Mitigation and Adaptation Studies

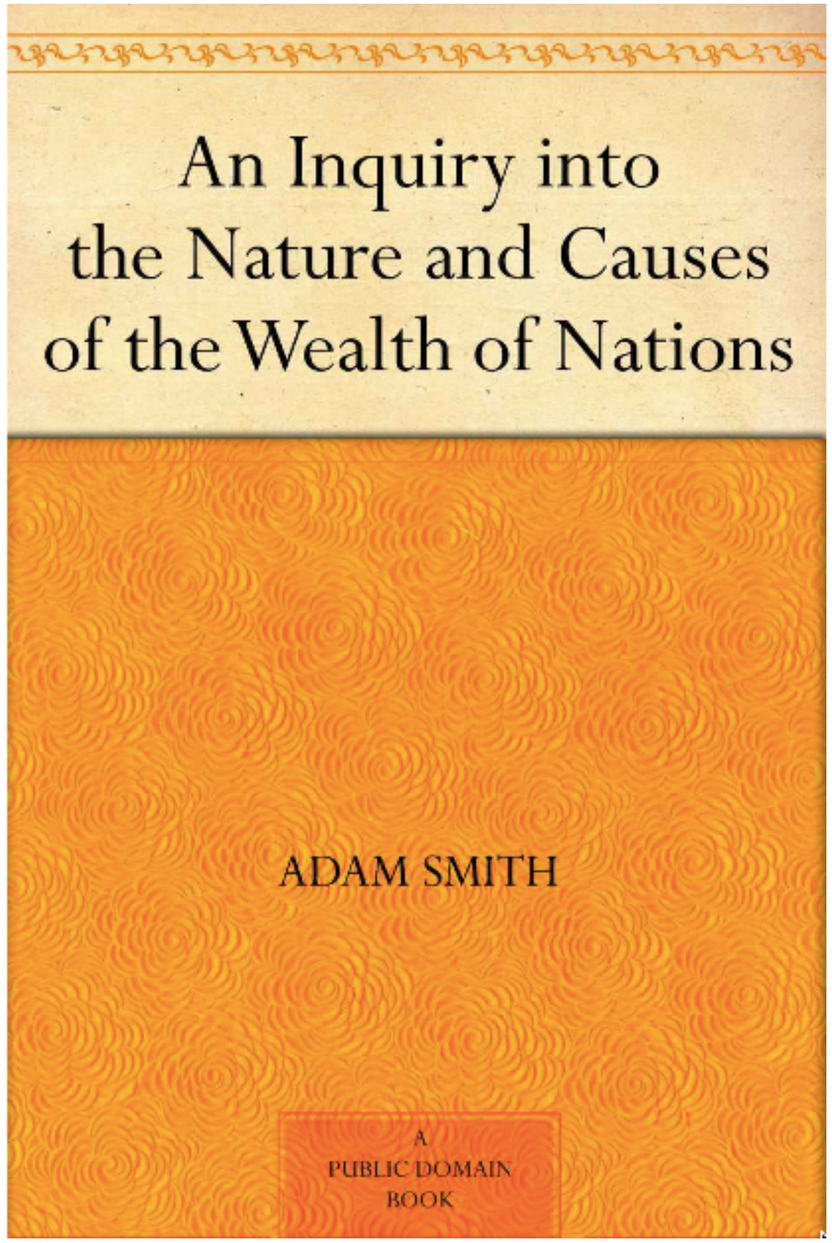
Class 4: The Syndrome of Modern Global Change: Diagnosis, Prognosis, Therapy

Also: Systems - Introduction

Contents:

- *Baseline*
- *Syndrome*
- Diagnosis (continued from class 3)
- Prognosis
- Therapy

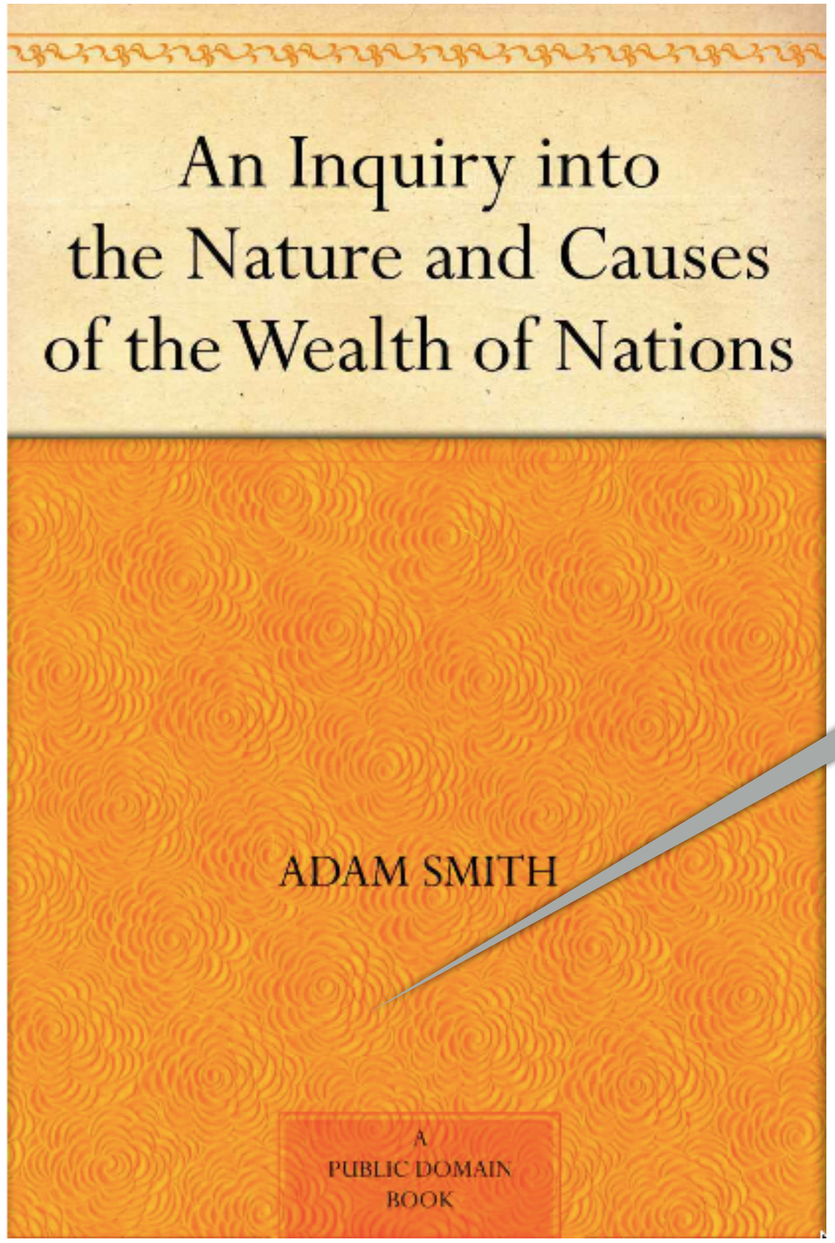
Role of Economy



Published in 1776

Diagnosis

Role of Economy

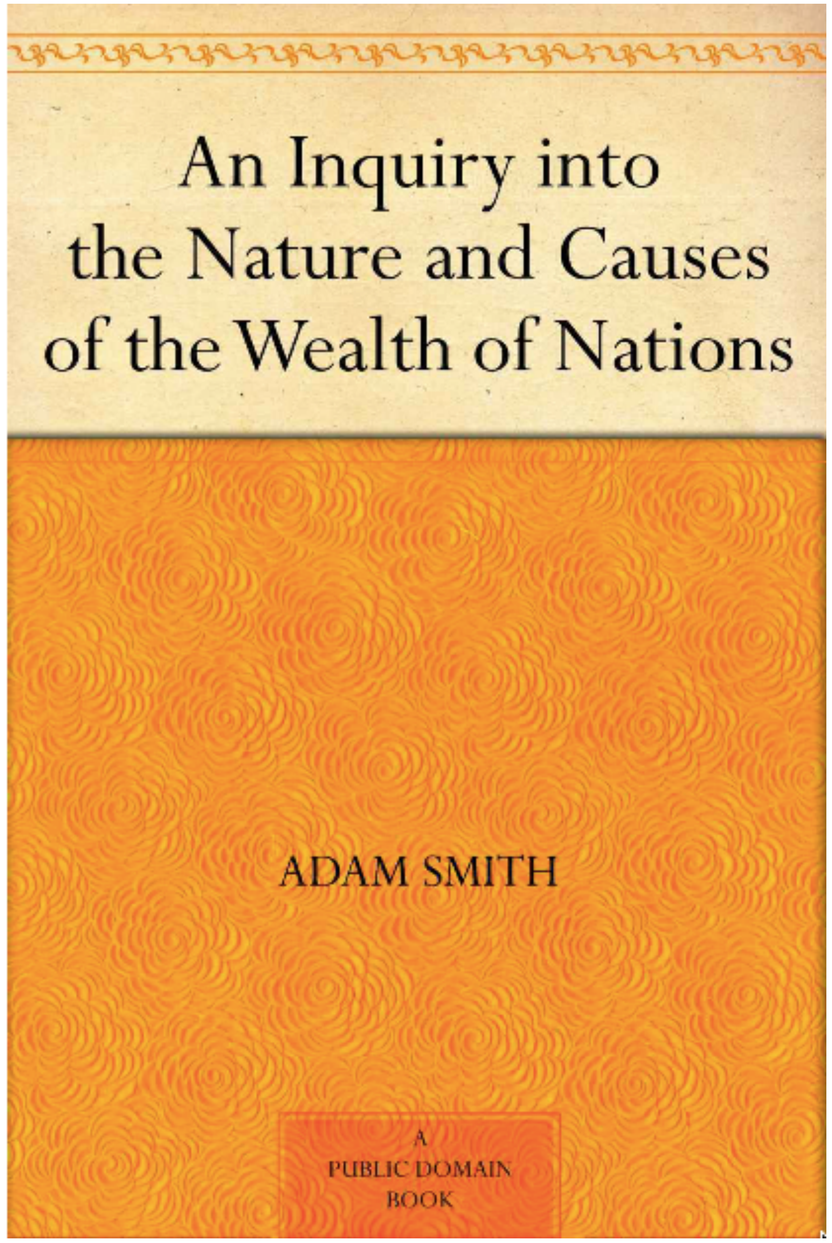


Economy: the “invisible hand”

Assumption:
Agents independently seeking their own gain will produce the overall best result for society

Published in 1776

Role of Economy



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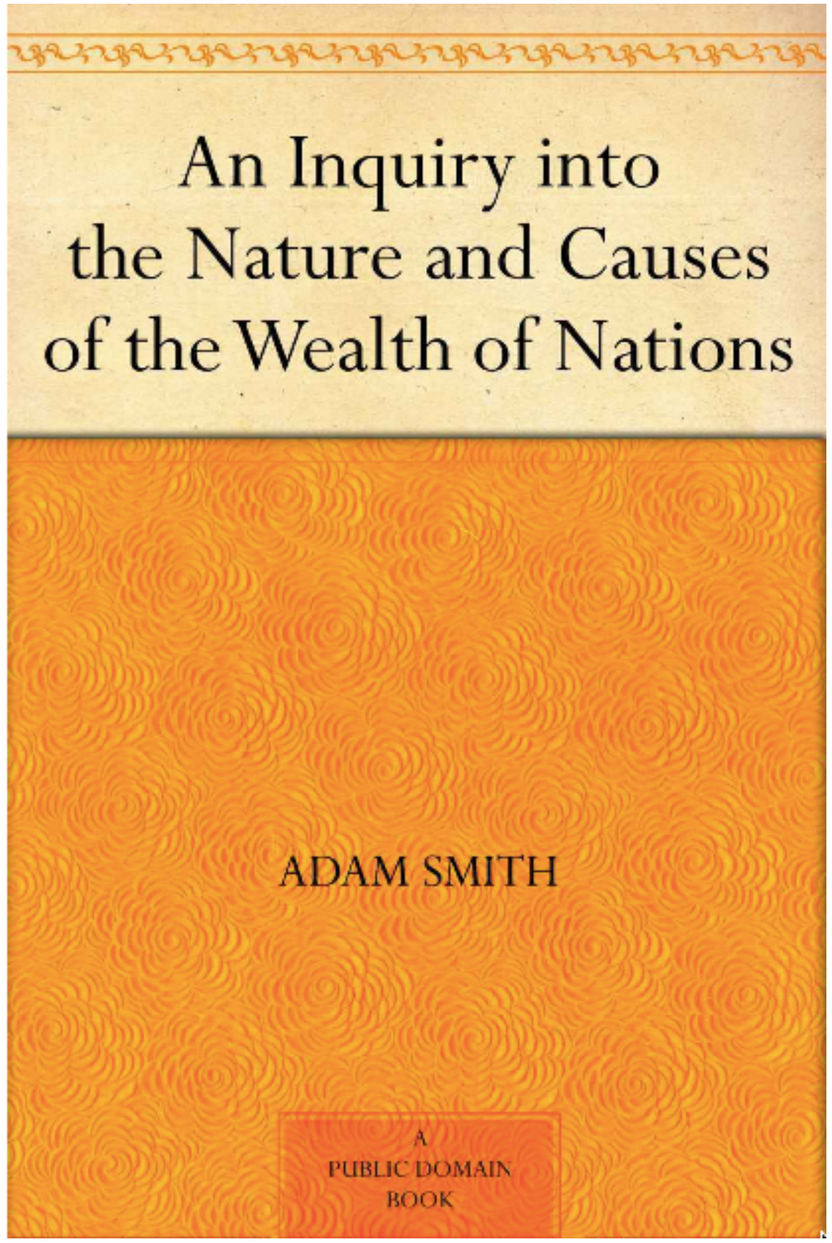
The current mainstream model of the global **economy is based on a number of assumptions** about the way the world works, what the economy is, and what the economy is for. **These assumptions arose in an earlier period, when the world was relatively empty of humans and their artifacts.** Built capital was the limiting factor, while natural capital was abundant. It made sense not to worry too much about environmental "externalities," since they could be assumed to be relatively small and ultimately solvable. It also made sense to focus on the growth of the market economy, as measured by gross domestic product (GDP), as a primary means to improve human welfare. And it made sense to think of the economy as only marketed goods and services and to think of the goal as increasing the amount of these that were produced and consumed.

The Worldwatch Institute. State of the World 2013: Is Sustainability Still Possible? (Kindle Locations 2921-2927). Island Press. Kindle Edition.

Role of Economy



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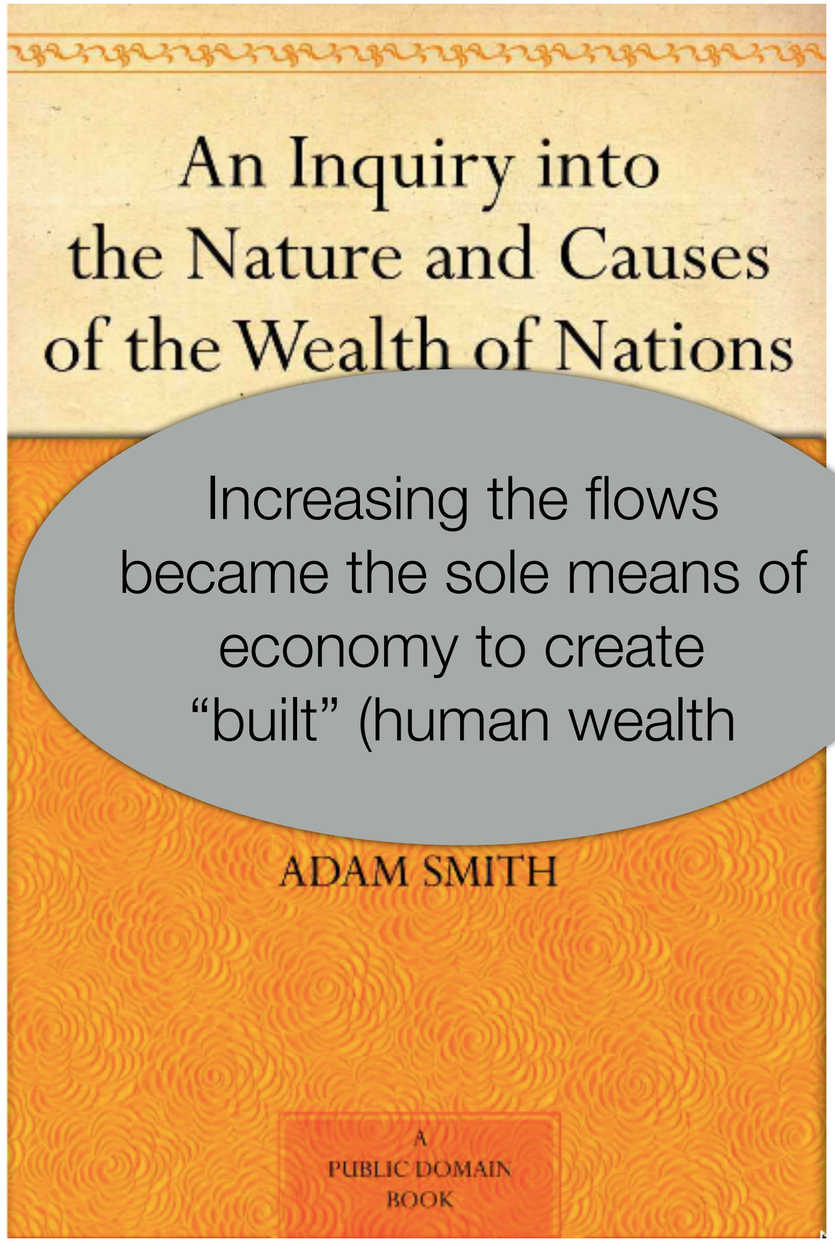

Increasing the flows became the sole means of economy to create "built" (human wealth

Published in 1776

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Role of Economy

For almost a century, the **consumption of products has been the dominant paradigm and mindset**.

John Maynard Keynes (*"The General Theory of Employment, Interest and Money"*, 1936):*"I should support at the same time all sorts of policies for increasing the propensity to consume. For it is unlikely that full employment can be maintained, whatever we may do about investment, with the existing propensity to consume."*

Victor Lebow (1955): *"Our enormously productive economy … demands that we make consumption our way of life, that we convert the buying and use of goods into rituals, that we* ***seek our spiritual satisfaction, our ego satisfaction, in consumption*** *… we need* ***things consumed, burned up, replaced and discarded at an ever-accelerating rate****."*

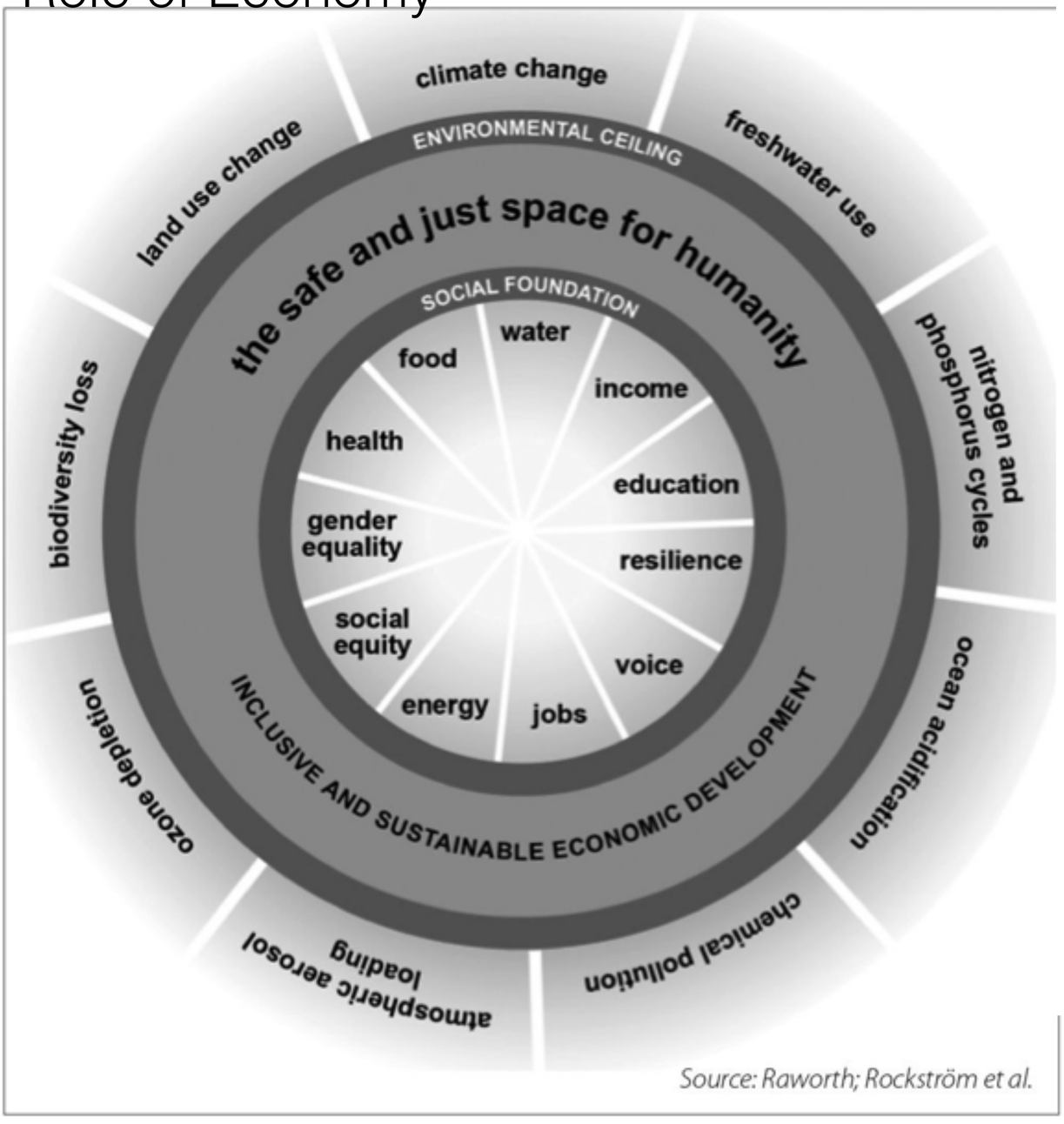
Role of Economy

In 1970, Milton Friedman argued that businesses' sole purpose is to generate profit for shareholders.

This led to globalization …

Diagnosis

Role of Economy



Source: Raworth; Rockström et al.

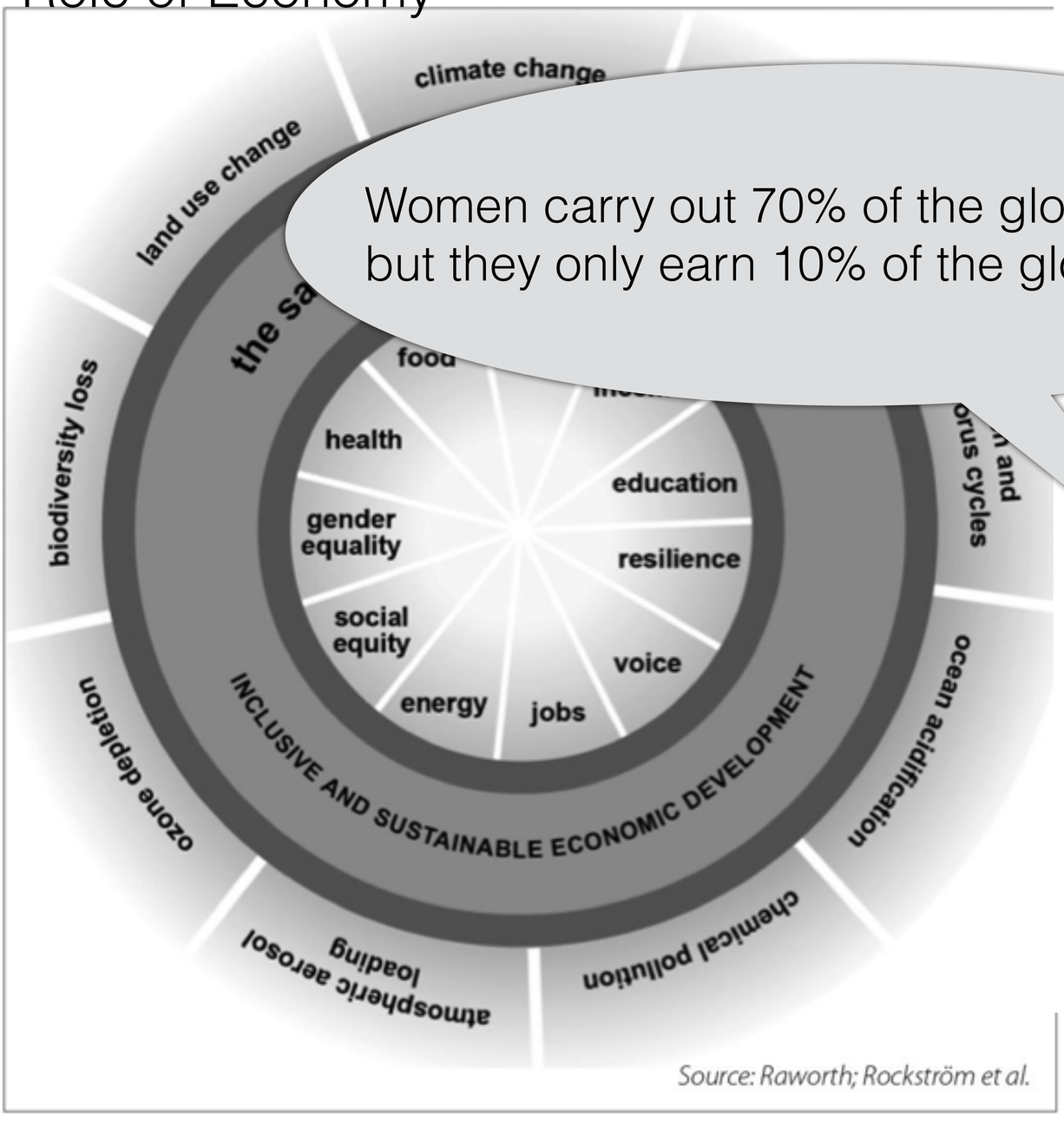
Social Foundation	Illustrative Indicators of Global Deprivation	Share of Population	Year
		(percent)	
Food security	Population undernourished	13	2010–12
Income	Population living below $1.25 (purchasing power parity) per day	21	2005
Water and sanitation	Population without access to an improved drinking water source	13	2008
	Population without access to improved sanitation	39	2008
Health care	Population without regular access to essential medicines	30	2004
Education	Children not enrolled in primary school	10	2009
	Illiteracy among 15–24 year olds	11	2009
Energy	Population lacking access to electricity	19	2009
	Population lacking access to clean cooking facilities	39	2009
Gender equality	Employment gap between women and men in waged work (excluding agriculture)	34	2009
	Representation gap between women and men in national parliaments	77	2011
Social equity	Population living in countries with significant income inequality	33	1995–2009
Voice	Population living in countries perceived (in surveys) not to permit political participation or freedom of expression	To be determined	
Jobs	Labor force not employed in decent work	To be determined	
Resilience	Population facing multiple dimensions of poverty	To be determined	

Source: See endnote 8.

Raworth, 2013

Diagnosis

Role of Economy



Source: Raworth; Rockström et al.

Women carry out 70% of the global work hours but they only earn 10% of the global salary

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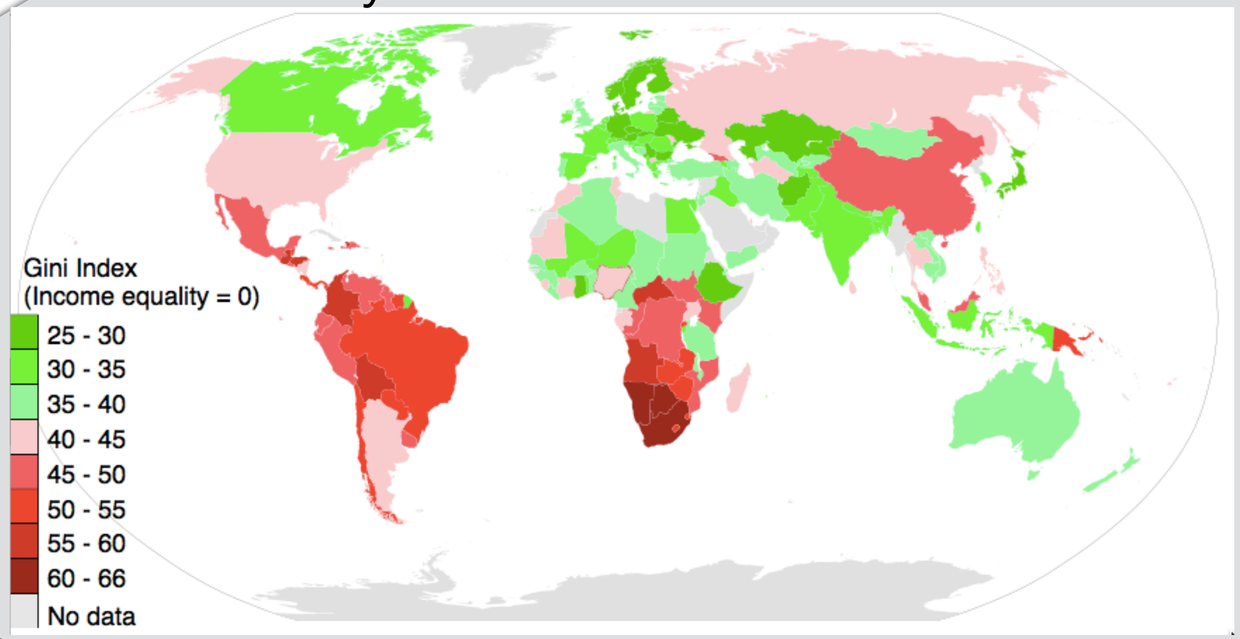

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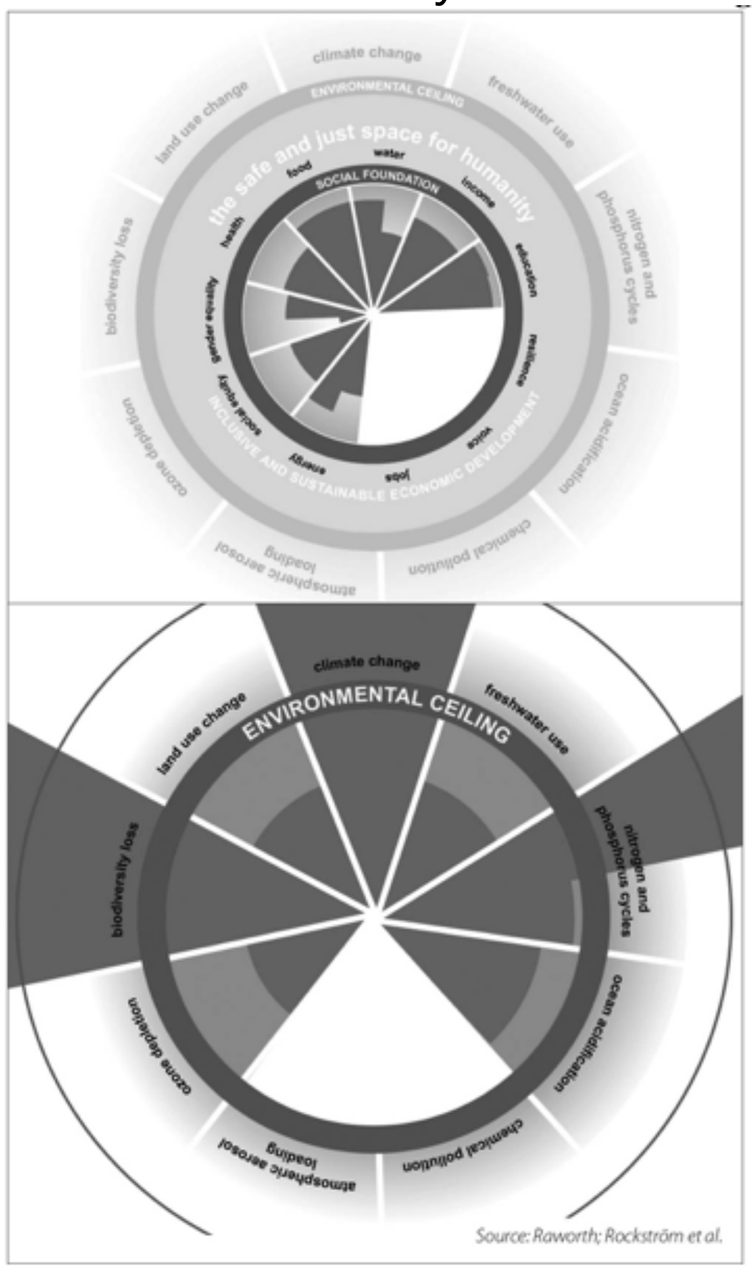

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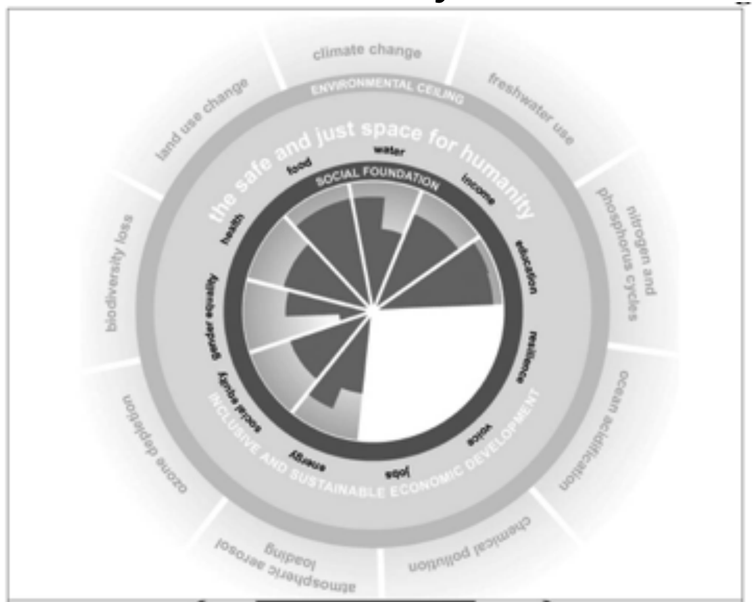

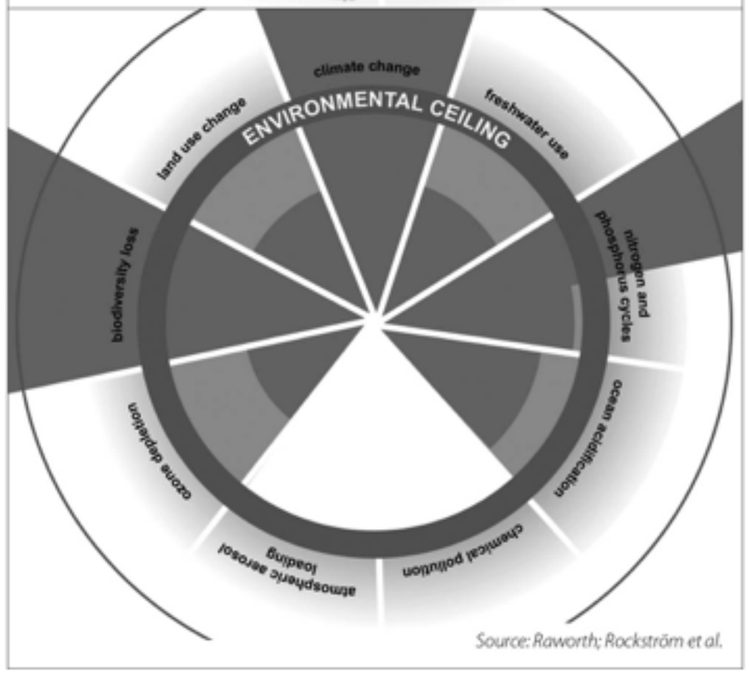

What, then, is the biggest source of stress on planetary boundaries today? It is the excessive consumption levels of roughly the wealthiest 10 percent of people in the world and the resource-intensive production patterns of companies producing the goods and services that they buy. The richest 10 percent of people in the world hold 57 percent of global income, emit 45 percent of the global population gen... ...ssions. And one third of t... nitrogen use is... Union, just 7 ...

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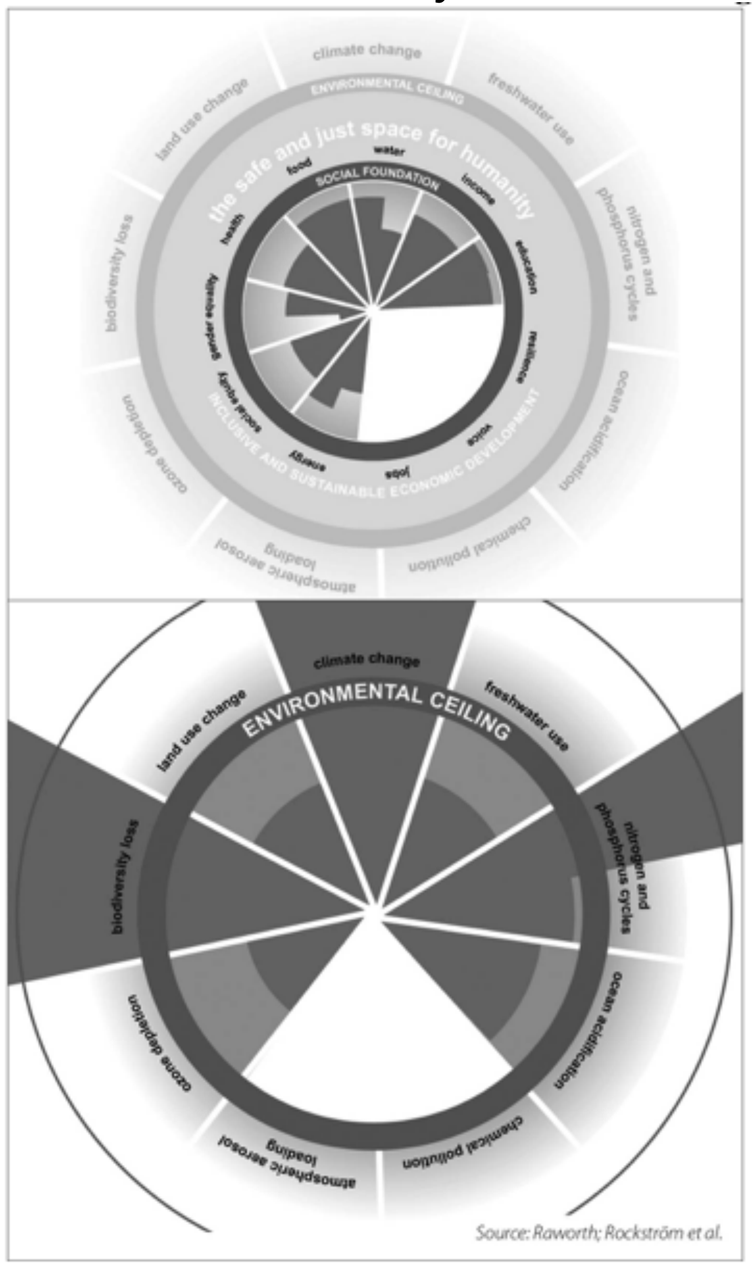

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Raworth, 2013

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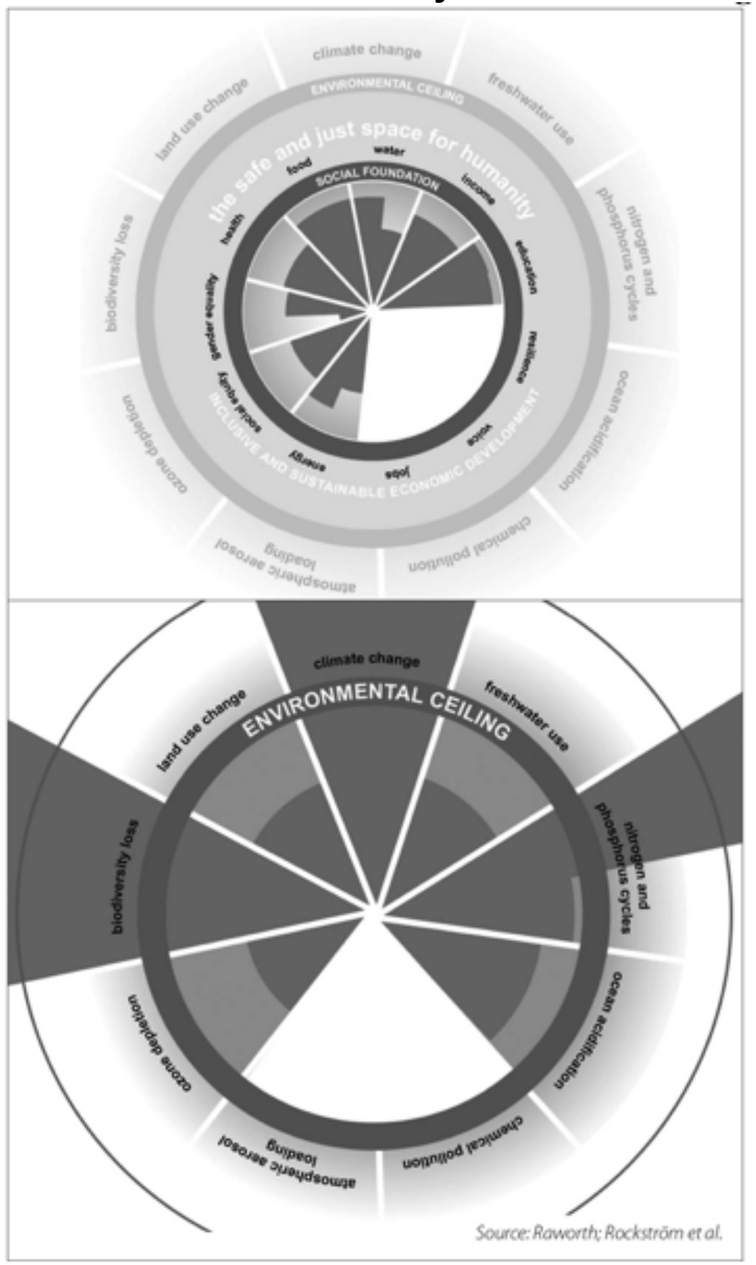

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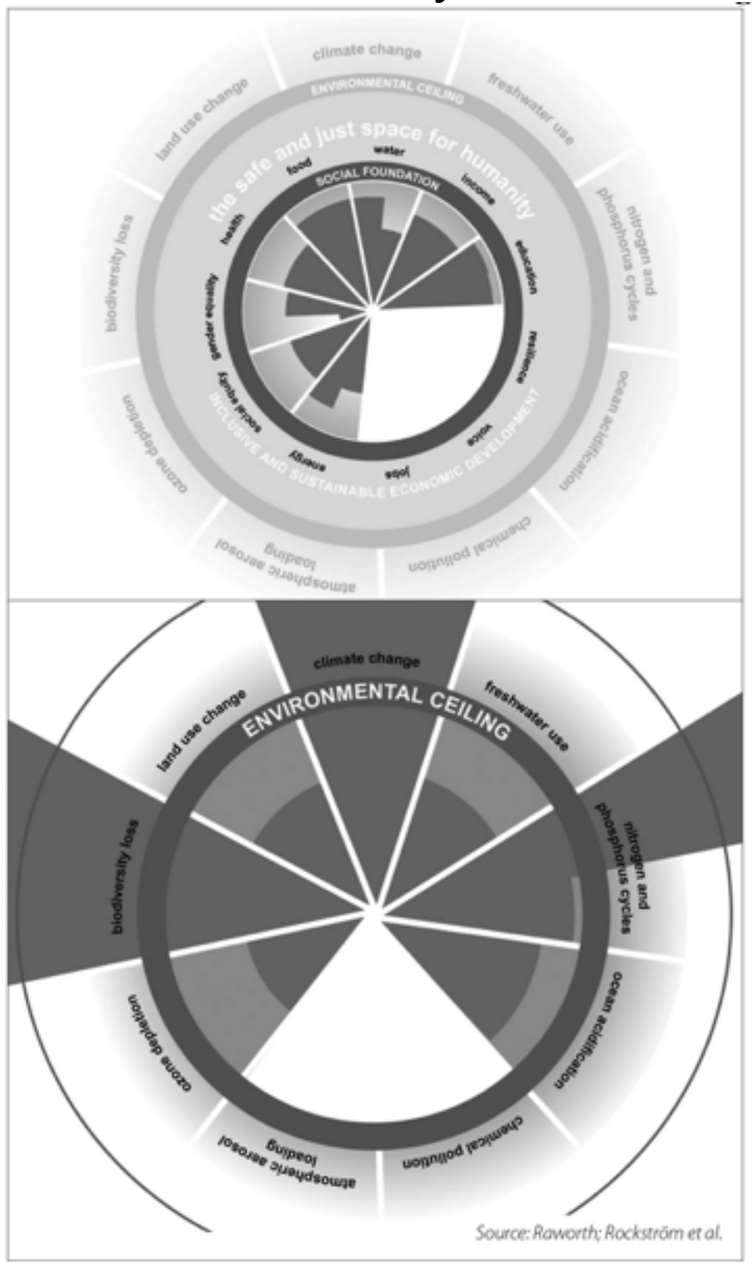
Raworth, 2013

Wealth Distribution:

Top 1%:	Top 5%:	Top 10%:
2000 49.6%	2000 77.2%	2000 89.4%
2009 45.4%	2009 73.7%	2009 86.5%
2016 50.8%	2016 77.7%	2016 89.1%

Diagnosis

Role of Economy



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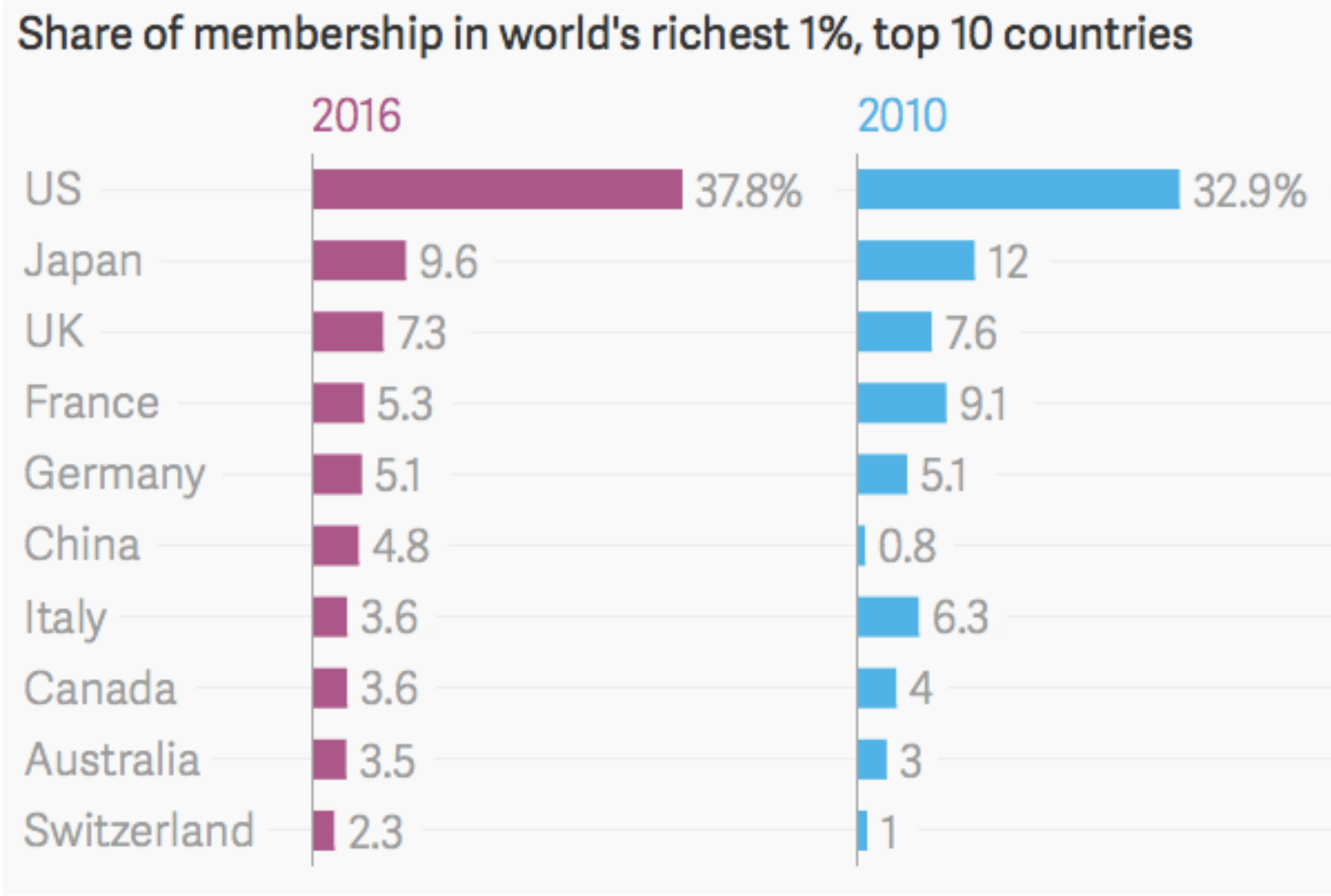
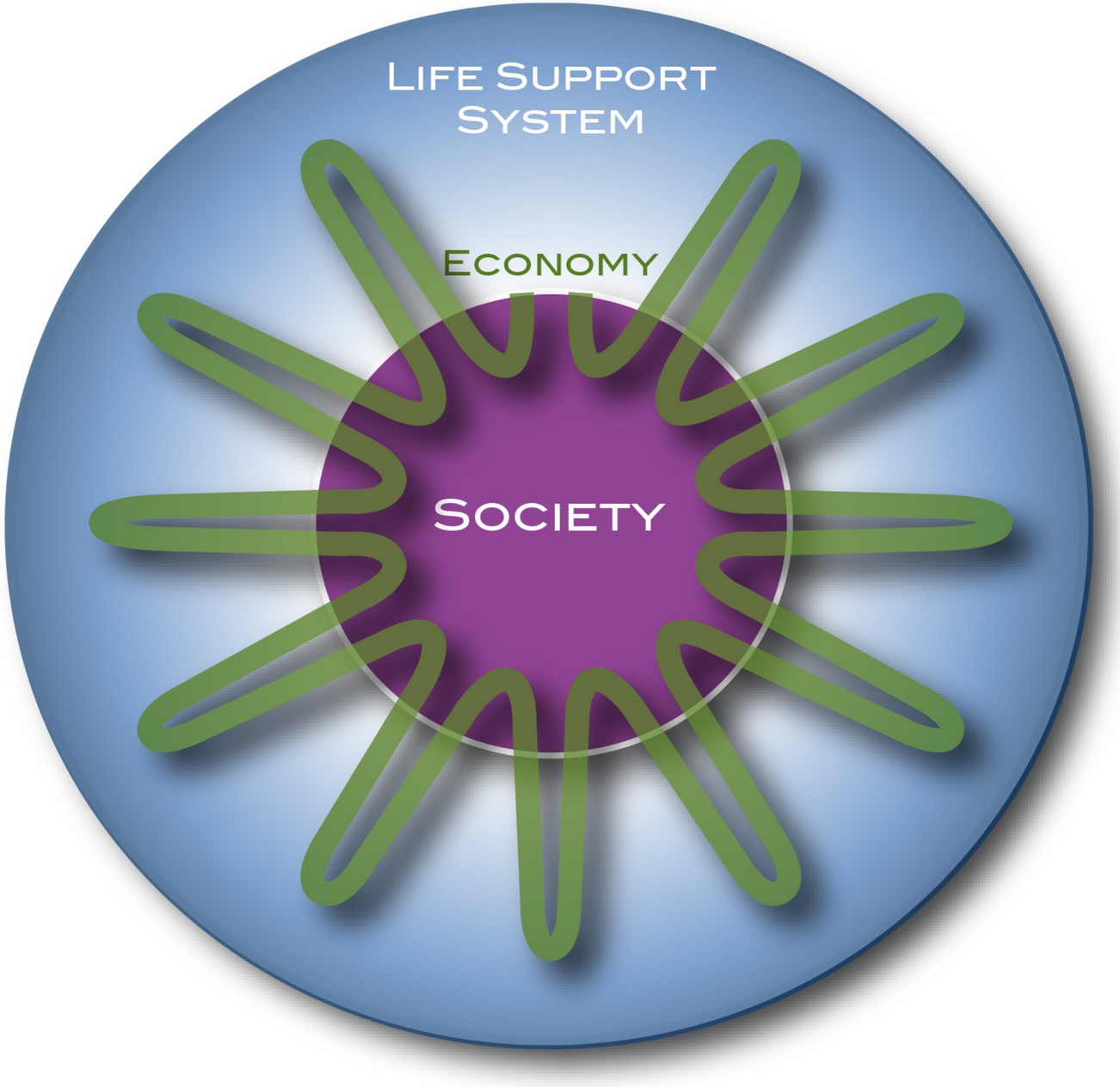


Role of Economy

Currently:
An Economy that meets the needs of the present while **destroying** the Earth's life-support system, on which the welfare of current and future generations depends.



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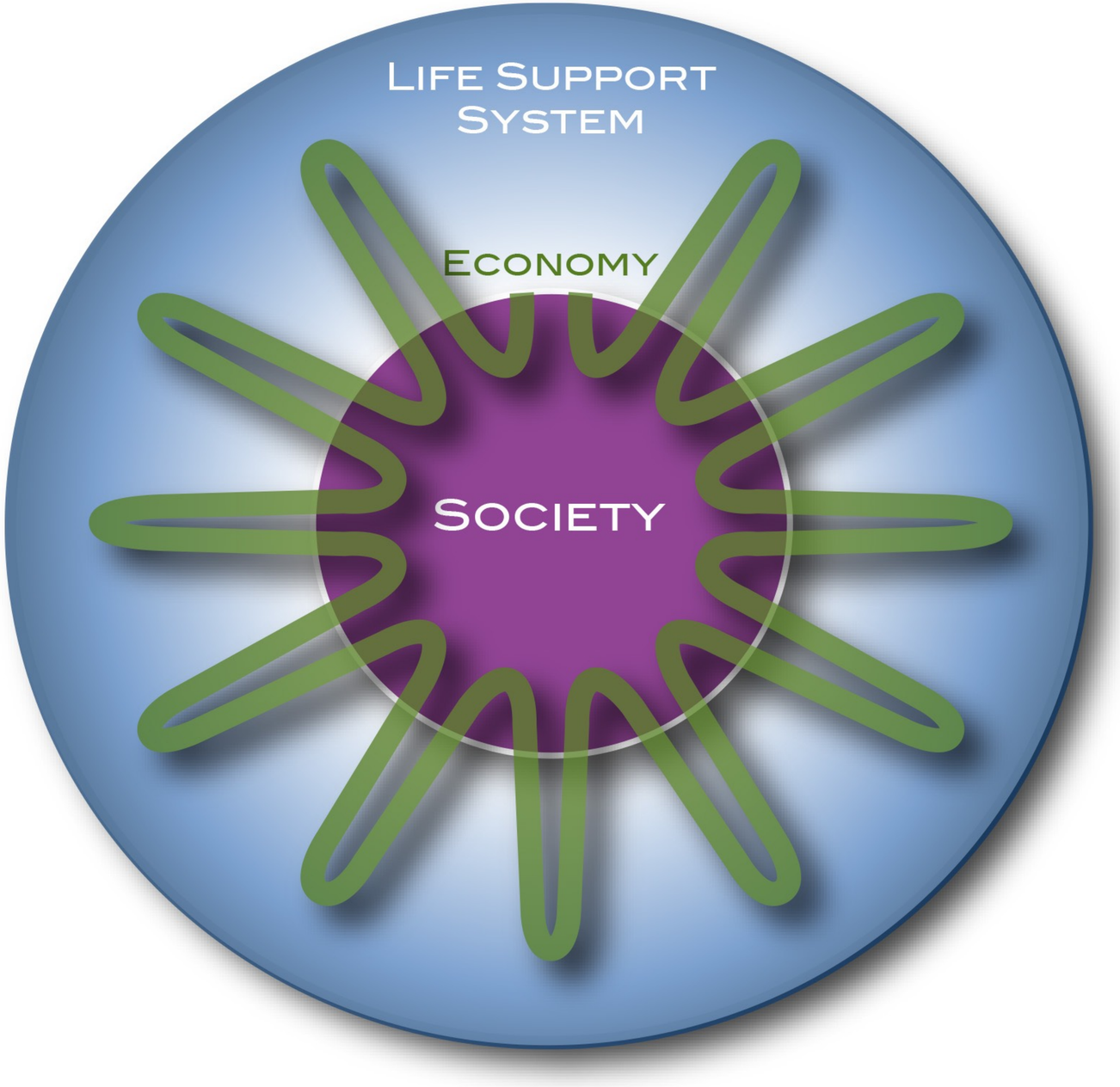
“Sustainable Development is a development that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends.”

Griggs et al., 2013



Key Points

Baseline

During the Holocene, climate and sea level were exceptionally stable

The Holocene was a “safe operating space for humanity”

Syndrome

During the last few hundred years, humanity has introduced rapid and large changes

The system is outside the “normal range” and in the dynamic transition into the Post-Holocene; we have increasing disequilibrium

Diagnosis

A consumption-based economy combined with easy access to energy caused humans to accelerate flows in the Earth’s life-support system and sustain rapid population growth.

Modern humans are the “Anthropogenic Cataclysmic Virus” (ACV) in the Earth’s life-support system

Mitigation and Adaptation Studies

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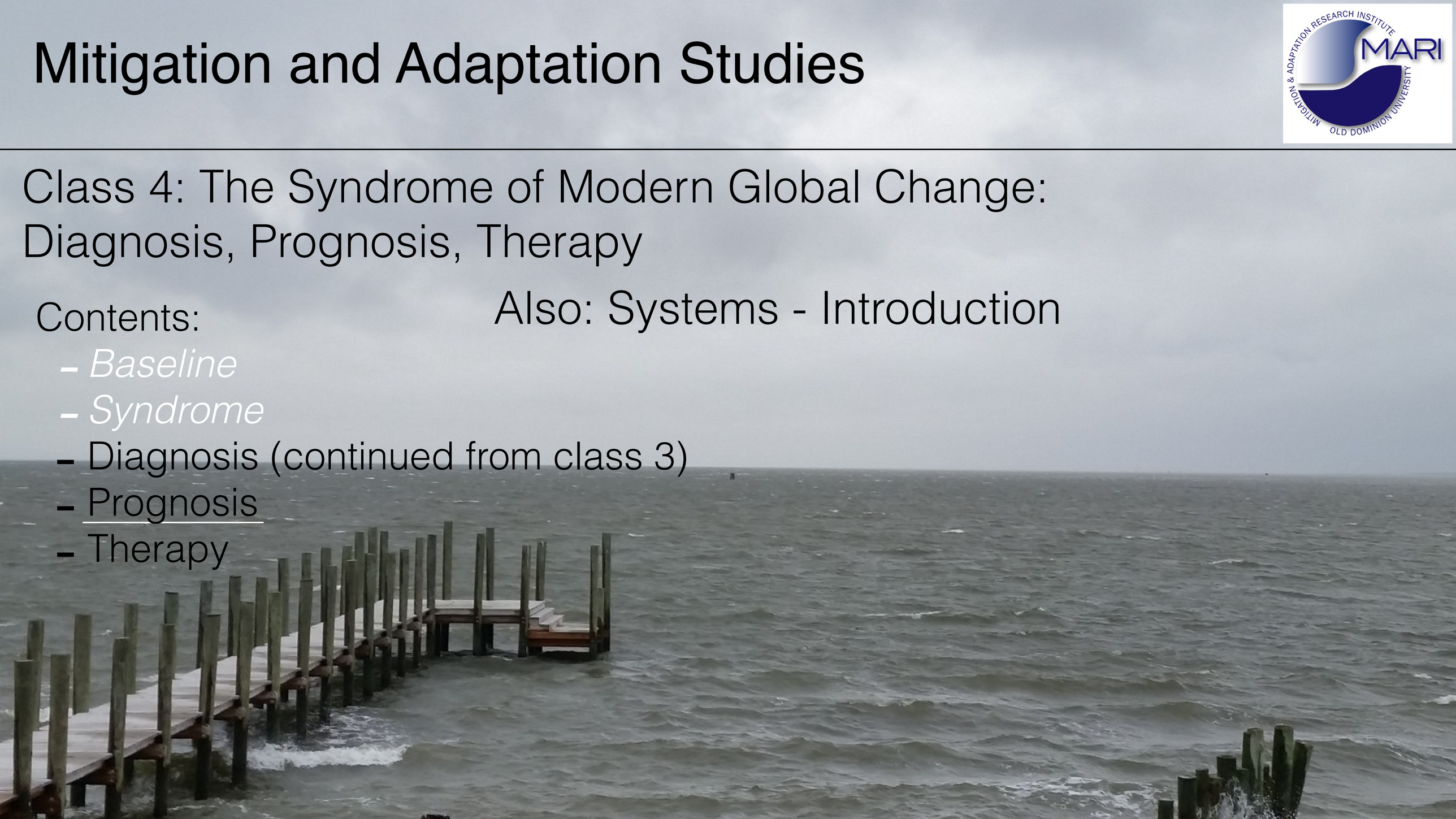

Prognosis

Exploring Possible Futures

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  - extreme weather
  - global atmospheric warming
  - ocean warming
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Methodology

- modeling and simulations
  - participatory modeling (*development of options*)
  - scenario-based modeling and simulations: *model validation, ensembles, selection of scenarios, not predictions*
- risk assessments:
  - risk perception and biases, comprehensiveness
  - based on past system behavior

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Prognosis

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- Scenarios
- Policy Responses
- Multiscale Assessments

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- Biodiversity
- Desertification
- Business & Industry
- Wetlands and Water
- Health

Statement of the MA Board

The MA Board of Directors has developed an interpretation of the key messages to emerge from the assessment, entitled *Living Beyond Our Means: Natural Assets and Human Well-Being.*
Learn more
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About the MA Board of Directors

A Framework for Assessment

In late 2003, the MA and Island Press published *Ecosystems and Human Well-being: A Framework for Assessment.* This volume lays out the assumptions, processes and parameters that were used in the MA.
Learn more

About the Millennium Assessment

The Millennium Ecosystem Assessment assessed the consequences of ecosystem change for human well-being. From 2001 to 2005, the MA involved the work of more than 1,360 experts worldwide. Their findings provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably.
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Scenarios Assessment

The Scenarios Working Group considered the possible evolution of ecosystem services during the twenty-first century by developing four global scenarios exploring plausible future changes in drivers, ecosystems, ecosystem services, and human well-being.

Three of four detailed scenarios examined by the Scenarios Working Group suggest that significant changes in policies, institutions, and practices can mitigate some but not all of the negative consequences of growing pressures on ecosystems, but the changes required are substantial and are not currently under way.

Order from Island Press

Assessment report chapters

- Contents, Foreword, Preface [pdf, 1640 KB]
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- 02. Global Scenarios in Historical Perspective [pdf, 291 KB]
- 03. Ecology in Global Scenarios [pdf, 295 KB]
- 04. State of Art in Describing Future Changes in Ecosystem Services [pdf, 425 KB]
- 05. Rationale and Logics of the Scenarios [pdf, 490 KB]
- 06. Methodology for Developing the MA Scenarios [pdf, 1619 KB]
- 07. Drivers of Change in Ecosystem Conditions and Services [pdf, 1492 KB]
- 08. Scenarios [pdf, 1872 KB]
- 09. Ecosystem Services across Scenarios [pdf, 4072 KB]
- 10. Biodiversity Across Scenarios [pdf, 1936 KB]
- 11. Human Well-being Across Scenarios [pdf, 266 KB]
- 12. Trade-offs Among Ecosystem Services [pdf, 307 KB]
- 13. Synthesis: Lessons Learned [pdf, 427 KB]
- 14. Synthesis: Policy Implications [pdf, 603 KB]
- Appendices [pdf, 4521 KB]

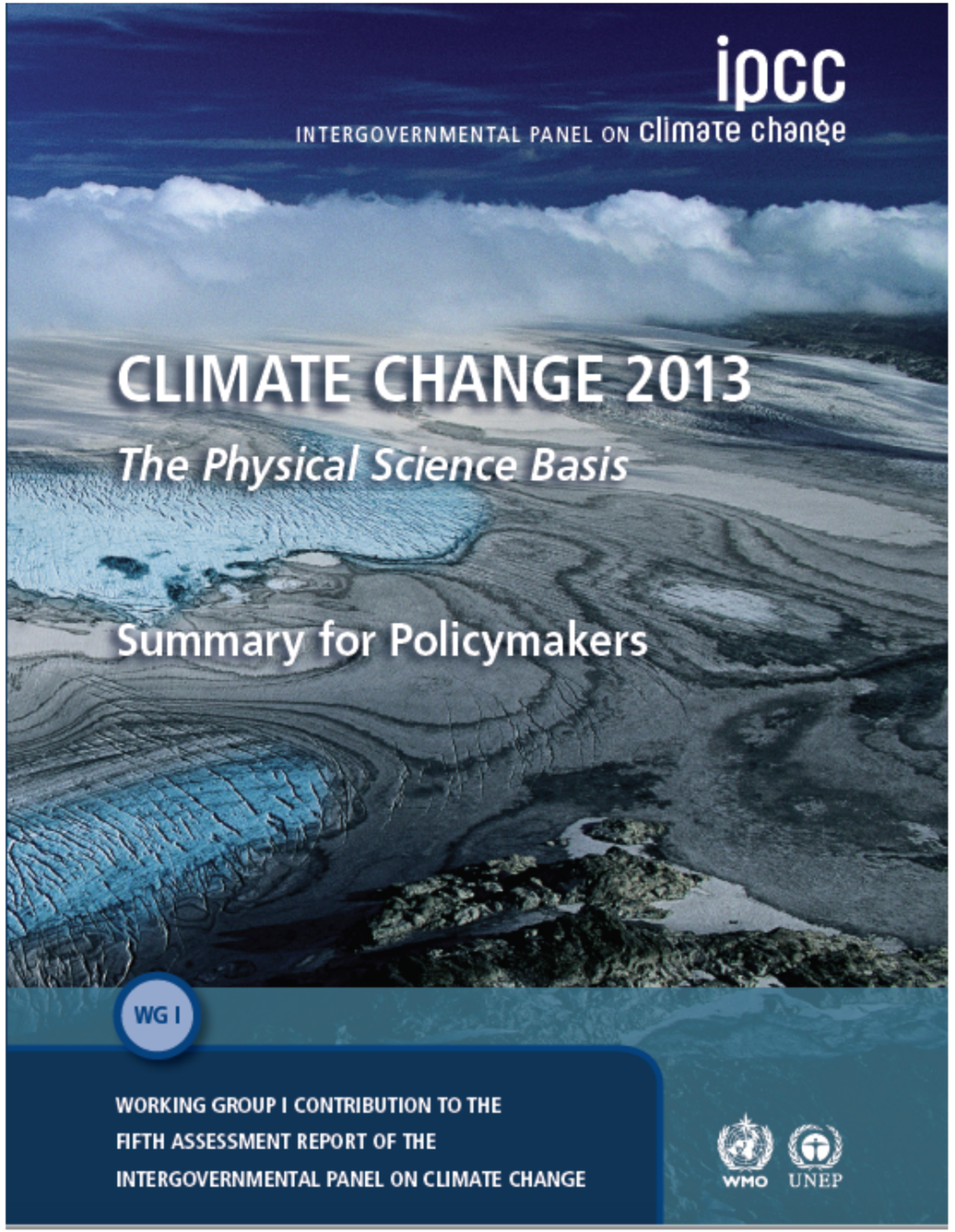
Scenarios Working Group

- Current State & Trends
- Scenarios
- Policy Responses

http://millenniumassessment.org/en/index.html

Prognosis

Prognosis



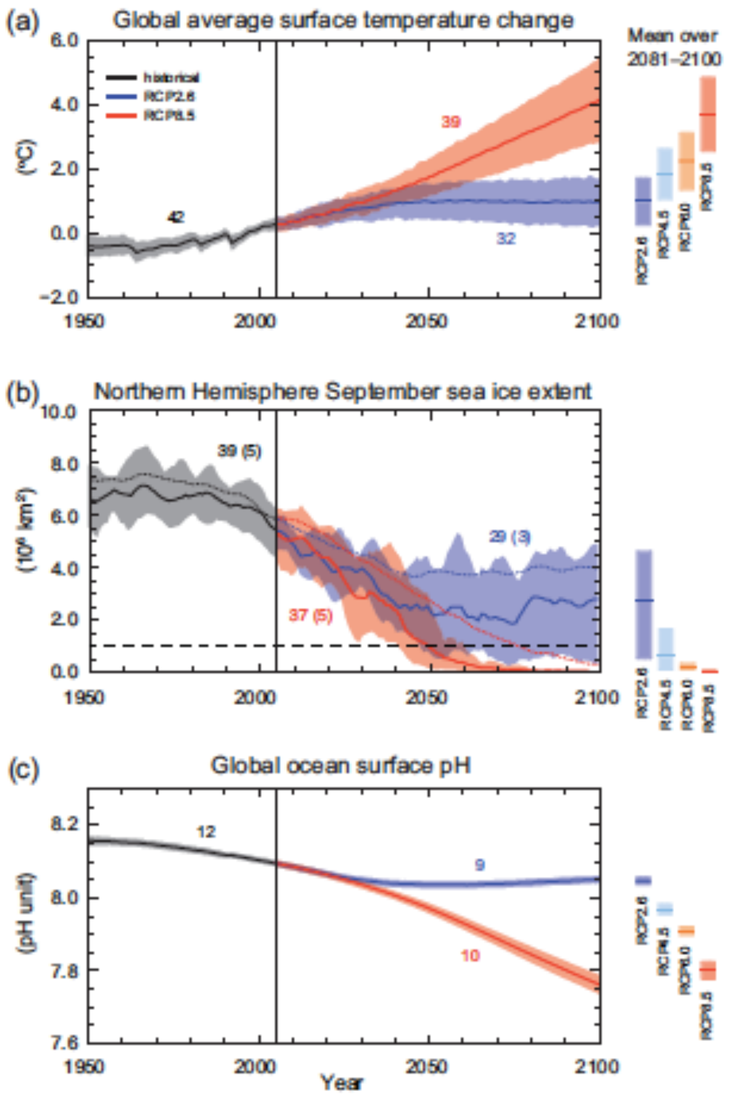
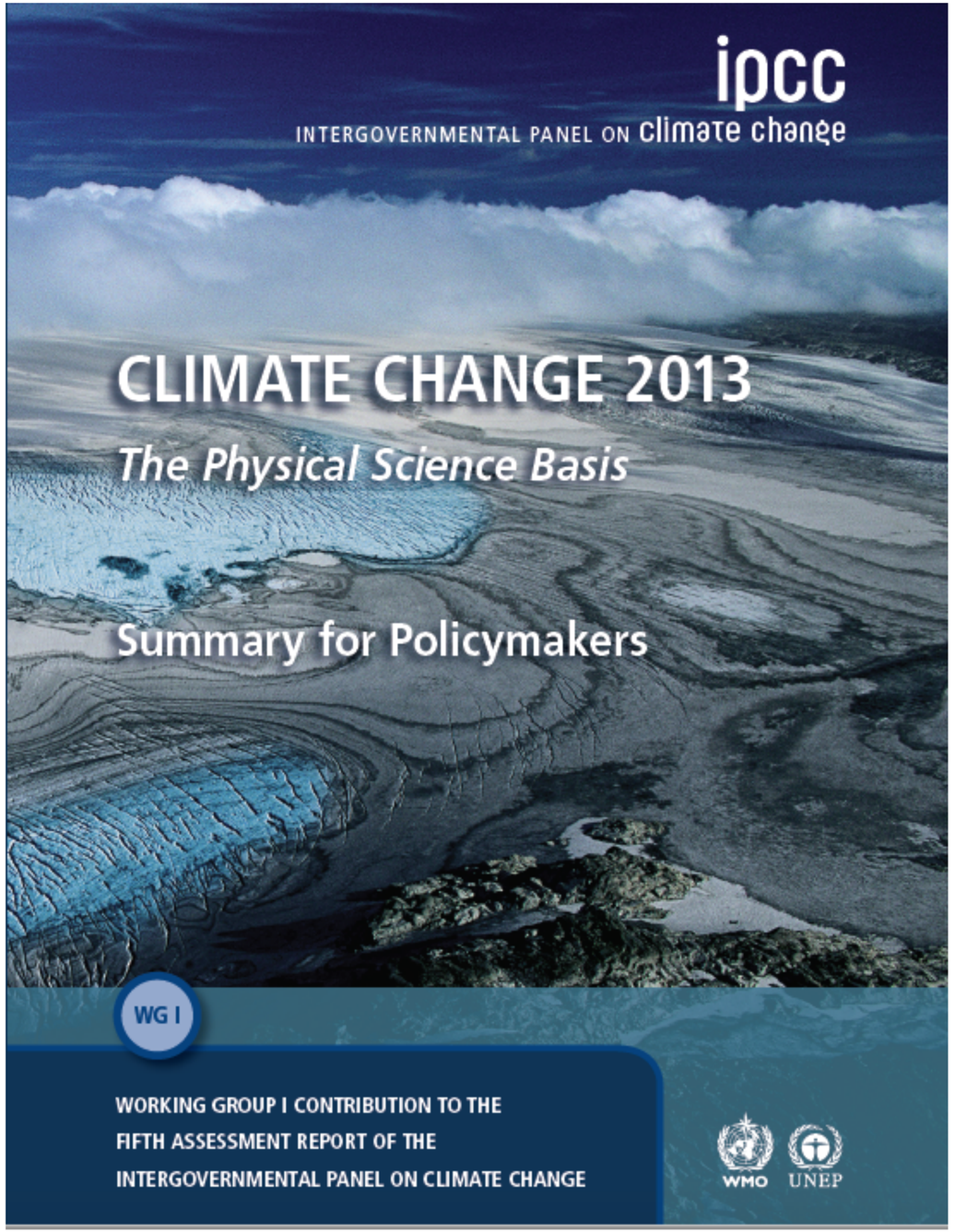


Figure SPM.7 | CMIP5 multi-model simulated time series from 1950 to 2100 for (a) change in global annual mean surface temperature relative to 1986–2005, (b) Northern Hemisphere September sea ice extent (5-year running mean), and (c) global mean ocean surface pH. Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). Black (grey shading) is the modelled historical evolution using historical reconstructed forcings. The mean and associated uncertainties averaged over 2081–2100 are given for all RCP scenarios as colored vertical bars. The numbers of CMIP5 models used to calculate the multi-model mean is indicated. For sea ice extent (b), the projected mean and uncertainty (minimum-maximum range) of the subset of models that most closely reproduce the climatological mean state and 1979 to 2012 trend of the Arctic sea ice is given (number of models given in brackets). For completeness, the CMIP5 multi-model mean is also indicated with dotted lines. The dashed line represents nearly ice-free conditions (i.e., when sea ice extent is less than 10^6 km² for at least five consecutive years). For further technical details see the Technical Summary Supplementary Material (Figures 6.28, 12.5, and 12.28–12.31; Figures TS.15, TS.17, and TS.20)

Prognosis



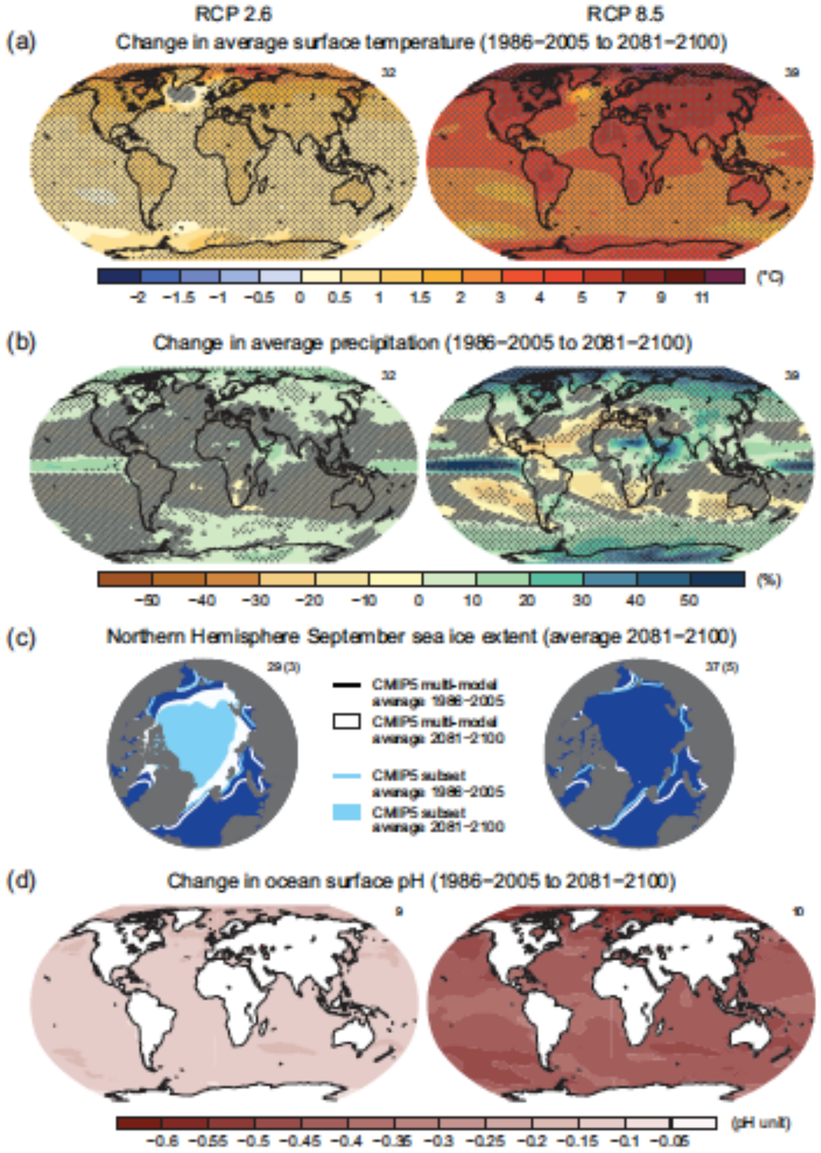
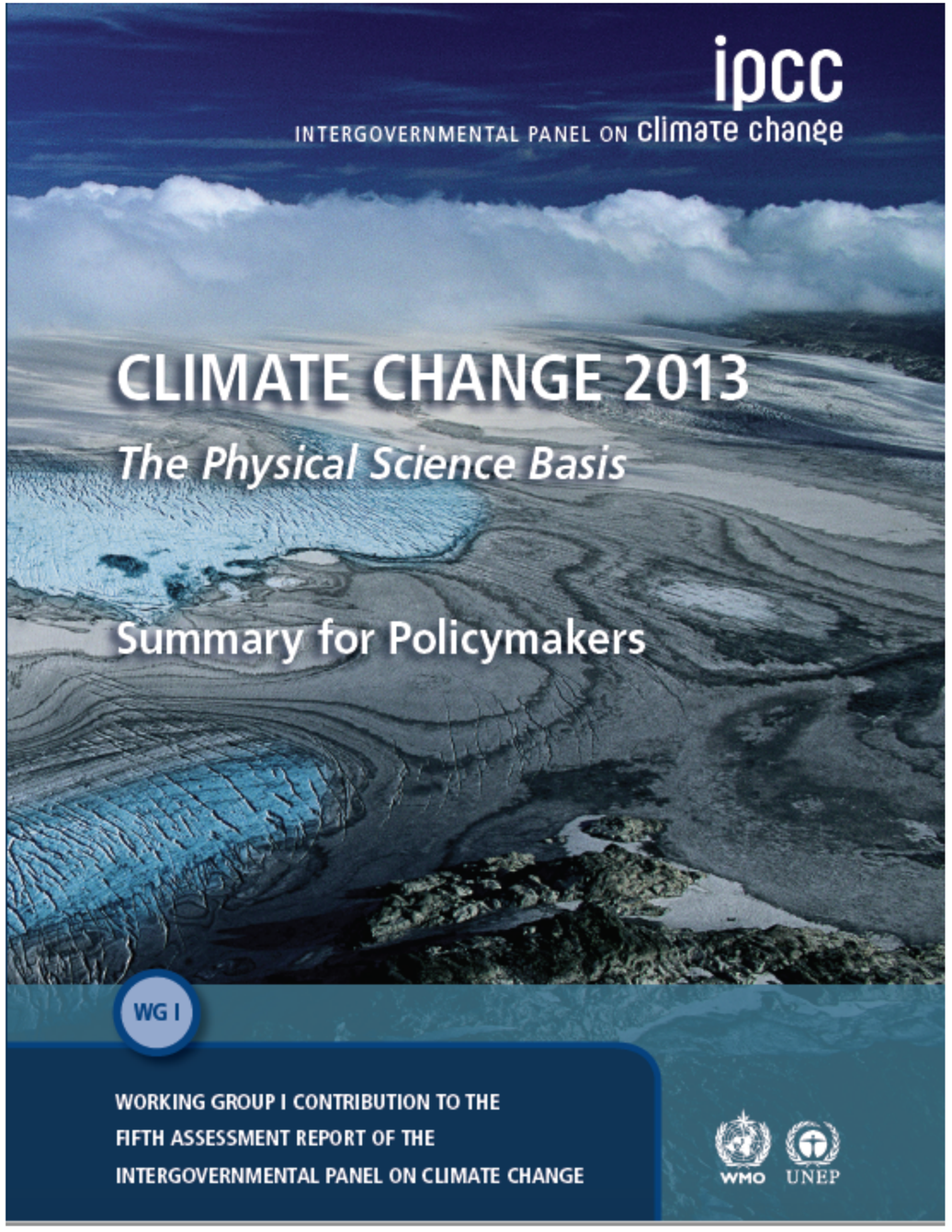


Figure SPM.8 | Maps of CMIP5 multi-model mean results for the scenarios RCP2.6 and RCP8.5 in 2081–2100 of (a) annual mean surface temperature change, (b) average percent change in annual mean precipitation, (c) Northern Hemisphere September sea ice extent, and (d) change in ocean surface pH. Changes in panels (a), (b) and (d) are shown relative to 1986–2005. The number of CMIP5 models used to calculate the multi-model mean is indicated in the upper right corner of each panel. For panels (a) and (b), hatching indicates regions where the multi-model mean is small compared to natural internal variability (i.e., less than one standard deviation of natural internal variability in 20-year means). Stippling indicates regions where the multi-model mean is large compared to natural internal variability (i.e., greater than two standard deviations of natural internal variability in 20-year means) and where at least 90% of models agree on the sign of change (see Box 12.1). In panel (c), the lines are the modelled means for 1986–2005; the filled areas are for the end of the century. The CMIP5 multi-model mean is given in white colour, the projected mean sea ice extent of a subset of models (number of models given in brackets) that most closely reproduce the climatological mean state and 1979 to 2012 trend of the Arctic sea ice extent is given in light blue colour. For further technical details see the Technical Summary Supplementary Material. [Figures 6.28, 12.11, 12.22, and 12.29; Figures TS.15, TS.16, TS.17, and TS.20]

Prognosis



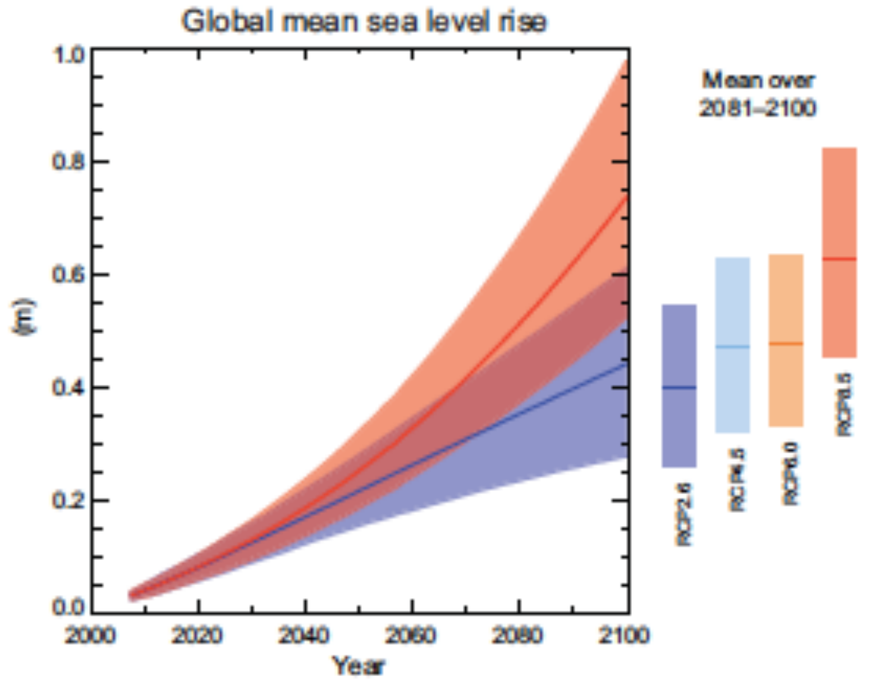
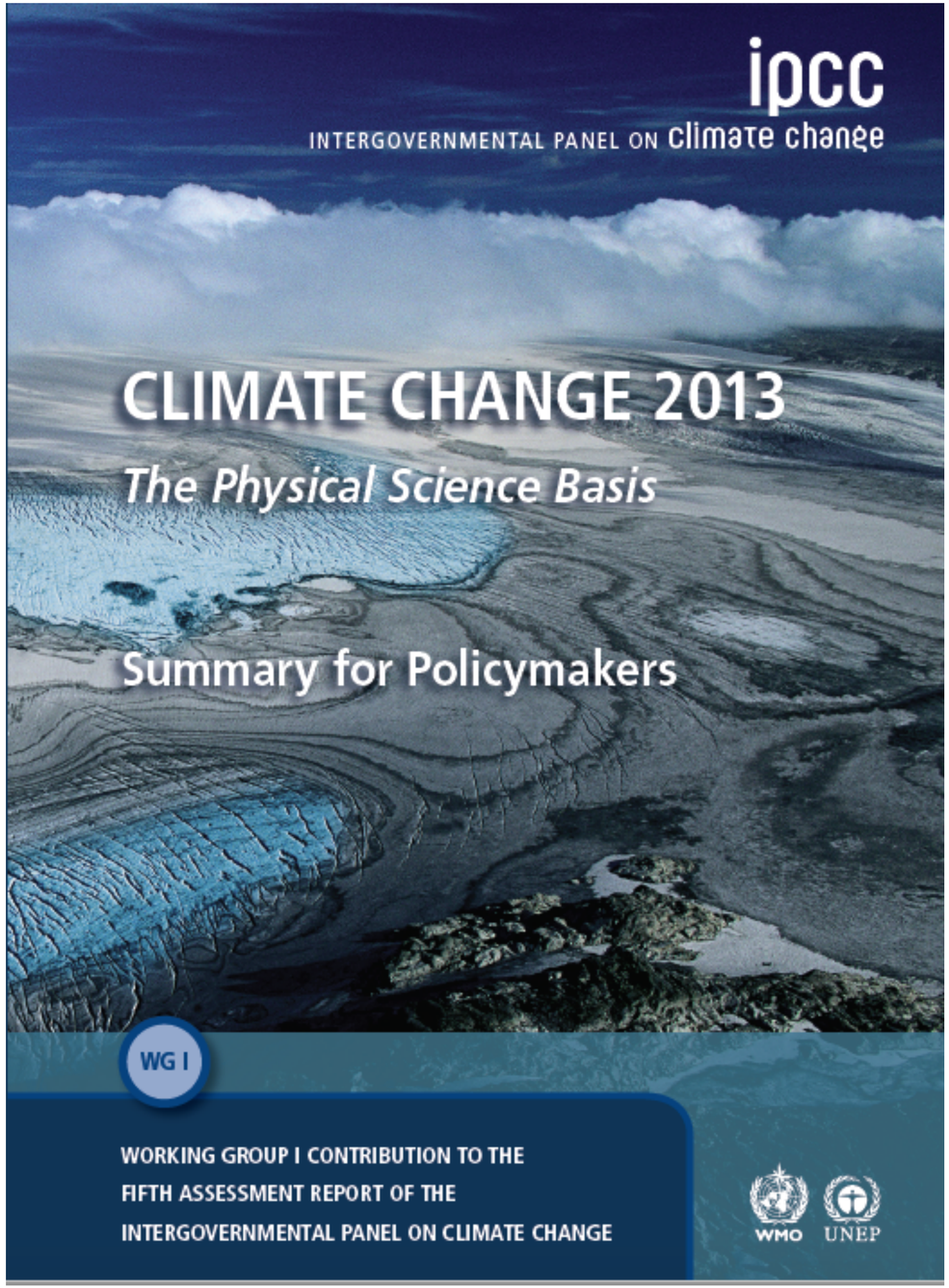


Figure SPM.9 | Projections of global mean sea level rise over the 21st century relative to 1986–2005 from the combination of the CMIP5 ensemble with process-based models, for RCP2.6 and RCP8.5. The assessed *likely* range is shown as a shaded band. The assessed *likely* ranges for the mean over the period 2081–2100 for all RCP scenarios are given as coloured vertical bars, with the corresponding median value given as a horizontal line. For further technical details see the Technical Summary Supplementary Material (Table 13.5, Figures 13.10 and 13.11; Figures TS.21 and TS.22)

Prognosis



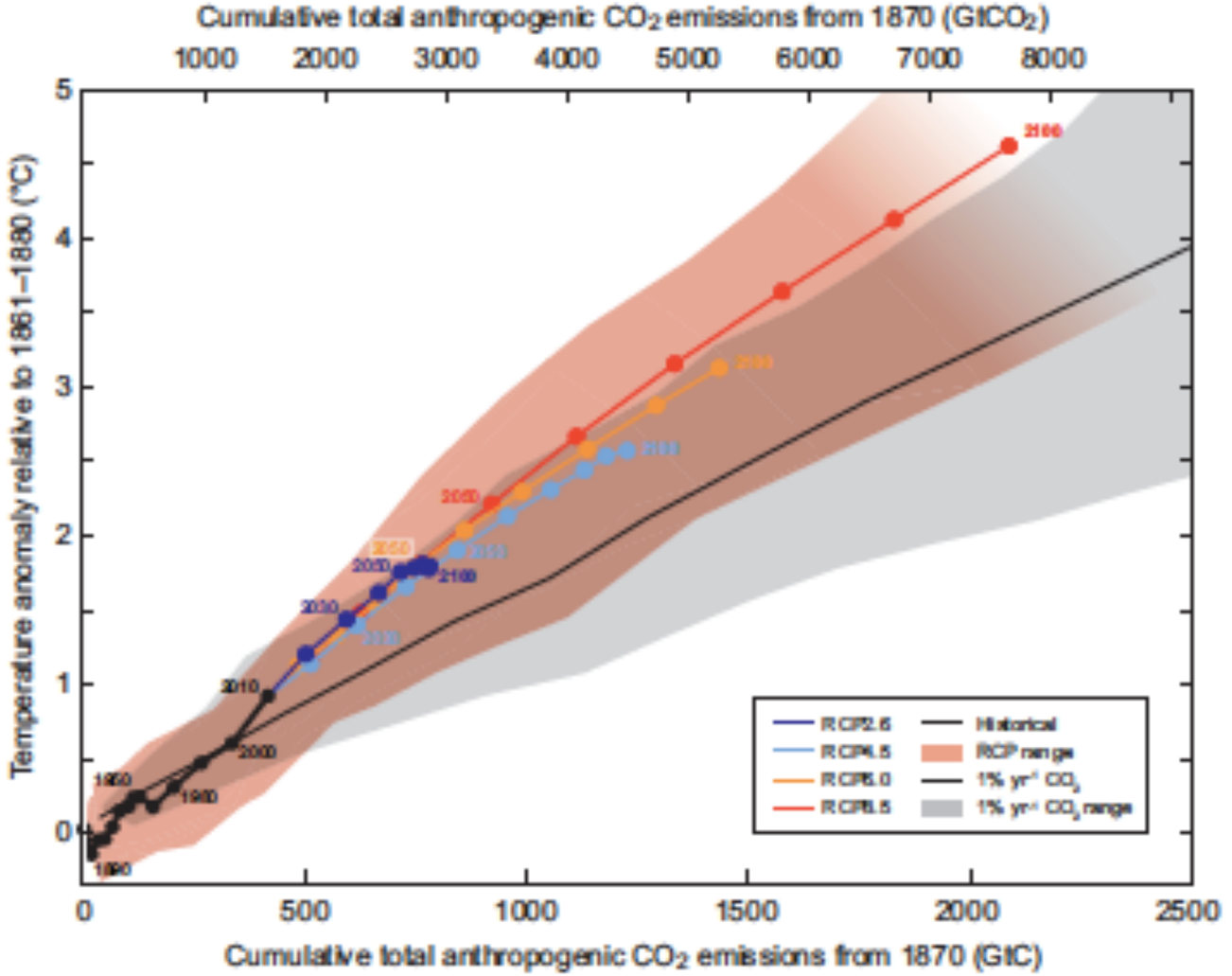
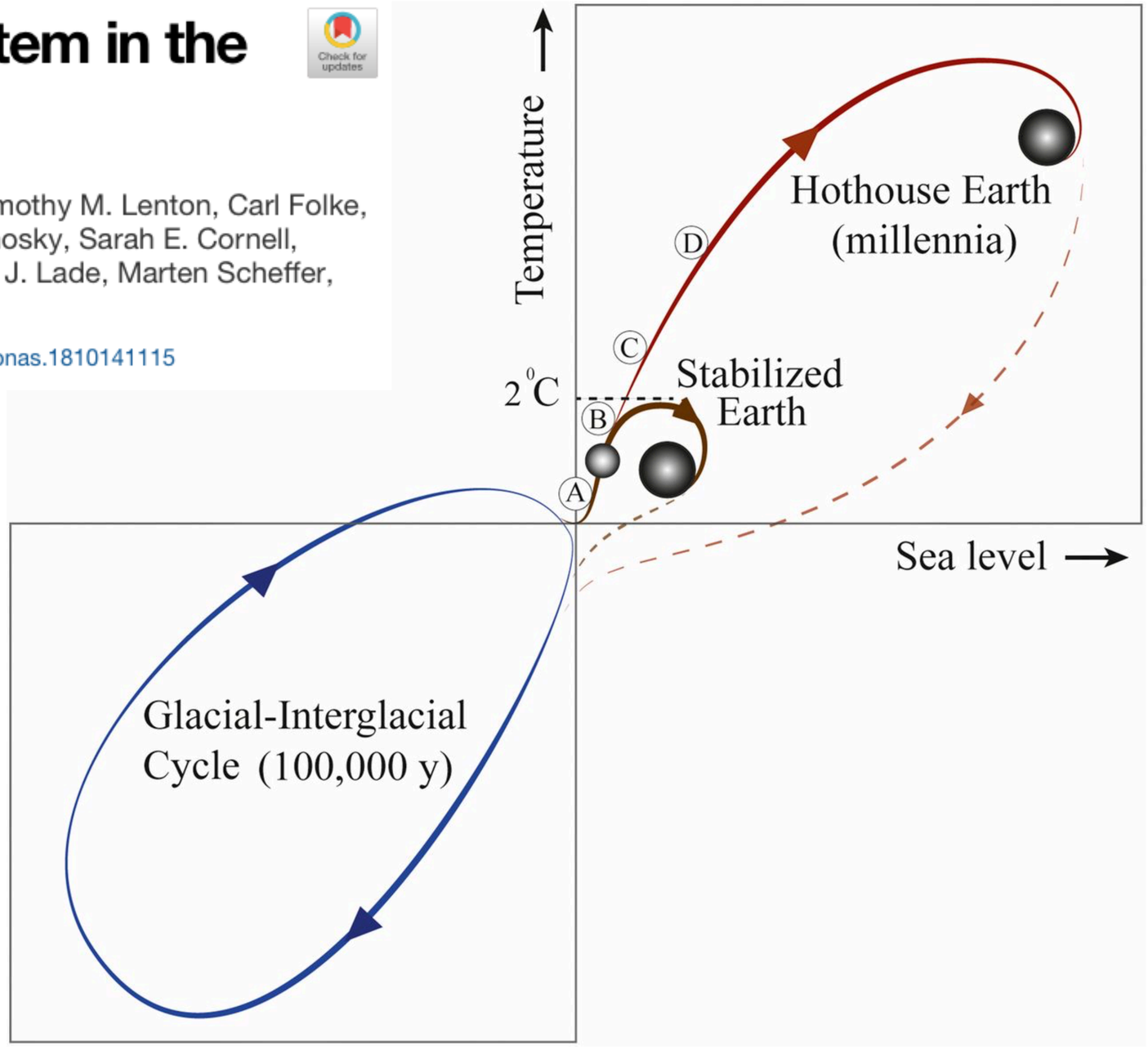


Figure SPM.10 | Global mean surface temperature increase as a function of cumulative total global CO_2 emissions from various lines of evidence. Multi-model results from a hierarchy of climate-carbon cycle models for each RCP until 2100 are shown with coloured lines and decadal means (dots). Some decadal means are labeled for clarity (e.g., 2050 indicating the decade 2040–2049). Model results over the historical period (1860 to 2010) are indicated in black. The coloured plume illustrates the multi-model spread over the four RCP scenarios and fades with the decreasing number of available models in RCP8.5. The multi-model mean and range simulated by CMIP5 models, forced by a CO_2 increase of 1% per year (1% yr^{-1} CO_2 simulations), is given by the thin black line and grey area. For a specific amount of cumulative CO_2 emissions, the 1% per year CO_2 simulations exhibit lower warming than those driven by RCPs, which include additional non-CO_2 forcings. Temperature values are given relative to the 1861–1880 base period, emissions relative to 1870. Decadal averages are connected by straight lines. For further technical details see the Technical Summary Supplementary Material. (Figure 12.45; TS TFE.8, Figure 1)

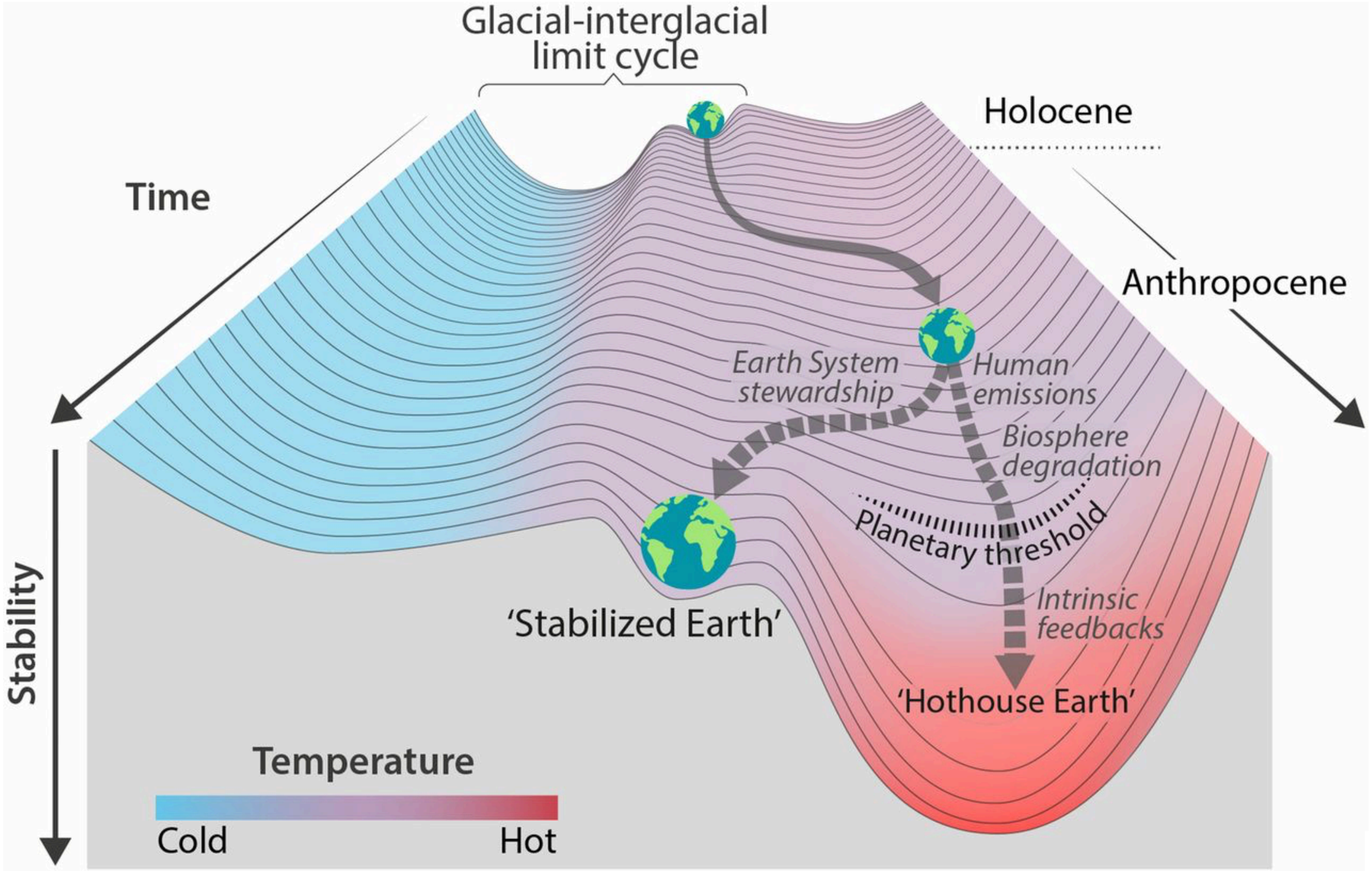
Trajectories of the Earth System in the Anthropocene

Will Steffen, Johan Rockström, Katherine Richardson, Timothy M. Lenton, Carl Folke, Diana Liverman, Colin P. Summerhayes, Anthony D. Barnosky, Sarah E. Cornell, Michel Crucifix, Jonathan F. Donges, Ingo Fetzer, Steven J. Lade, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber

PNAS published ahead of print August 6, 2018 https://doi.org/10.1073/pnas.1810141115



Prognosis



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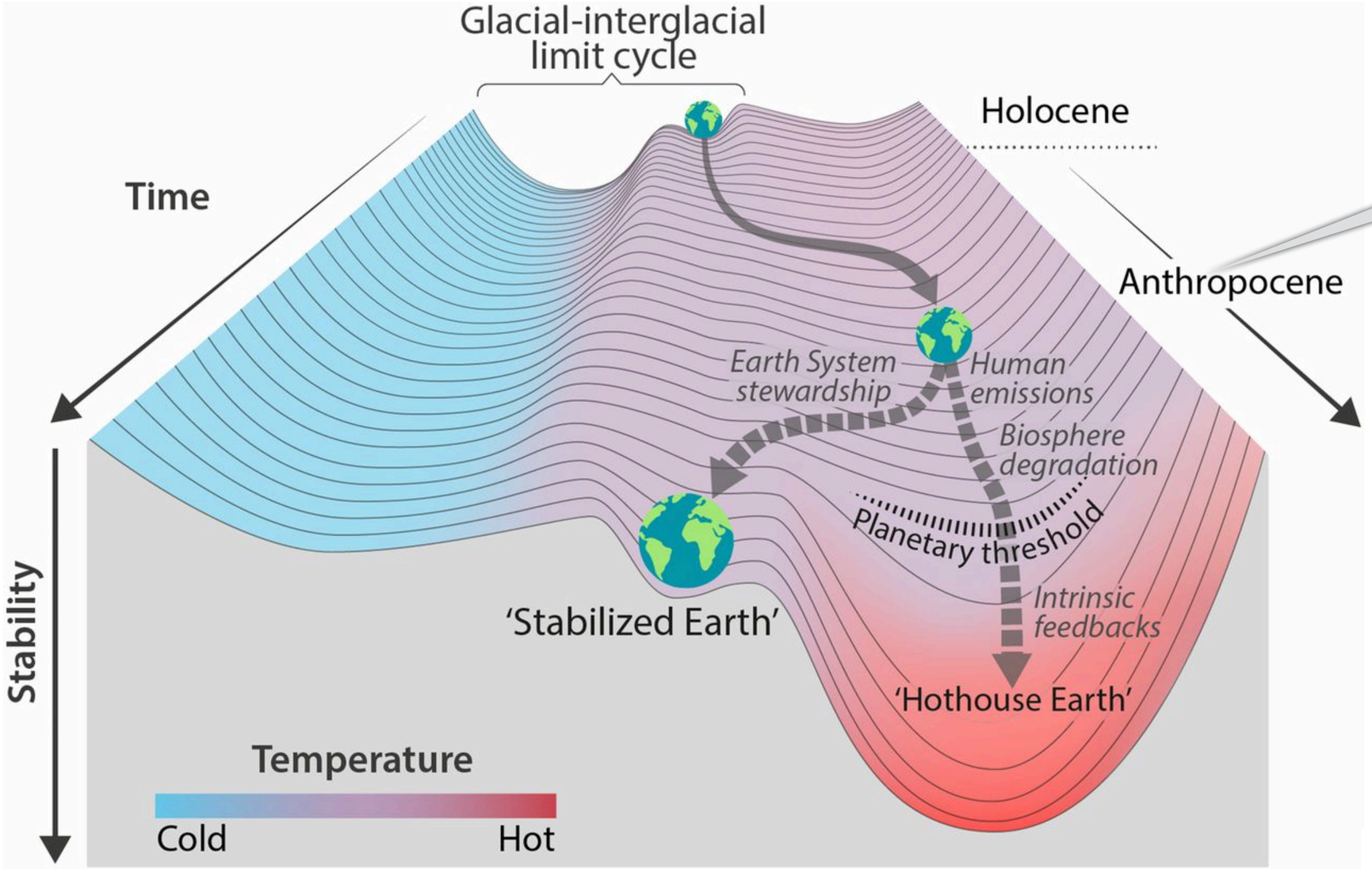

Anthropocene or Post-Holocene?

Trajectories of the Earth System in the Anthropocene

Will Steffen, Johan Rockström, Katherine Richardson, Timothy M. Lenton, Carl Folke, Diana Liverman, Colin P. Summerhayes, Anthony D. Barnosky, Sarah E. Cornell, Michel Crucifix, Jonathan F. Donges, Ingo Fetzer, Steven J. Lade, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber

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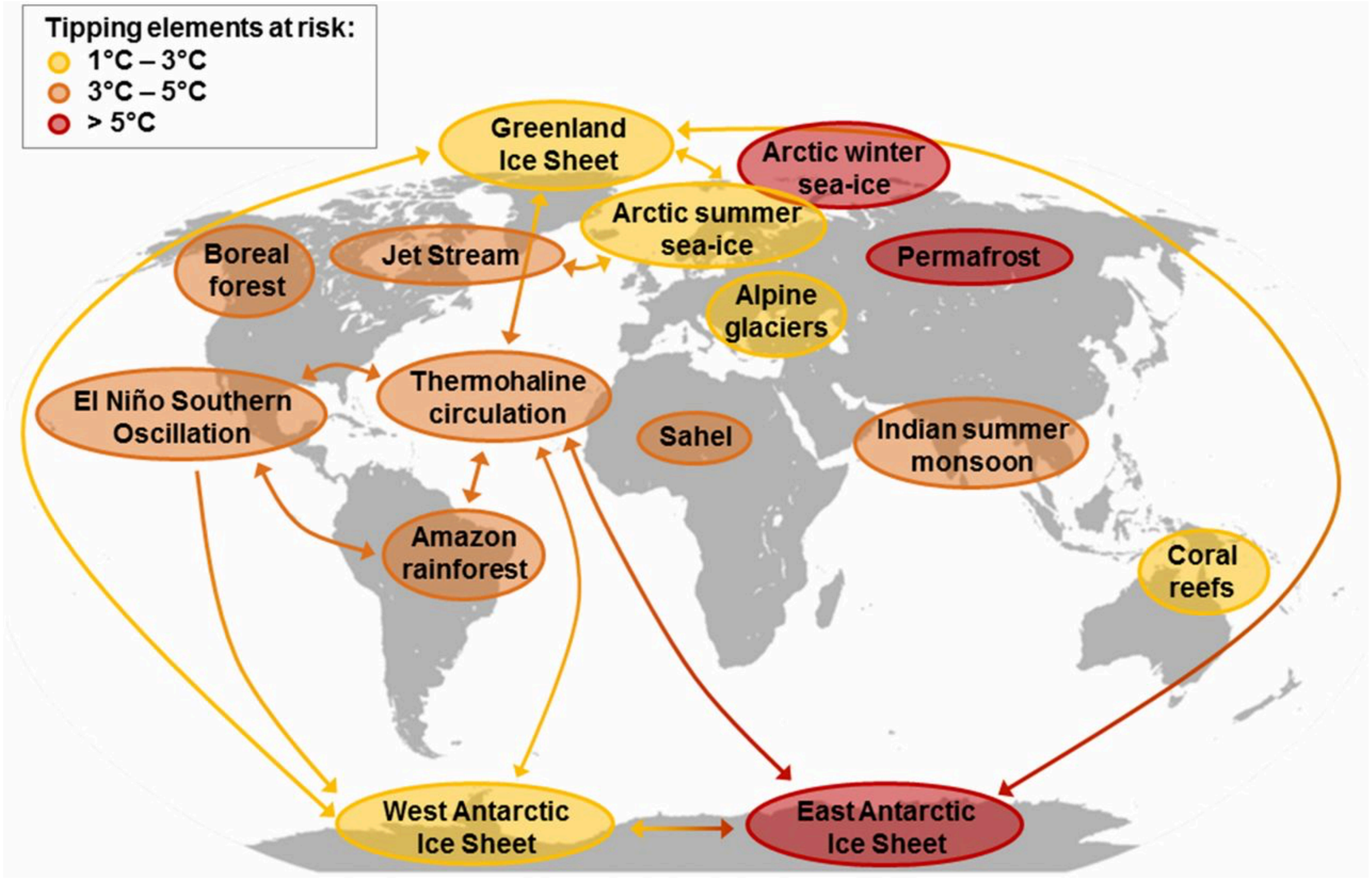

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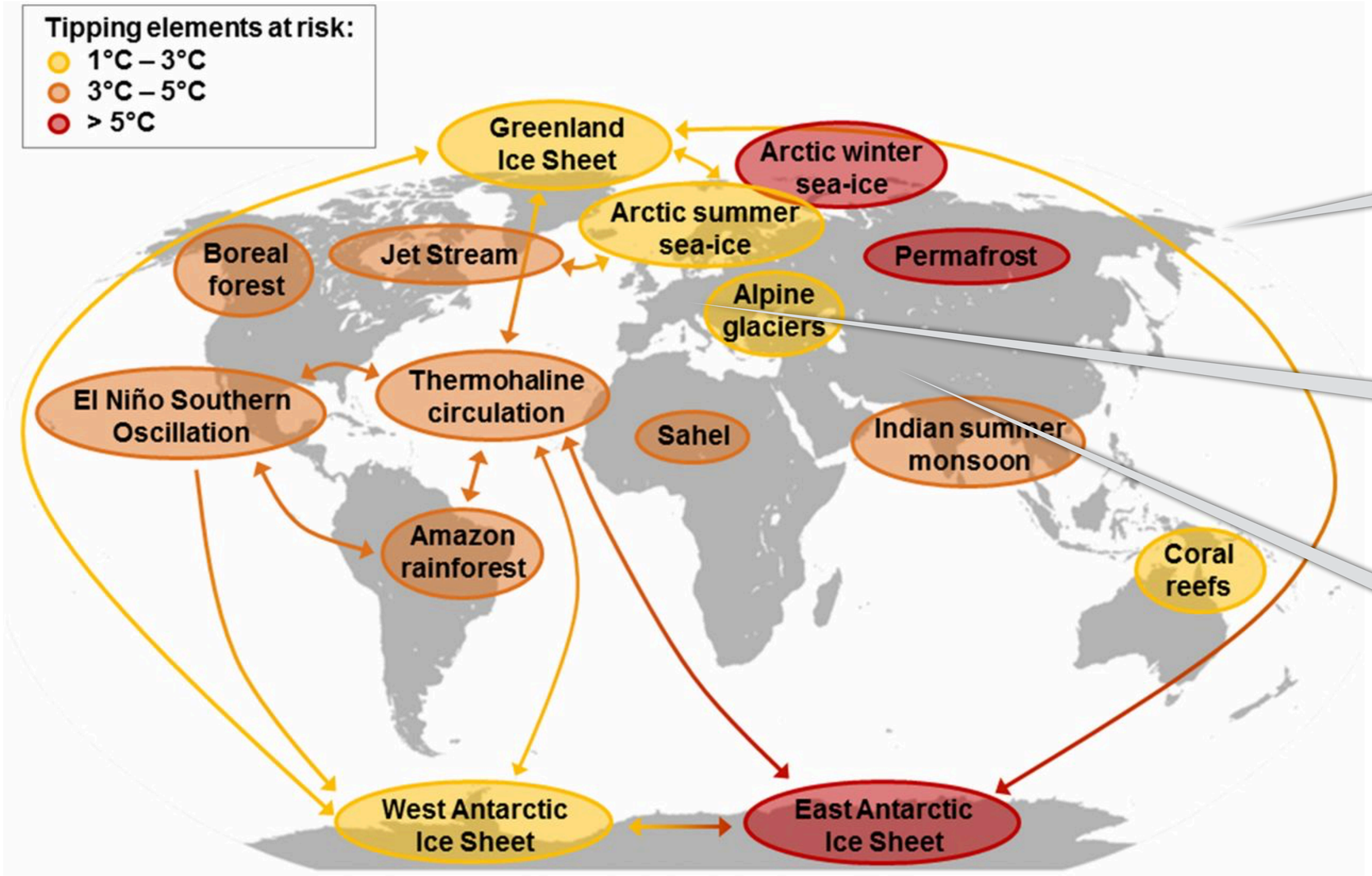

Extinction of mammals and birds

Extinction of insects

Loss of soil

Trajectories of the Earth System in the Anthropocene

Will Steffen, Johan Rockström, Katherine Richardson, Timothy M. Lenton, Carl Folke, Diana Liverman, Colin P. Summerhayes, Anthony D. Barnosky, Sarah E. Cornell, Michel Crucifix, Jonathan F. Donges, Ingo Fetzer, Steven J. Lade, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber

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Exploring Possible Futures

- climate change:
  - extreme weather
  - global atmospheric warming
  - ocean warming
  - ocean acidification
  - sea level rise
- global disasters
- population growth
- economic growth
- land use, food and water security
- social and technological risks inc. wars)
- extinction
- governance
- pandemics

Methodology

- modeling and simulations
  - participatory modeling (*development of options*)
  - scenario-based modeling and simulations: *model validation, ensembles, selection of scenarios, not predictions*
- risk assessments:
  - risk perception and biases, comprehensiveness
  - based on past system behavior

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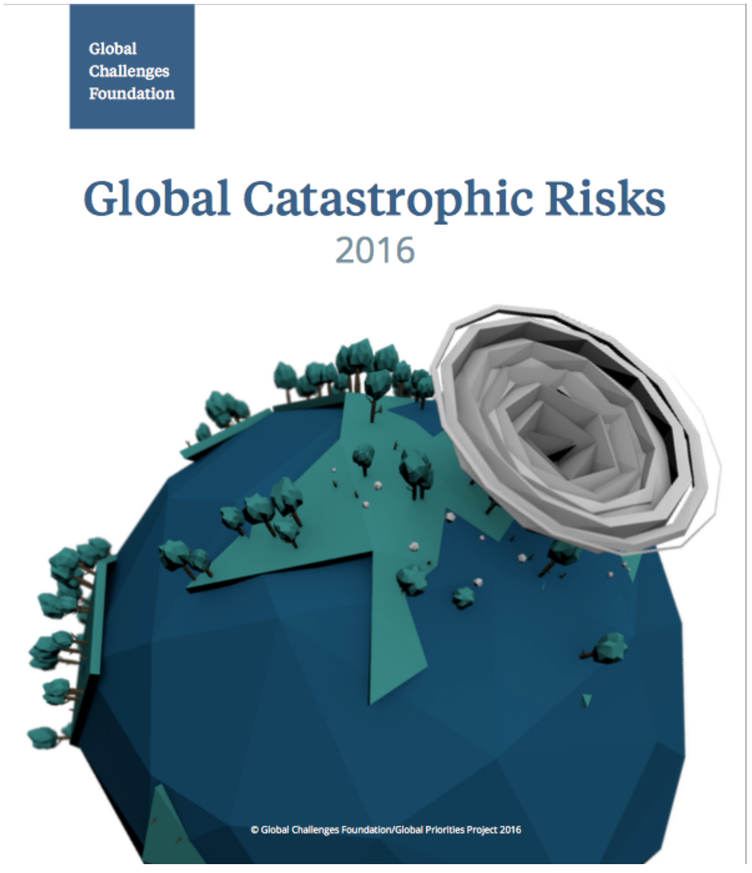
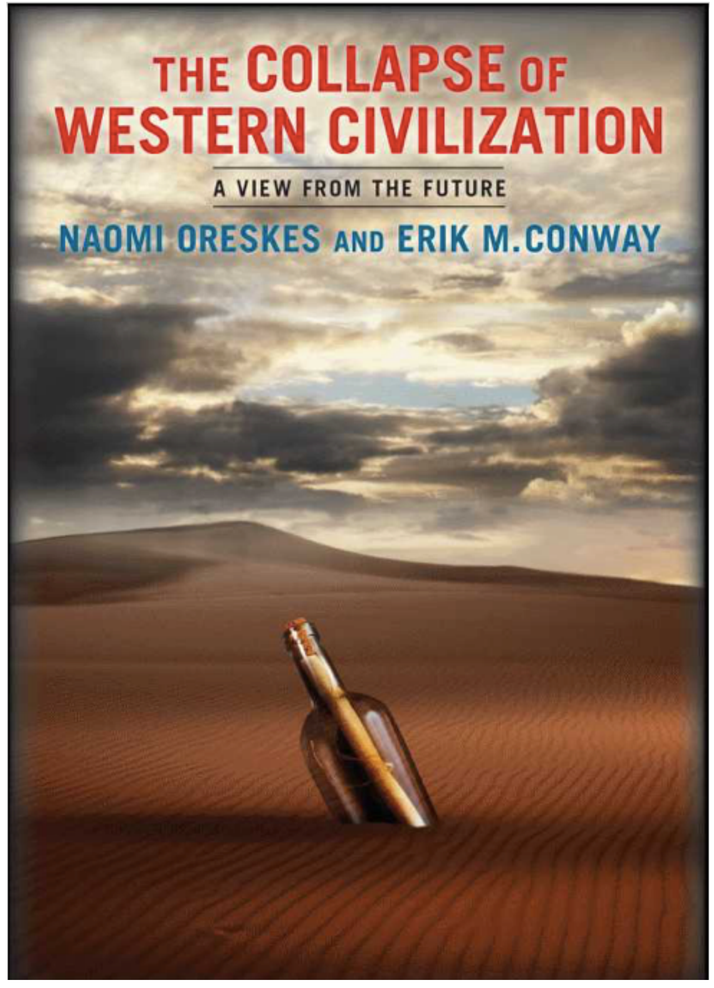
Prognosis

Assessing the risk …

Assessing the risk …





Prognosis

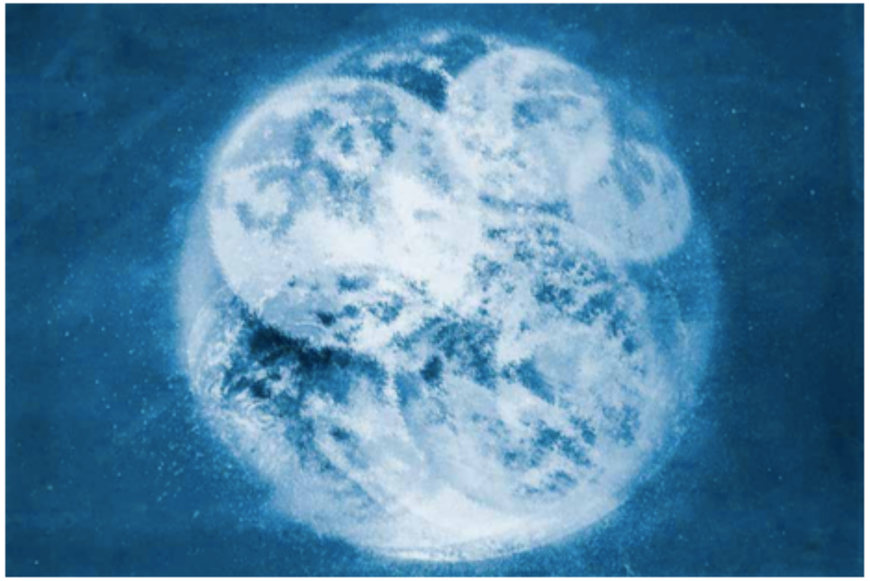
WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Insight Report

The Global Risks Report 2019
14th Edition

In partnership with Marsh & McLennan Companies and Zurich Insurance Group



Prognosis

Insight Report

The Global I
Report 201
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Top 5 Global Risks in Terms of Likelihood

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1st	Asset price collapse	Asset price collapse	Storms and cyclones	Severe income disparity	Severe income disparity	Income disparity	Interstate conflict with regional consequences	Large-scale involuntary migration	Extreme weather events	Extreme weather events	Extreme weather events
2nd	Slowing Chinese economy (<6%)	Slowing Chinese economy (<6%)	Flooding	Chronic fiscal imbalances	Chronic fiscal imbalances	Extreme weather events	Extreme weather events	Extreme weather events	Large-scale involuntary migration	Natural disasters	Failure of climate-change mitigation and adaptation
3rd	Chronic disease	Chronic disease	Corruption	Rising greenhouse gas emissions	Rising greenhouse gas emissions	Unemployment and underemployment	Failure of national governance	Failure of climate-change mitigation and adaptation	Major natural disasters	Cyber-attacks	Natural disasters
4th	Global governance gaps	Fiscal crises	Biodiversity loss	Cyber-attacks	Water supply crises	Climate change	State collapse or crisis	Interstate conflict with regional consequences	Large-scale terrorist attacks	Data fraud or theft	Data fraud or theft
5th	Retrenchment from globalization	Global governance gaps	Climate change	Water supply crises	Mismanagement of population	Cyber-attacks	High structural unemployment or underemployment	Major natural catastrophes	Massive incident of data fraud/theft	Failure of climate-change mitigation and adaptation	Cyber-attacks

Top 5 Global Risks in Terms of Impact

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1st	Asset price collapse	Asset price collapse	Fiscal crises	Major systemic financial failure	Major systemic financial failure	Fiscal crises	Water crises	Failure of climate-change mitigation and adaptation	Weapons of mass destruction	Weapons of mass destruction	Weapons of mass destruction
2nd	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Climate change	Water supply crises	Water supply crises	Climate change	Rapid and massive spread of infectious diseases	Weapons of mass destruction	Extreme weather events	Extreme weather events	Failure of climate-change mitigation and adaptation
3rd	Oil and gas price spike	Oil price spikes	Geopolitical conflict	Food shortage crises	Chronic fiscal imbalances	Water crises	Weapons of mass destruction	Water crises	Water crises	Natural disasters	Extreme weather events
4th	Chronic disease	Chronic disease	Asset price collapse	Chronic fiscal imbalances	Diffusion of weapons of mass destruction	Unemployment and underemployment	Interstate conflict with regional consequences	Large-scale involuntary migration	Major natural disasters	Failure of climate-change mitigation and adaptation	Water crises
5th	Fiscal crises	Fiscal crises	Extreme energy price volatility	Extreme volatility in energy and agriculture prices	Failure of climate-change mitigation and adaptation	Critical information infrastructure breakdown	Failure of climate-change mitigation and adaptation	Severe energy price shock	Failure of climate-change mitigation and adaptation	Water crises	Natural disasters

Economic Environmental Geopolitical Societal Technological

Source: World Economic Forum 2009–2019, Global Risks Reports.
Note: Global risks may not be strictly comparable across years, as definitions and the set of global risks have evolved with new issues emerging on the 10-year horizon. For example, cyberattacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks were reclassified: water crises and rising income disparity were re-categorized first as societal risks and then as a trend in the 2015 and 2016 *Global Risks Reports*, respectively.

Prognosis

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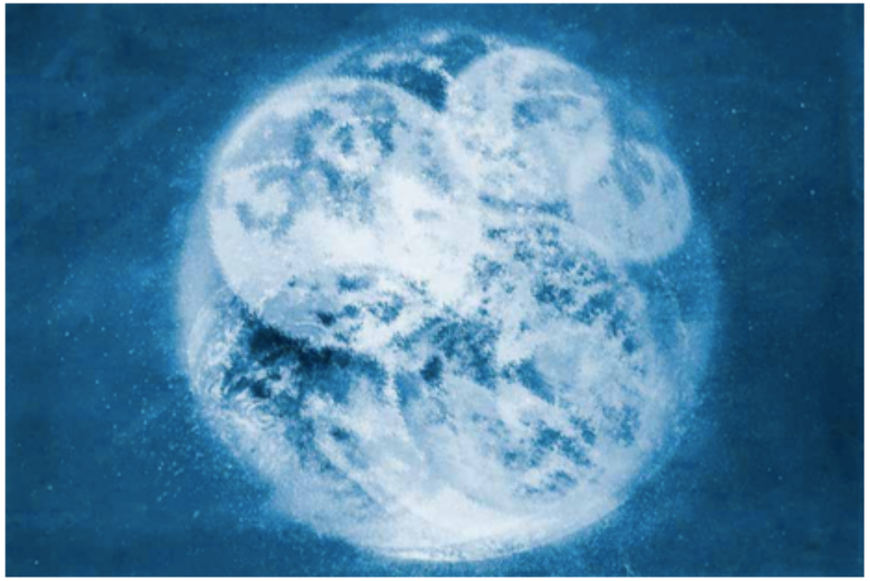


Prognosis

Economic Risks

Geopolitical Risks

Technological Risks

Environmental Risks

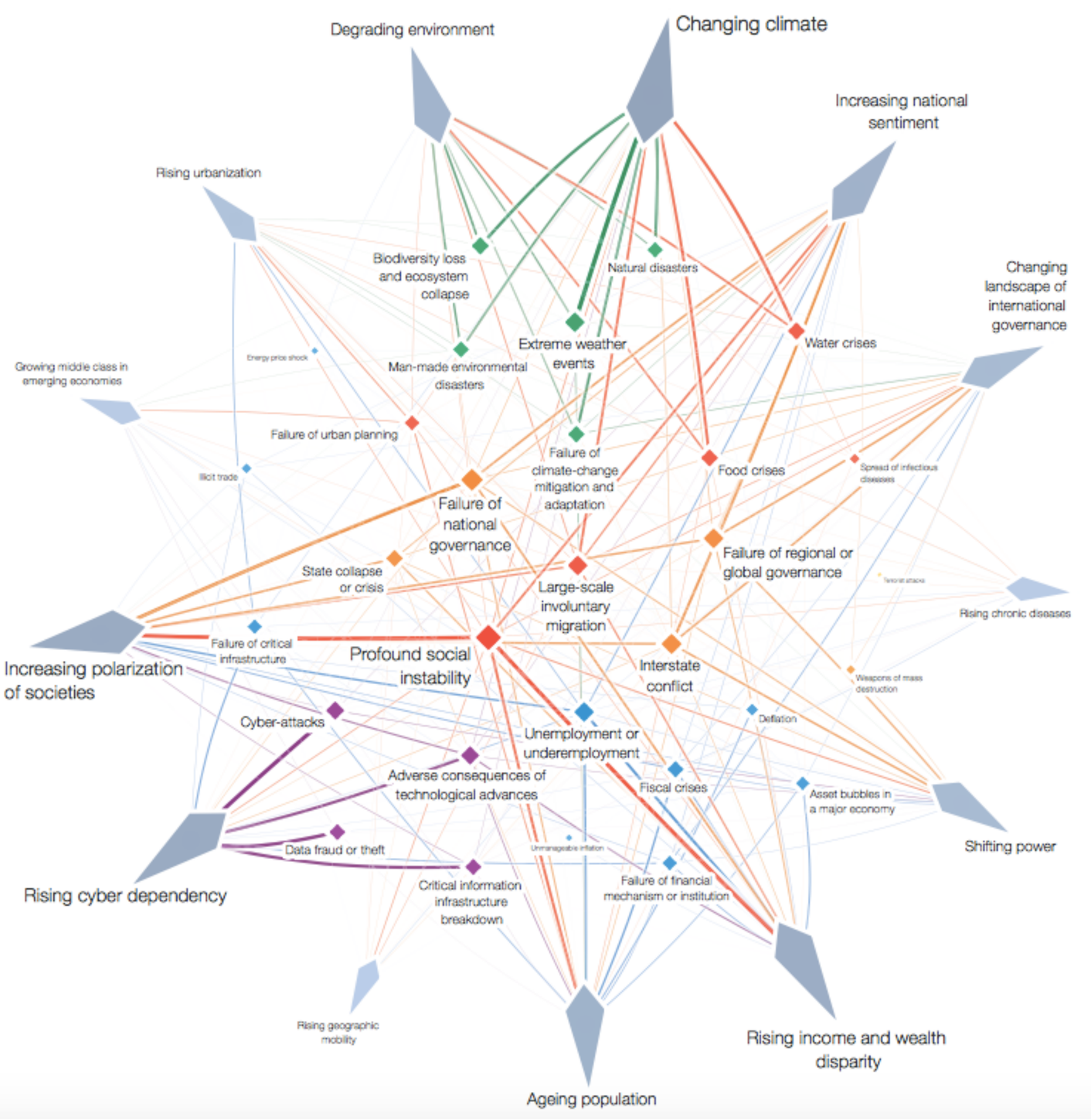
Societal Risks

Risks

Number and strength of connections ("weighted degree")

Trends

Number and strength of connections ("weighted degree")



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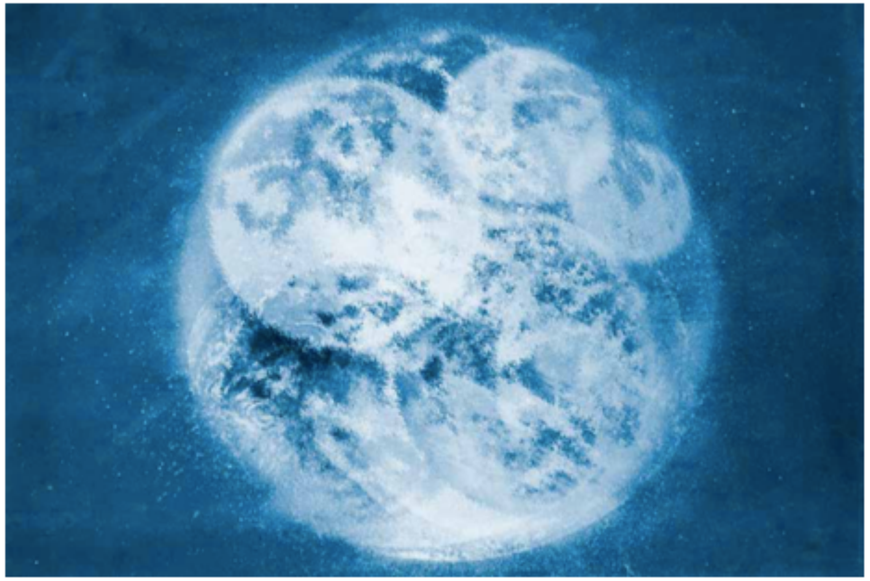
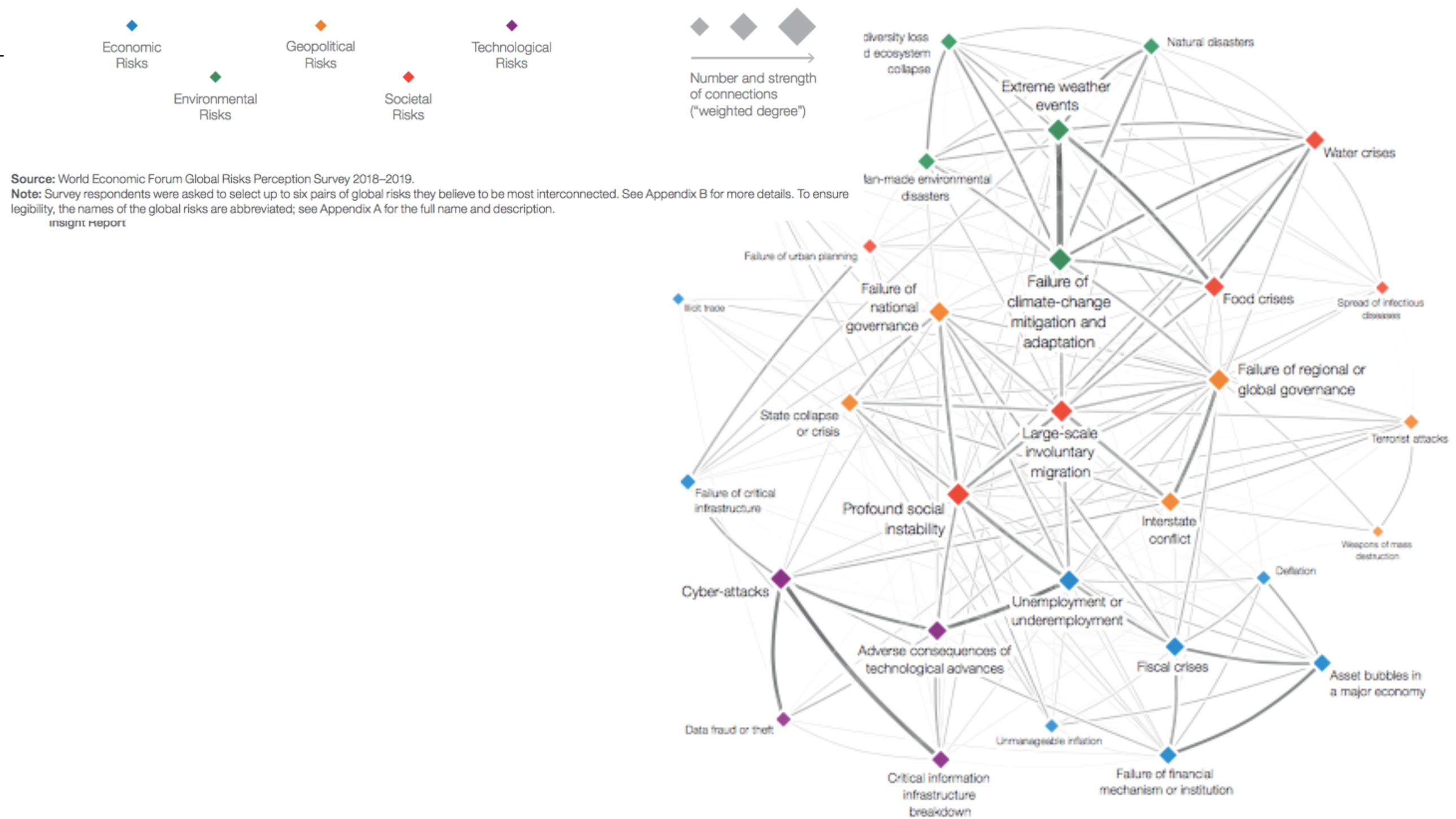
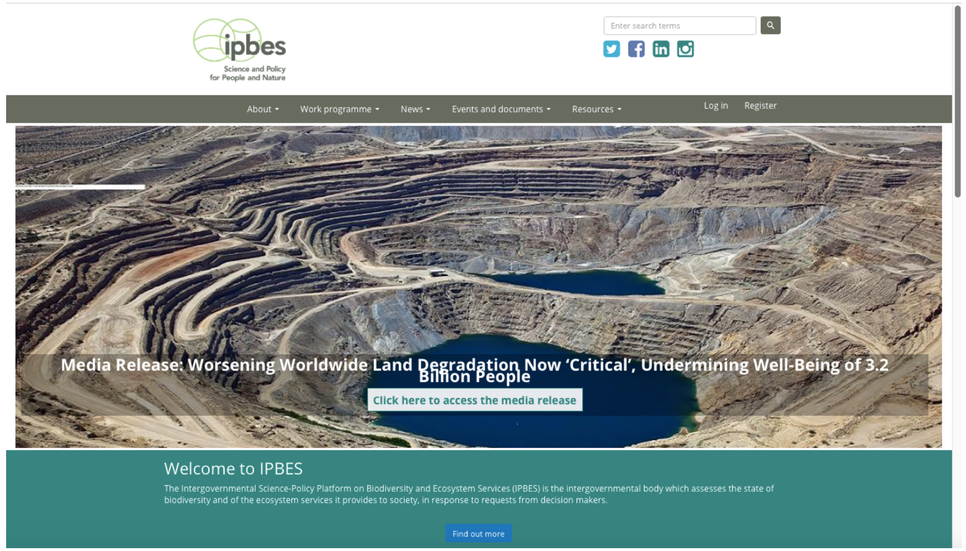




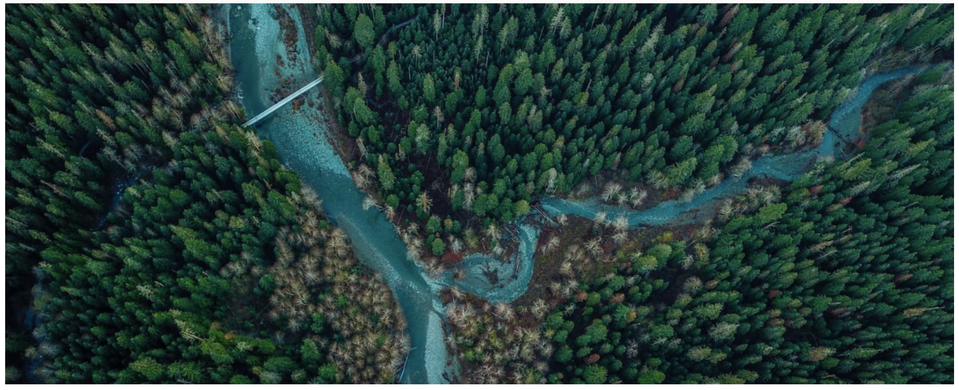
Source: World Economic Forum Global Risks Perception Survey 2018–2019.
Note: Survey respondents were asked to select up to six pairs of global risks they believe to be most interconnected. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated; see Appendix A for the full name and description.

Prognosis

Assessing the risk …



We can't engineer our way out of an impending water scarcity epidemic



Homo sapiens have a huge amount of data and knowledge

ipcc
INTERGOVERNMENTAL PANEL ON climate change

GLOBAL WARMING OF 1.5 °C

an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty

Summary for Policymakers

This Summary for Policymakers was formally approved at the First Joint Session of Working Groups I, II and III of the IPCC and accepted by the 48th Session of the IPCC, Incheon, Republic of Korea, 6 October 2018.

Mammal diversity will take millions of years to recover from the current biodiversity crisis

Matt Davis, Søren Faurby, and Jens-Christian Svenning

PNAS published ahead of print October 15, 2018 https://doi.org/10.1073/pnas.1804906115

Climate-driven declines in arthropod abundance restructure a rainforest food web

Bradford C. Lister and Andres Garcia

PNAS published ahead of print October 15, 2018 https://doi.org/10.1073/pnas.1722477115

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Prognosis

Our Commitment: The “~400 ppm CO_2 World”:

Prognosis

Our Commitment: The "~400 ppm CO_2 World":

Example: Mid-Pliocene, 3.3 to 3.0 Million Years ago
Temperature: ~1 - 2 ^oC higher
Sea level:

- global average on the order of 10 m higher than today
- regionally 5 to 40 m higher;
- most likely, much stronger storms due to larger temperature difference between tropics and polar regions

Prognosis

Hansen et al., 2016:"… Evidence … that 2°C global warming is highly dangerous."

Example: A
Temperature: ~1 - 2 °C higher
Sea level:

- global average on the order of
- regionally 5 to 40 m higher;
- most likely, much stronger stor
  temperature difference betwee
  regions

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www.atmos-chem-phys-discuss.net/15/20059/2015/
doi:10.5194/acpd-15-20059-2015

Research Article 23 Jul 2015

Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming is highly dangerous

Review Status
This discussion paper is under review for the journal Atmospheric Chemistry and Physics (ACP).

J. Hansen[1], M. Sato[1], P. Hearty[2], R. Ruedy[3,4], M. Kelley[3,4], V. Masson-Delmotte[5], G. Russell[4], G. Tselioudis[4], J. Cao[6], E. Rignot[7,8], I. Velicogna[7,8], E. Kandiano[9], K. von Schuckmann[10], P. Kharecha[1,4], A. N. Legrande[4], M. Bauer[11], and K.-W. Lo[3,4]

[1]Climate Science, Awareness and Solutions, Columbia University Earth Institute, New York, NY 10115, USA
[2]Department of Environmental Studies, University of North Carolina at Wilmington, North Carolina 28403, USA
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[6]Key Lab of Aerosol Chemistry & Physics, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710075, China
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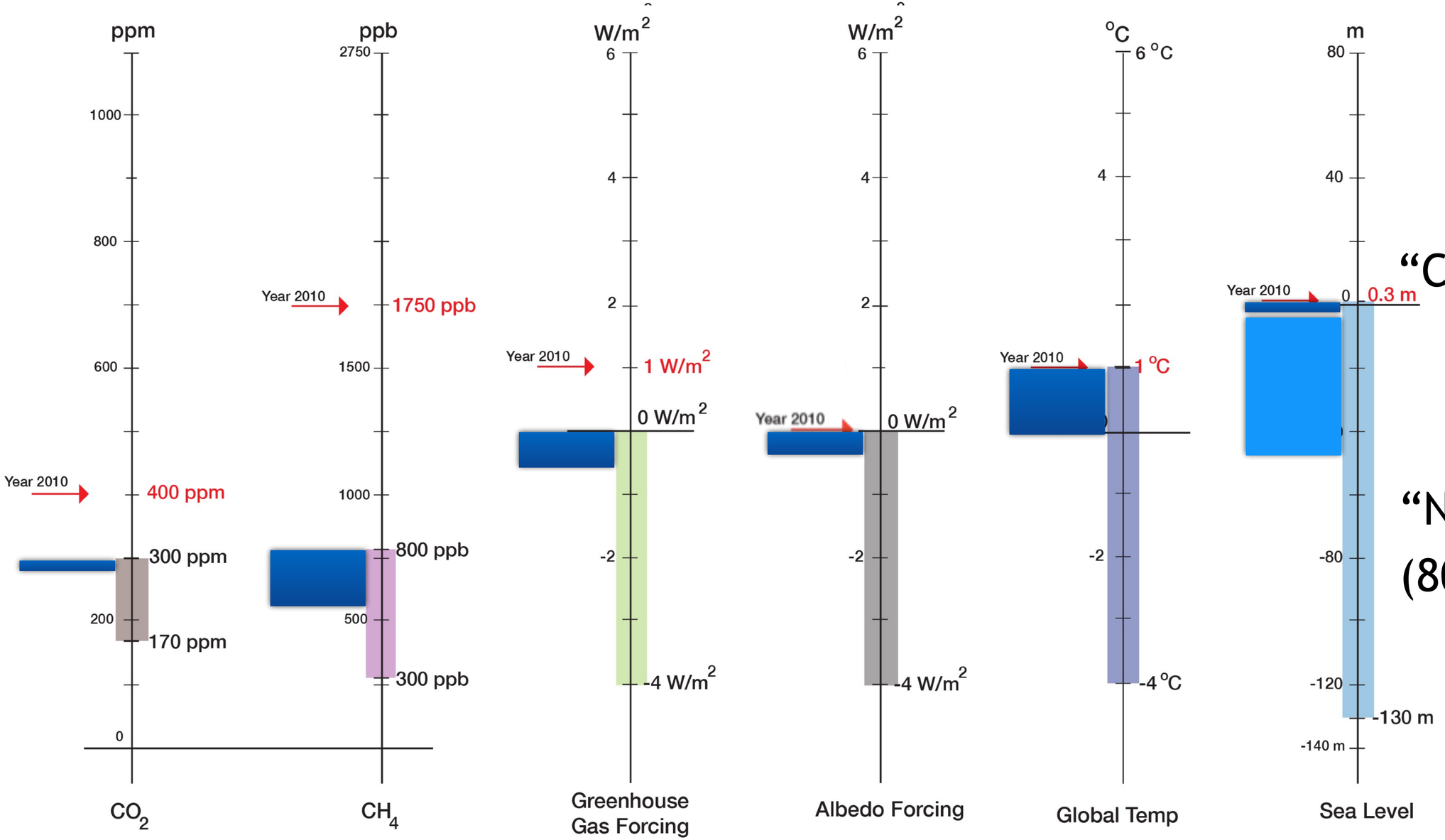
[11]Department of Applied Physics and Applied Mathematics, Columbia University, New York, NY, 10027, USA

Received: 11 Jun 2015 – Accepted: 09 Jul 2015 – Published: 23 Jul 2015

Abstract. There is evidence of ice melt, sea level rise to +5–9 m, and extreme storms in the prior interglacial period that was less than 1 °C warmer than today. Human-made climate forcing is stronger and more rapid than paleo forcings, but much can be learned by combining insights from

Prognosis

Exploring possible futures and developing foresight:
Broad range of futures



"Current State"

"Normal Range"
(800,000 years)

Prognosis

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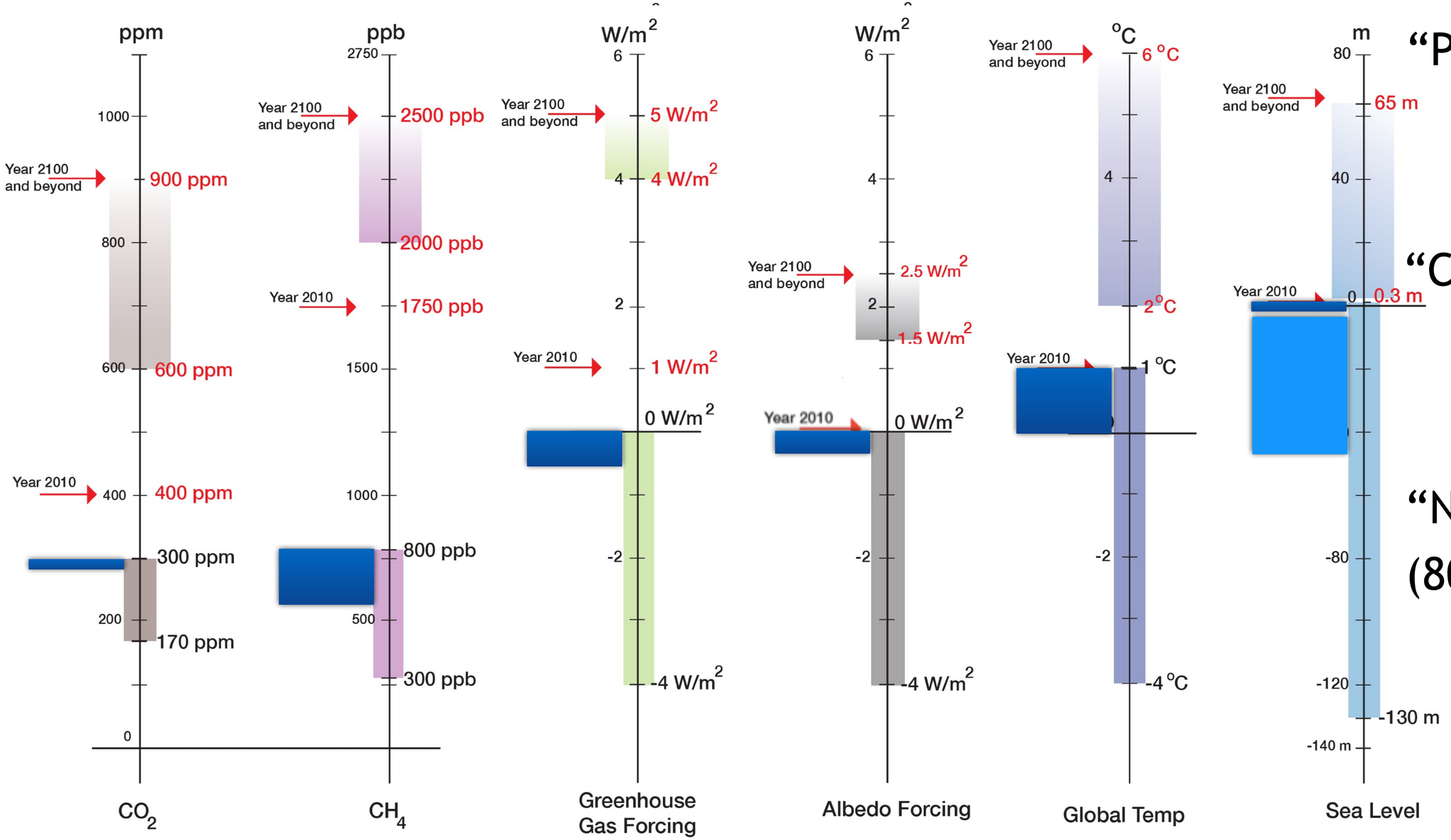
Broad range of futures



“Prognosis”

“Current State”

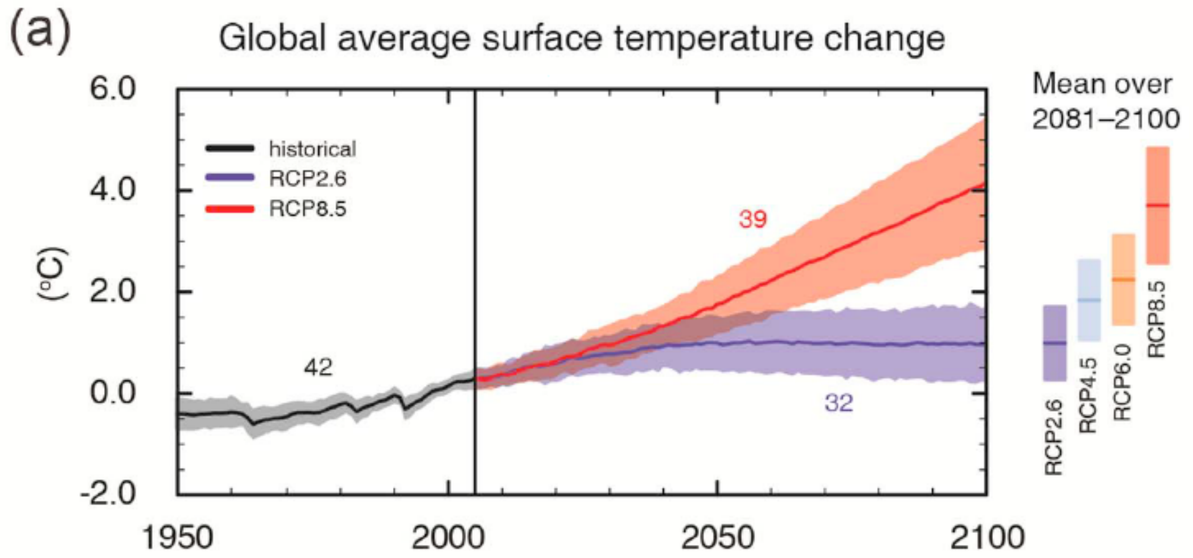
“Normal Range”
(800,000 years)

Prognosis

Exploring possible futures and developing foresight:
How to present the futures?

Prognosis

Exploring possible futures and developing foresight:
How to present the futures?



Prognosis

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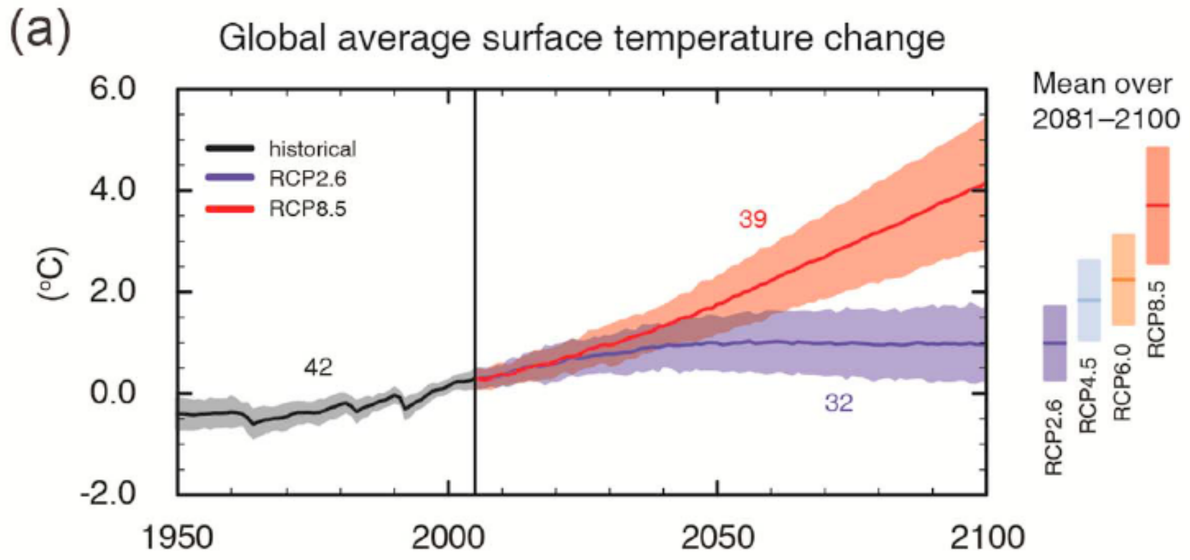
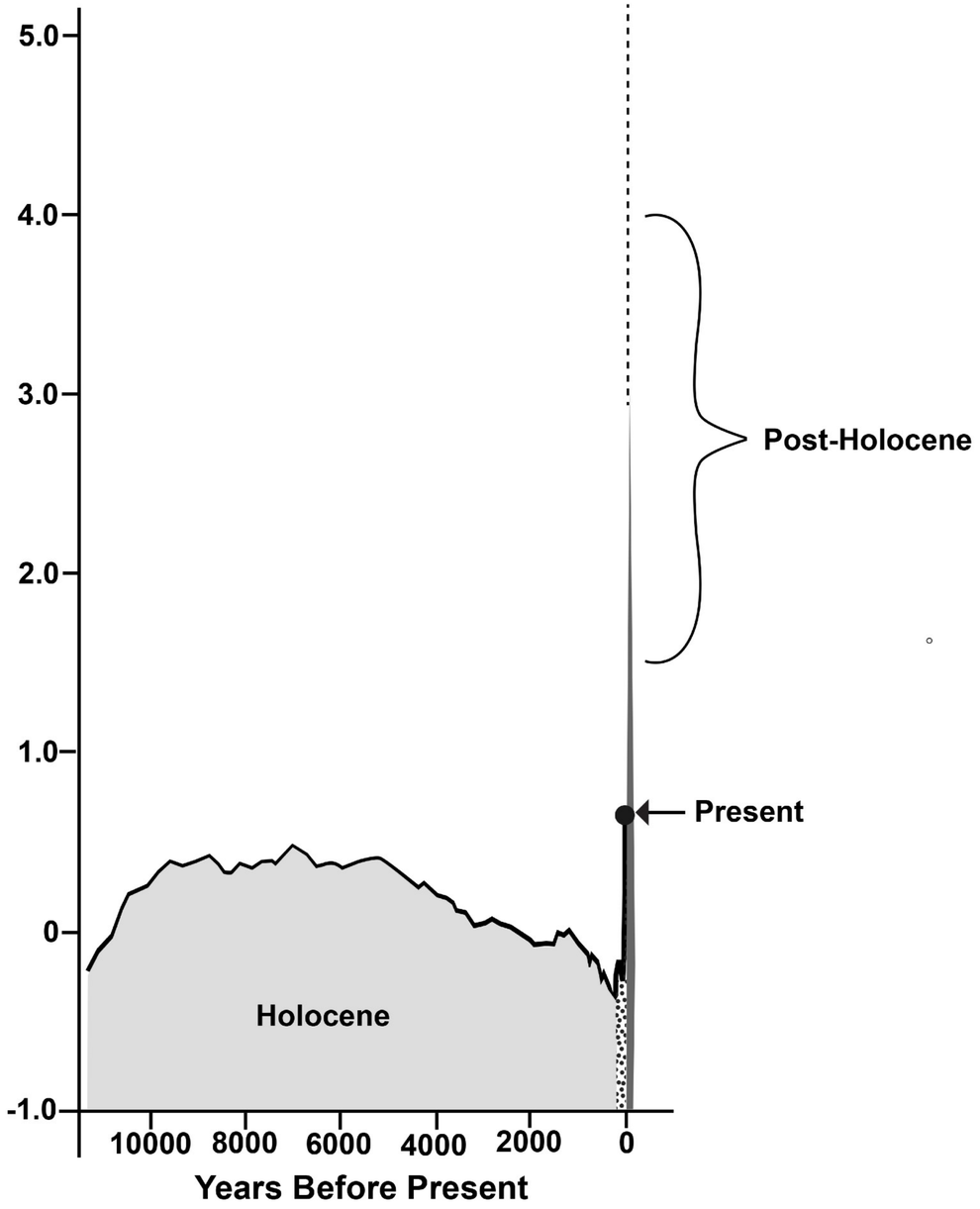
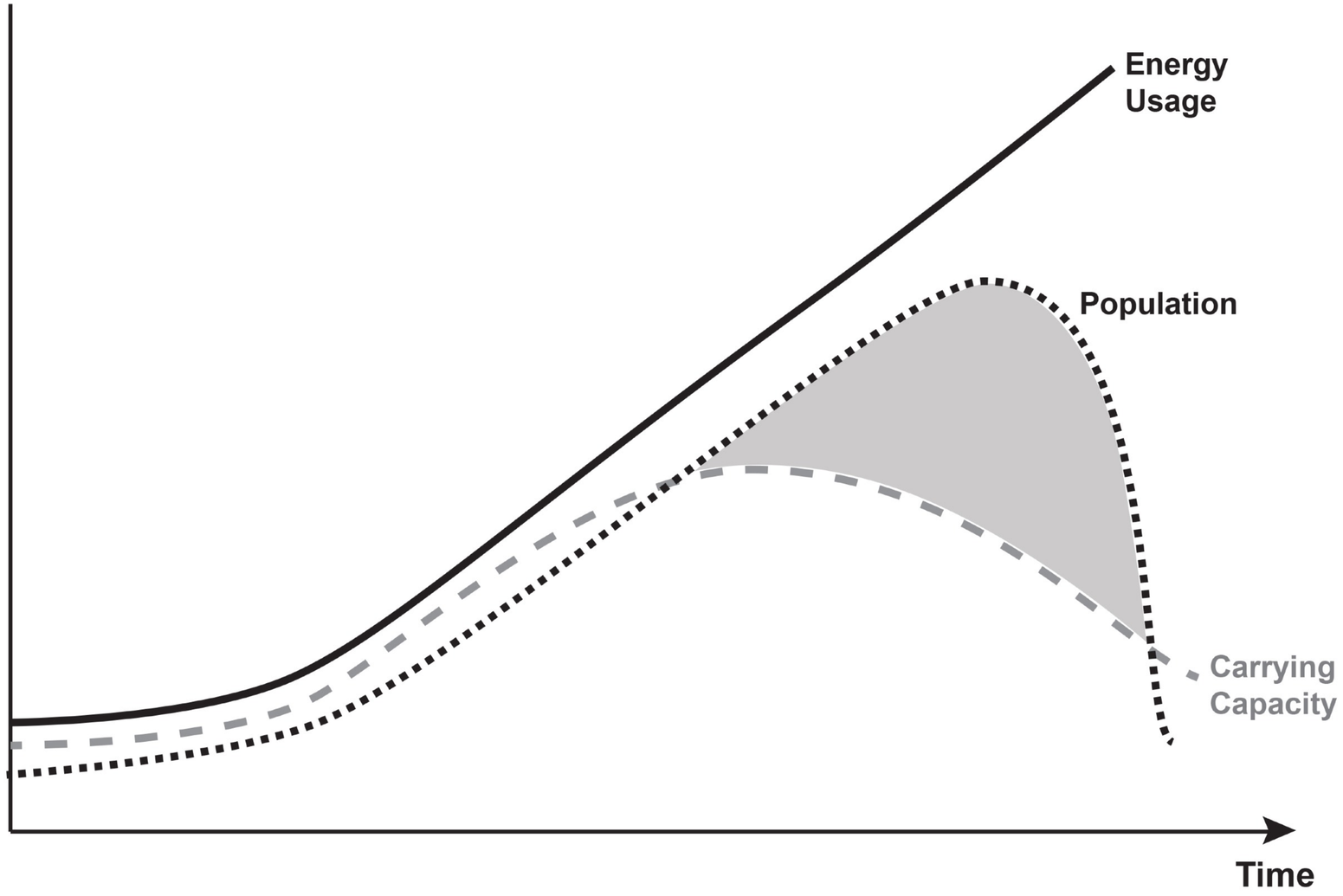


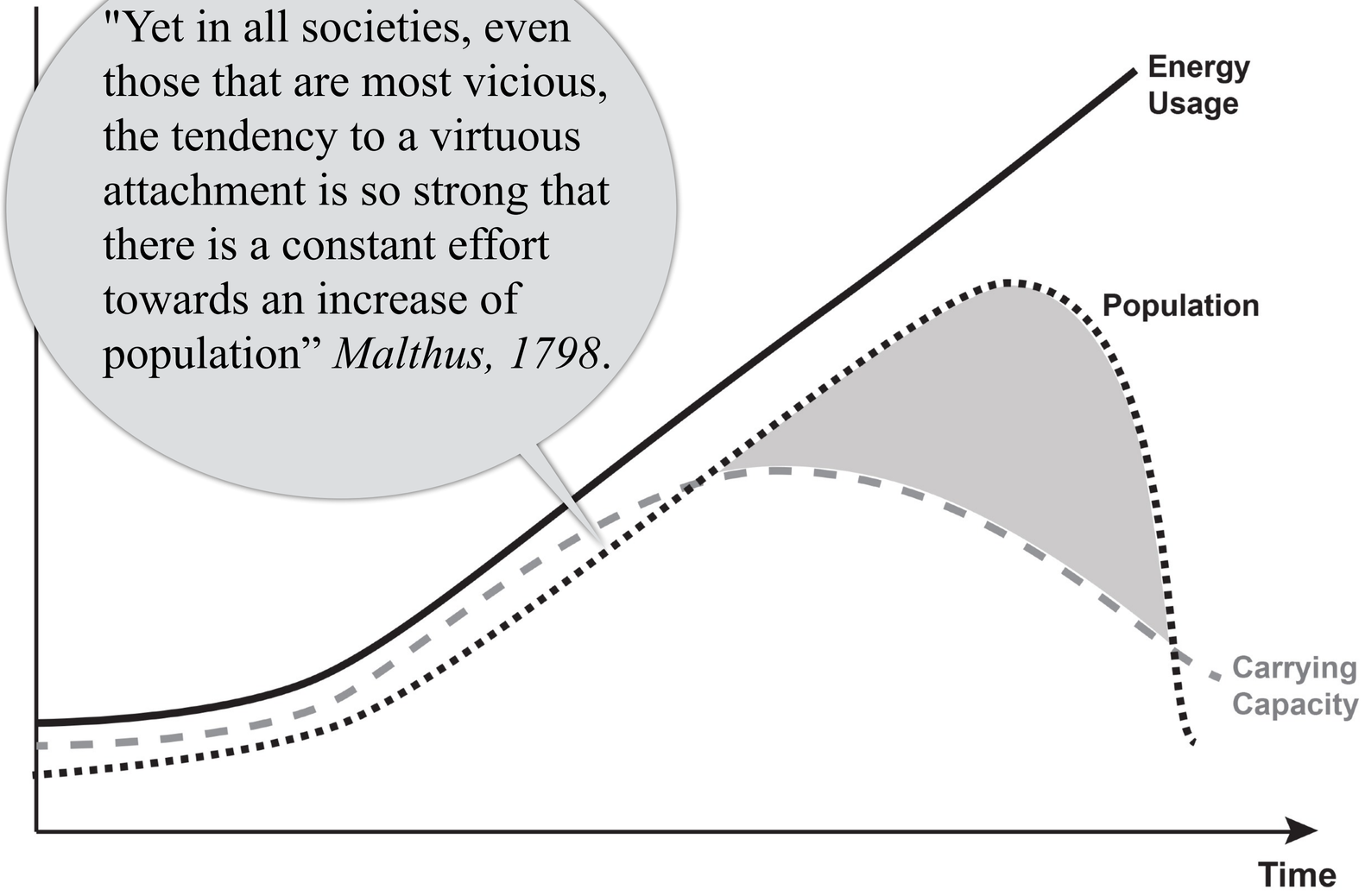


Prognosis



Prognosis

"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*.



Prognosis

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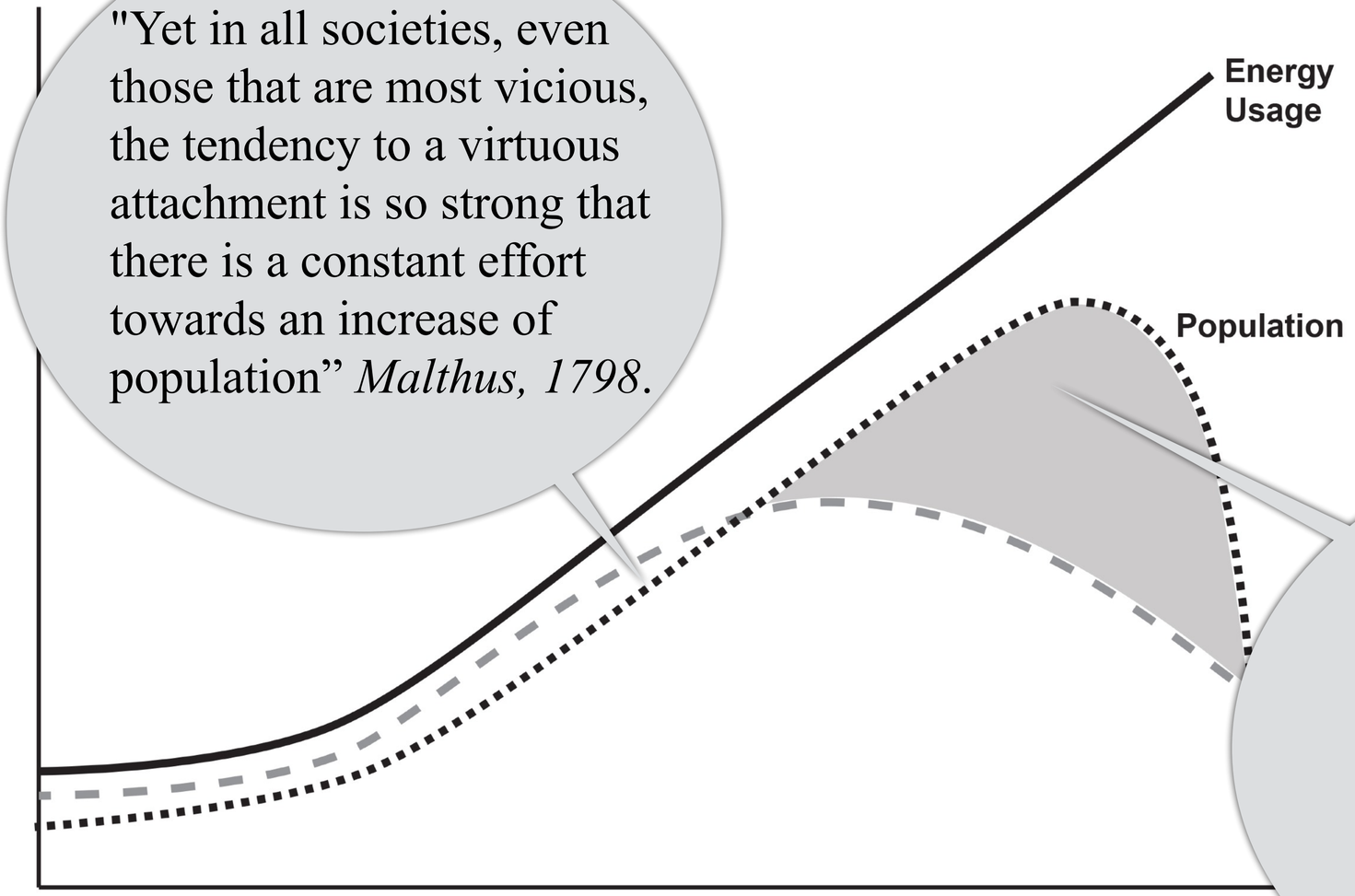
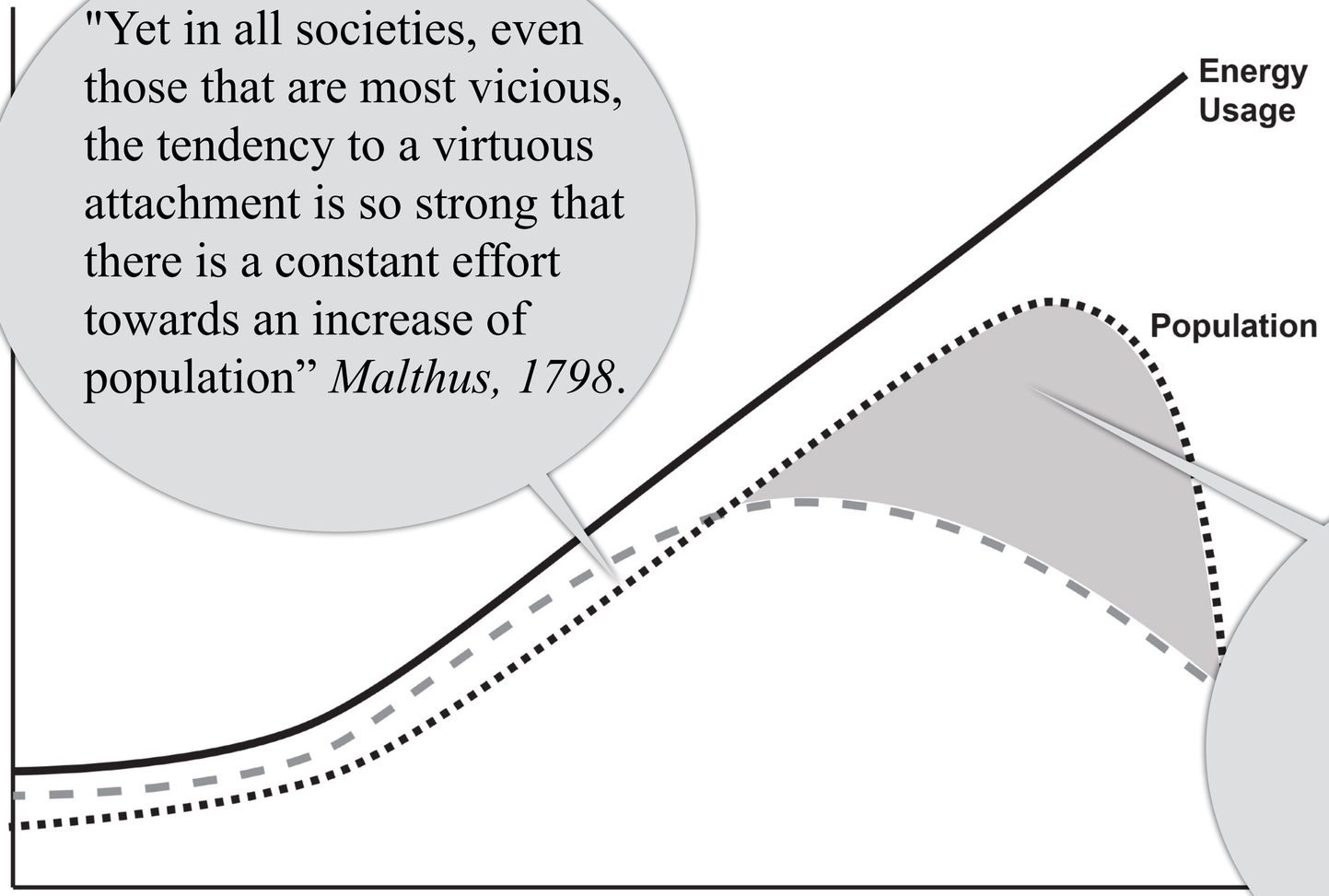


"That the increase of population is necessarily limited by the means of subsistence, That population does invariably increase when the means of subsistence increase, and, That the superior power of population is repressed, and the actual population kept equal to the means of subsistence, **by misery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

Malthus, 1798.

Prognosis

"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*.



"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

Key Points

Baseline

During the Holocene, climate and sea level were exceptionally stable

The Holocene was a “safe operating space for humanity”

Syndrome

During the last few hundred years, humanity has introduced rapid and large changes

The system is outside the “normal range” and in the dynamic transition into the Post-Holocene; we have increasing disequilibrium

Diagnosis

A consumption-based economy combined with easy access to energy caused humans to accelerate flows in the Earth’s life-support system and sustain rapid population growth.

Modern humans are the “Anthropogenic Cataclysmic Virus” (ACV) in the Earth’s life-support system

Prognosis

We are heading rapidly into a very different system state (tipping points; Post-Holocene)
Our knowledge is changing rapidly; there is room for surprises; Foresight is needed

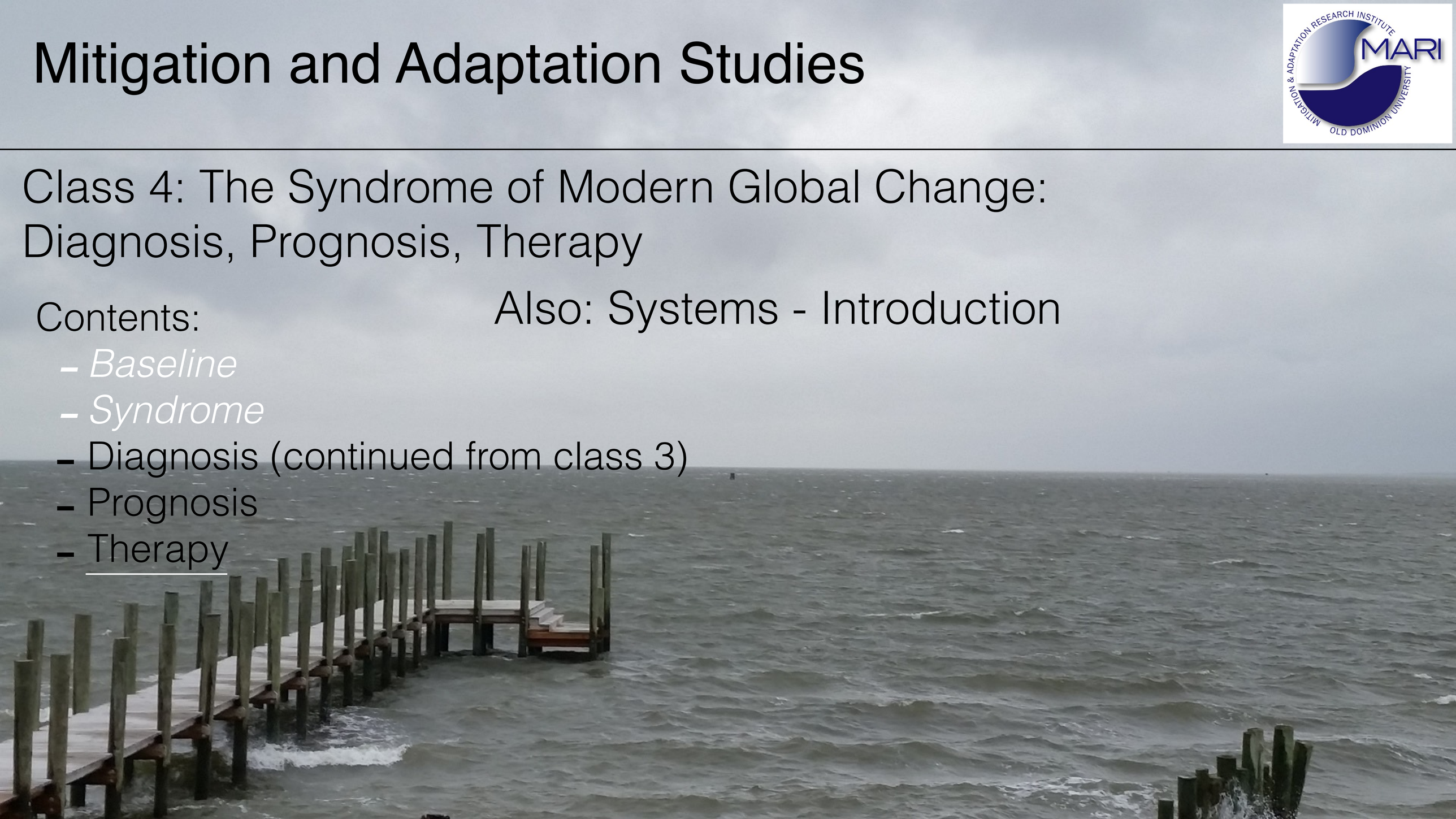
Mitigation and Adaptation Studies

Class 4: The Syndrome of Modern Global Change: Diagnosis, Prognosis, Therapy

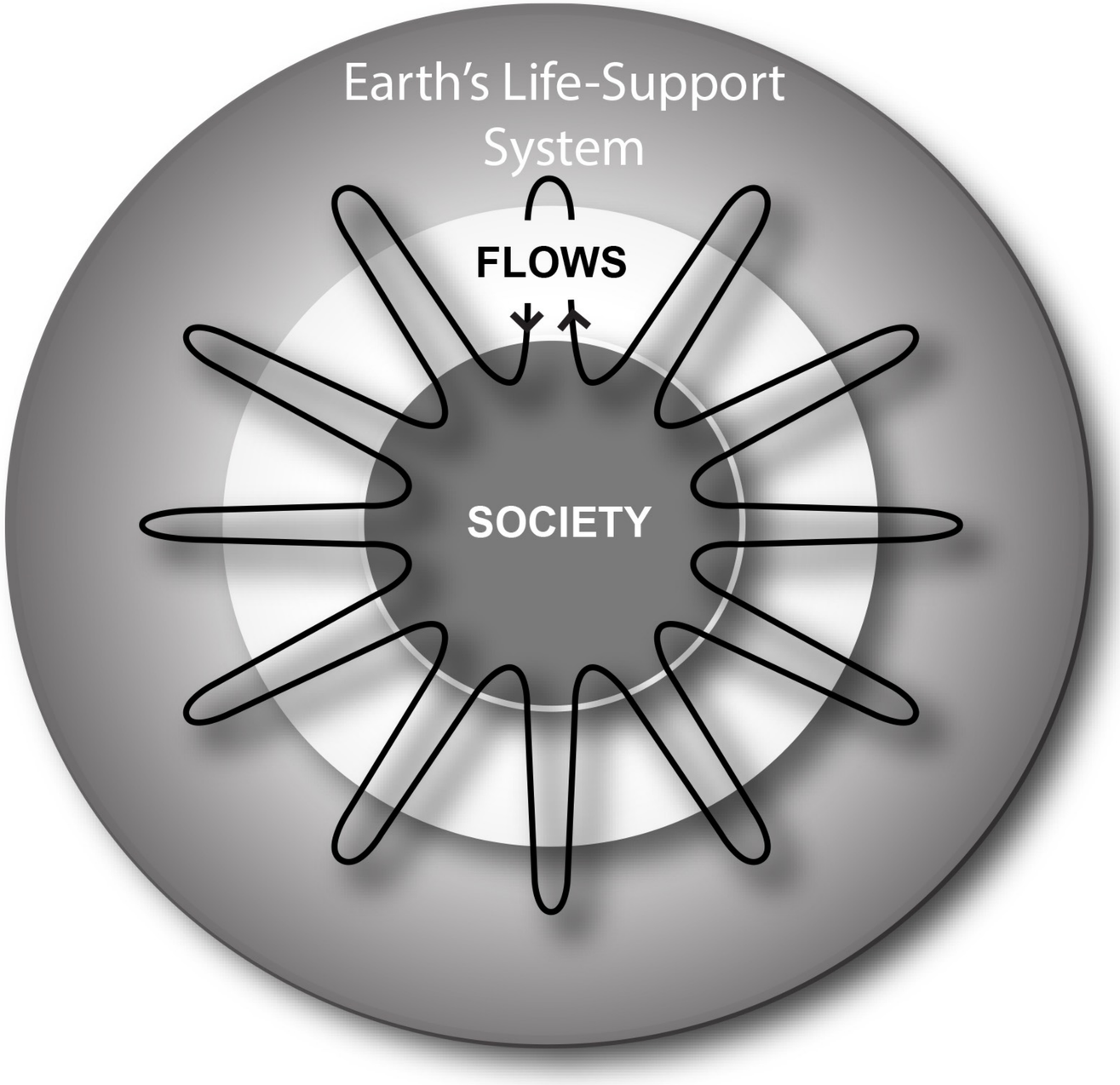
Also: Systems - Introduction

Contents:

- *Baseline*
- *Syndrome*
- Diagnosis (continued from class 3)
- Prognosis
- Therapy



Therapy



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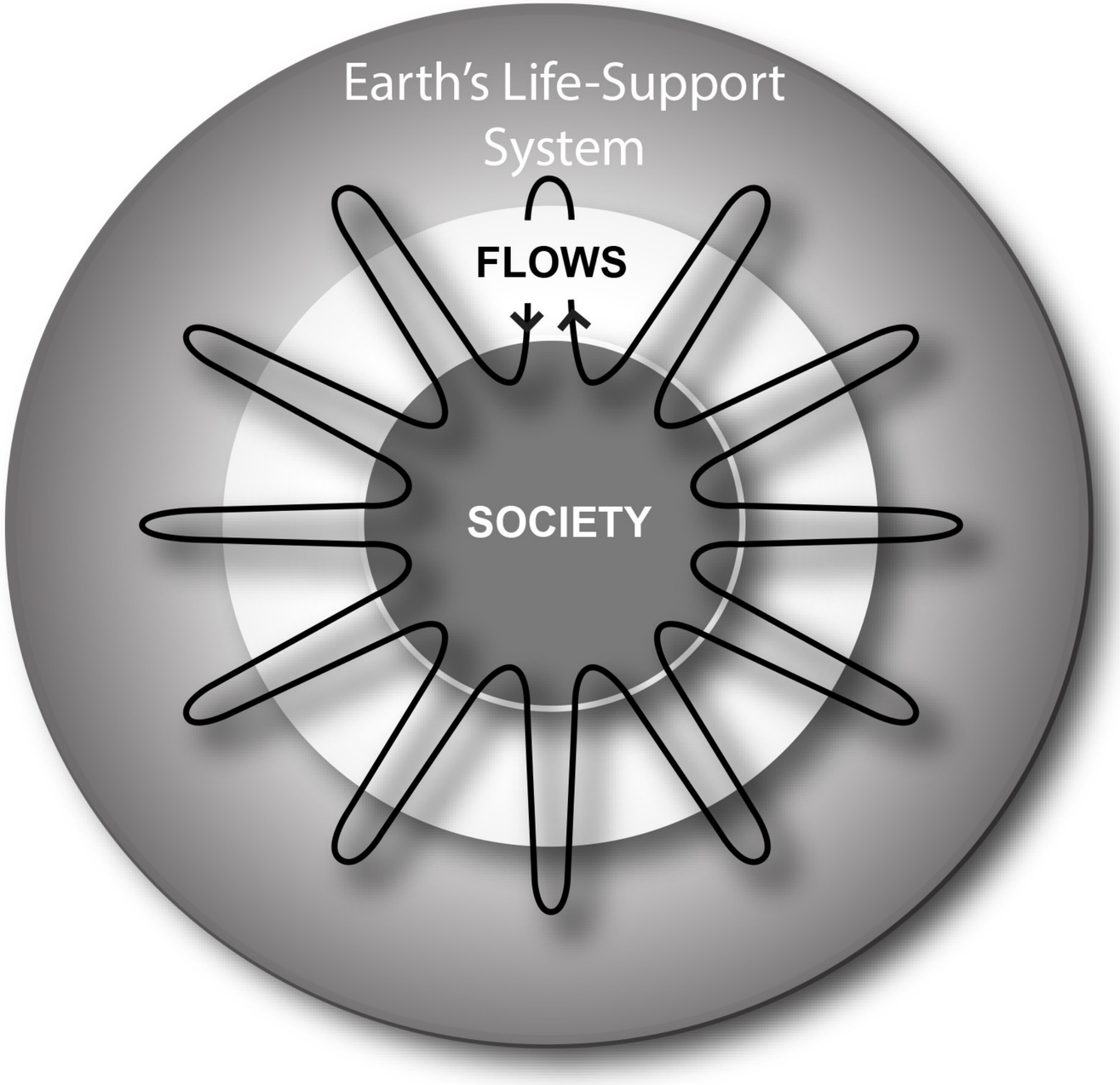

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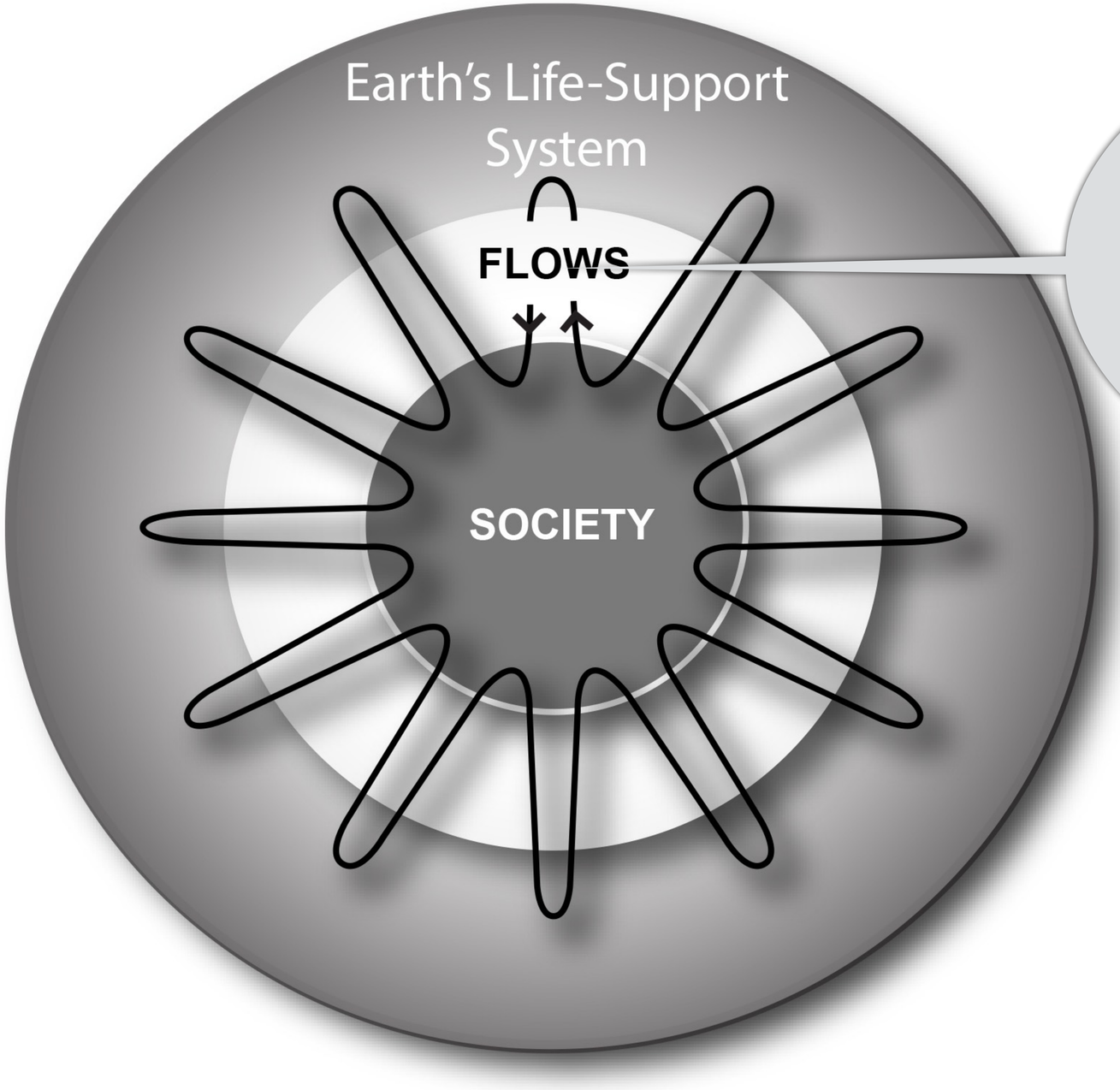
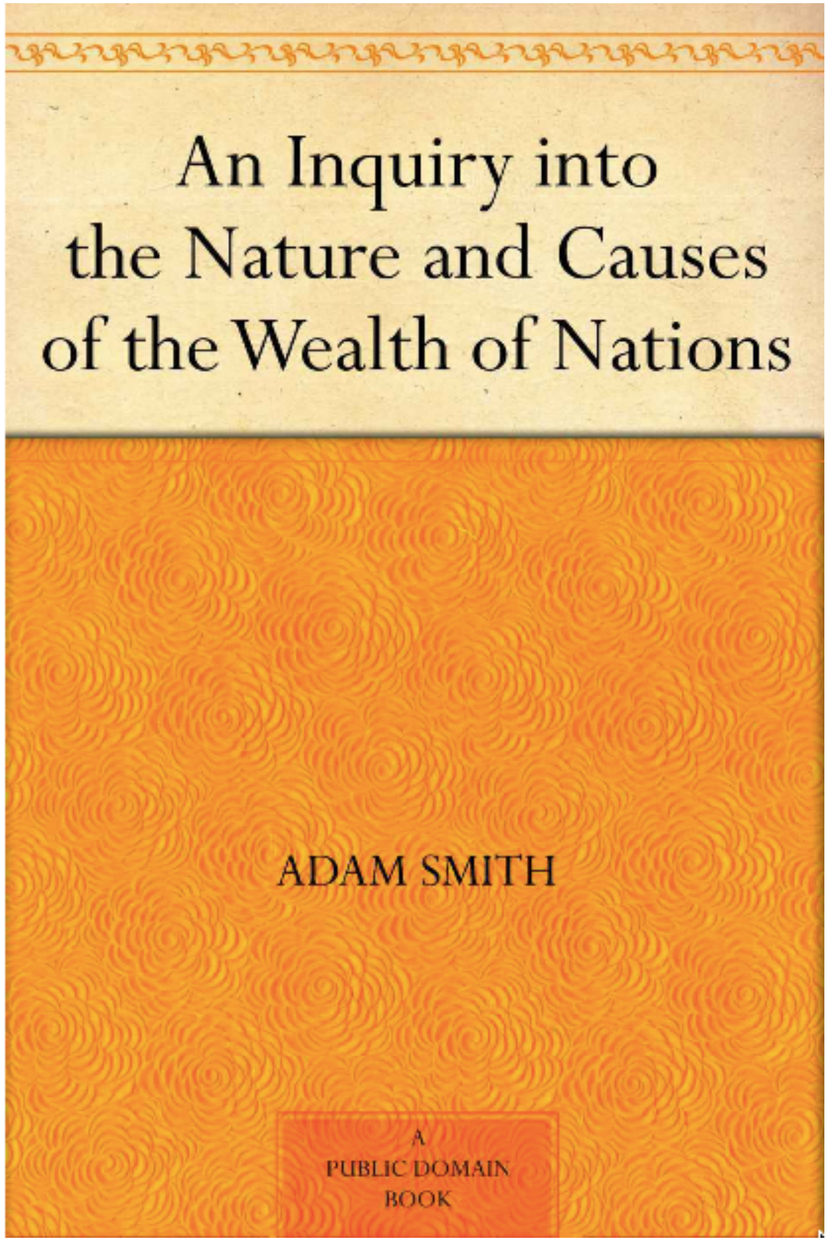


For Homo sapiens, flows are regulated by

- ethics,
- social norms,
- economic rules

Therapy



Published in 1776

- Purpose of economy is to increase human wealth;
- Earth and its natural wealth is basically infinite.

Smith (1776)

Therapy

Published in 1987

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"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

WCED (1987)

Therapy

COMMENT

ENVIRONMENT Conservationists call for a global zoning exercise for roads p.300

HISTORY Ripping yarn of the ape-man of Victorian England p.310

EVOLUTION First biography of W. D. Hamilton, the gentle giant of genetics p.313

FUNDING Australia's grant system wastes centuries of researchers' time p.314

ILLUSTRATION BY PHIL DISLEY

Sustainable development goals for people and planet

Planetary stability must be integrated with United Nations targets to fight poverty and secure human well-being, argue **David Griggs** and colleagues.

The United Nations Rio+20 summit in Brazil in 2012 committed governments to create a set of sustainable development goals (SDGs) that would be integrated into the follow-up to the Millennium Development Goals (MDGs) after their 2015 deadline. Discussions on how to formulate these continue this week at UN headquarters in New York.

We argue that the protection of Earth's life-support system and poverty reduction must be the twin priorities for SDGs. It is not enough simply to extend MDGs, as some are suggesting, because humans are transforming the planet in ways that could undermine development gains.

As mounting research shows, the stable functioning of Earth systems — including the atmosphere, oceans, forests, waterways, biodiversity and biogeochemical cycles — is a prerequisite for a thriving global society. With the human population set to rise to 9 billion by 2050, definitions of sustainable development must be revised to include the security of people and the planet.

Defining a unified set of SDGs is challenging, especially when there can be conflict between individual goals, such as energy provision and climate-change prevention. But we show here that it is possible. By ▶

- Purpose of economy is to increase human wealth;
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Smith (1776)

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

WCED (1987)

"Sustainable Development is a development that meets the needs of the present while safeguarding Earth's life support systems, on which the welfare of current and future generations depends."

Griggs et al. (2013)

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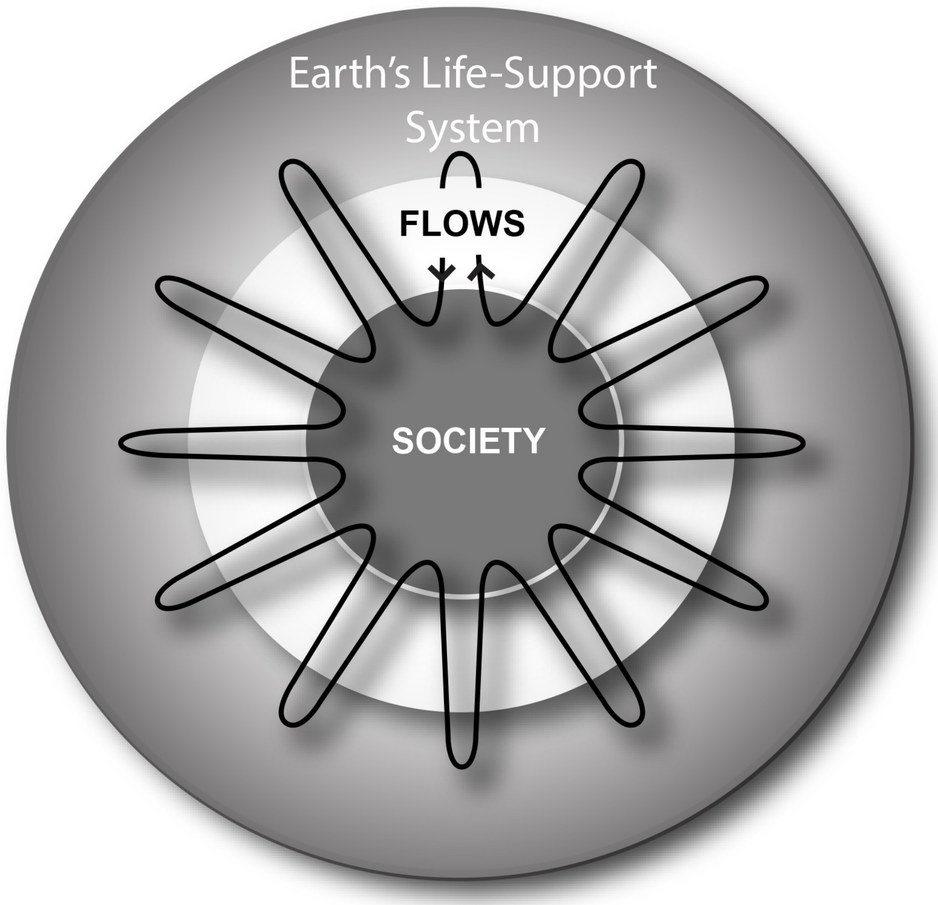

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Humanity needs an economy that meets the needs of the present while safeguarding Earth's life support systems, on which the welfare of current and future generations depends.

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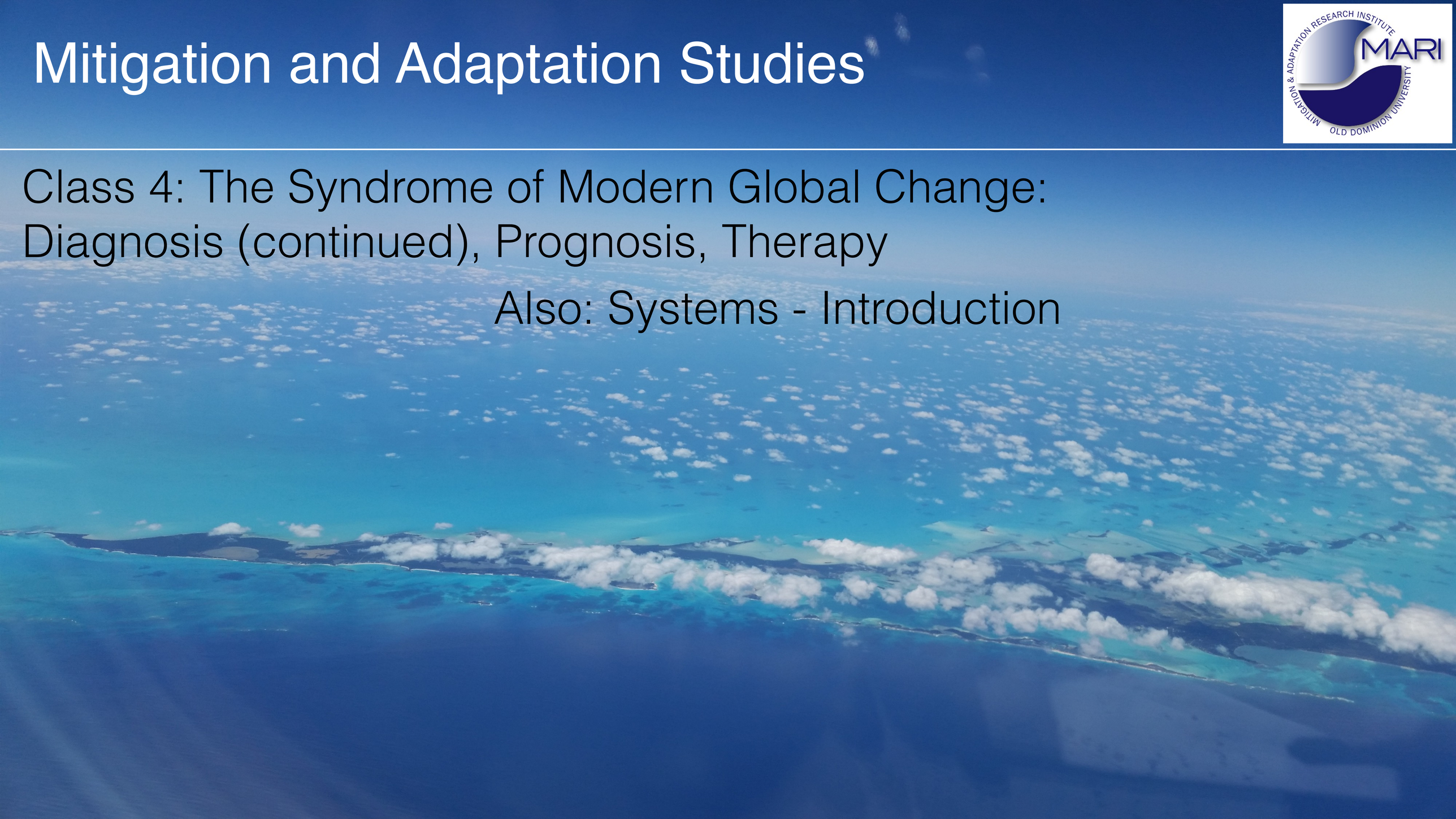
Change in the purpose of economy from growing human wealth (growth addiction) to meeting our needs while safe-guarding the life-support system

Mitigation and Adaptation Studies



Class 4: The Syndrome of Modern Global Change: Diagnosis (continued), Prognosis, Therapy

Also: Systems - Introduction

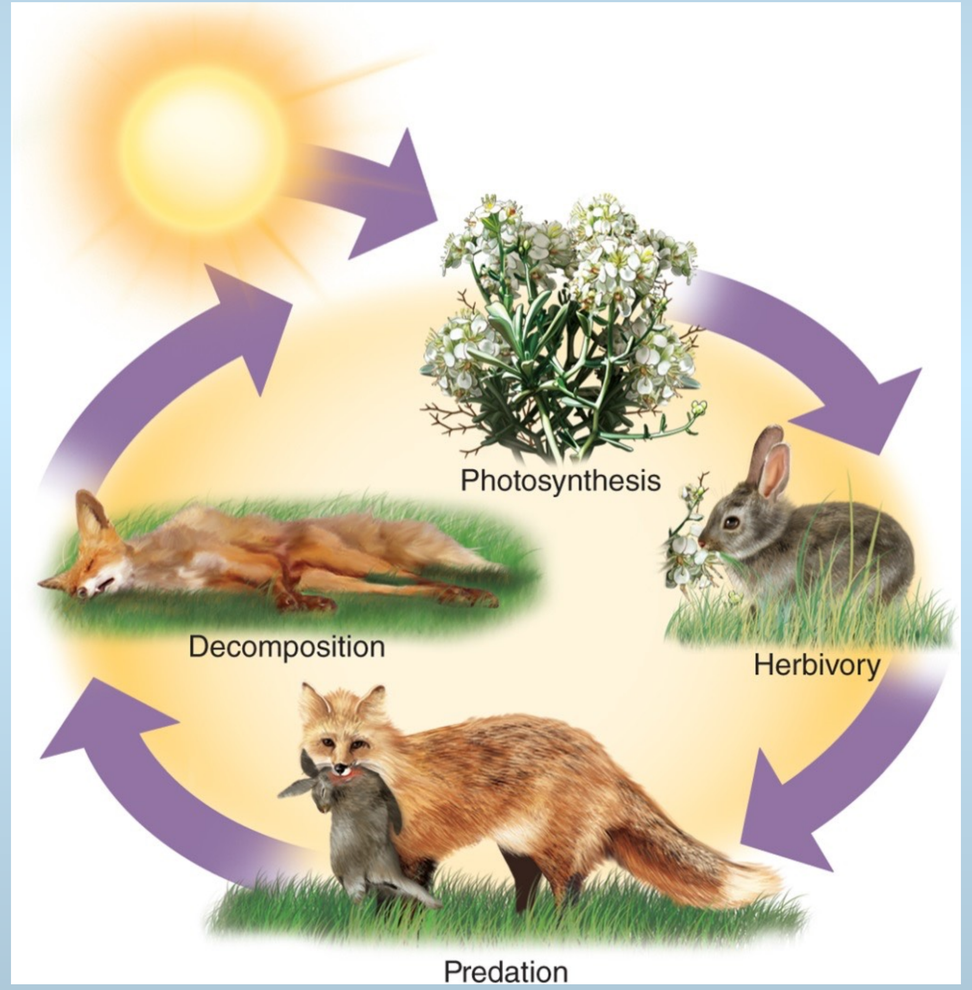
Systems

Systems

- are networks of interdependent components and processes, with ***materials*** and ***energy*** flowing from one component of the system to another.
  - *Together have properties beyond those of individual parts*
- Central concept in environmental science.
- <u>Examples</u>: ecosystems, climates systems, geologic systems, economic systems

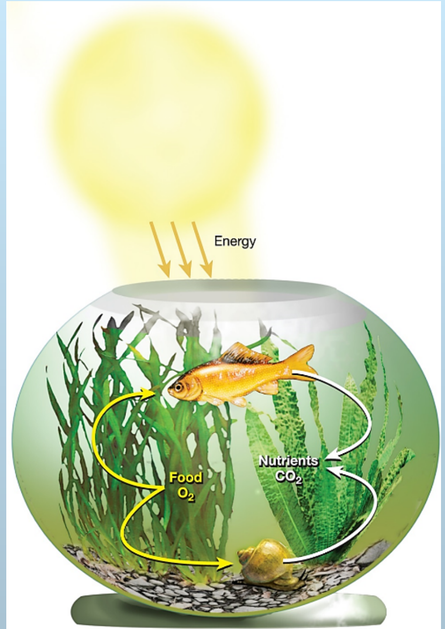
Components of a System

- State Variables store resources such as matter or energy or have the pathways through which these resources move from one state variable to another



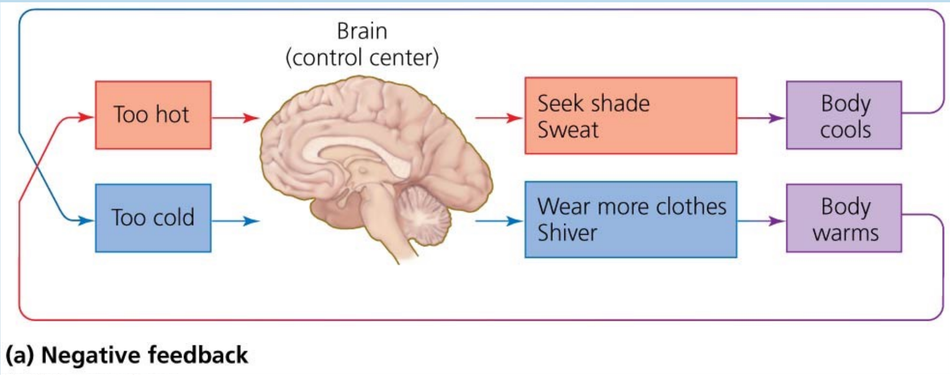
System Characteristics

- A System can be closed or open.
  - Open – exchanges matter and energy with surroundings
  - Closed - self contained, exchanges no matter or energy with the outside
- Throughput –the energy and matter that flow into, through, and out of a system



Systems involve feedback loops

- **Negative feedback loop** = system changes and moves in one direction; that movement acts as an output, and as an input back into the system; the input then moves the system in the other direction
- Input and output ***neutralize*** one another
  - Stabilizes the system
  - Example: body temperature
- **Most** systems in nature



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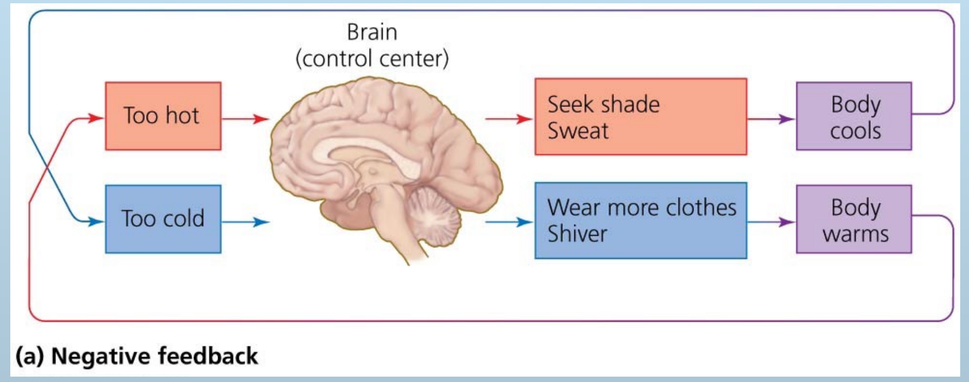
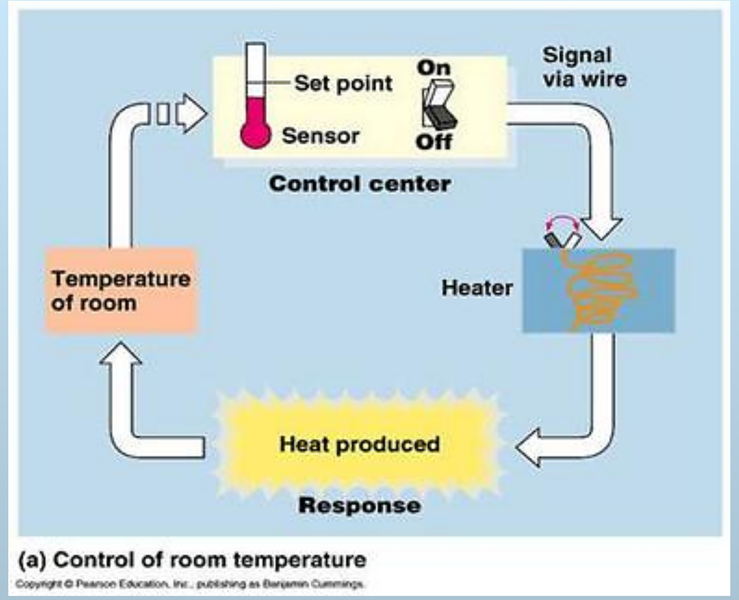
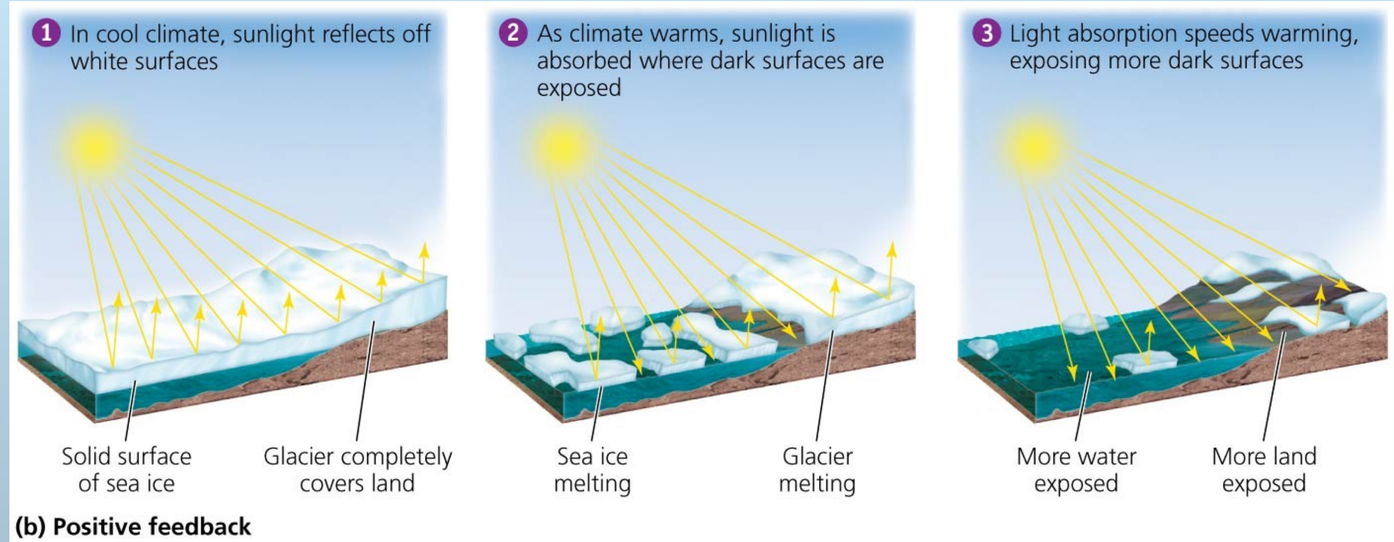




Systems involve feedback loops

- **Positive feedback loop** = system output causes the system to change in the *same way* and drives it *further* toward one extreme or another
  - Example: exponential population growth, spread of cancer, melting sea ice
- ***Rare*** in nature
  - *But is common in natural systems altered by humans*

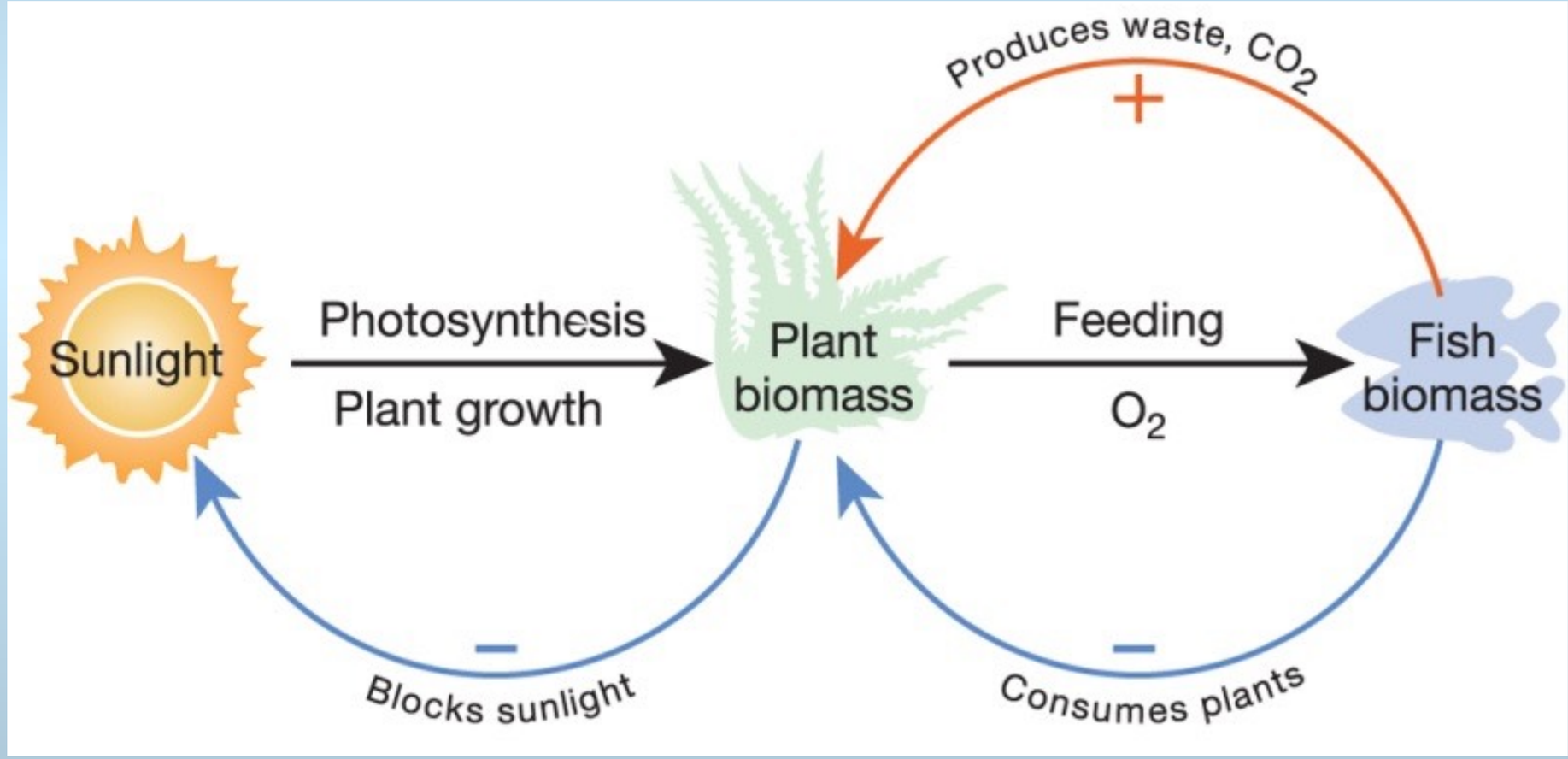


Systems show several defining properties

- **Dynamic equilibrium** = when system processes move in opposing directions; balancing their effects
- **Homeostasis** = when a system maintains constant (stable) internal conditions

System Characteristics

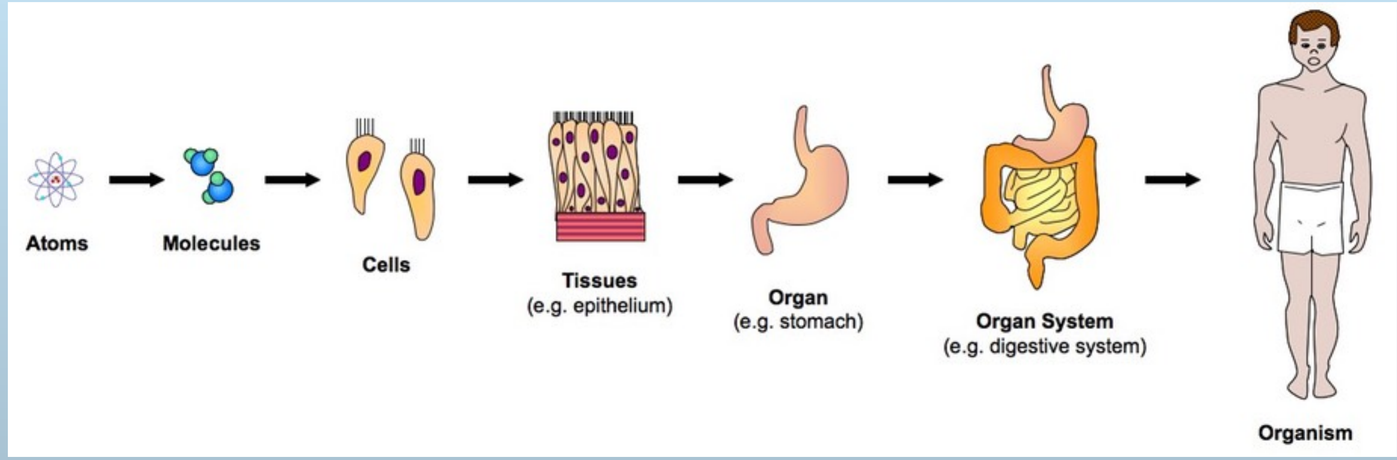
Dynamic equilibrium



Emergent properties

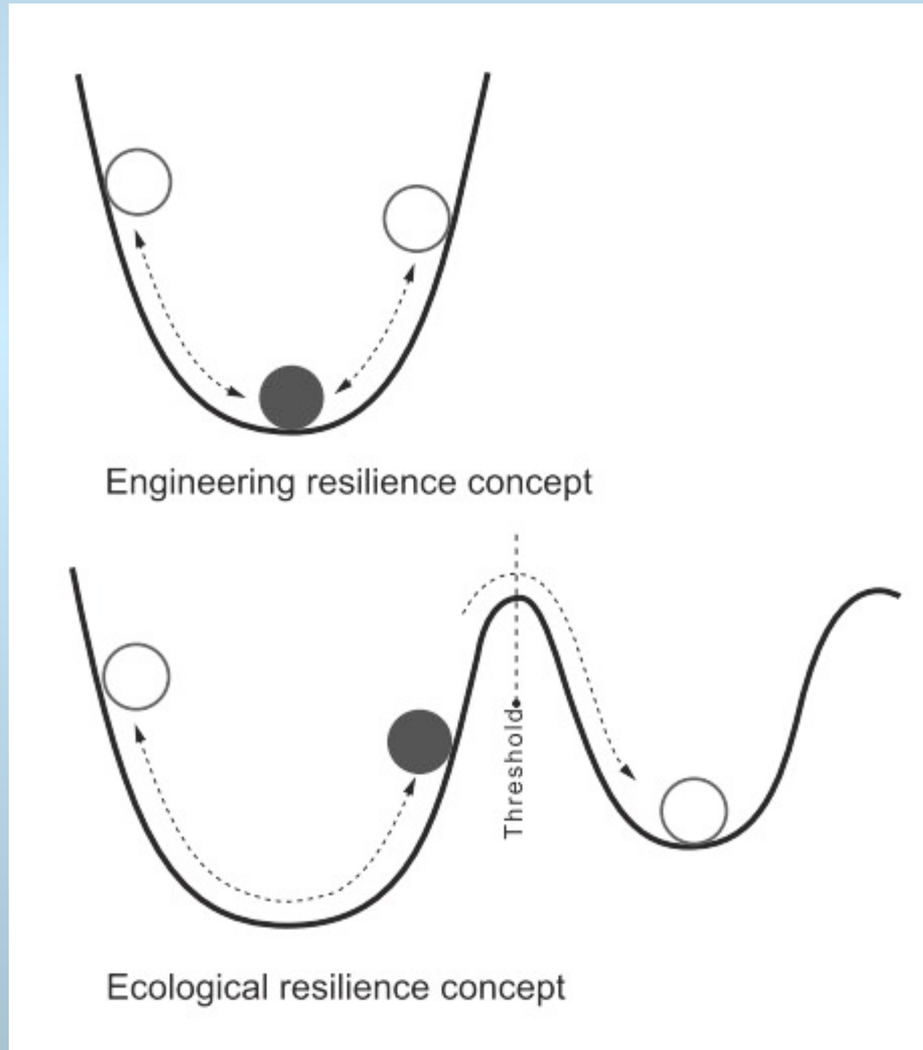
- **Emergent properties** = system characteristics that are not evident in the components alone
  - The whole is more than the sum of the parts

It is hard to fully understand systems; they connect to other systems and do not have sharp boundaries



Stability of Systems

- Disturbance - periodic destructive events such as fire or flood that destabilize or change the system
- Resilience - ability of system to recover from disturbance
- State Shift –a severe disturbance in which the system does not return to normal but instead results in significant changes in some of its state variables



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