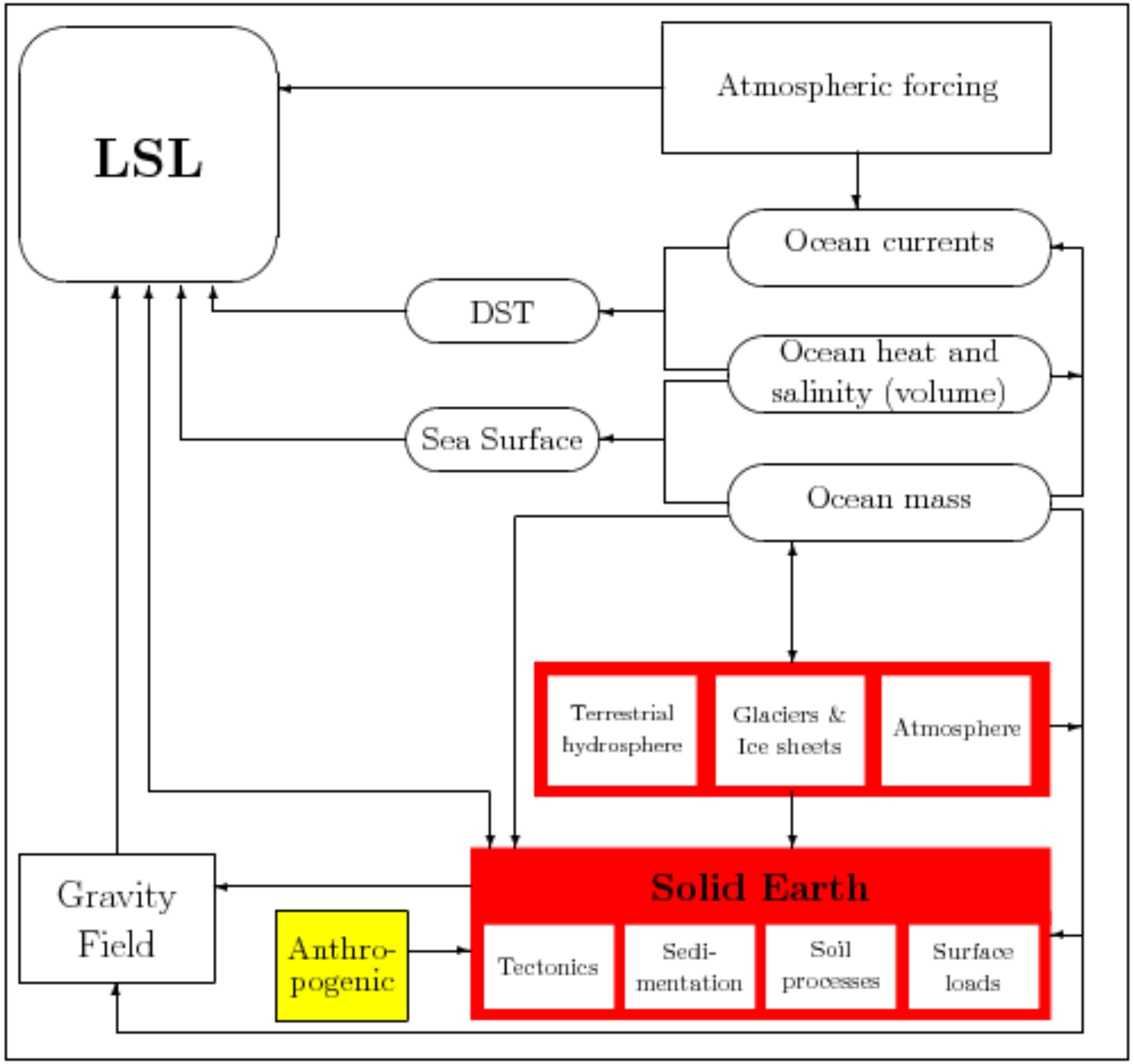
Understanding the Processes



Local Sea Level:
vertical distance between sea surface and land surface

Local Sea Level (LSL) changes =
Sea Surface Height (SSH) changes -
Land surface height (LSH) changes.

$$LSL(x,t) = SSH(x,t) - LSH(x,t)$$



Understanding the Processes

LSL = short-period part + long-period part

Separation at a period of about 2 months:

High-frequency part of LSL equation:

$$h_{\mathrm{hf}}t = w(t) + h_{\mathrm{tidal}}(t) + h_{\mathrm{atmos}}(t) + h_{\mathrm{seiches}}(t) + h_{\mathrm{tsunami}}(t).$$

Important for projection of maximum flood levels

Short-period variations are the result of local to regional processes

LSL = short-period part + long-period part

Low-Frequency part of the LSL equation:

$$\delta h_{\mathrm{M}}(\vec{x},t) = N(\vec{x},t) + S(\vec{x},t) + C(\vec{x},t) + F(\vec{X},t) + A(\vec{x},t) + I(\vec{x},t) + G(\vec{x},t) + T(\vec{x},t) + P(\vec{x})(t-t_0) + V_0(\vec{x})(t-t_0) + \delta V(\vec{x},t) + B(\vec{x},t)$$

N: nodal tide
S: steric changes
C: changes in ocean currents
A: changes in atmospheric circulation
F: freshening
I: changes in the mass of the large ice sheets
G: changes in continental glaciers
T: changes in terrestrial hydrosphere
P: postglacial rebound
V_0: secular vertical land motion
δV: non-linear vertical land motion
B: changes in shape and extent of ocean basins.

Comments on the relation between mass changes (exchange and redistribution) and LSL

Important for projections of LSL

Long-period variations are the result of local to global processes

Understanding the Processes

Sea level equation (Farrell&Clark, 1976)

$$\xi(\vartheta,\lambda,t) = c(t) + O(\vartheta,\lambda,t)\int_{-\infty}^{t}\int_0^{\pi}\int_0^{2\pi} G(\vartheta,\lambda,\vartheta',\lambda',t-t')$$
$$\frac{\mathrm{d}}{\mathrm{d}t'}\left\{O(\vartheta',\lambda',t')\rho_{\mathrm{W}}\xi(\vartheta',\lambda',t') + \left[1 - O(\vartheta',\lambda',t')\right]\rho_{\mathrm{L}}\eta(\vartheta',\lambda',t')\right\}\sin\vartheta'\mathrm{d}\lambda'\mathrm{d}\vartheta'\mathrm{d}t'.$$

ξ: local sea level change (distance to the deformable solid Earth surface),
G: Green's function for sea level,
O: ocean function,
η: cumulated water/ice load change due to mass added or removed from land,
ρ_{W} and ρ_{L}: densities of the ocean water and the load (water or ice), respectively,
$c(t)$: quantity to ensure mass conservation.

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LSL change

Load on ocean areas

Load on land areas

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LSL change

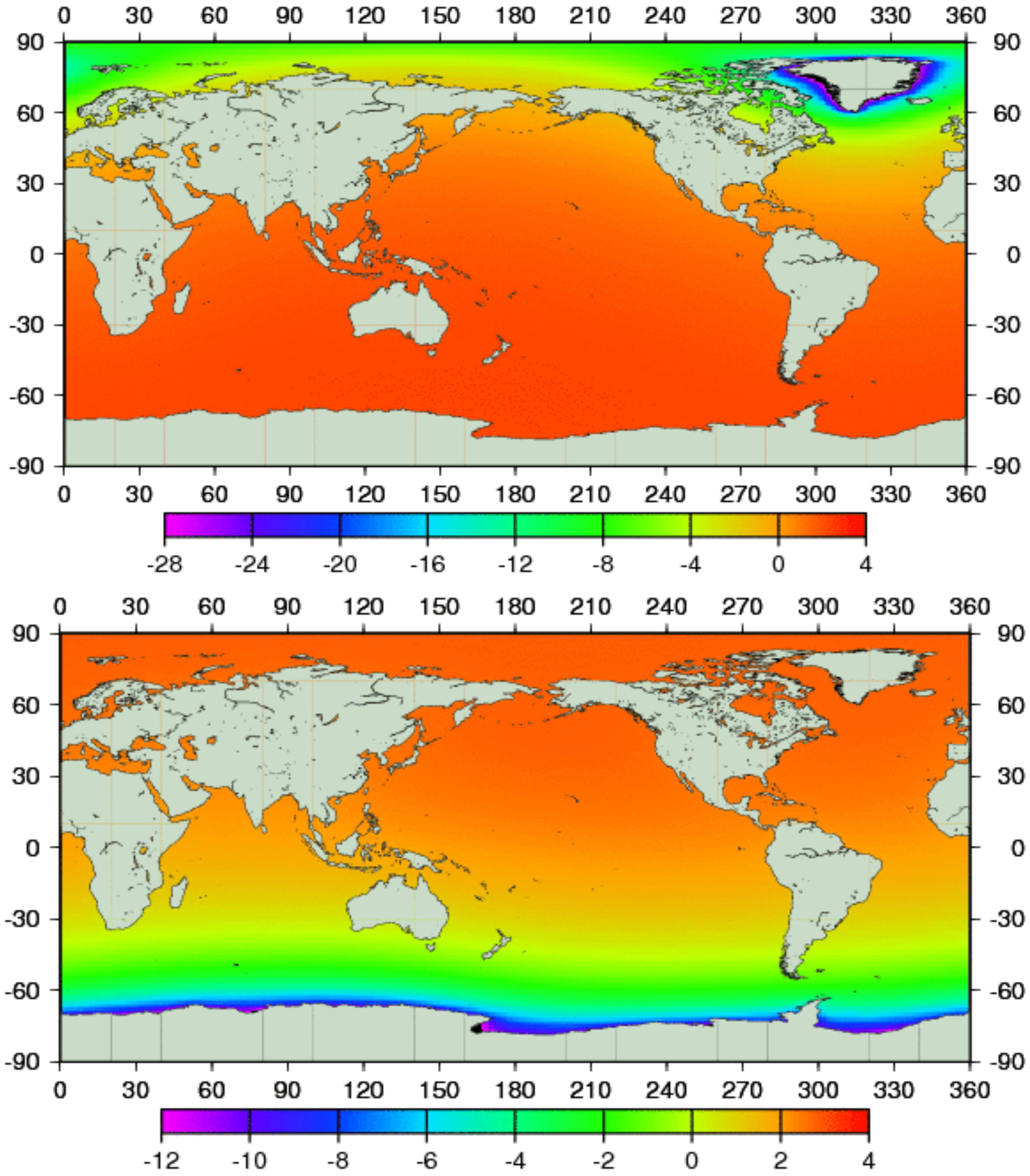
Load on ocean areas

Load on land areas

All mass movements:
- change the geoid
- displace the ocean bottom vertically
- redistribute the water masses in the ocean

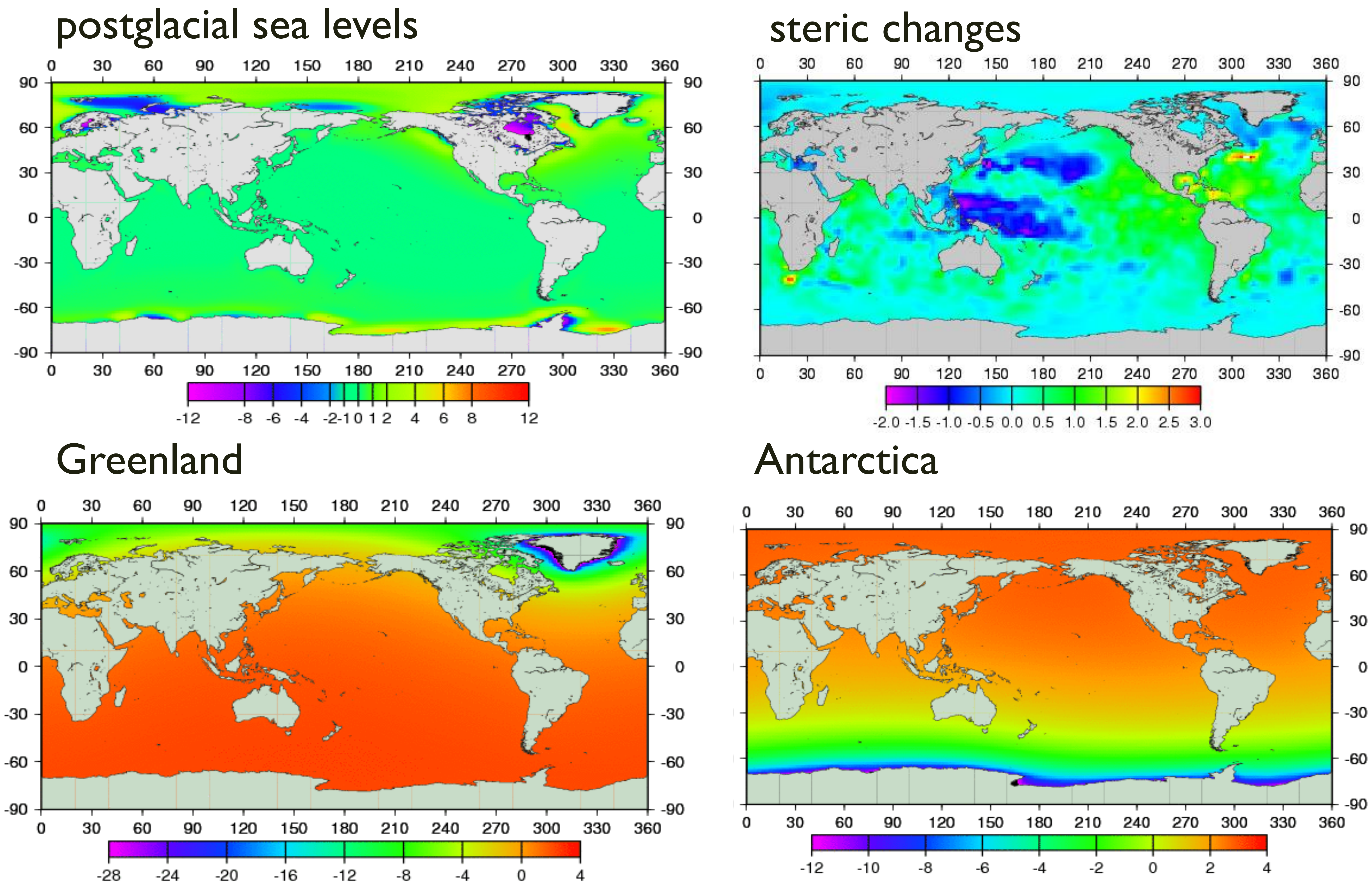
Understanding the Processes

Fingerprints of the large ice sheets



Plag and Juettner, 2001

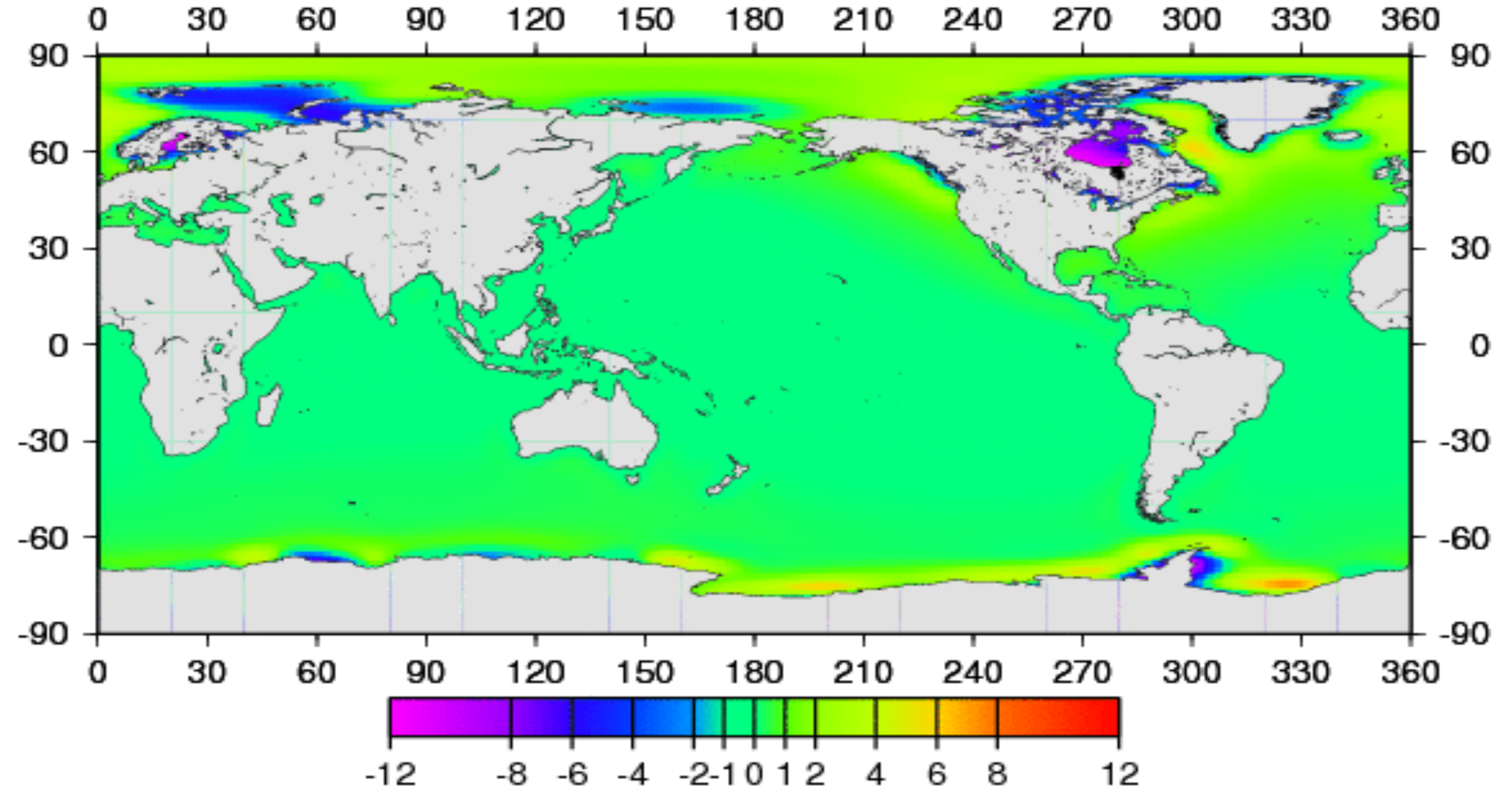
Understanding the Processes



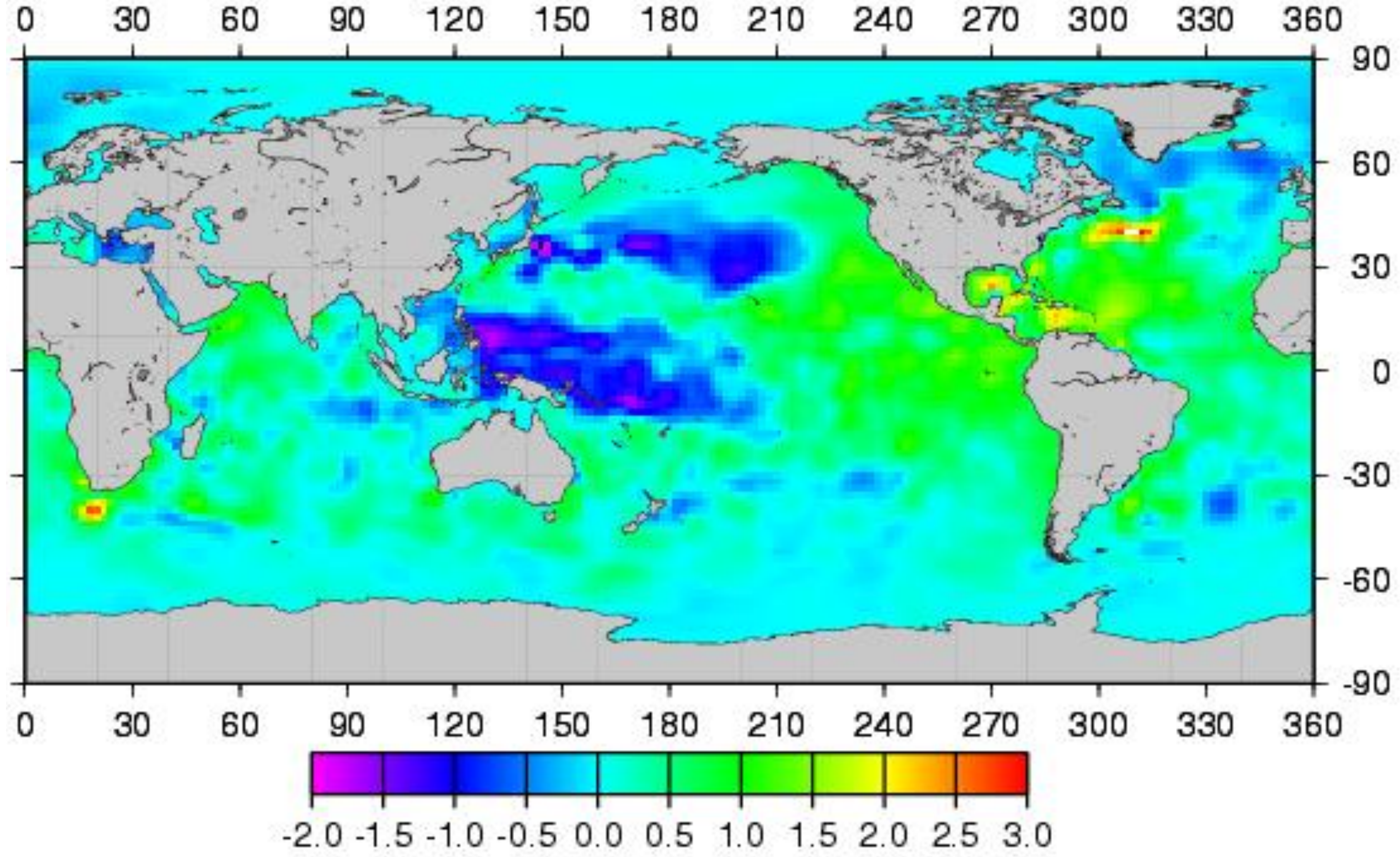
Plag, 2006

Understanding the Processes

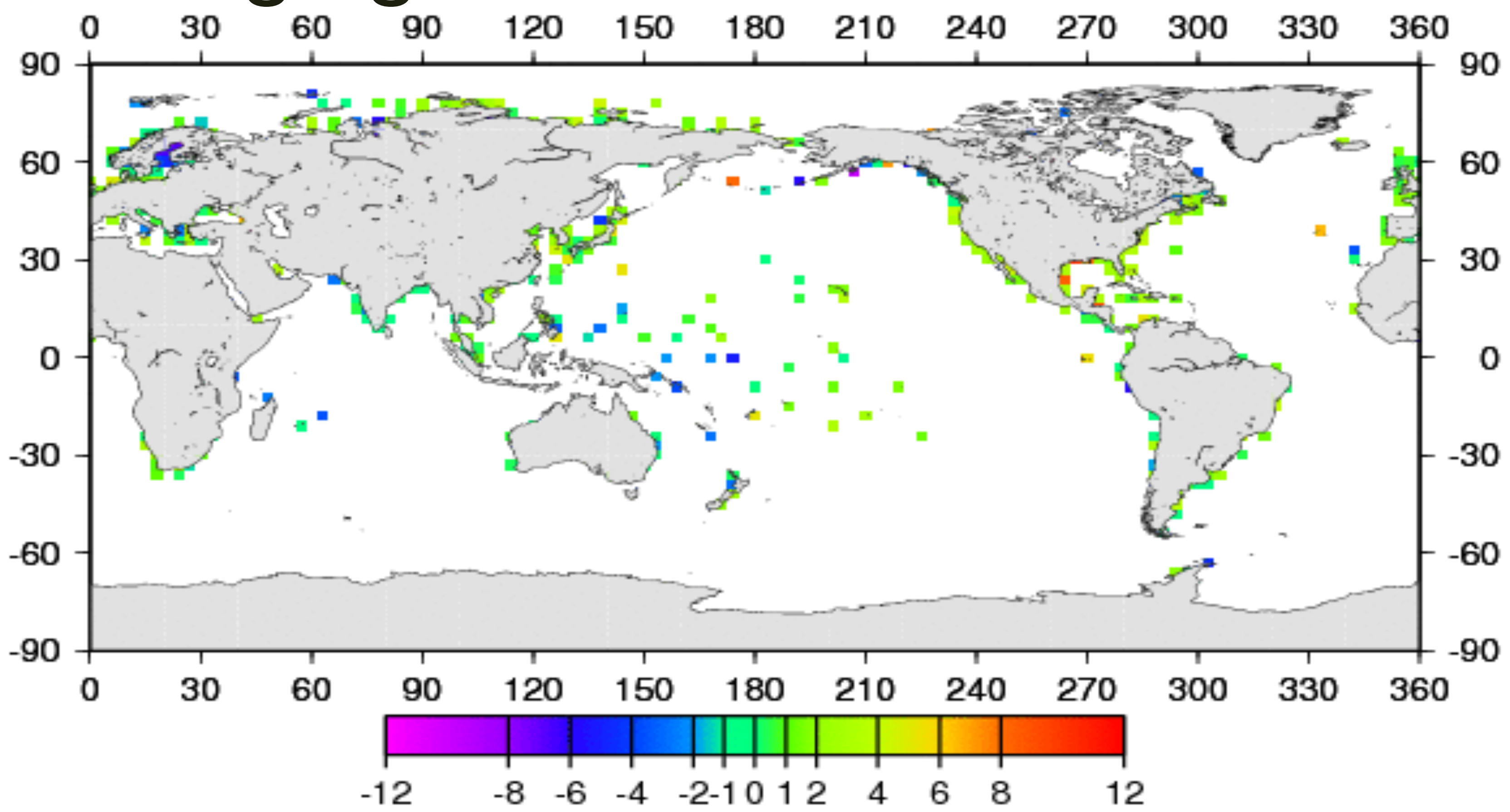
postglacial sea levels



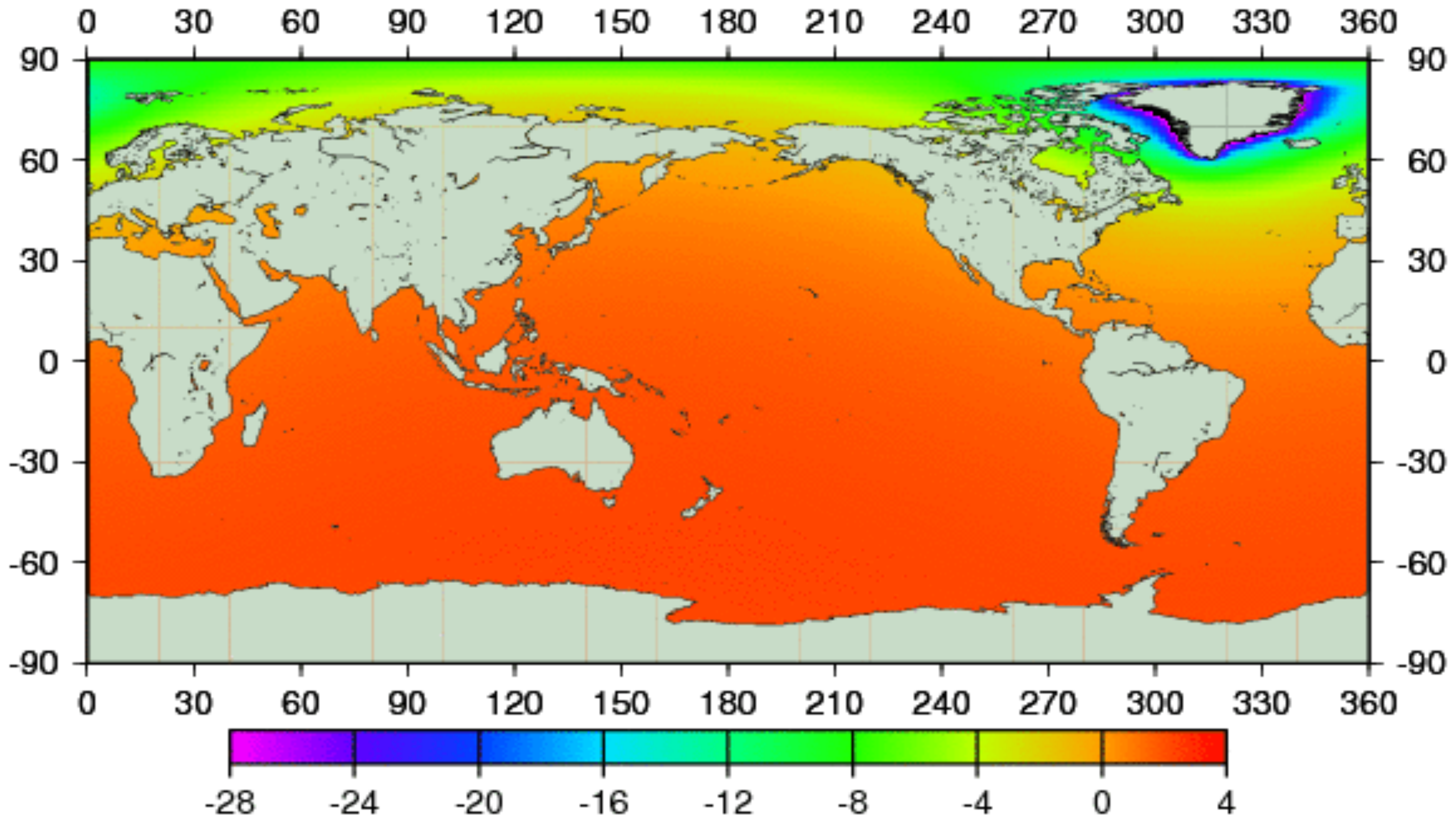
steric changes



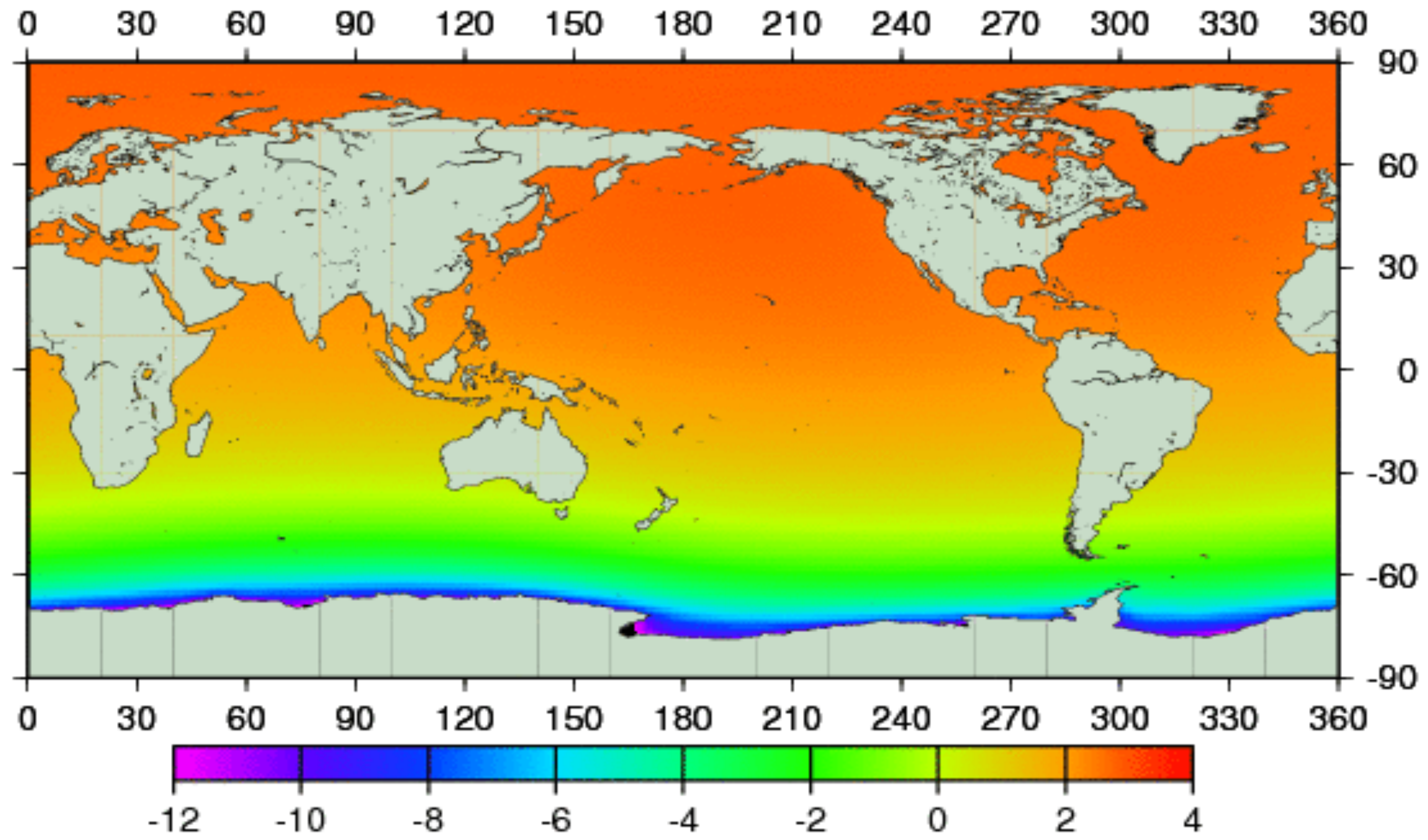
tide gauges



Greenland



Antarctica



Plag, 2006

Understanding the Processes

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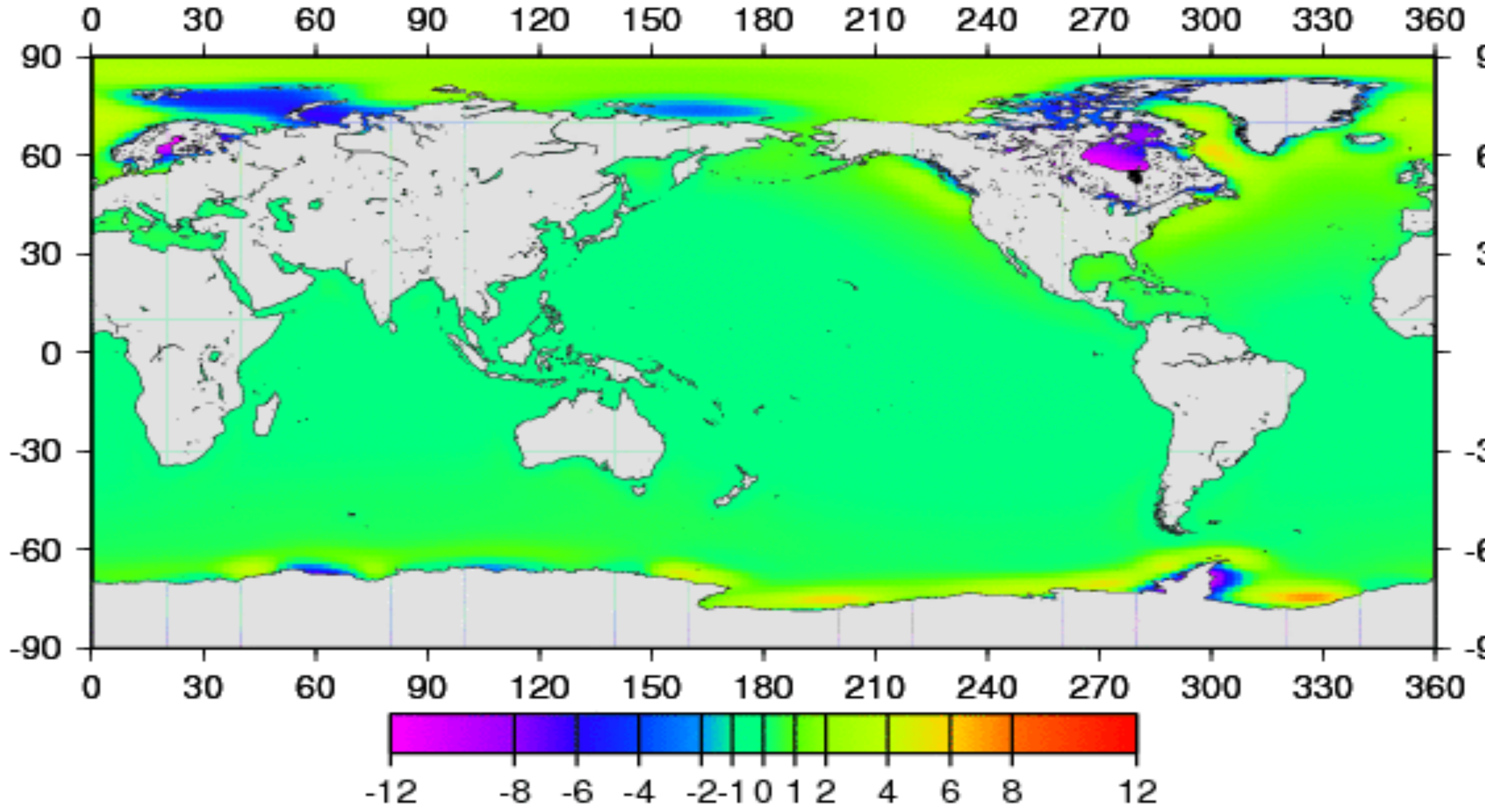
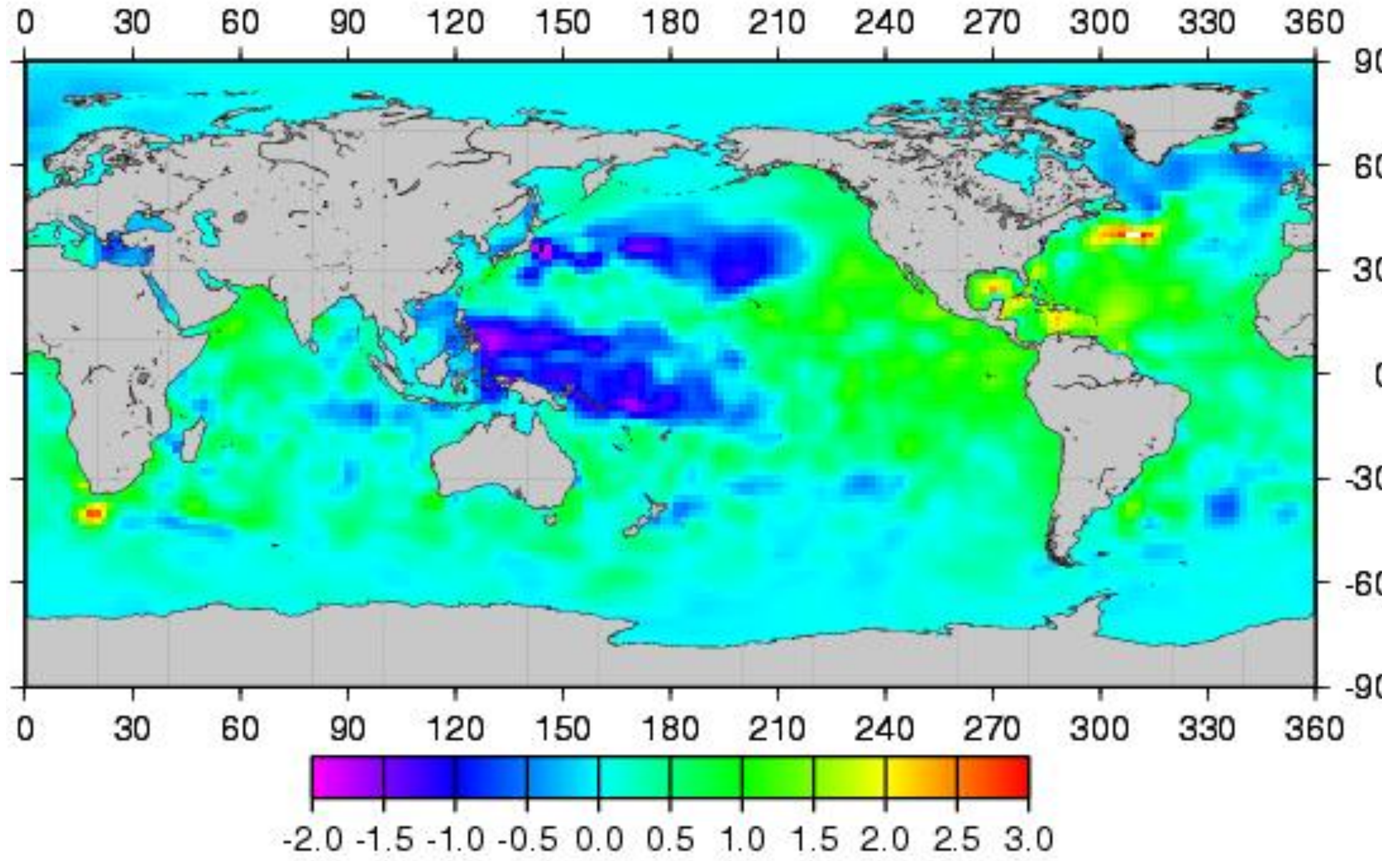


steric changes



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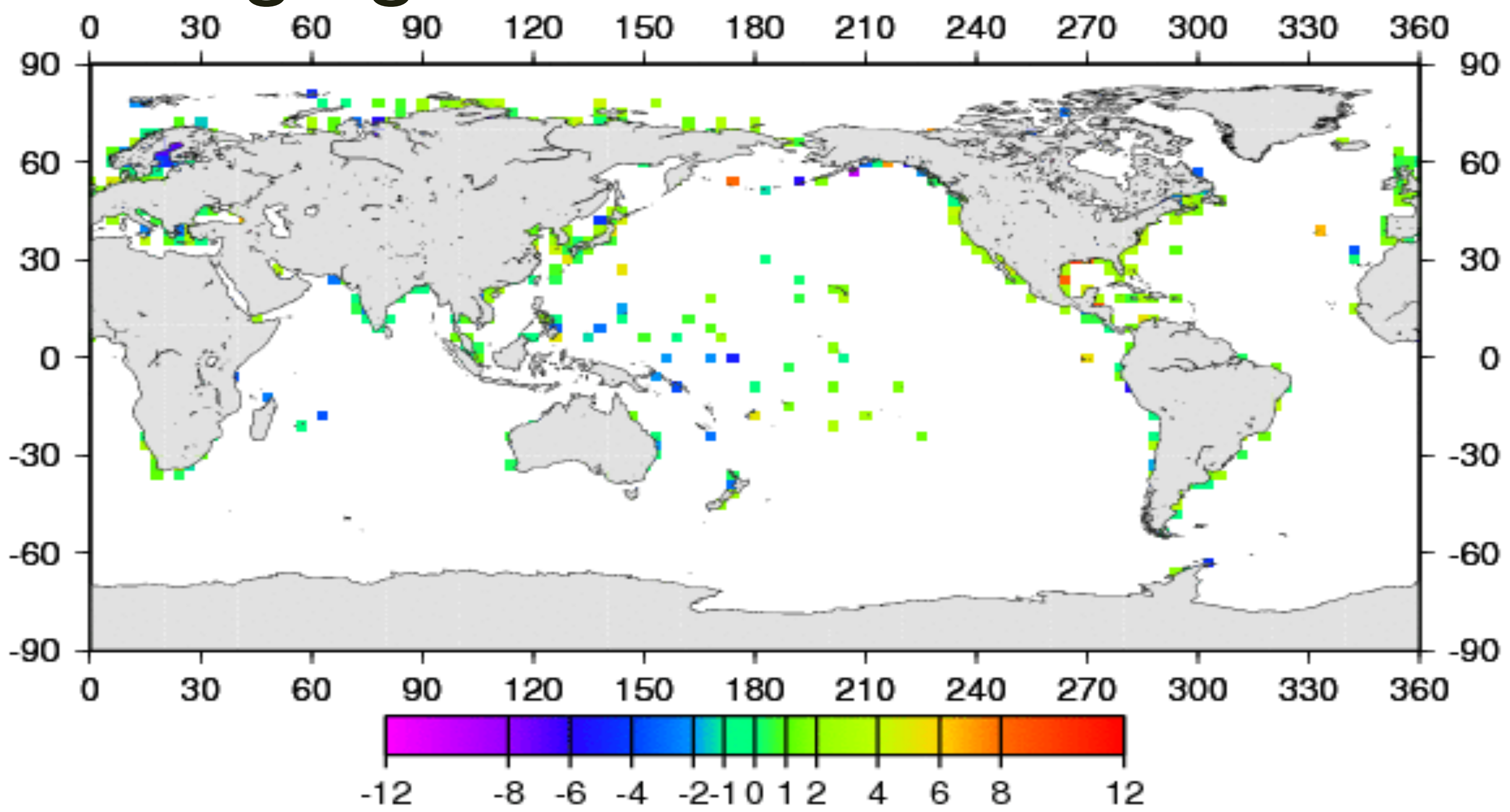

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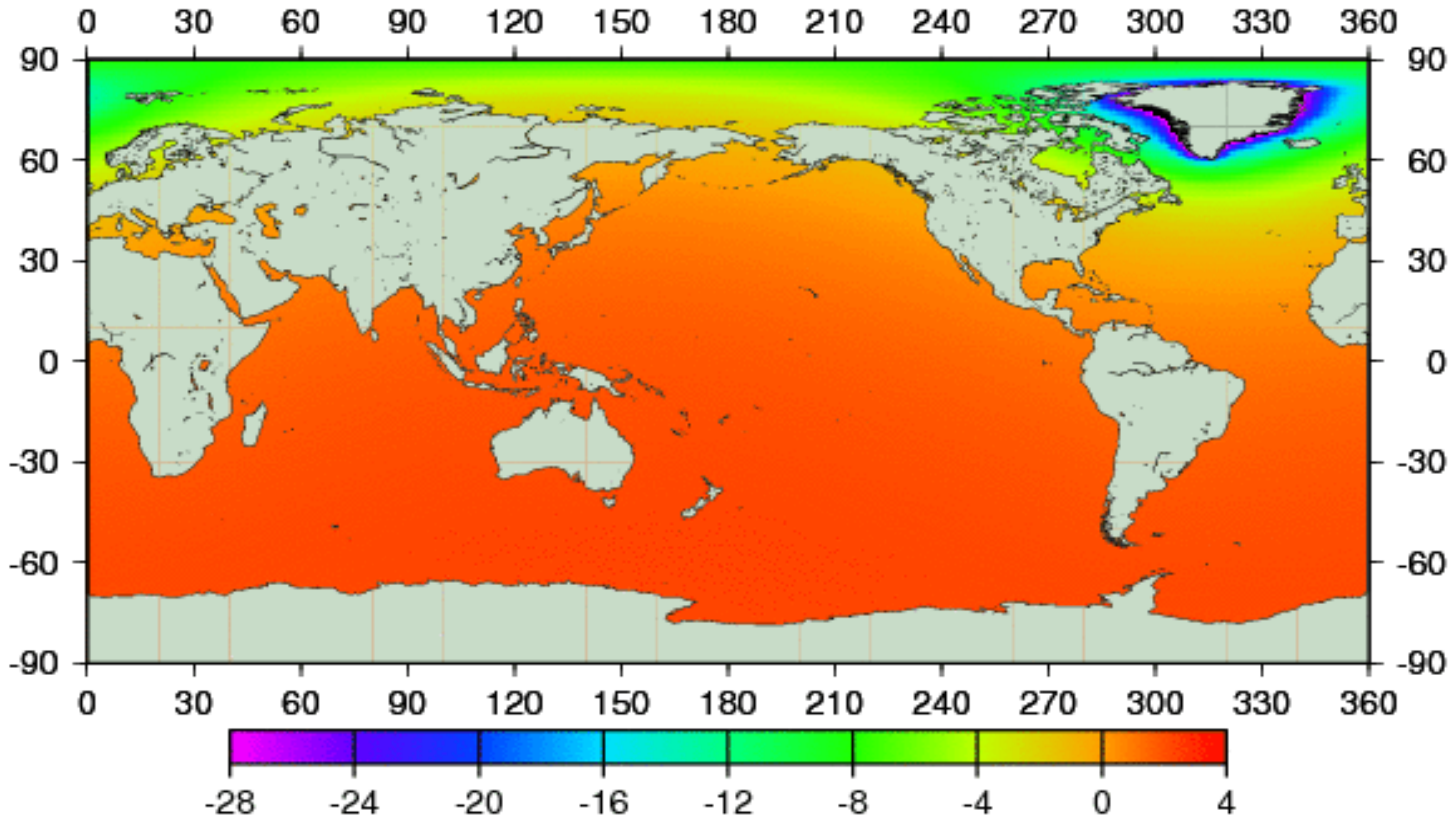

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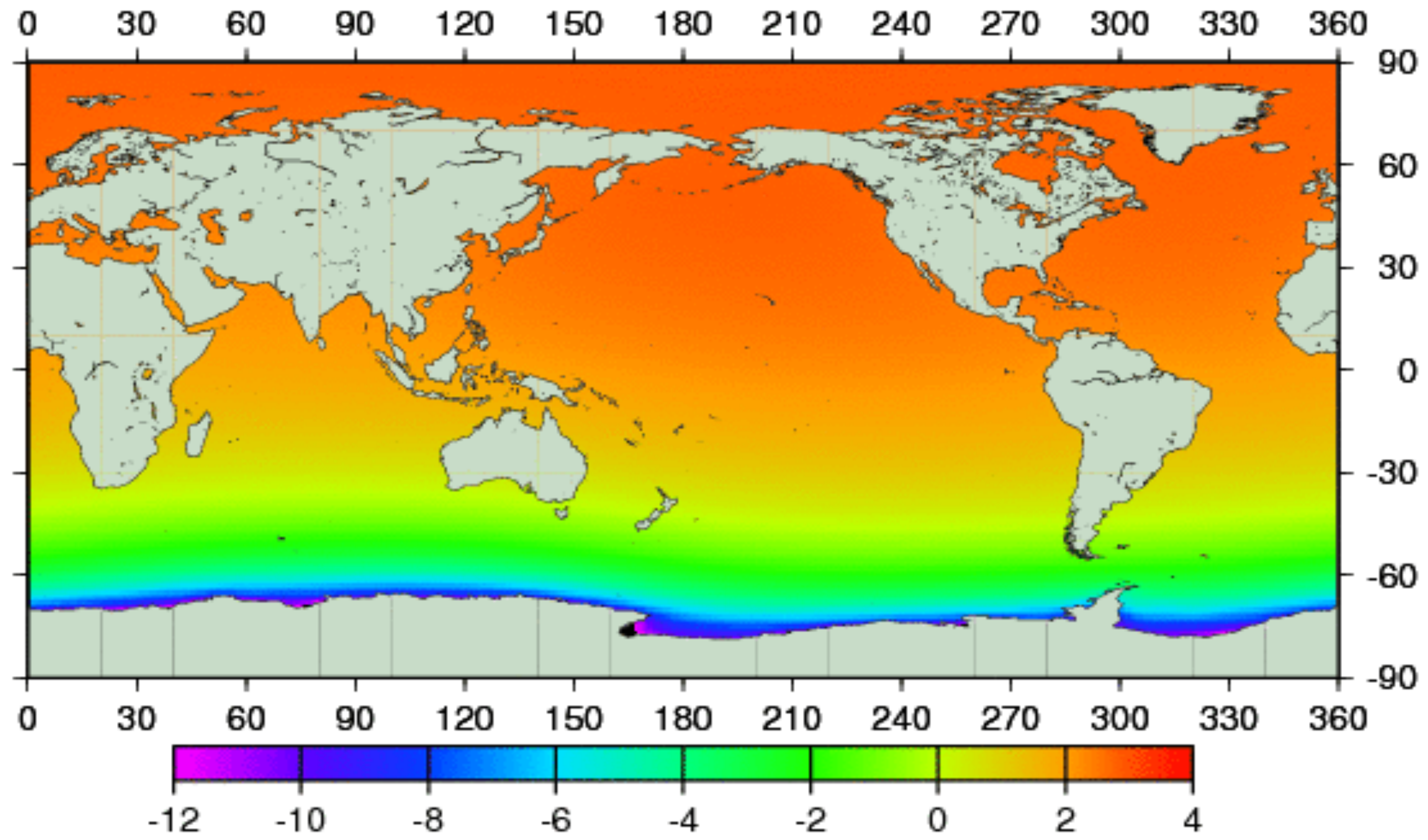
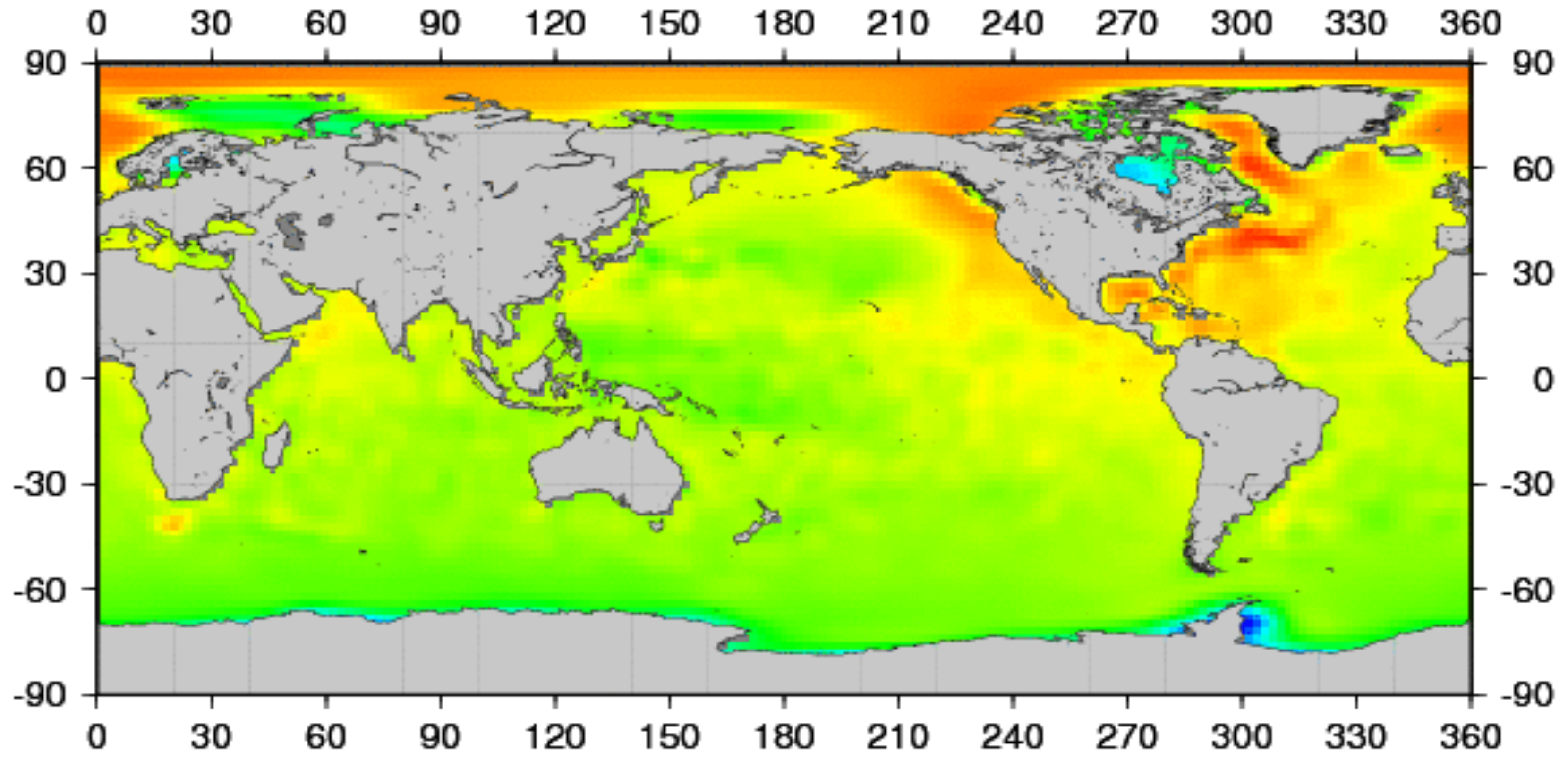


reconstructed LSL



Greenland Ice sheet
contribution: 0.3 - 0.5 mm/yr

Antarctica Ice sheet
contribution: 0.1 - 0.3 mm/yr

Example global average:
1.14 mm/yr at tide gauges
0.90 mm/yr global average

Plag, 2006

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Causes

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Understanding the Causes

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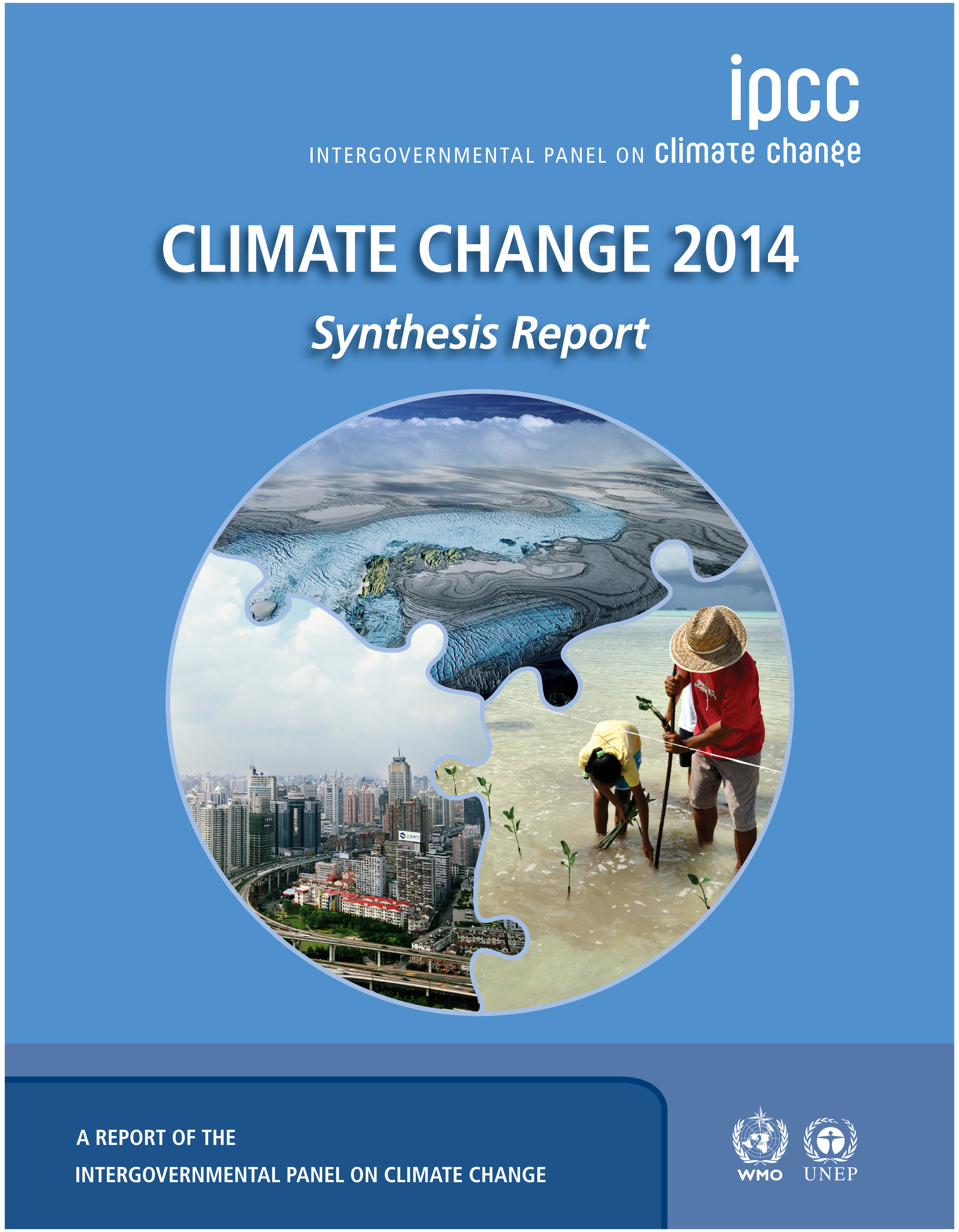

SPM

Summary for Policymakers

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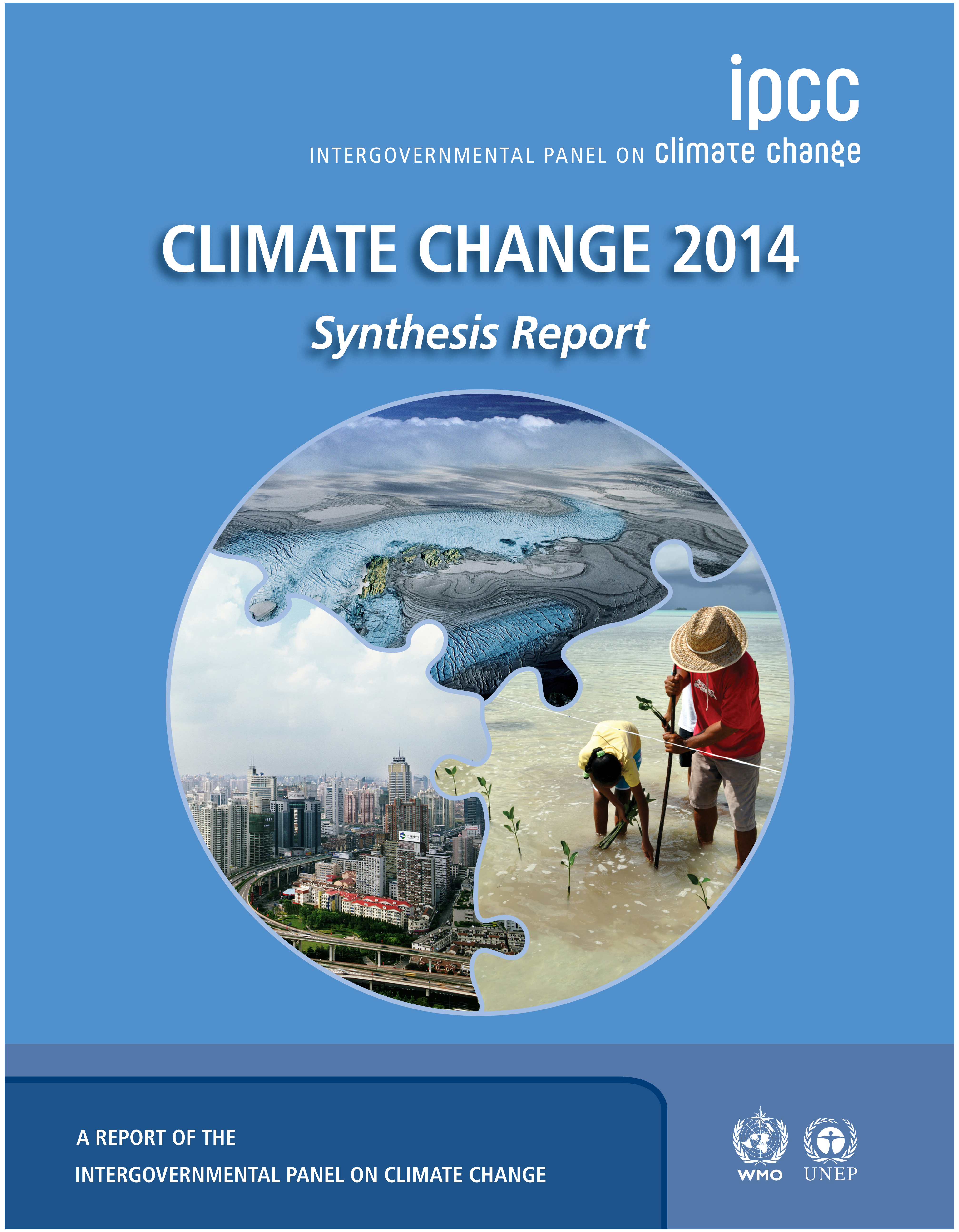
3

Understanding the Causes



SPM

C. Drivers of Climate Change

Natural and anthropogenic substances and processes that alter the Earth's energy budget are drivers of climate change. Radiative forcing[14] (RF) quantifies the change in energy fluxes caused by changes in these drivers for 2011 relative to 1750, unless otherwise indicated. Positive RF leads to surface warming, negative RF leads to surface cooling. RF is estimated based on in-situ and remote observations, properties of greenhouse gases and aerosols, and calculations using numerical models representing observed processes. Some emitted compounds affect the atmospheric concentration of other substances. The RF can be reported based on the concentration changes of each substance[15]. Alternatively, the emission-based RF of a compound can be reported, which provides a more direct link to human activities. It includes contributions from all substances affected by that emission. The total anthropogenic RF of the two approaches are identical when considering all drivers. Though both approaches are used in this Summary for Policymakers, emission-based RFs are emphasized.

Total radiative forcing is positive, and has led to an uptake of energy by the climate system. The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of CO_2 since 1750 (see Figure SPM.5). {3.2, Box 3.1, 8.3, 8.5}

- The total anthropogenic RF for 2011 relative to 1750 is 2.29 [1.13 to 3.33] W m^{-2} (see Figure SPM.5), and it has increased more rapidly since 1970 than during prior decades. The total anthropogenic RF best estimate for 2011 is 43% higher than that reported in AR4 for the year 2005. This is caused by a combination of continued growth in most greenhouse gas concentrations and improved estimates of RF by aerosols indicating a weaker net cooling effect (negative RF). {8.5}

- The RF from emissions of well-mixed greenhouse gases (CO_2, CH_4, N_2O, and Halocarbons) for 2011 relative to 1750 is 3.00 [2.22 to 3.78] W m^{-2} (see Figure SPM.5). The RF from changes in concentrations in these gases is 2.83 [2.26 to 3.40] W m^{-2}. {8.5}

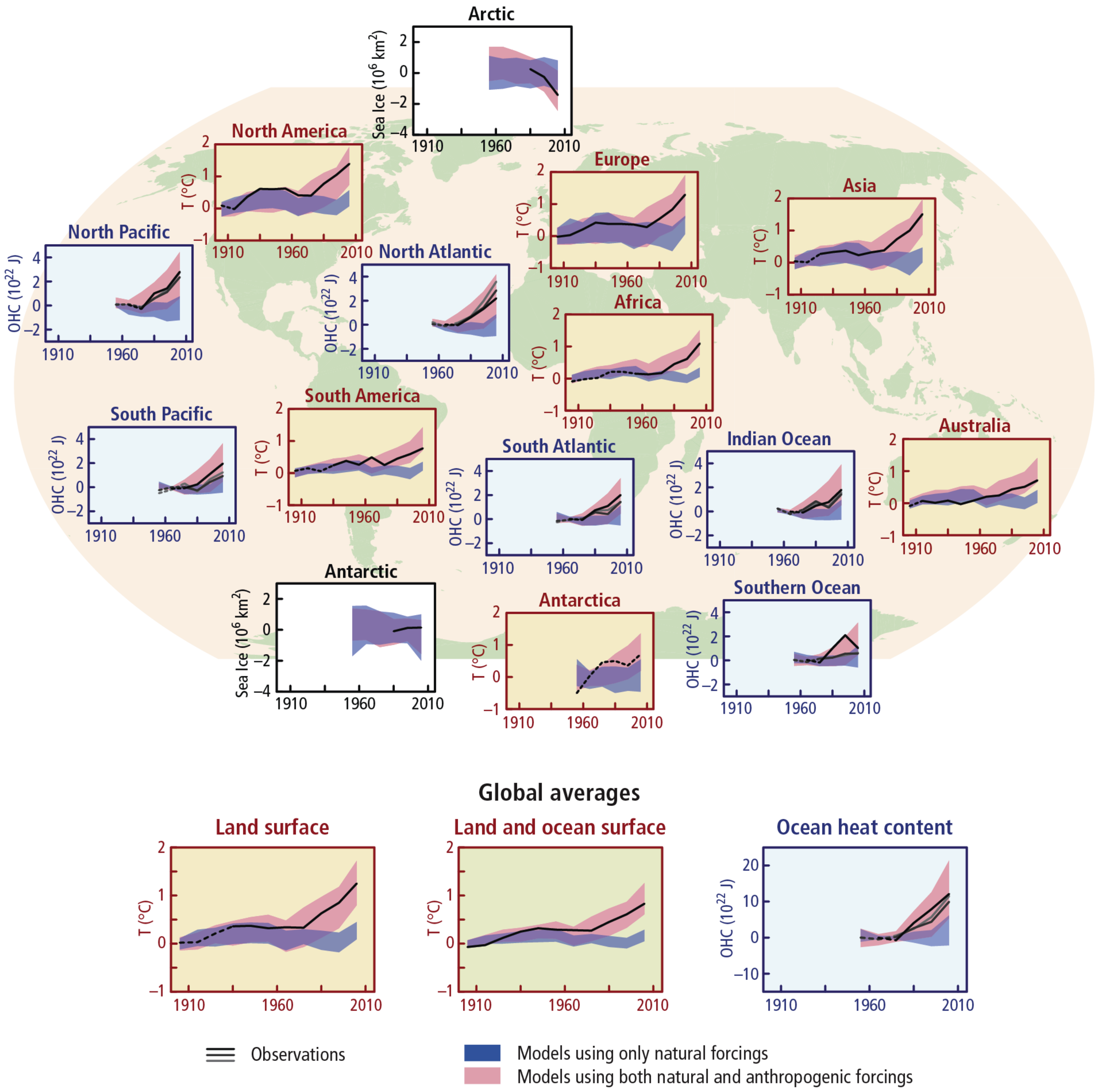
- Emissions of CO_2 alone have caused an RF of 1.68 [1.33 to 2.03] W m^{-2} (see Figure SPM.5). Including emissions of other carbon-containing gases, which also contributed to the increase in CO_2 concentrations, the RF of CO_2 is 1.82 [1.46 to 2.18] W m^{-2}. {8.3, 8.5}

- Emissions of CH_4 alone have caused an RF of 0.97 [0.74 to 1.20] W m^{-2} (see Figure SPM.5). This is much larger than the concentration-based estimate of 0.48 [0.38 to 0.58] W m^{-2} (unchanged from AR4). This difference in estimates is caused by concentration changes in ozone and stratospheric water vapour due to CH_4 emissions and other emissions indirectly affecting CH_4. {8.3, 8.5}

- Emissions of stratospheric ozone-depleting halocarbons have caused a net positive RF of 0.18 [0.01 to 0.35] W m^{-2} (see Figure SPM.5). Their own positive RF has outweighed the negative RF from the ozone depletion that they have induced. The positive RF from all halocarbons is similar to the value in AR4, with a reduced RF from CFCs but increases from many of their substitutes. {8.3, 8.5}

- Emissions of short-lived gases contribute to the total anthropogenic RF. Emissions of carbon monoxide (CO) are *virtually certain* to have induced a positive RF, while emissions of nitrogen oxides (NO_x) are *likely* to have induced a net negative RF (see Figure SPM.5). {8.3, 8.5}

Understanding the Causes



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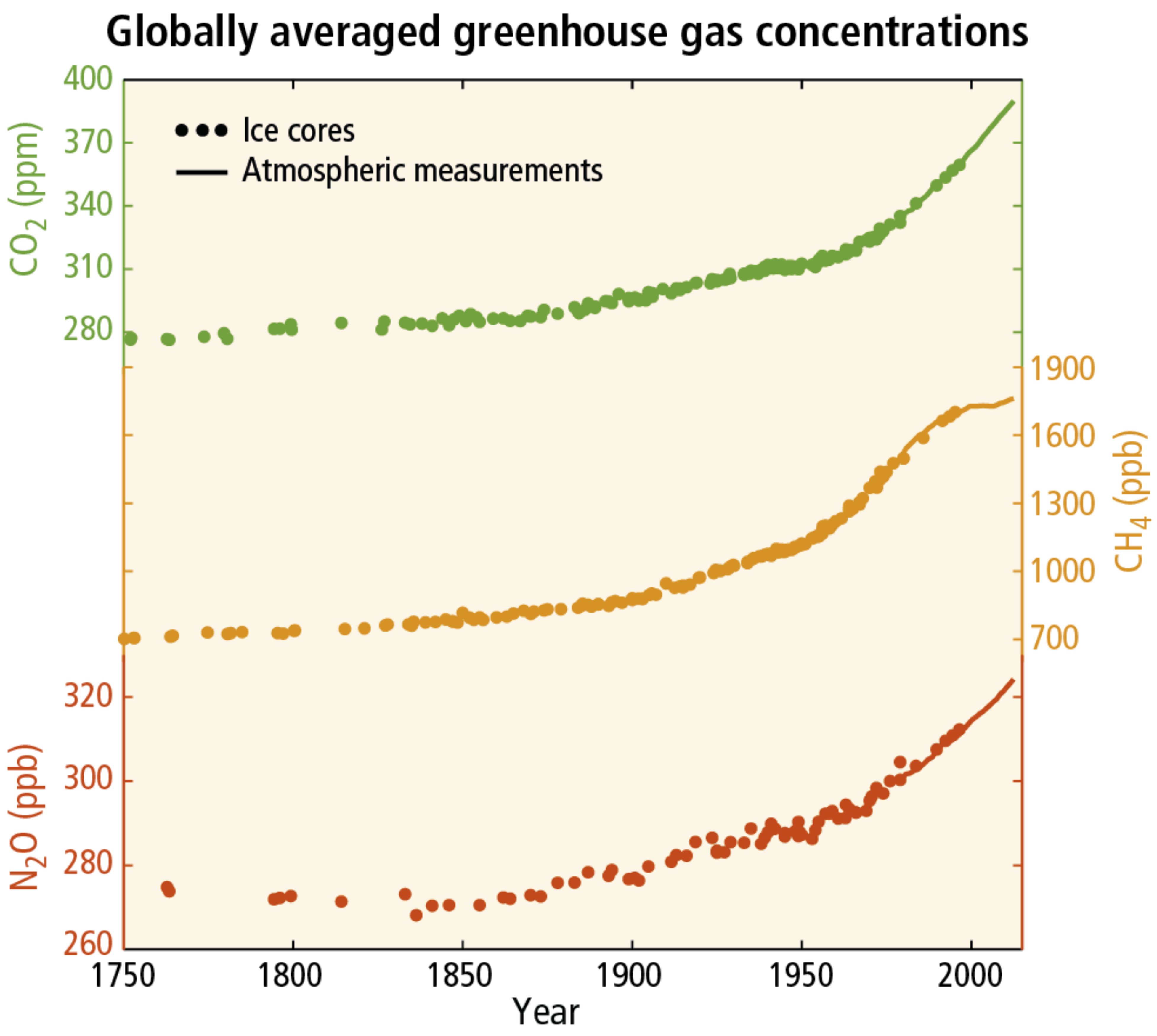
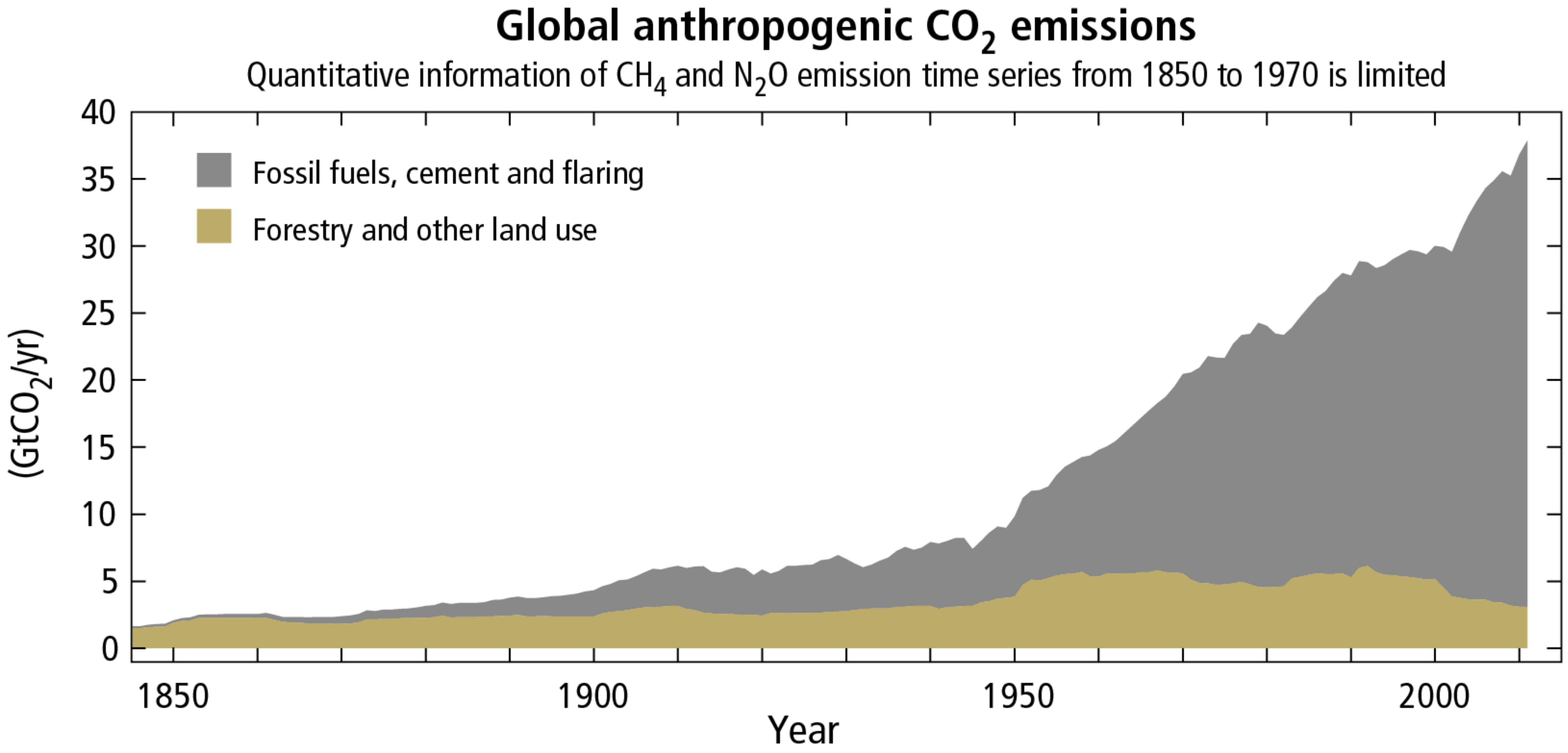
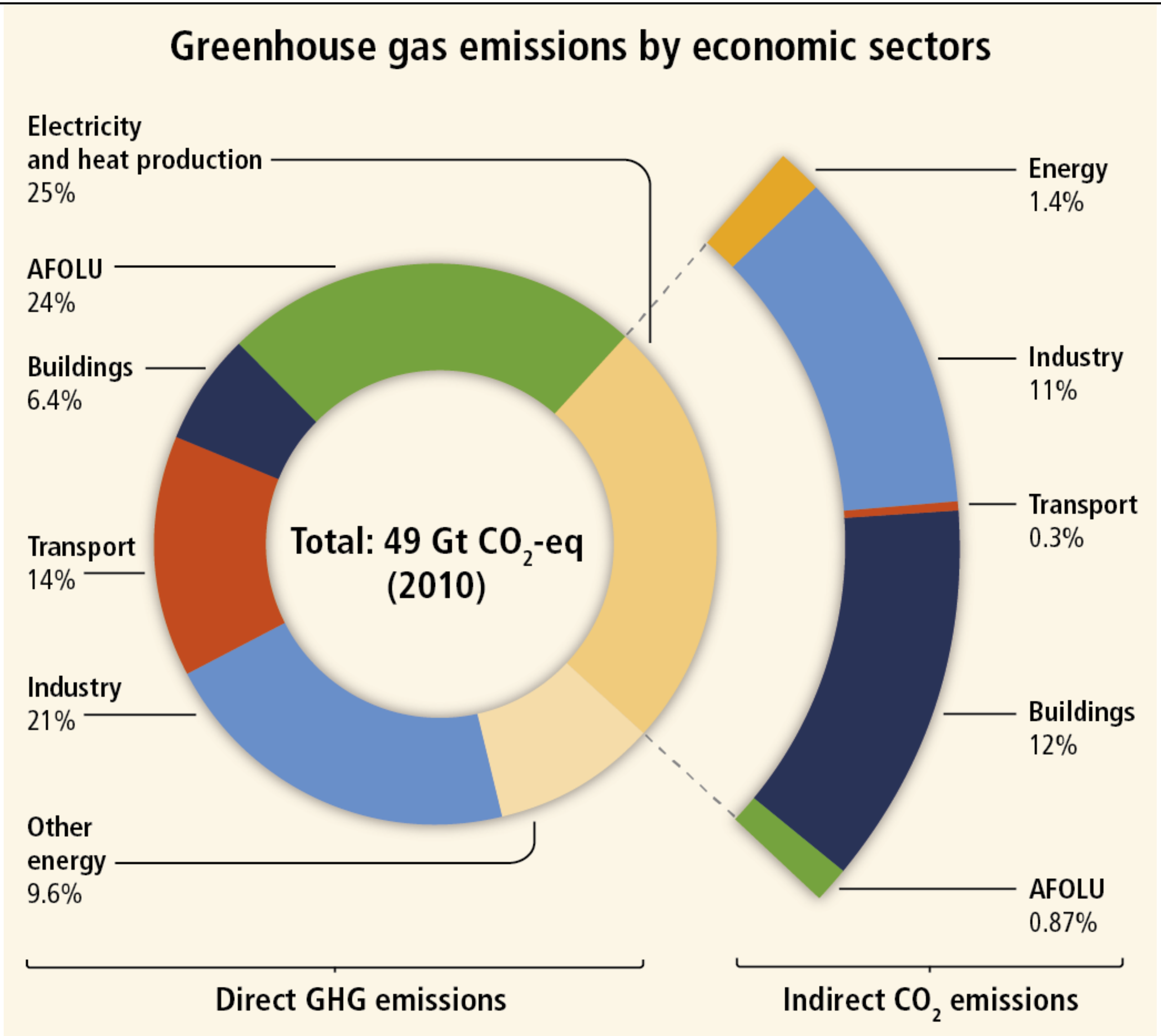


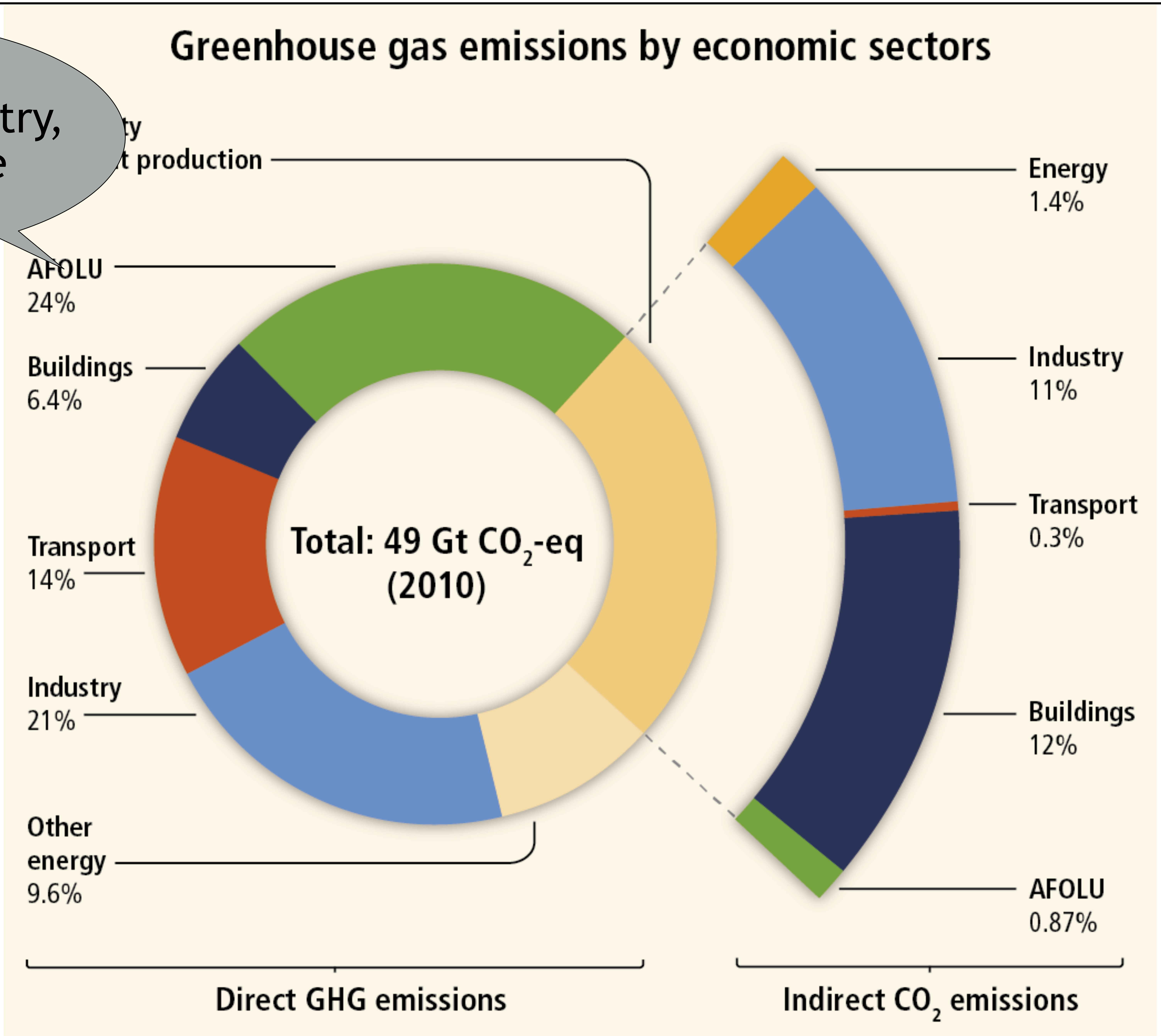


Understanding the Causes



Understanding the Causes

Agriculture, Forestry, Other Land Use



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Questions and Conclusions:

- How well do we understand past and current changes:
  - We have comprehensive observations that document the variability of the system
  - Detecting changes in dynamics and system state is nevertheless difficult due to large variability
  - Knowledge about changes in variables and underlying processes is evolving rapidly
- How well do we understand the processes?
- How well can we anticipate future changes
- Do we have sufficient foresight in terms of what might happen?

Mitigation and Adaptation Studies

Class 19: Developing Foresight

Contents

- The Role of Paradigms
- Uncertainty or Probability?
- Foresight and Foreseeability
- Foresight, Foreseeability, and Decision Making

The Role of Paradigms

Oxford English Dictionary: a paradigm is "a typical example or pattern of something; a pattern or model"

Kuhn (1962). The Structure of Scientific Revolutions:

- Sciences go through alternating periods of normal science (existing model of reality dominates a period of puzzle-solving), and revolution (the model of reality itself undergoes sudden drastic change).
- Paradigms have two different aspects in periods of normal science and scientific revolution
- Normal science: paradigm refers to a set of exemplary experiments that are likely to be copied or emulated. Underpinning this set are shared preconceptions, made prior to – and conditioning – the collection of evidence. These preconceptions embody quasi-metaphysical hidden assumptions and elements, although the interpretations of the paradigm may vary among individual scientists. Conviction that the current paradigm *is* reality tends to disqualify evidence that might undermine the paradigm itself. This leads to unreconciled anomalies.
- Scientific Revolution: The unreconciled anomalies eventual lead to a revolutionary overthrow of the incumbent paradigm, and its replacement by a new one: *paradigm shift.* Comparable to the perceptual change that occurs when the interpretation of an ambiguous image shifts from one state to another.

The Role of Paradigms

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Knowing the "paradigms", "immutable truths"

The Role of Paradigms

Knowing the “paradigms”, “immutable truths”

James Balog, 2013:

- “Slavery is necessary”
- “Child work is acceptable”
- “Women should not vote”

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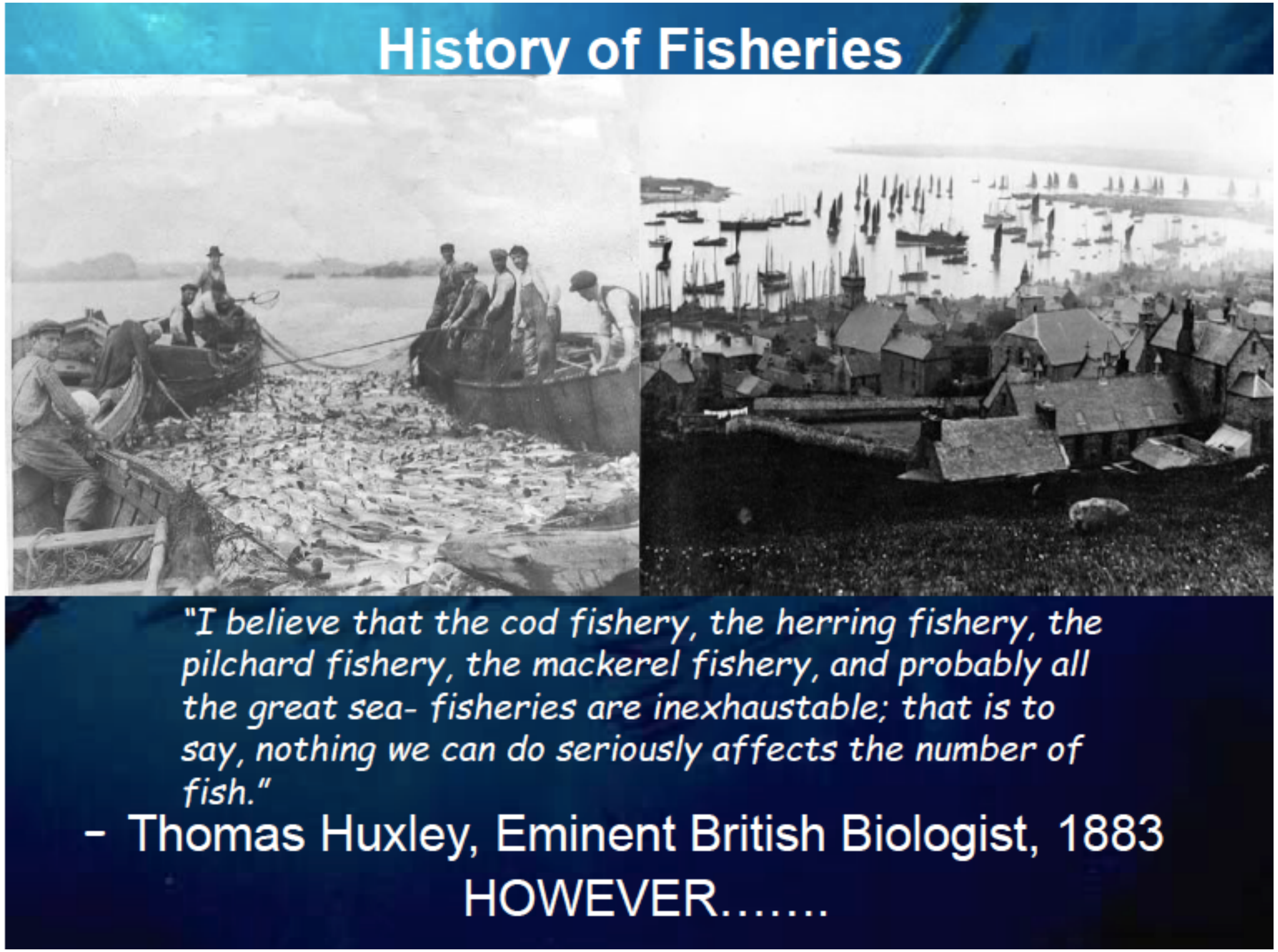
Recent “immutable truths”:

- The oceans are invincible …



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Living Blue Planet Report 2015

DATE:
September 15, 2015

THIS PUBLICATION RELATES TO:
Ocean Habitat | Overfishing | Oil and Gas Development | Oceans

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WWF's Living Blue Planet Report takes a deep look at the health of our oceans and the impact of human activity on marine life. Data on marine ecosystems and human impacts upon them is limited, reflecting the lack of attention the ocean has received to date. Nevertheless, the trends shown here present a compelling case for action to restore our ocean to health.

https://www.worldwildlife.org/publications/living-blue-planet-report-2015

Download (7.79 MB)

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Recent “immutable truths”:

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- Growth is necessary for economic prosperity

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WWF's Living Blue Planet Report takes a deep look at the health of our oceans and the impact of human activity on marine life. Data on marine ecosystems and human impacts upon them is limited, reflecting the lack of attention the ocean has received to date. Nevertheless, the trends shown here present a compelling case for action to restore our ocean to health.

Download (7.79 MB)

https://www.worldwildlife.org/publications/living-blue-planet-report-2015

Mitigation and Adaptation Studies

Class 19: Developing Foresight

Contents

- The Role of Paradigms
- Uncertainty or Probability?
- Foresight and Foreseeability
- Foresight, Foreseeability, and Decision Making

Uncertainty or Probability?

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"A **good understanding of the climate system** is essential to allow society to prepare for the future. Increasing populations, diminishing resources, changing weather patterns and extreme events in combination with water scarcity and changing crop yields will all put pressure on communities. The only sure thing is that the climate and weather in the coming years will continue to have a **degree of uncertainty and surprise us**."

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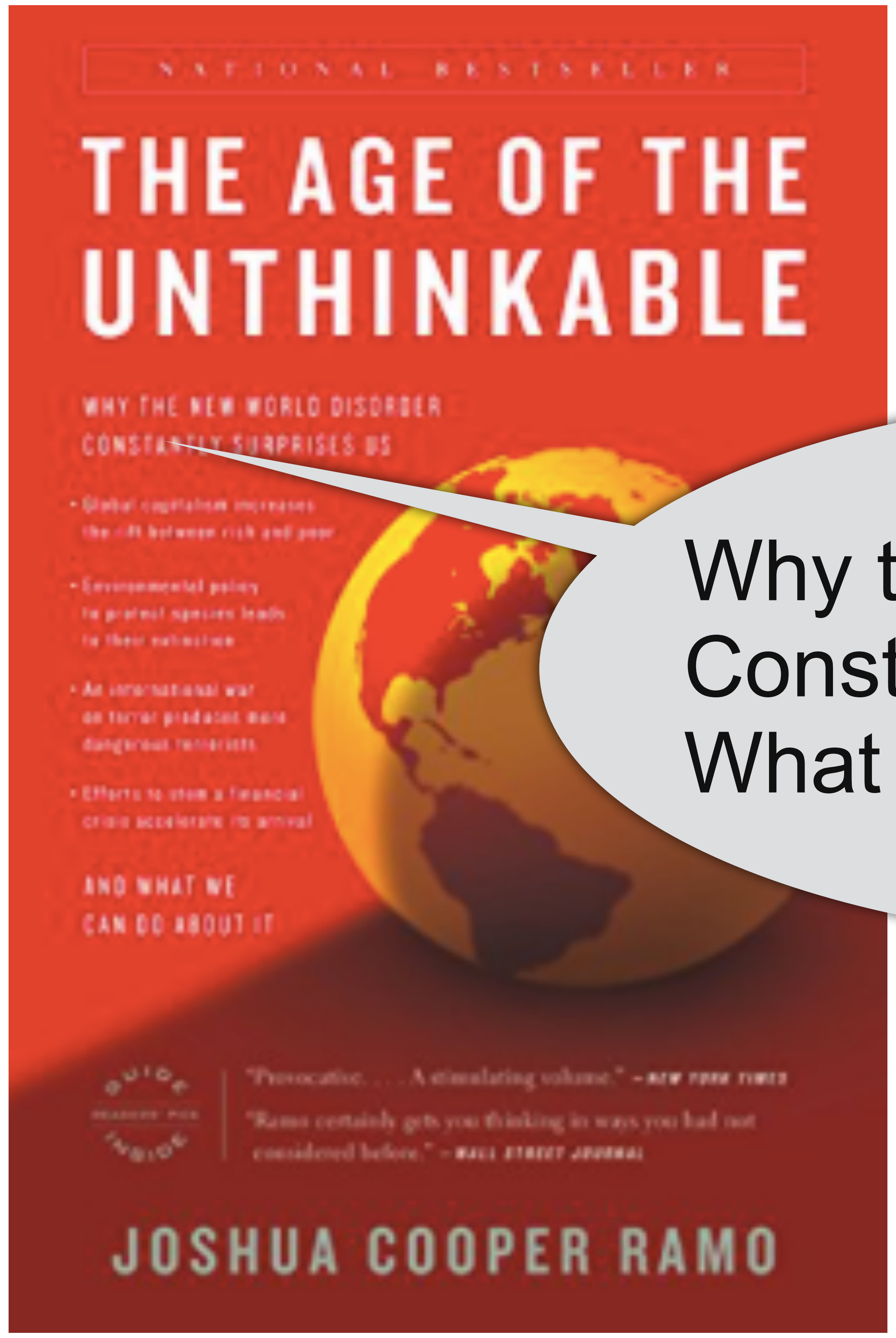
Complex systems:
Aiming at understanding (foreseeing) what the system might do, instead of trying to predict (with uncertainty) what it will do …



Why the New World Disorder Constantly Surprises Us And What We Can Do About It

Uncertainty or Probability?

Decision Making:

Half full or half empty?

Decision Making:

Half full or half empty?

What we don't know

Focus on what we don't know, uncertainty

Our knowledge

Uncertainty or Probability?

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Glass of knowledge

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Using what we know to develop foresight

Uncertainty or Probability?

WORKING WITH A CHANGING CLIMATE, NOT AGAINST IT

PROJECT REPORT

Hydro-Meteorological Disaster Risk Reduction:
A Survey of Lessons Learned for Resilient Adaptation
to a Changing Climate

Is Resilience the key?

http://fcw.com/articles/2013/07/08/exectech-operational-resilience.aspx

Michael H. Glantz (PI), Marie-Ange Baudoin (co-PI), Arielle Tozier de la Poterie, Lino Naranjo, Gregory Pierce, Dhiraj Pradhananga, Tsegay Wolde-Georgis, Bapon Fakhruddin, Atiq Kainan Ahmed, Netra Chapsoporn, P.E.O Usher, Ivan Ramirez

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source: www.forbes.com

Actions based on one's perceptions of reality have real consequences.

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Self-Perception and Perception of the World

source: www.forbes.com

Actions based on one's perceptions of reality have real consequences.

Complexity, creeping normalcy and conceit: sexy and unsexy catastrophic risks

Author(s): Karin Kuhlemann , (School of Public Policy, University College London, London, UK)

Before delving into the existential vs sub-existential and sexy vs unsexy dichotomies, it is useful to consider three cognitive weaknesses[2] that hinder recognition, engagement and rational responses to GCRs: probabilistic thinking, caring about people we cannot see and valuing the future.

First, and stating the obvious, GCRs are risks. Engaging with risks of any kind requires probabilistic thinking, at which human beings in general are notoriously poor (Dawes, 2001; Tversky & Kahneman, 1974). We tend to inappropriately focus on specific rather than general information, neglecting base rates (Tversky and Kahneman, 1982; Welsh and Navarro, 2012). We are prone to overestimating the probability of positive events and underestimating the likelihood of negative ones (Sharot, 2011), in particular when predicting what will happen to ourselves (Weinstein and Klein, 1995; Weinstein, 1980, 1989) or those we care about (Kappes et al., 2018). We tend to be particularly optimistic in predicting outcomes that will not be known for some time (Armor & Taylor, 2002, pp. 339-340), and our optimistic beliefs tend to persevere even in the face of contrary evidence (Garrett and Sharot, 2017). Faced with information about a risk, we tend to assume that it will not actually materialise, or that its consequences will not really be catastrophic.

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Foresight and Foreseeability

Academic disciplines have a beginning, just like any other institution in society. The ancient Greeks were particularly inventive in establishing many of the disciplines we take for granted today – history, geometry, and a form of physics. We may be in a similar position today with the study of the future. Before the Enlightenment, **religion was in charge of our knowledge of the future** supplemented by a healthy dose of superstition. The **modern world** improved on that approach by introducing the **concepts of mathematical extrapolation and prediction**. That approach served us well when the world was more orderly, but simple extrapolation does not do justice to a **complex and increasingly novel future**. Nevertheless, we are still equipping our students to deal with the future in this century with the tools from the last few centuries. My recommended change, therefore, is that every student in the world takes at least one **required course on foresight and futures studies** in order to handle change in the world that they will live in rather than the world that their parents and teachers did.

Peter Bishop, 2017, Fast Future Publishing

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Oracle of Delphi: People came from all over Greece and beyond to have their questions about the future answered by the Pythia, the priestess of Apollo.

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Foresight and Foreseeability

Foreseeability
n. reasonable anticipation of the possible results of an action, such as what may happen if one is negligent or consequential damages resulting a from breach of a contract.

The facility to perceive, know in advance, or reasonably anticipate that damage or injury will probably ensue from acts or omissions.

In the law of **Negligence**, the foreseeability aspect of proximate cause—the event which is the primary cause of the injury—is established by proof that the actor, as a person of ordinary intelligence and circumspection, should reasonably have foreseen that his or her negligent act would imperil others, whether by the event that transpired or some similar occurrence, and regardless of what the actor surmised would happen in regard to the actual event or the manner of causation of injuries.
West's Encyclopedia of American Law, edition 2.

Foresight and Foreseeability

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In his law dictionary, Gifis (1991, 195–196) writes that “Foreseeability encompasses not only that which the defendant foresaw, but that which the defendant ought to have foreseen.”

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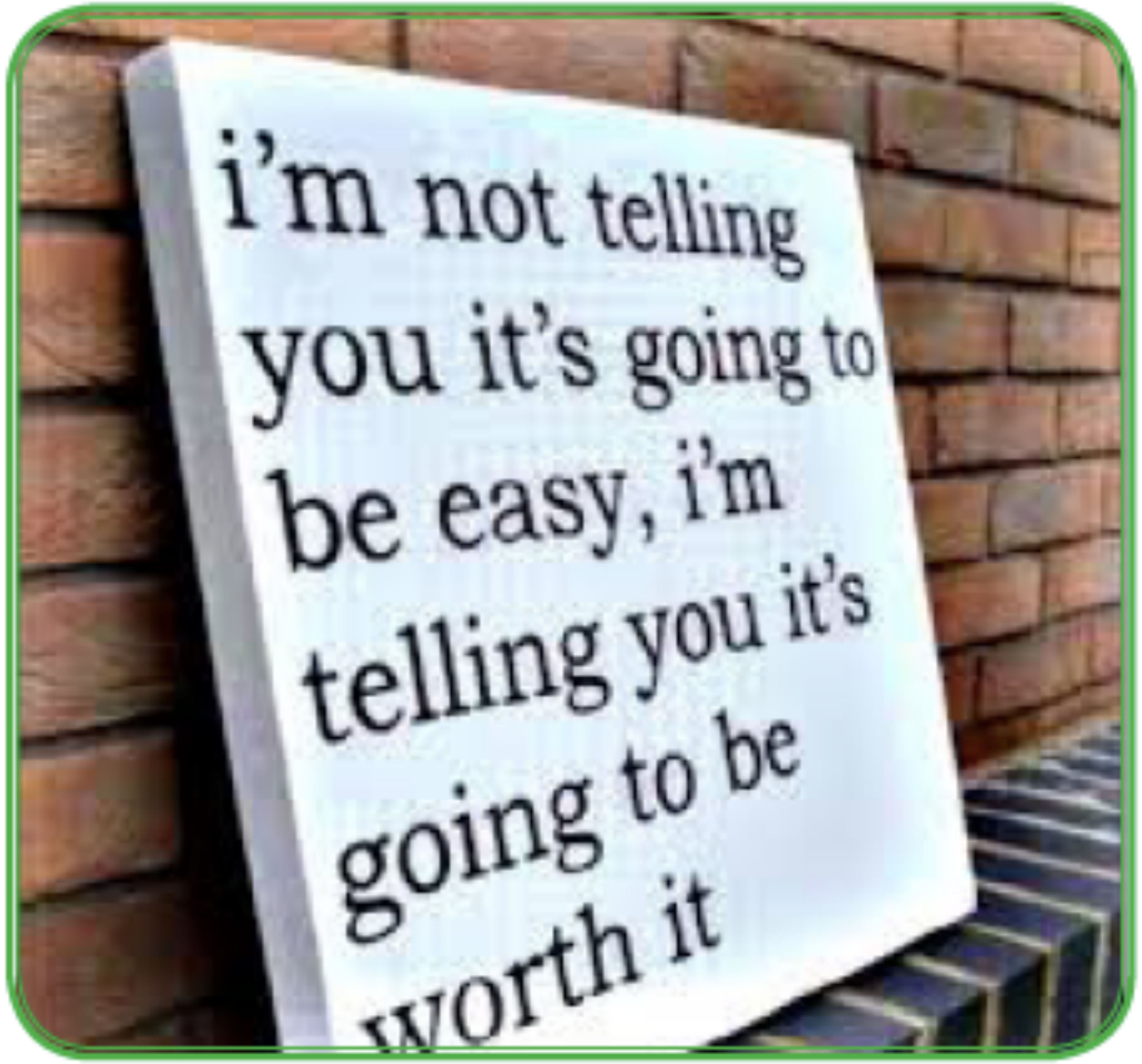

Foresight and Foreseeability

Source: www.uowblogs.com

ABOUT LESSONS LEARNED

Why:

Philosopher Santana was noted as having said, "Those who do not learn from history are doomed to repeat it." There are now variations on this theme, uttered by famous as well as the not so famous individuals, but the core message remains: people must know history in order to learn from it. People around the globe, through trial and error, have forever been learning tactical and strategic responses to their local and regional hydro-meteorological hazards and disasters.

Much of what they have learned in their local environments could be of value to others facing similar hazards and disasters far away.

Source: www.uowblogs.com

“Lessons learned” instead of “Lessons noted”

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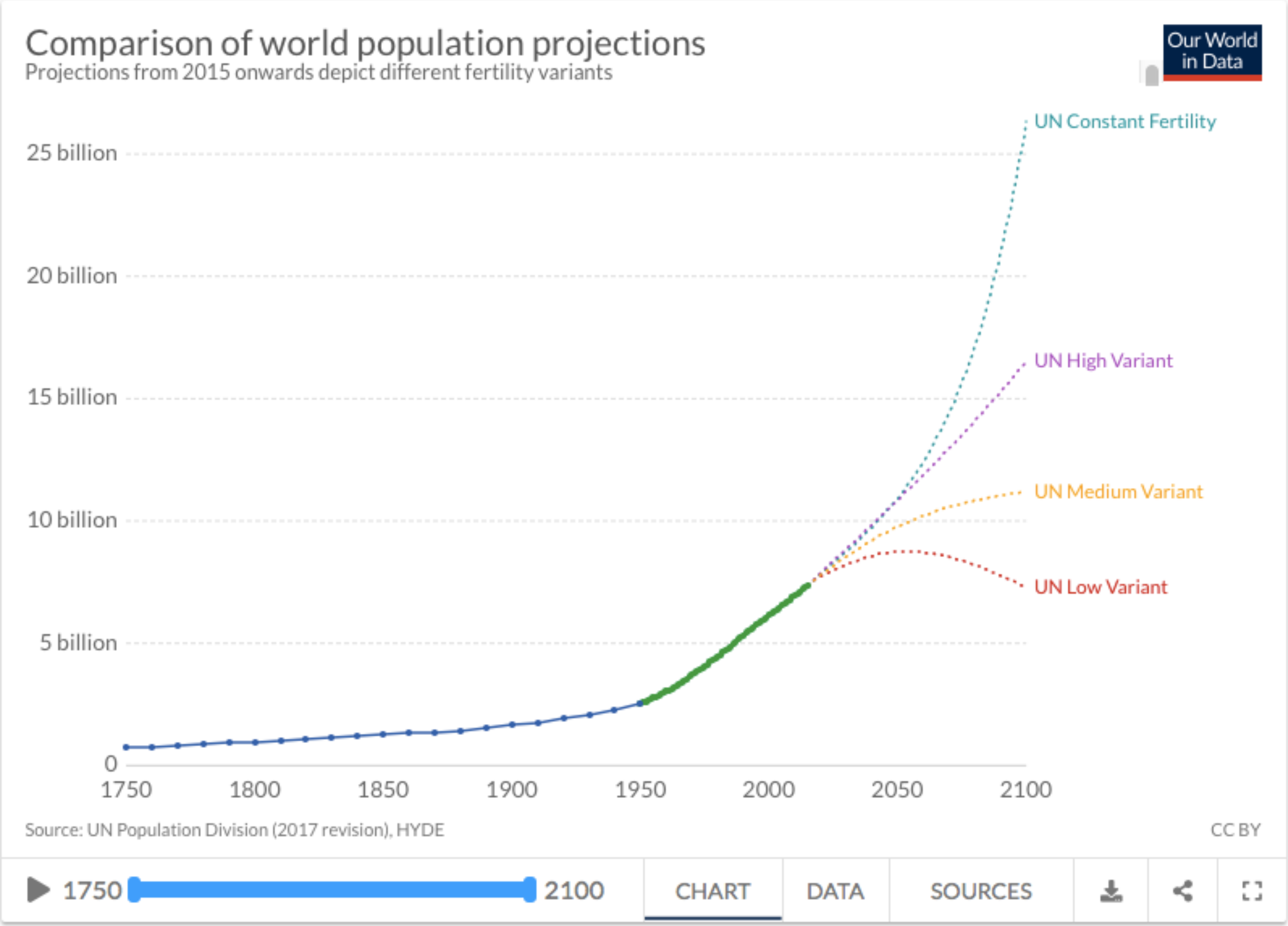
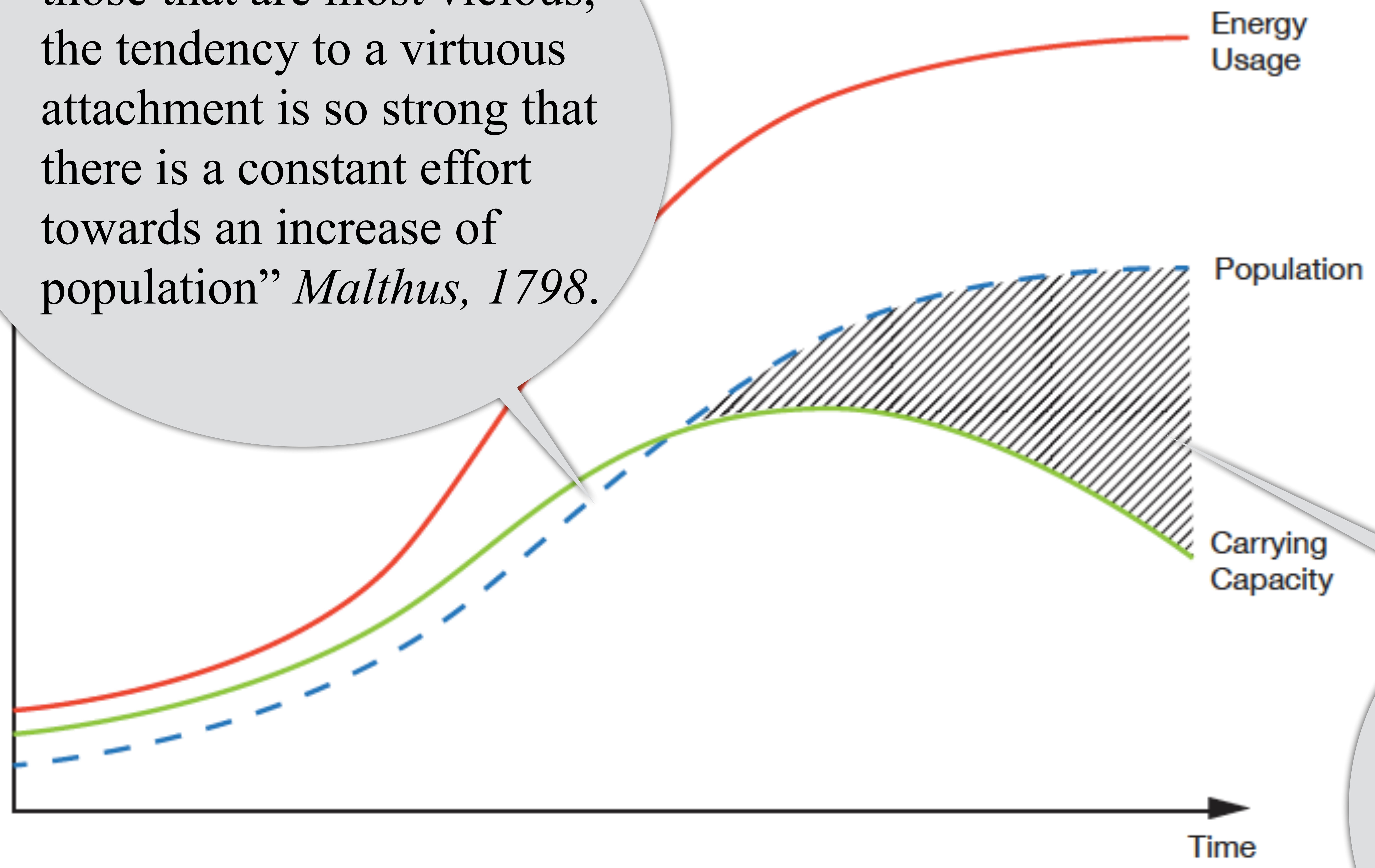


https://ourworldindata.org/future-population-growth

Population Growth

"Yet in all societies, even those that are most vicious, the tendency to a virtuous attachment is so strong that there is a constant effort towards an increase of population” *Malthus, 1798.*



Carrying Capacity = function of: Arable Land, Nitrogen, Phosphorous, Climate, Water, Biodiversity, Land Use, Energy, Degradation, Technology, …

$CC = f(A, N, P, C, W, B, L, E, D, T, \ldots)$

$C = f(E, L, \ldots)$

$W = f(C$

“That the increase of population is necessarily limited by the means of subsistence, That population does invariably increase when the means of subsistence increase, and, That the superior power of population is repressed, and the actual population kept equal to the means of subsistence, **by misery and vice**.”

Malthus, 1798.

Lovelock: Carrying Capacity will be down to 1 Billion in 2050

Foresight and Foreseeability

Population Growth

Millions in South Sudan in Urgent Need of Food, U.N.

By JEFFREY GETTLEMAN FEB. 20, 2017

Energy

Carrying Capacity = function of: Arable Land, Nitrogen, Phosphorous, Climate, Land Use, Energy, ‑logy, …

Women who fled fighting in South Sudan waited for food to be
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South Sudan, the United Nations annou
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AFRICA

Why 20 Million People Are on Brink of Famine in a 'World of Plenty'

By SOMINI SENGUPTA FEB. 22, 2017

Nigerians displaced by Boko Haram insurgents last February at Dikwa camp in northe
United Nations raised the alarm on Wednesday about the risk of famine in northern N
Agence France-Presse — Getty Images

Africa hit by worst famine crisis, 20 million people face death

COMPILED FROM WIRE SERVICES

ISTANBUL

Published March 12, 2017

A Somali woman walks through a camp of people displaced from their homes elsewhere in the country by the drought, shortly after dawn in Qardho, Somalia on March 9.

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Foresight and Foreseeability

Population Growth

IOM
UN MIGRATION

1. MIGRANT POPULATION (STOCKS)

258 Million

INTERNATIONAL MIGRANTS

were counted globally in 2017 – people residing in a country other than their country of birth. This represented 3.4% of the world's total population.

6. DISPLACEMENT

68.5 Million

INDIVIDUALS

were forcibly displaced worldwide due to persecution, conflict, generalized violence, human rights violations, or other reasons by the end of 2017.

11. TRAFFICKING & MODERN SLAVERY

25 Million

VICTIMS OF FORCED LABOUR

were estimated in 2016. Out of those, 5 million may have crossed an international border.

16. ENVIRONMENT

18.8 Million

PEOPLE

in 135 countries were newly displaced by sudden-onset disasters within their own countries in 2017.

Population Growth

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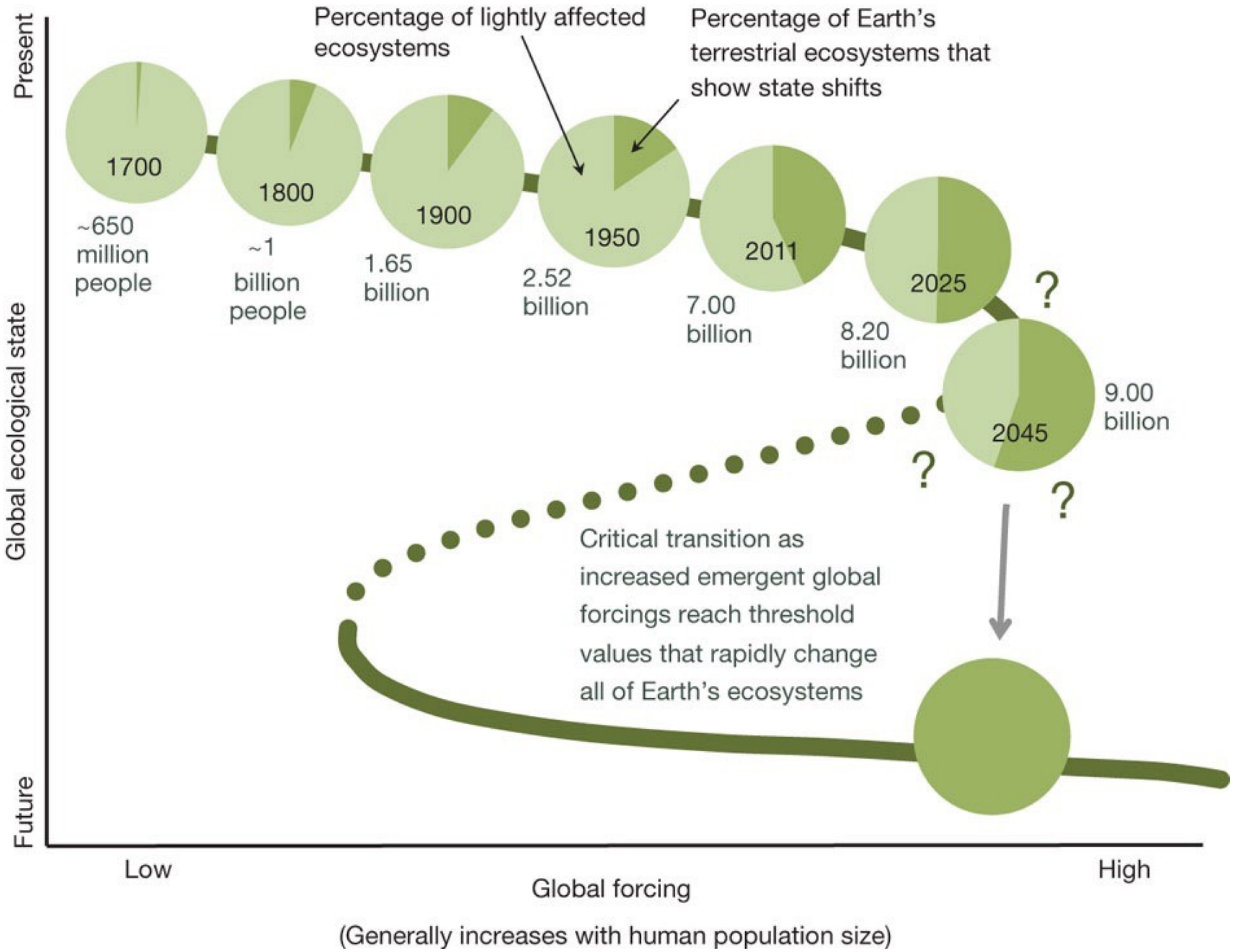


Foresight and Foreseeability

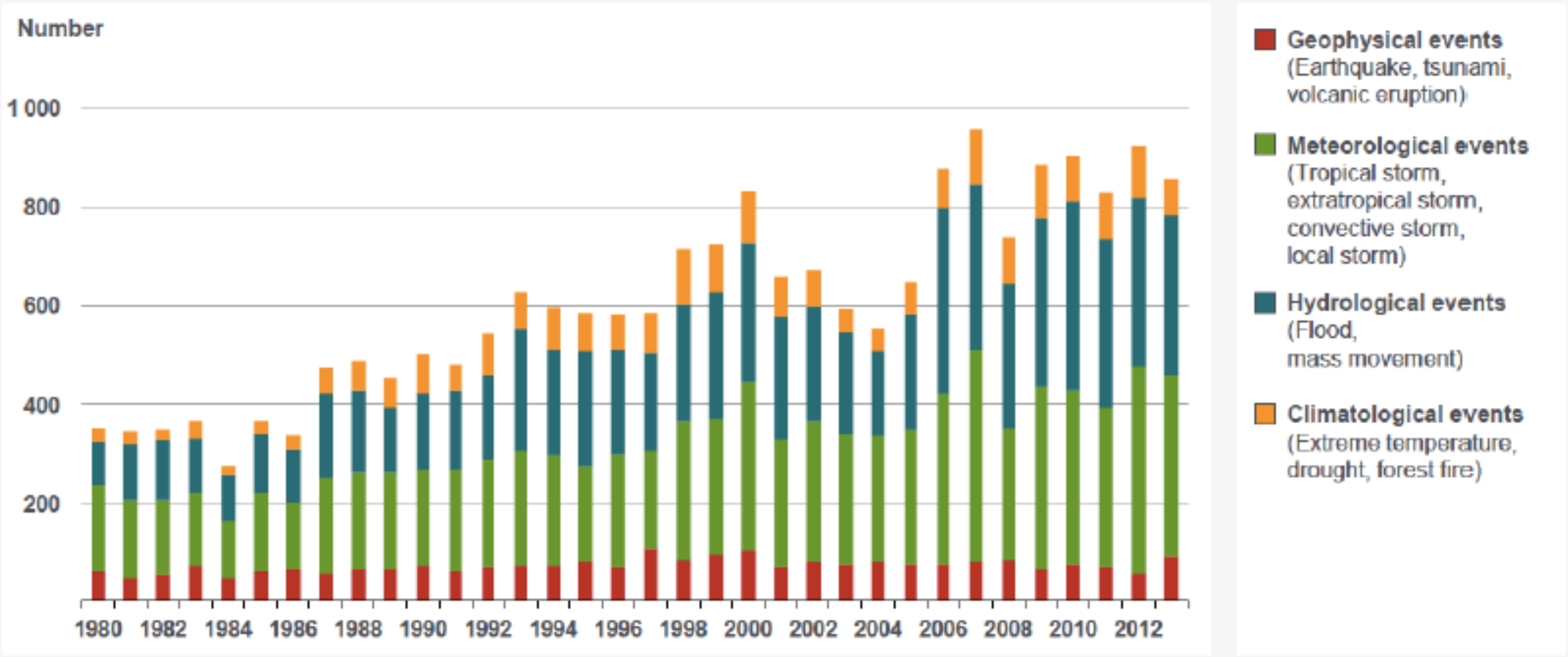
Hazards and Disasters

NatCatSERVICE

Loss events worldwide 1980 – 2013

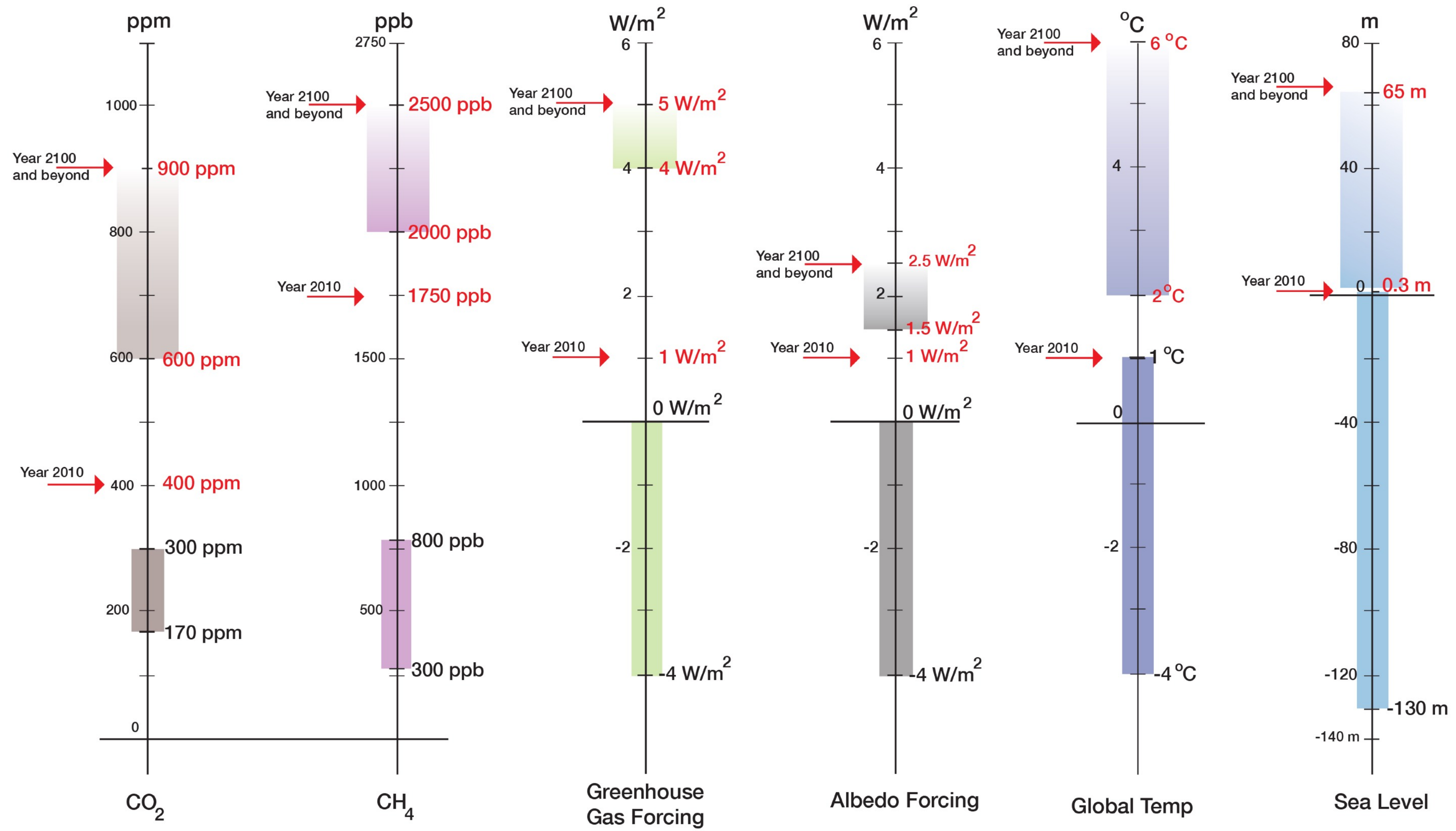
Number of events

Munich RE



Foresight and Foreseeability

Climate Change



"Prognosis"

"Current State"

"Normal Range"
(800,000 years)

Climate Change

Climate Change

What are the Impacts of Climate Change?

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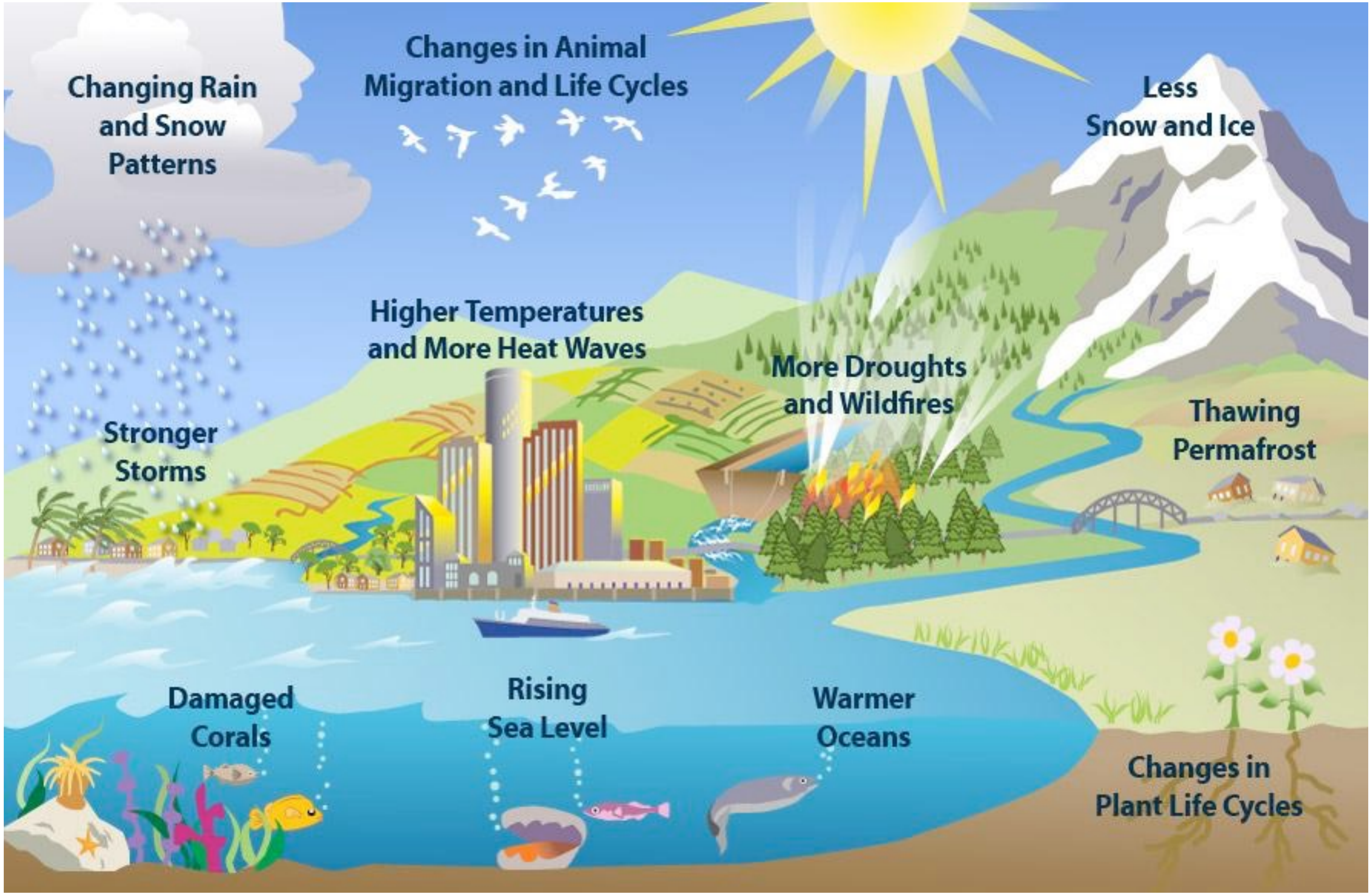
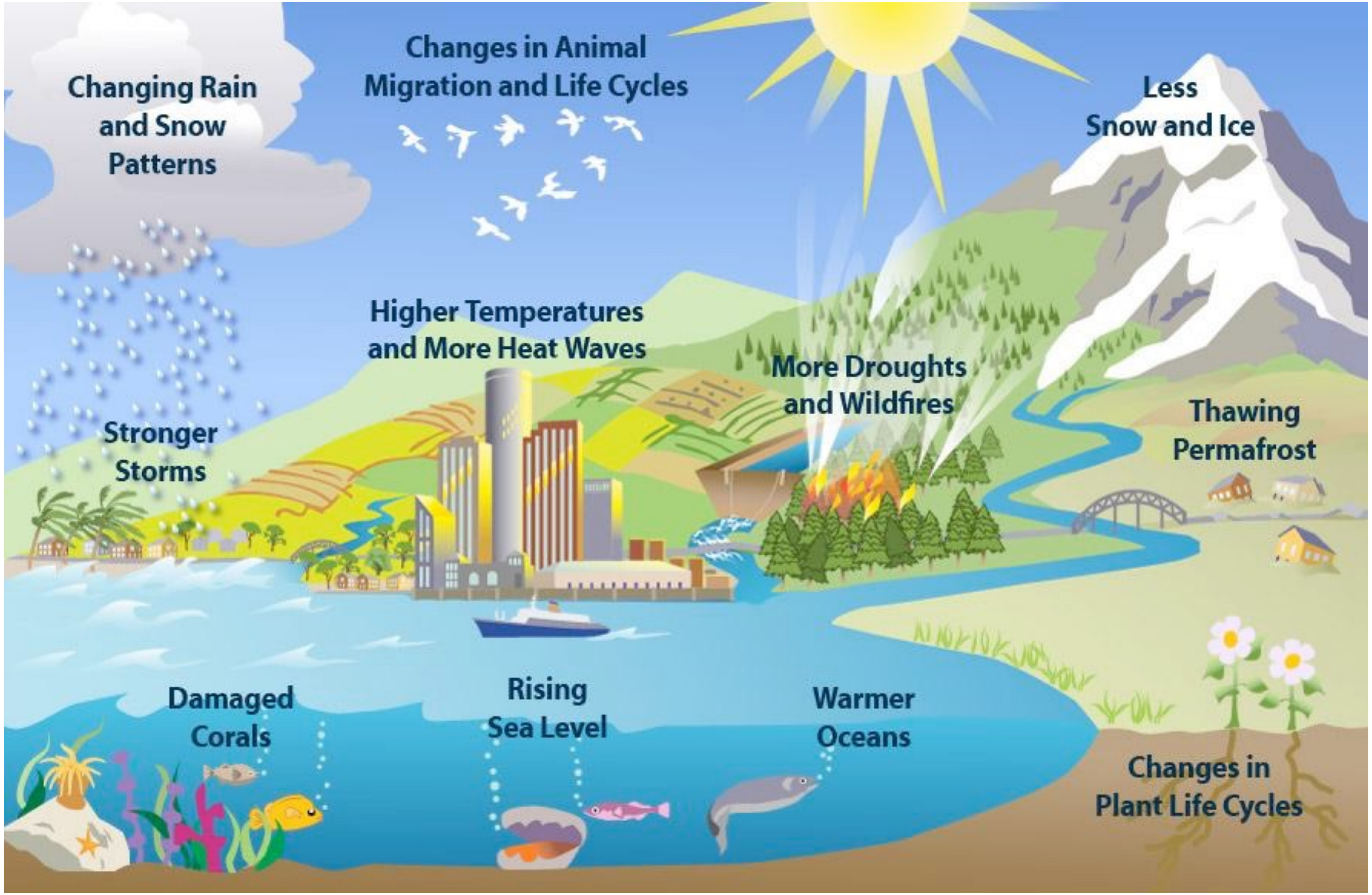


Climate Change

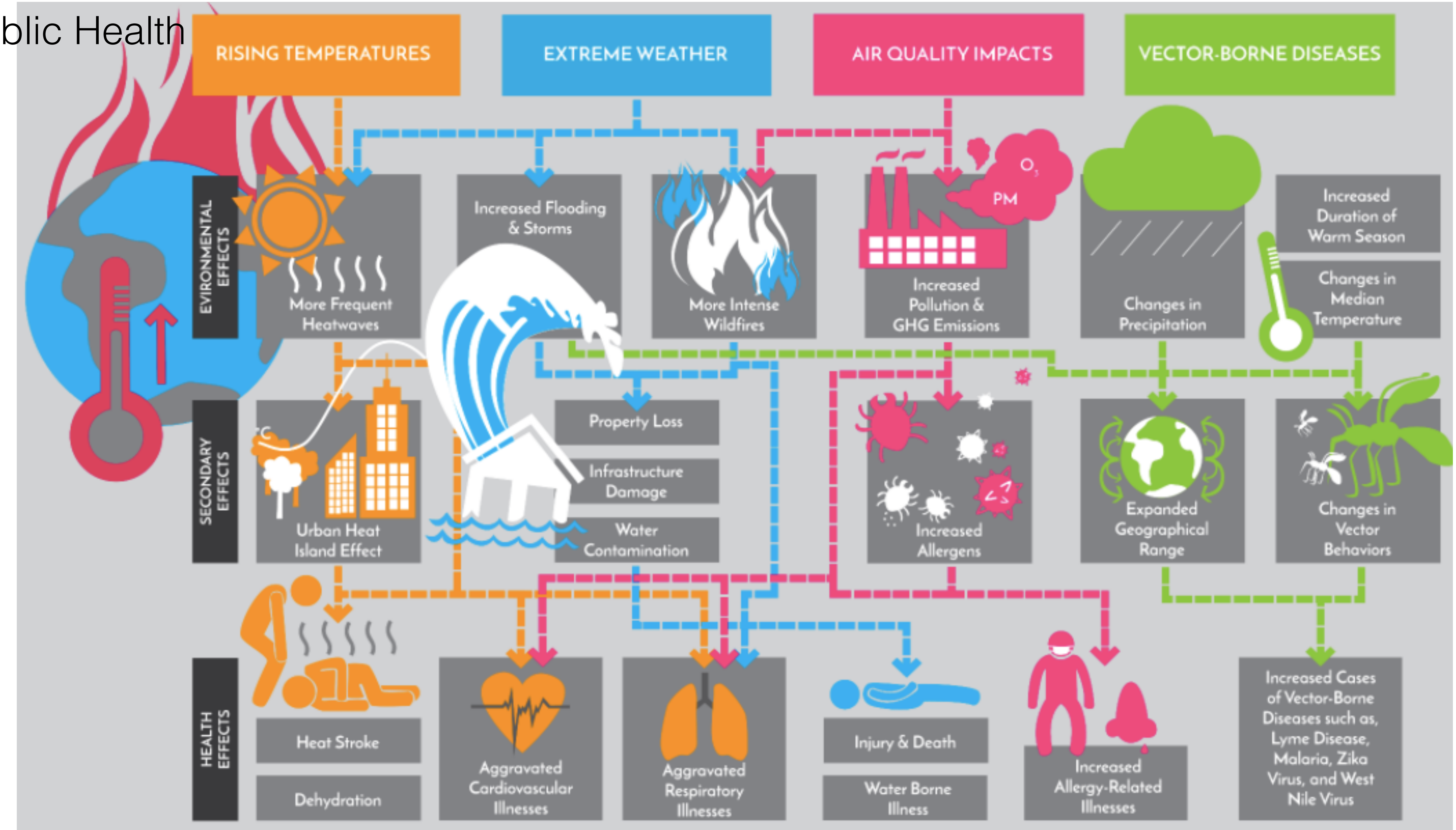
What are the Impacts of Climate Change?

... and there is more:
- health
- supply chains
- mass extinction
- water security
- food security
- migration
- social unrest
...



Foresight and Foreseeability

Public Health



Foresight and Foreseeability

Public Health

THE CONVERSATION

Academic rigor, journalistic flair

Se

Arts + Culture Economy + Business Education Environment + Energy Ethics + Religion Health + Medicine Politics

How global warming is adding to the health risks of poor people

January 27, 2019 4.14am EST

People living in run-down, inner city apartments, like these in Cairo, are at risk of heat-stress health problems. Shutterstock

Foresight and Foreseeability

Public Health

Humanitarian response

Cyclone Idai crisis deepens as first cases of cholera confirmed in Mozambique

Five people test positive for waterborne disease in flooded port city of Beira amid warnings outbreak will spread

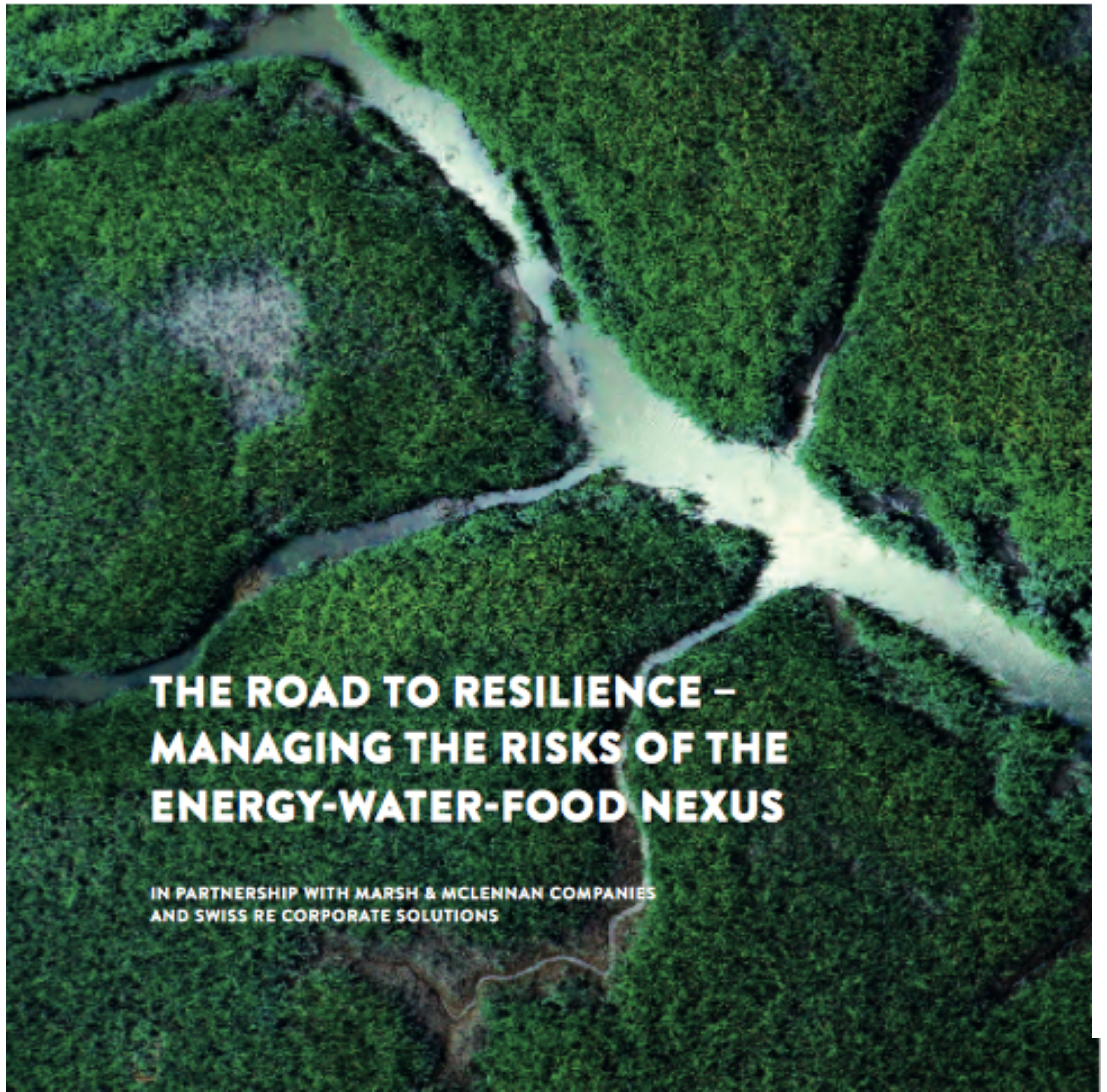
▲ Residents survey the devastation caused by Cyclone Idai in the Mozambican city of Beira, where fears of a cholera outbreak have been realised. Photograph: Karel Prinsloo/DEC

Foresight and Foreseeability

Food-Water-Energy Nexus

WORLD ENERGY COUNCIL

World Energy Perspectives | 2016



KEY FINDINGS

1 **ENERGY IS THE SECOND LARGEST FRESHWATER USER** after agriculture. Water is used all along the energy value chain in primary energy production (coal, oil, gas, biofuels) and in power generation (hydro, cooling). 98% of the power currently produced needs water.

2 **THE RISKS POSED BY THE ENERGY-WATER-FOOD NEXUS WILL BECOME MORE SIGNIFICANT** because of growing demand for energy, water and food. Moreover, some of the regions that are currently water stressed are also likely to see significant economic development, population growth and changing consumption patterns, and a higher concentration of people and assets in critical areas, intensifying the risks posed by the nexus.

3 **ALONGSIDE GROWING DEMAND, INCREASING UNCERTAINTY ABOUT WATER AVAILABILITY** and quality – driven by climate change impacts such as declining freshwater availability, increased ocean temperatures and more extreme weather – will further increase the significance of risks posed by the nexus.[1]

4 **ANALYSIS IN NATURE CLIMATE CHANGE**[2] highlights that from 2014 to 2069, reductions in usable water capacity could impact two-thirds of the 24,515 hydropower plants analysed and more than 80% of the 1,427 thermal electric power plants assessed.

5 **IN MANY CASES, THERE IS A LACK OF LOCATION-SPECIFIC KNOWLEDGE ON WATER ISSUES** and a lack of modelling tools to adequately reflect risks posed by the nexus in energy infrastructure investment decisions. Such risks can be associated with large economic stakes: in 2015, hydropower facilities in Brazil sustained economic losses of more than US$4.3 billion due to drought-related energy and water rationing measures.

6 **THE RISKS POSED BY THE NEXUS ARE OFTEN EXACERBATED** by the lack of sound water governance such as well-defined water rights for competing users, water pricing and trading arrangements.

7 **CROSS-BORDER COOPERATION IS A KEY ISSUE.** 261 international trans-boundary basins cover 45% of the earth's land surface, serve 40% of the world's population and provide 60% of the earth's entire freshwater volume. This affects the operation of planned and proposed energy infrastructures, and there is a need to ensure that adequate cross-border water management frameworks are in place.

Food-Water-Energy Nexus

Science & Environment

UN: Growing threat to food from decline in biodiversity

By Matt McGrath
Environment correspondent

22 February 2019

Share

The plants, animals, and micro-organisms that are the bedrock of food production are in decline, according to a UN study.

Interconnection between hazards can only be understood in a systems thinking approach.

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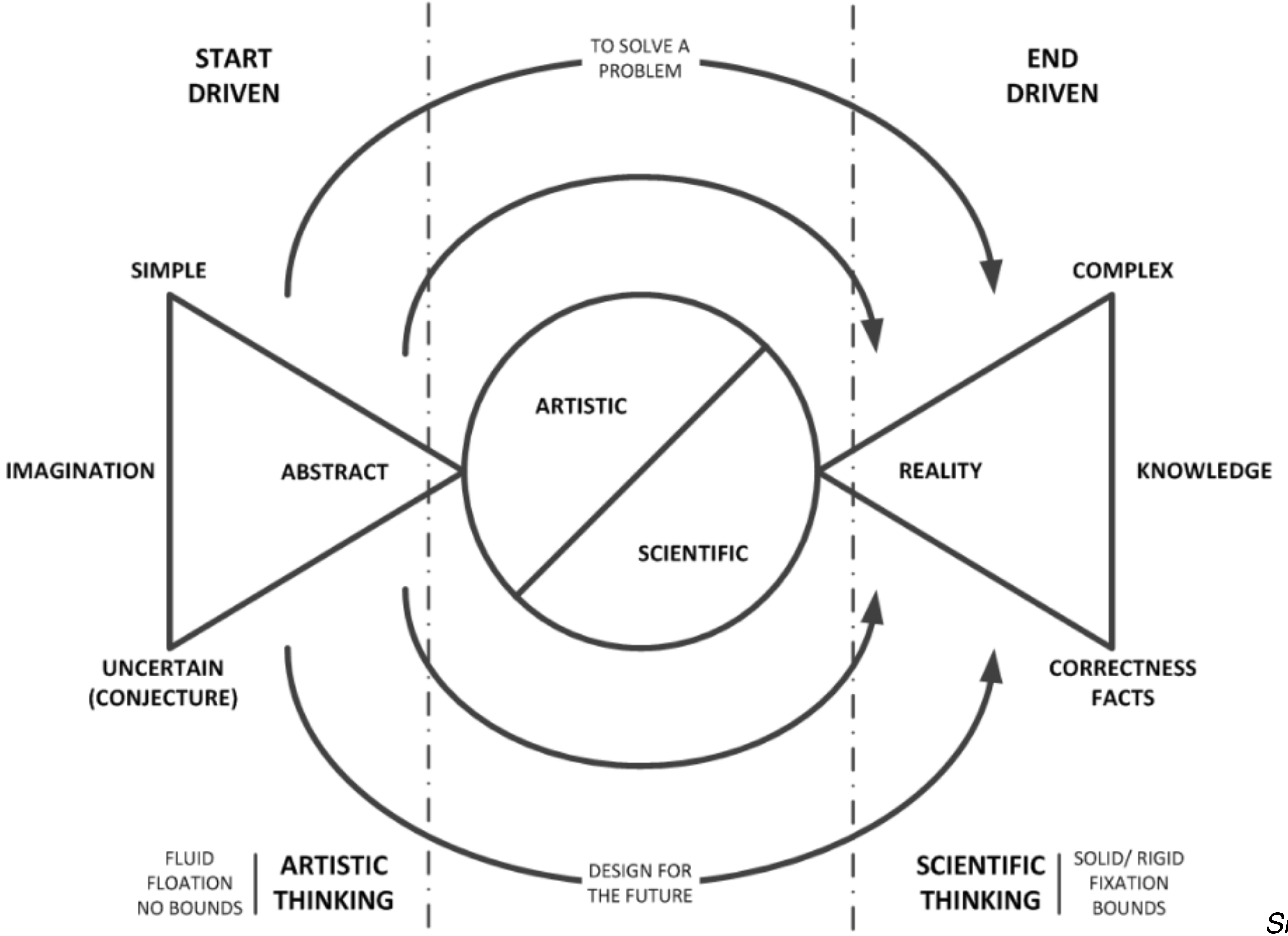
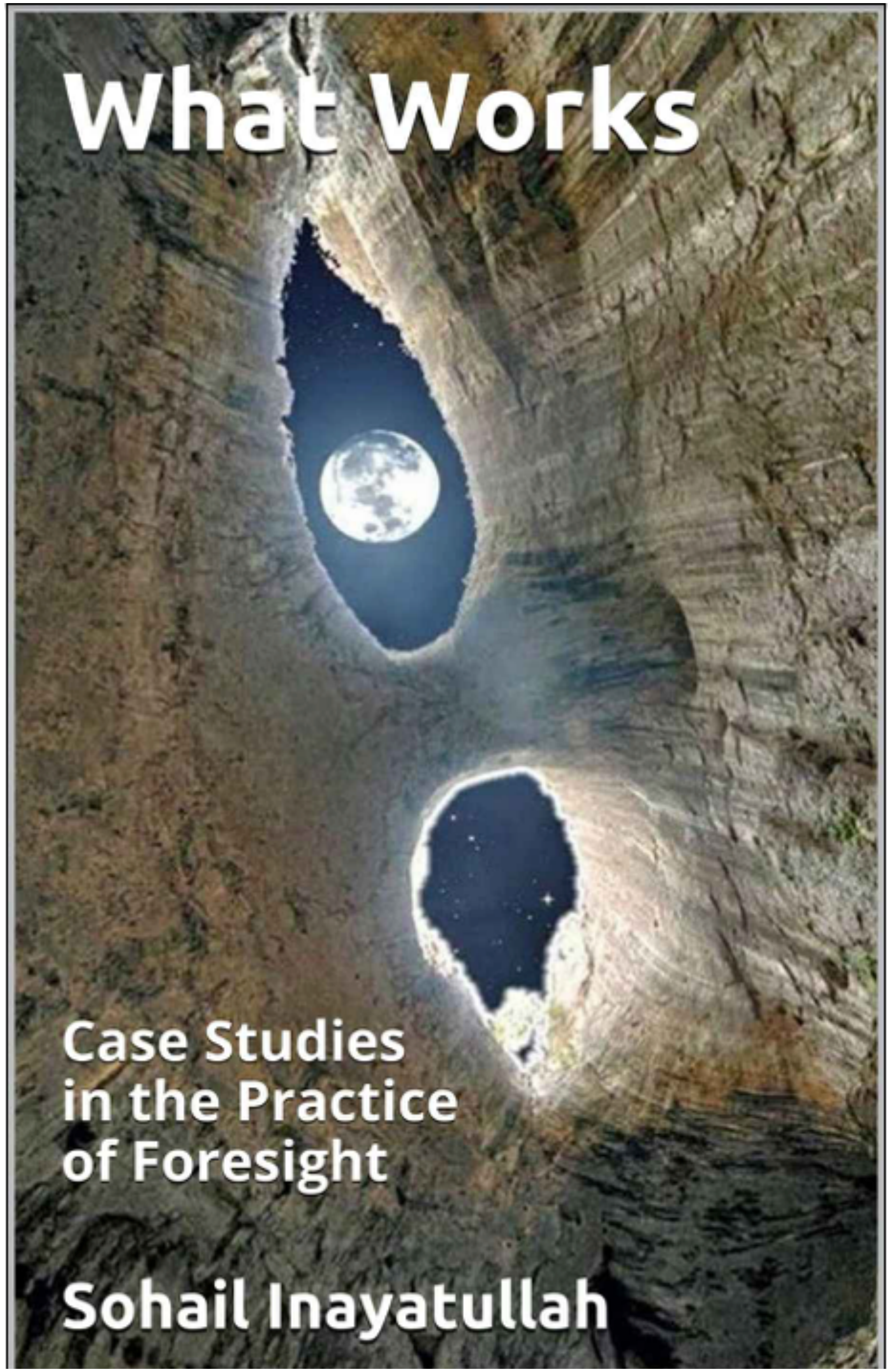
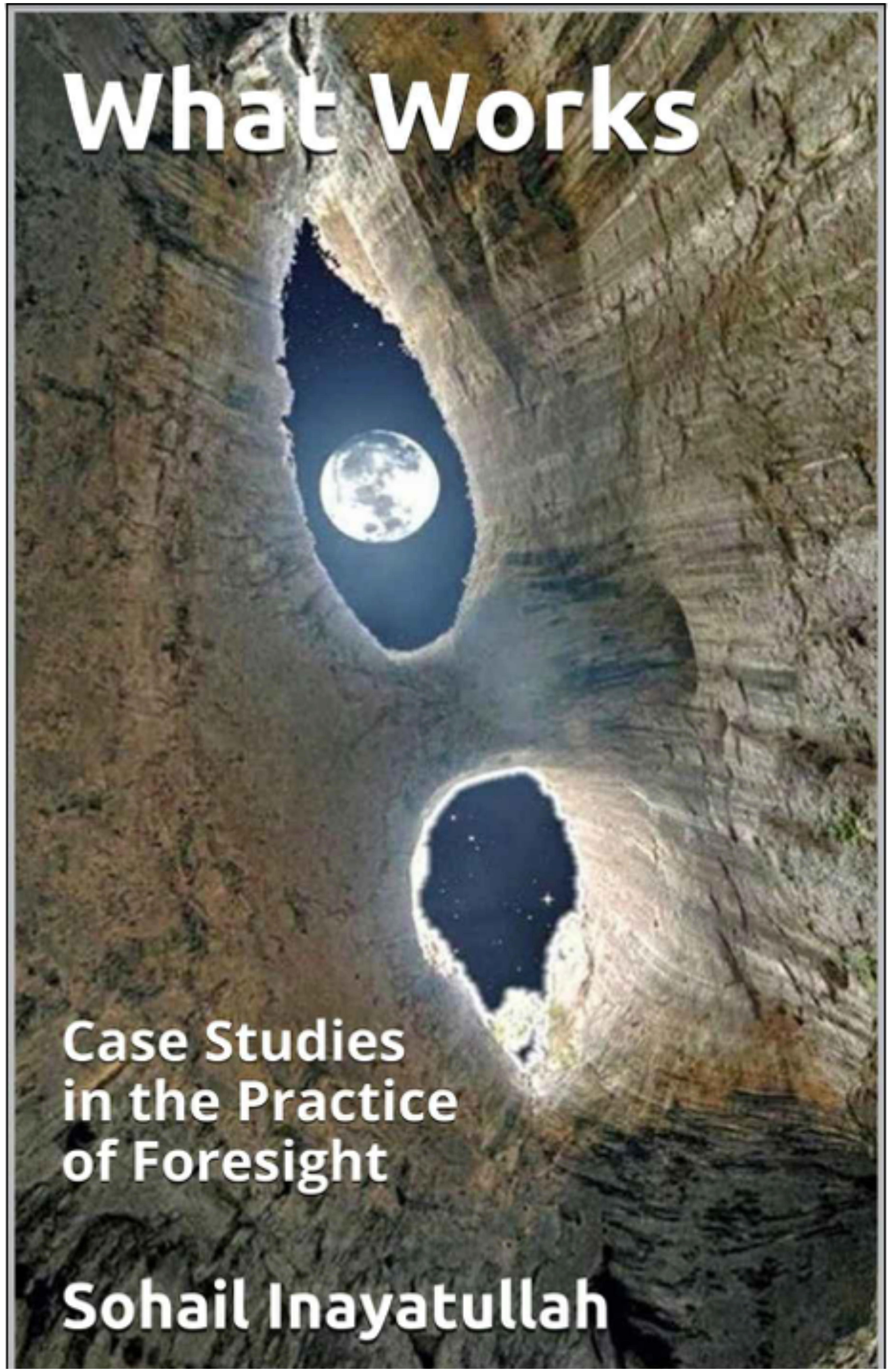
Foresight, Foreseeability, and Decision Making



Smith, 2015


What Works
Case Studies
in the Practice
of Foresight
Sohail Inayatullah

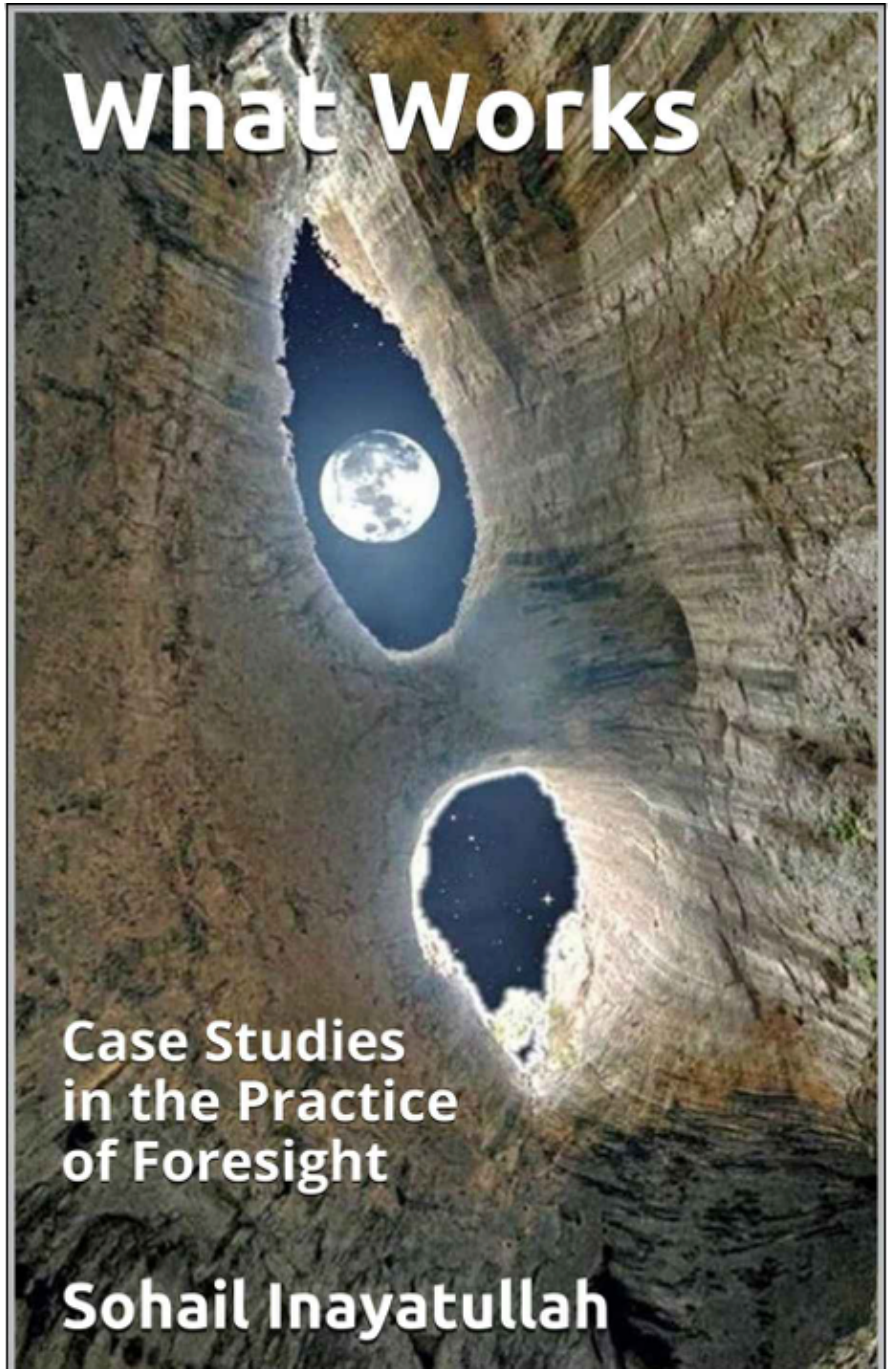
Foresight, Foreseeability, and Decision Making



Futures study is the **systematic study** of preferred, probable, and **possible futures** including the worldviews and myths that underlie each future. Futures research has moved from external forces influencing the future—astrology and prophecy—to structure (historical patterns of change, of the rise and fall of nations and systems) and agency (the study and creation of preferred images of the future).

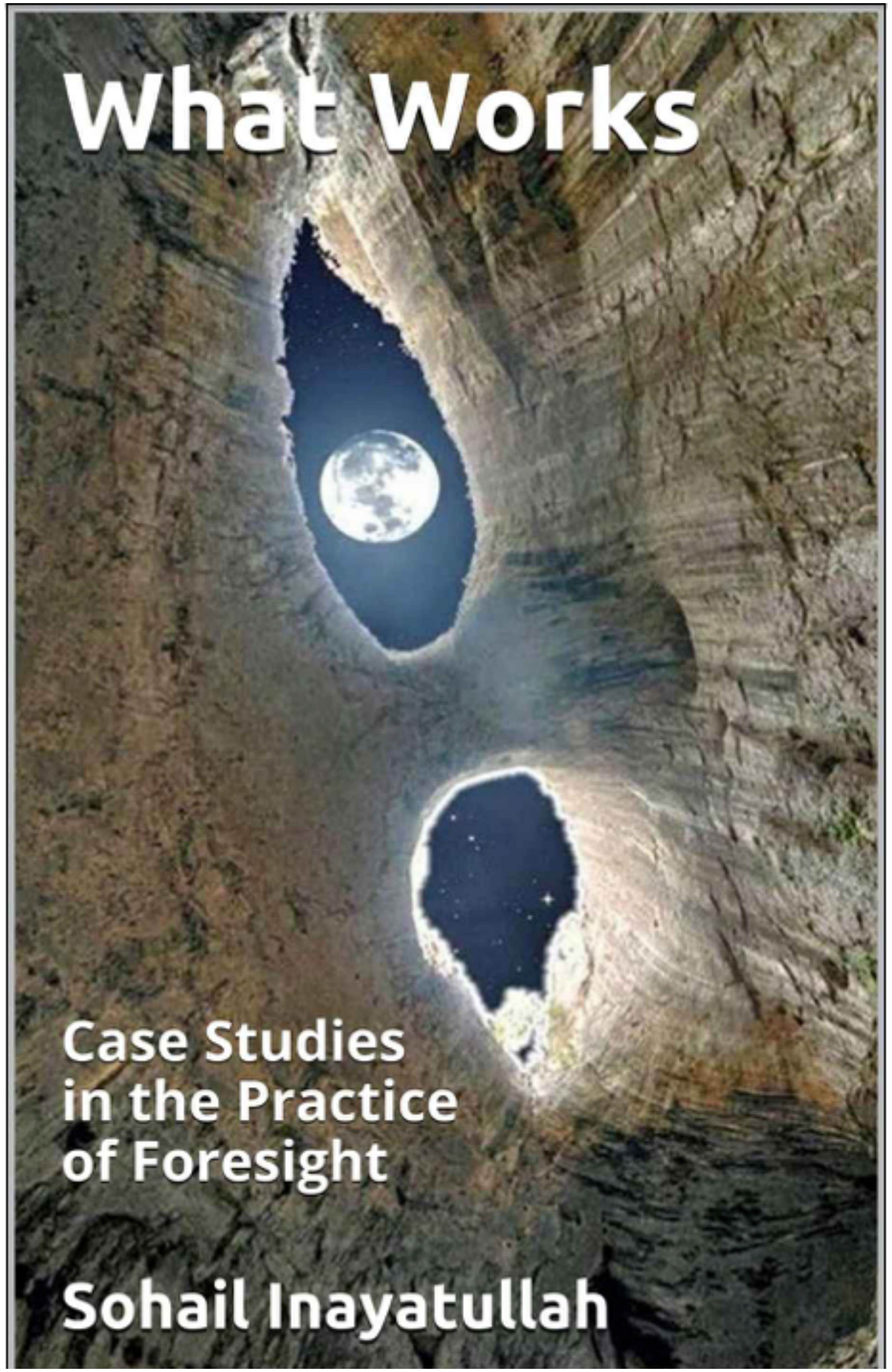
Futures studies has been eagerly adopted by planning departments in organizations and nations. Yet there are clear differences between the planning and futures framework. **Planning seeks to control and close the future**, while f**utures studies seeks to open up the future**, moving from the future to **alternative futures**.

Inayatullah, 2013



From a focus on **predicting the future**, the modern discipline of futures studies has broadened to an **exploration of alternative futures** and deepened to investigate the worldviews and mythologies that underlie possible, probable and preferred futures.

Foresight, Foreseeability, and Decision Making



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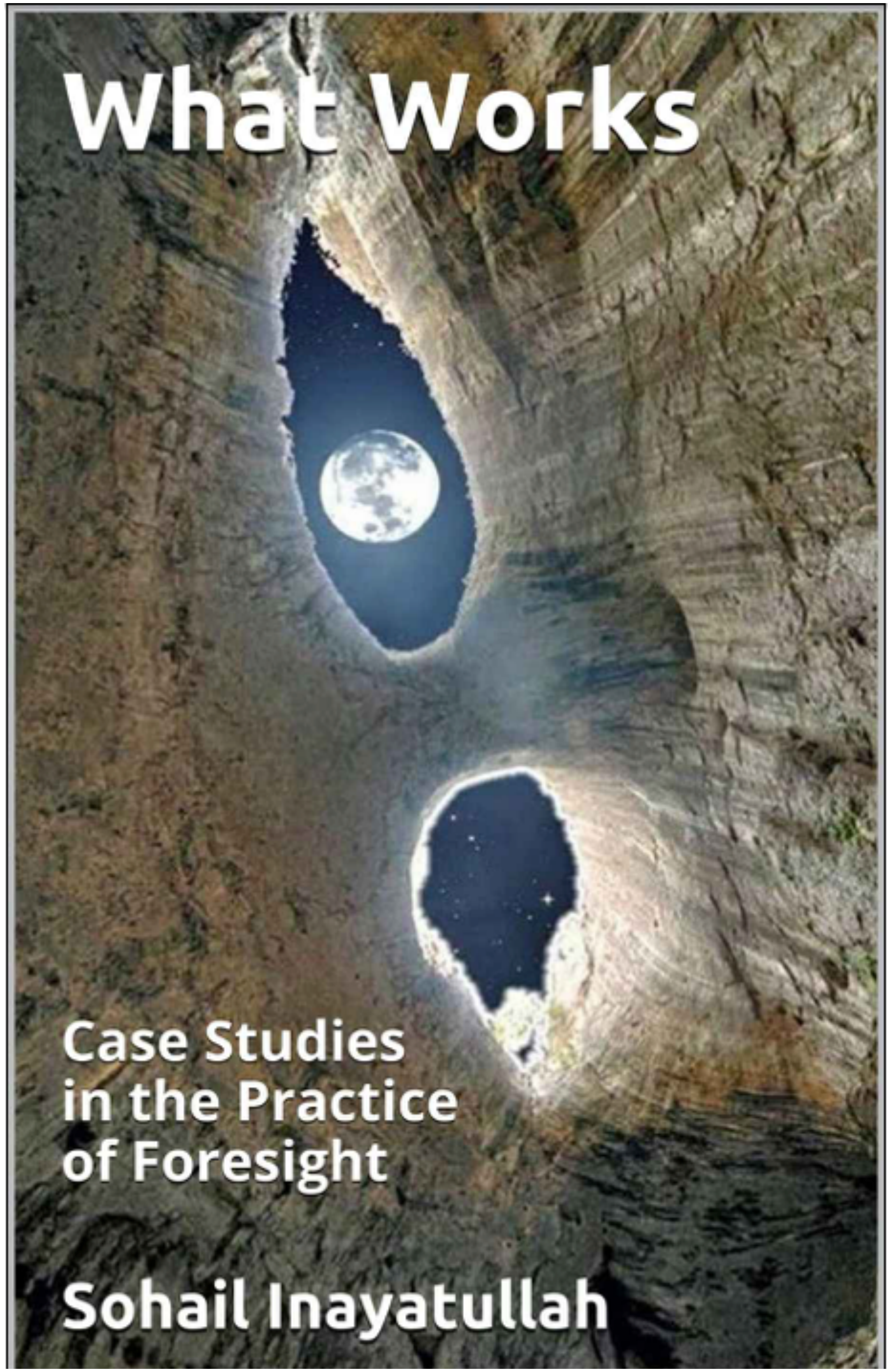
To understand the future(s), one needs a cogent theoretical framework. Four approaches are crucial to foresight (Inayatullah, 1990). The first is **predictive**, based on empirical social sciences. The second is **interpretive**, based not on forecasting the future but on understanding competing images of the future. The third is **critical**, derived from poststructural thought and focused on asking who benefits by the realisation of certain futures and which methodologies privilege certain types of futures studies. While truth claims are eschewed, the price of epistemology is not: every knowledge decision privileges reality in particular ways (Shapiro, 1992; Foucault, 1973). The fourth approach is **participatory action learning/research**. This approach is far more democratic and focuses on stakeholders developing their own future, based on their assumptions of the future (for example, if the future is linear or cyclical) and what is critical to them (Inayatullah, 2007).

Foresight, Foreseeability, and Decision Making



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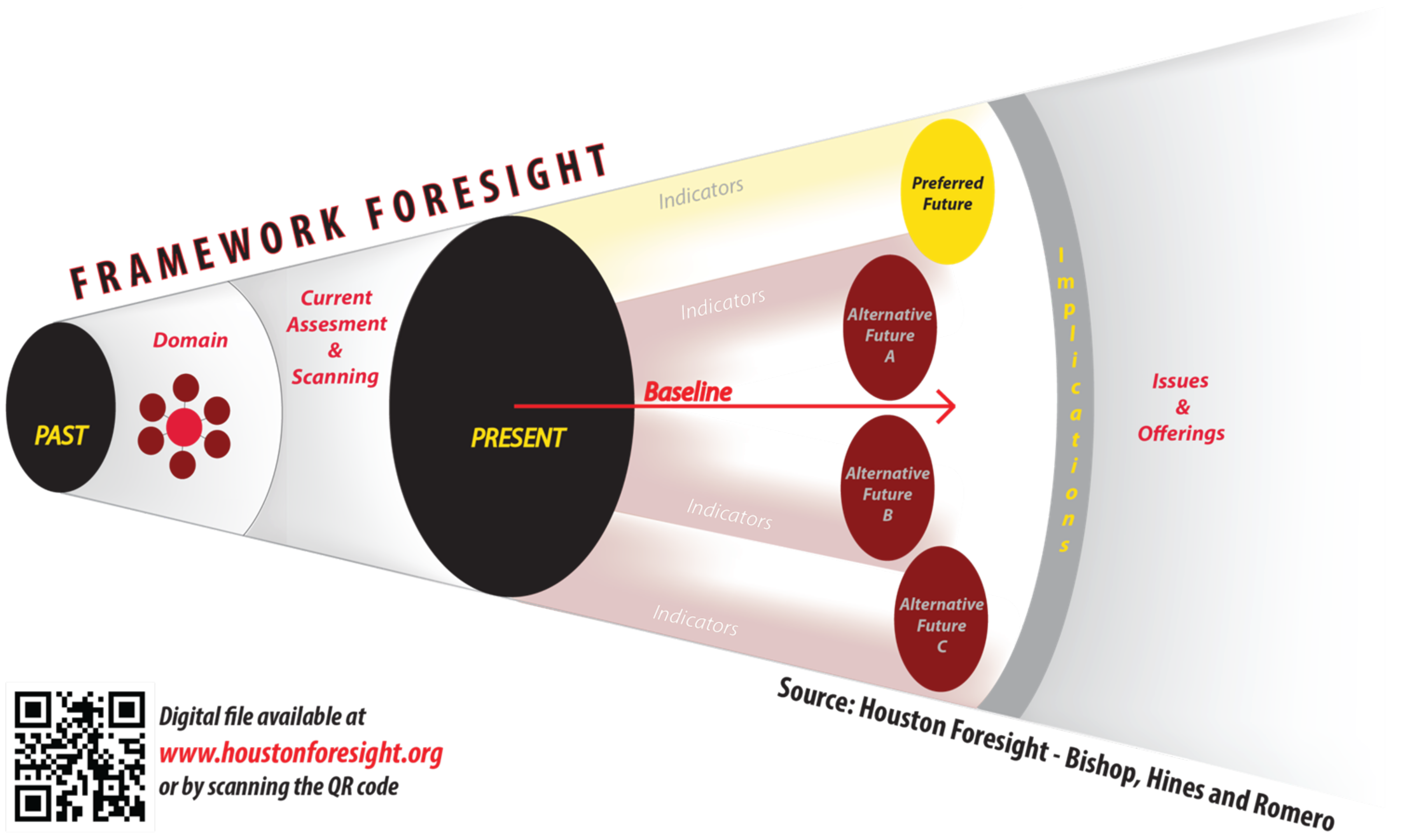
The six pillars provide a theory of futures thinking that is linked to methods and tools, and developed through praxis. The pillars are: **mapping, anticipation, timing, deepening, creating alternatives and transforming**.

Foresight, Foreseeability, and Decision Making



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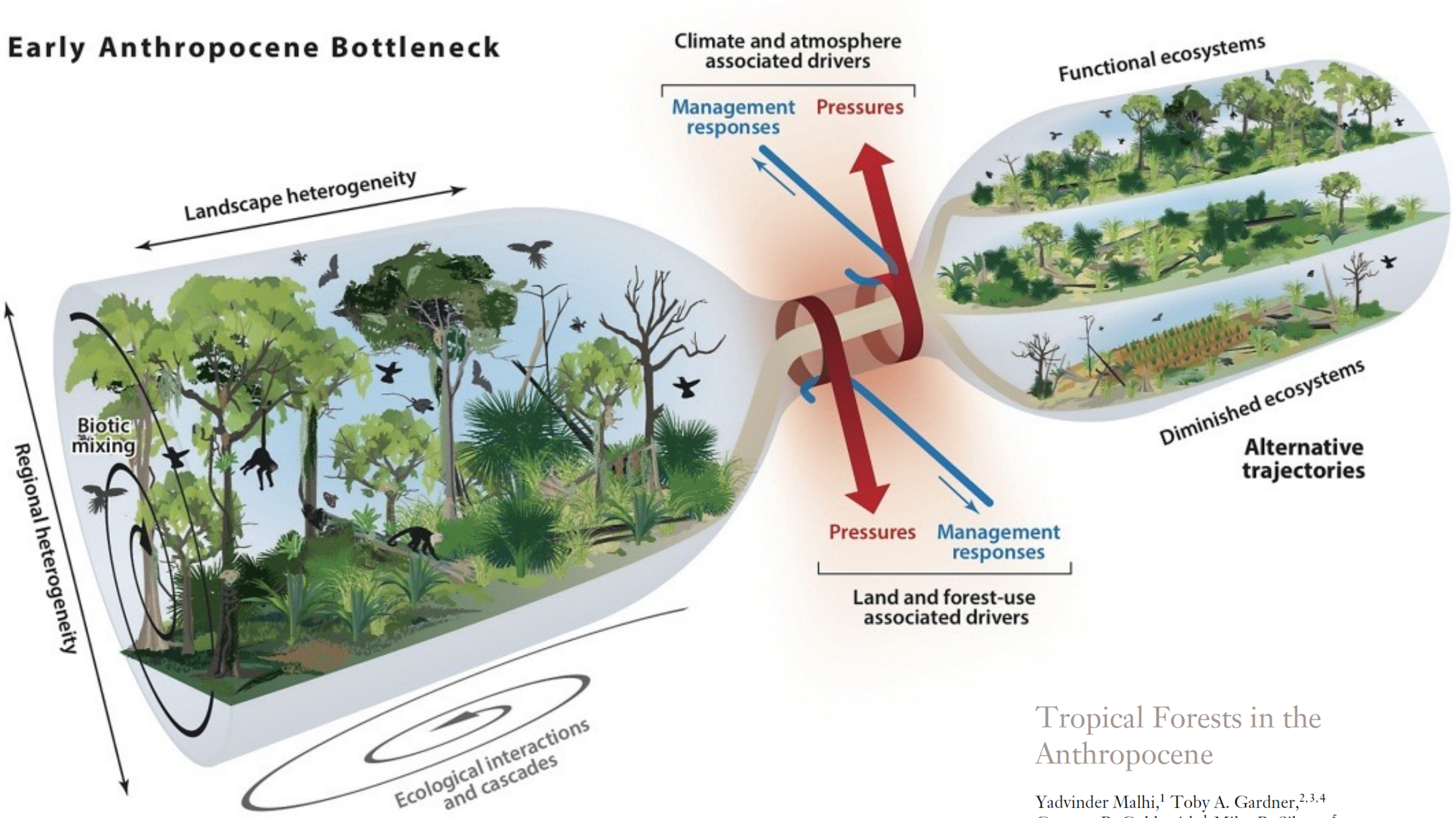
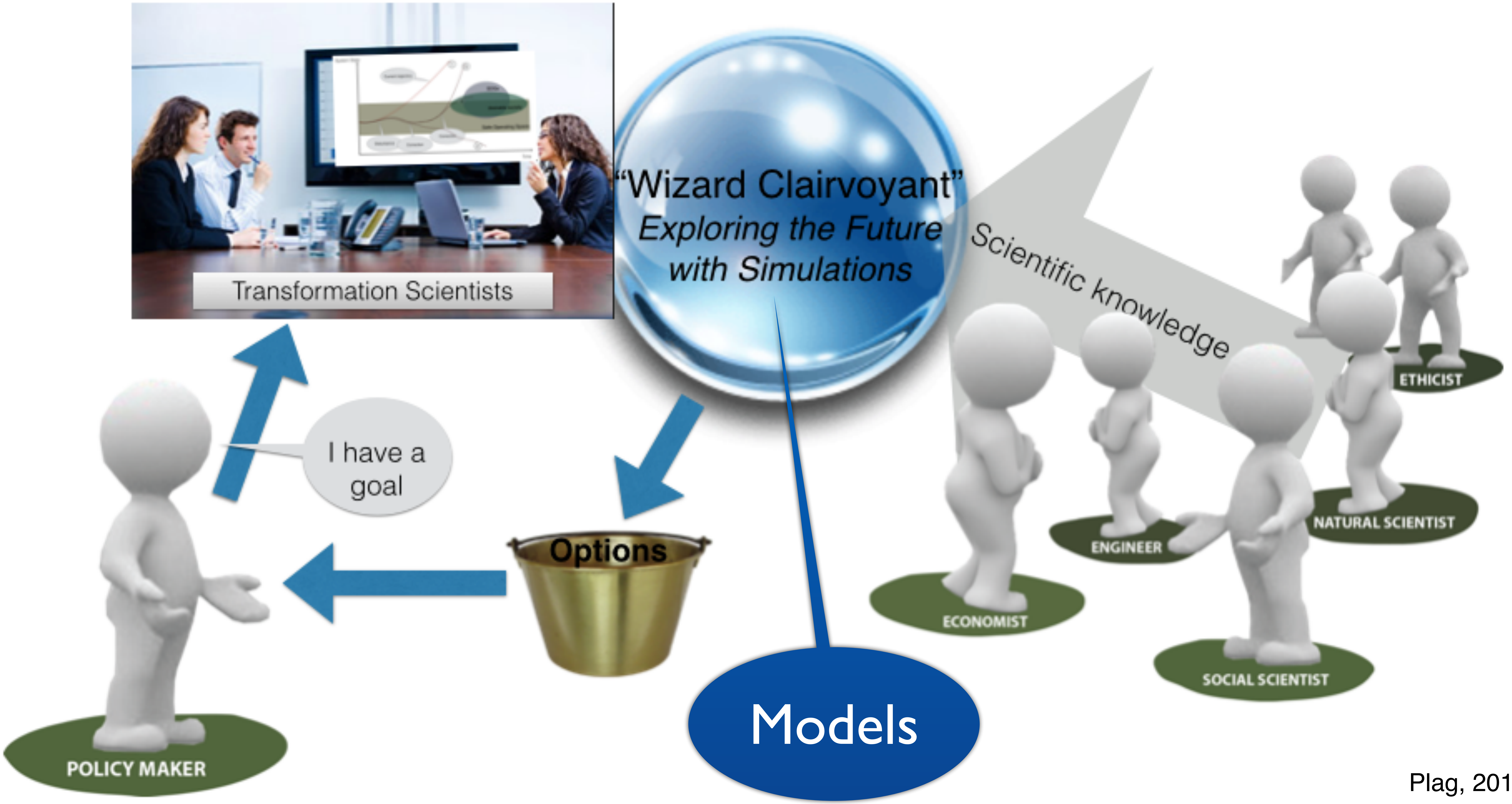


Tropical Forests in the Anthropocene

Yadvinder Malhi,[1] Toby A. Gardner,[2,3,4] Gregory R. Goldsmith,[1] Miles R. Silman,[5] and Przemyslaw Zelazowski[1,6]

Foresight, Foreseeability, and Decision Making



Plag, 2016

Foresight, Foreseeability, and Decision Making

Decision Making Under Uncertainty (DMUU):
Planning and preparing for a (somewhat) predictable future

- Choose a range of plausible trajectories (for droughts, heat waves, sea level rise, extreme events, ...)
- Determine the range of risks to be reduced based on these trajectories and vulnerabilities
- Adapt land use, building codes, protective measures accordingly

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Decision Making Under Foreseeability (DMUF):
Anticipating and preparing for surprises, developing general resilience

Imagining the "worst case" and facilitating adaptation to unpredictable future:

- understanding the vulnerabilities and comprehensively assessing the risks
- including the worst cases (food, water, heat waves, droughts, storms, sicknesses, social unrest, wars, ...)
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Knowing the paradigms our knowledge creations and decision making are based on …

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Paradigm shift to overcome normalcy bias:
Instead of
“Sea level is stable and coastlines don’t move”
(last 6,000 years) assume
“Sea level is variable and coastlines can migrate fast”