Great Barrier Reef bleached for unprecedented second year running

Reef authority says findings of aerial surveys show enough to confirm another mass coral bleaching event, after last year's dramatic death rate

Photos taken by marine biologist Brett Monroe Garner on the Great Barrier Reef between Port Douglas and Cairns show bleaching of corals he said were 'full of colour' just months ago. Photograph: Brett Monroe Garner/Greenpeace

Mitigation and Adaptation Studies

Mitigation and Adaptation Studies

Class 14: (continued) Vulnerabilities of natural and human built environment; Economy, Inequality and injustice

Contents

- Terminology: What are risk, vulnerability, resilience, adaptation?
- Vulnerabilities of the natural and built environment to climate change and sea level rise
- Inequality and Injustice in Climate and Global Change Impacts
- Economic Risks

Summary

Risk: static, event based loss

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Risk reduction —-> risk governance

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Anti-fragile: learning from disturbances and impacts

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It depends…

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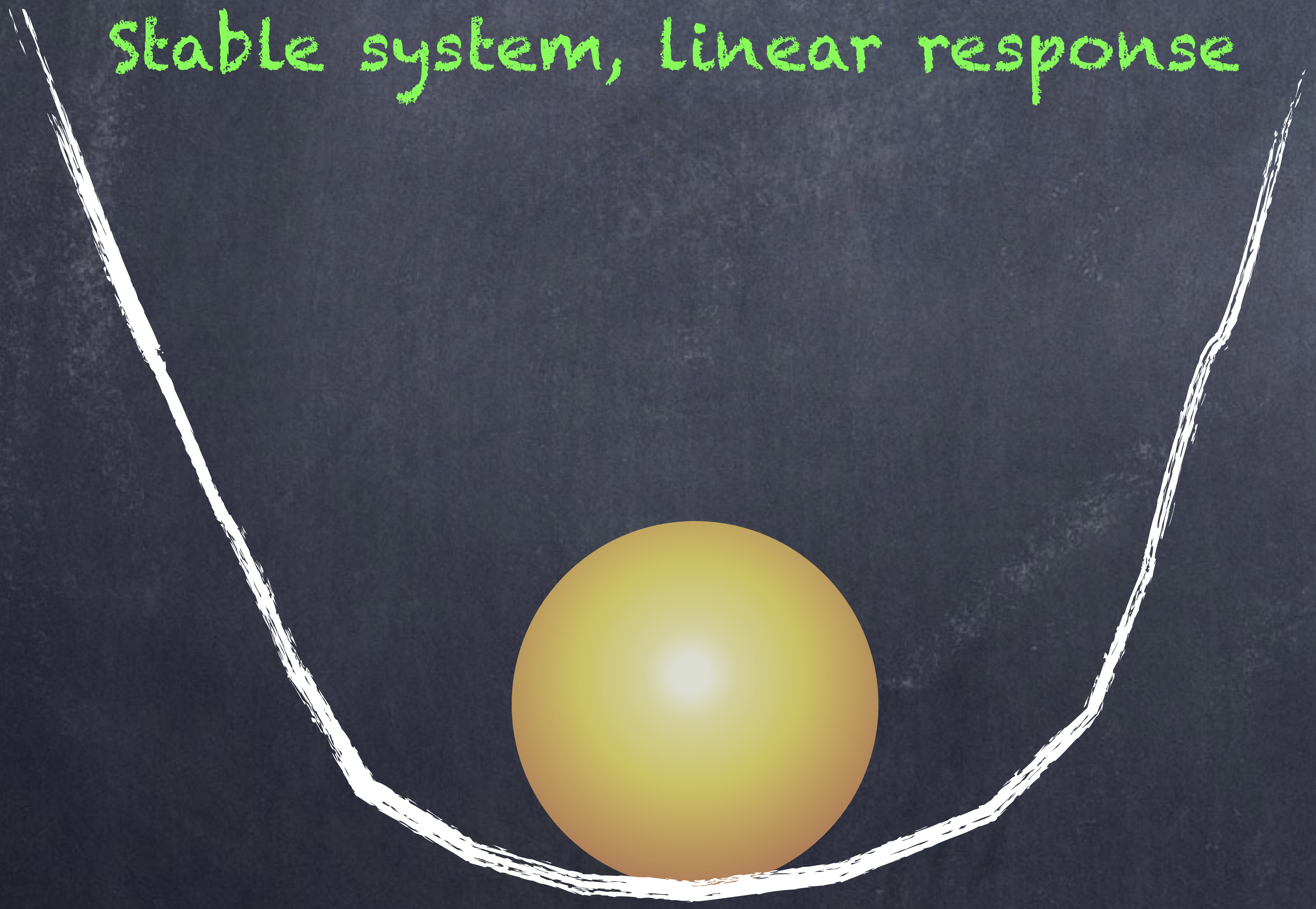

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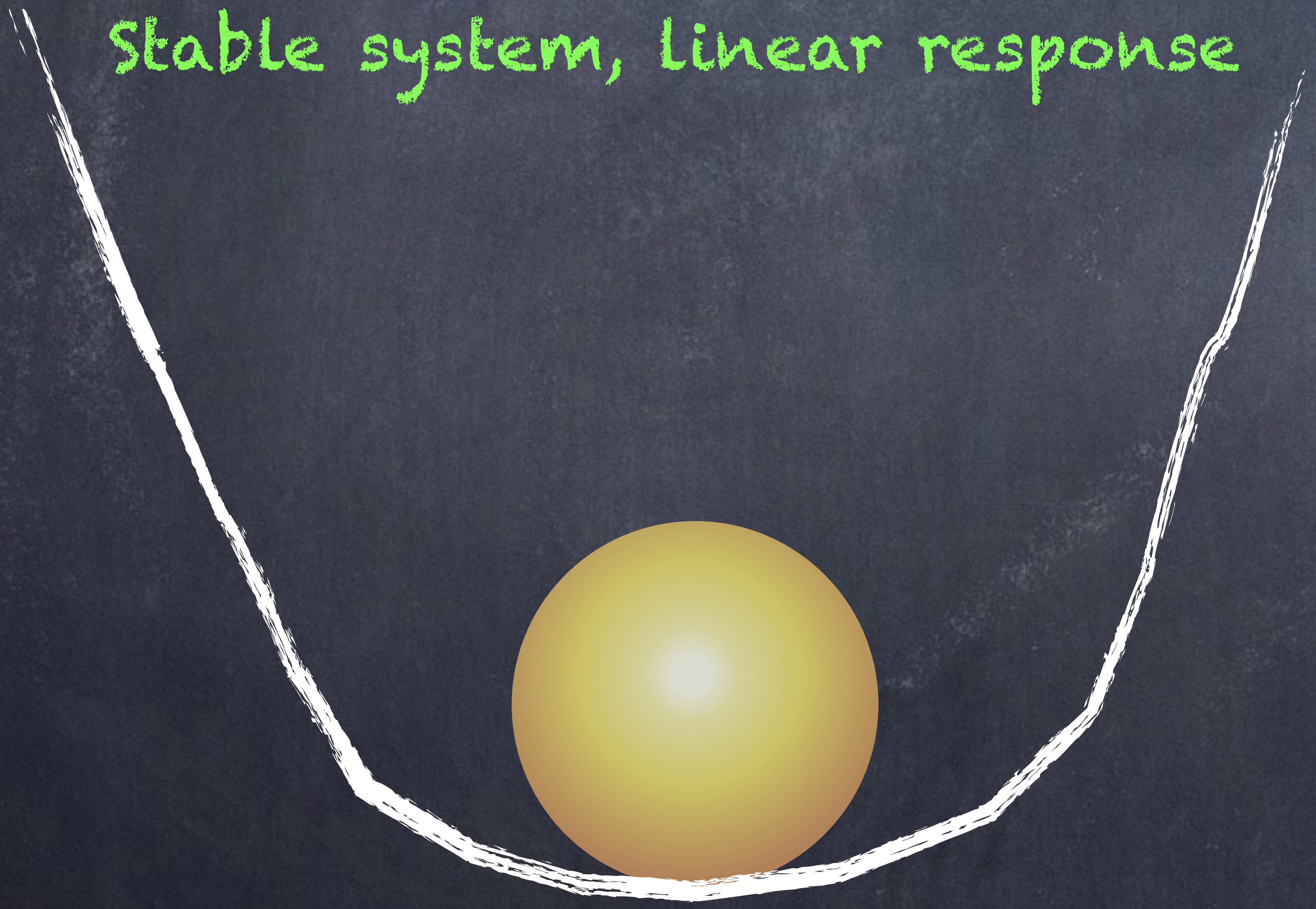

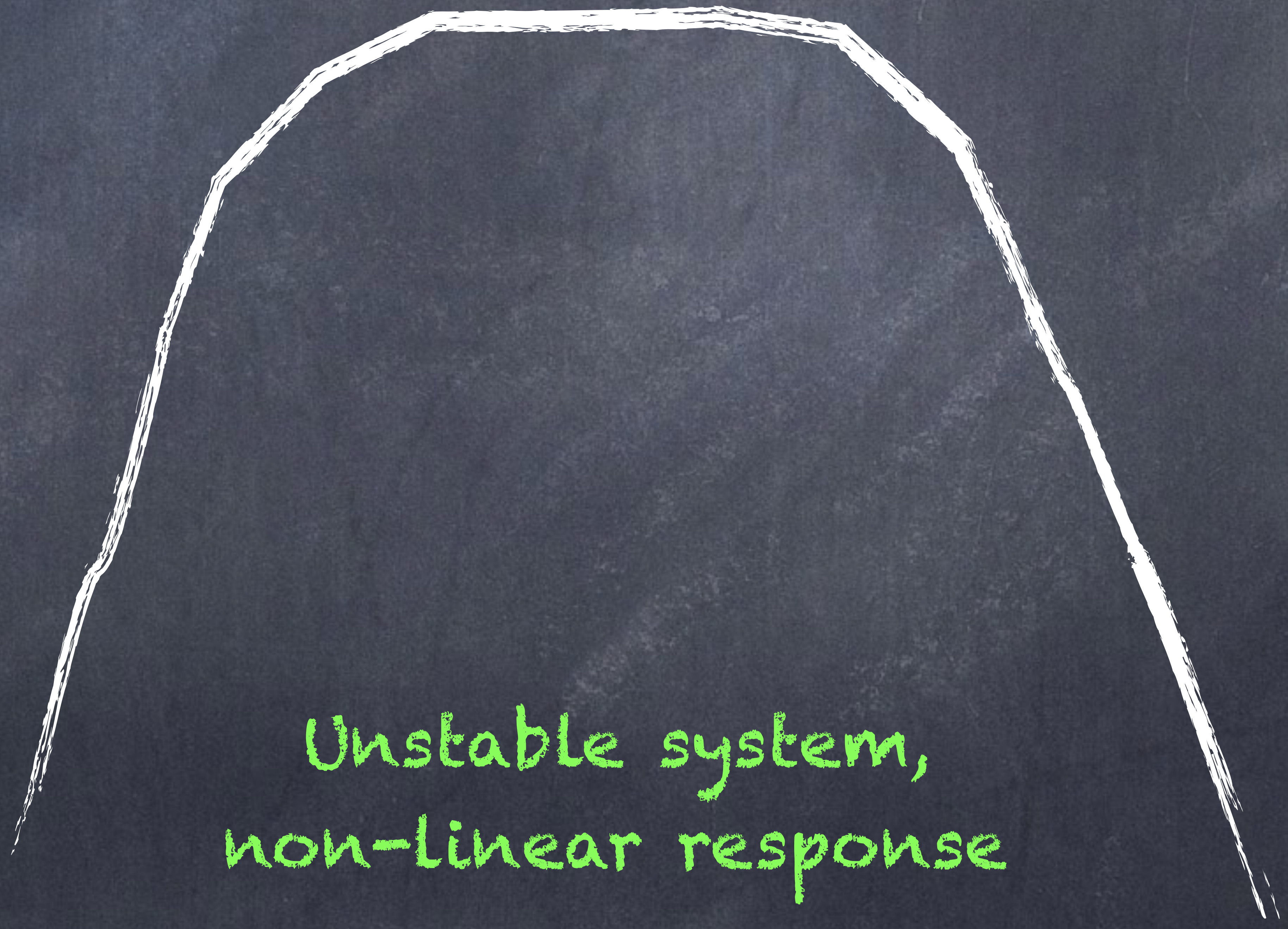

Terminology

Thresholds and Resilience Thinking

Thresholds (chapter 3) and the adaptive cycle metaphor are both central to resilience thinking. Adaptive cycles describe how many systems behave over time, and how resilience varies according to the phase where the system lies. Thresholds represent transitions between alternate regimes. While the two concepts can sometimes be related in the pattern of a particular system's dynamics, this not always the case. They are different models used for different purposes, and it is not always possible to equate the dynamics of a basin of attraction with the dynamics ics of an adaptive cycle. Where they do coincide, however, alternate regimes generally represent a new adaptive cycle, indicating that the system has new structures and feedbacks.

Brian Walker PhD. Resilience Thinking: Sustaining Ecosystems and People in a Changing World (Kindle Locations 1168-1170). Kindle Edition.

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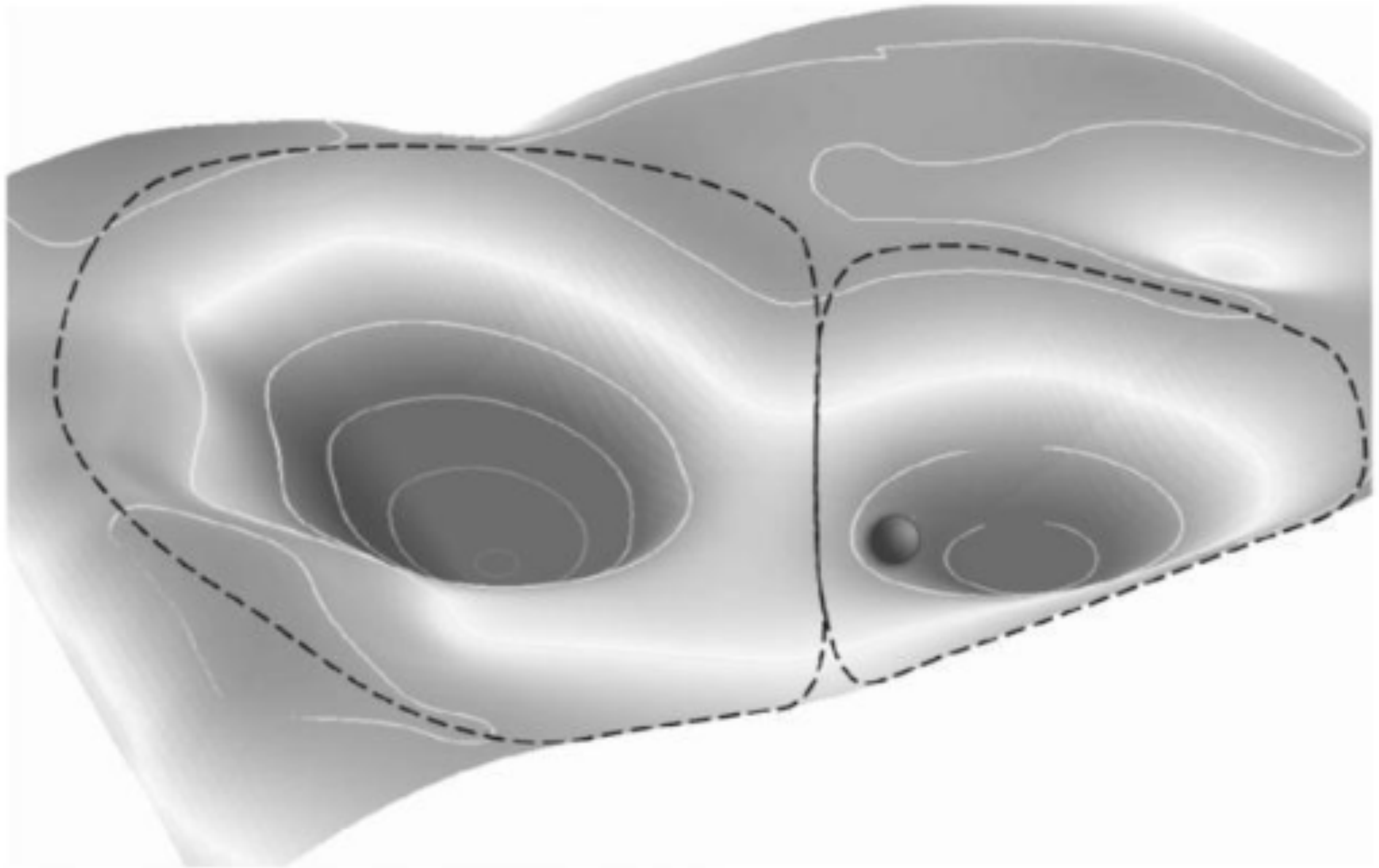

FIGURE 3 The System as a Ball-in-the-Basin Model

The ball is the state of the social-ecological system. The basin in which it is moving is the set of states which have the same kinds of functions and feedbacks, resulting in the ball moving towards the equilibrium. The dotted line is a threshold separating alternate basins. *(From Walker et al , 2004)*

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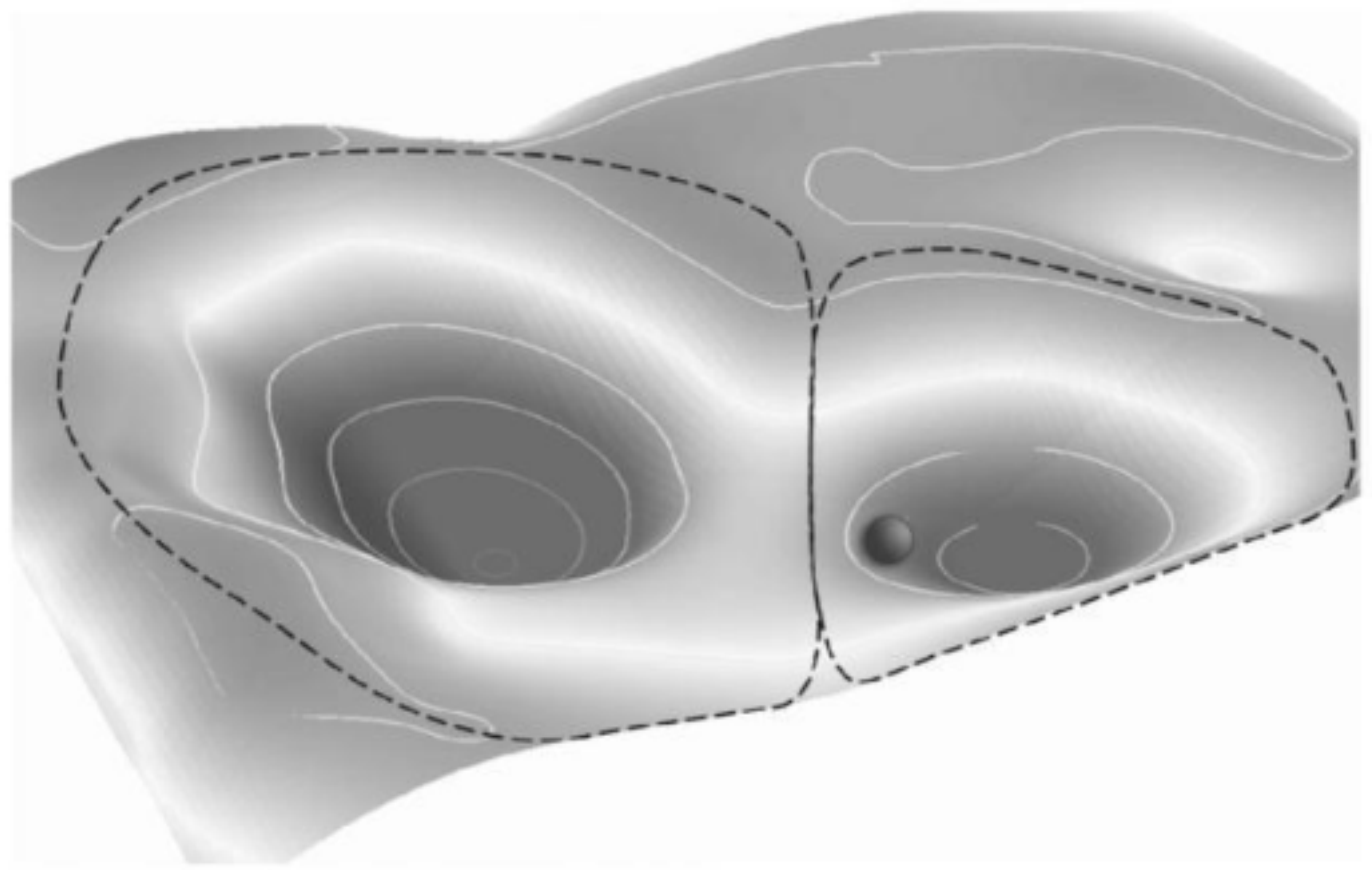

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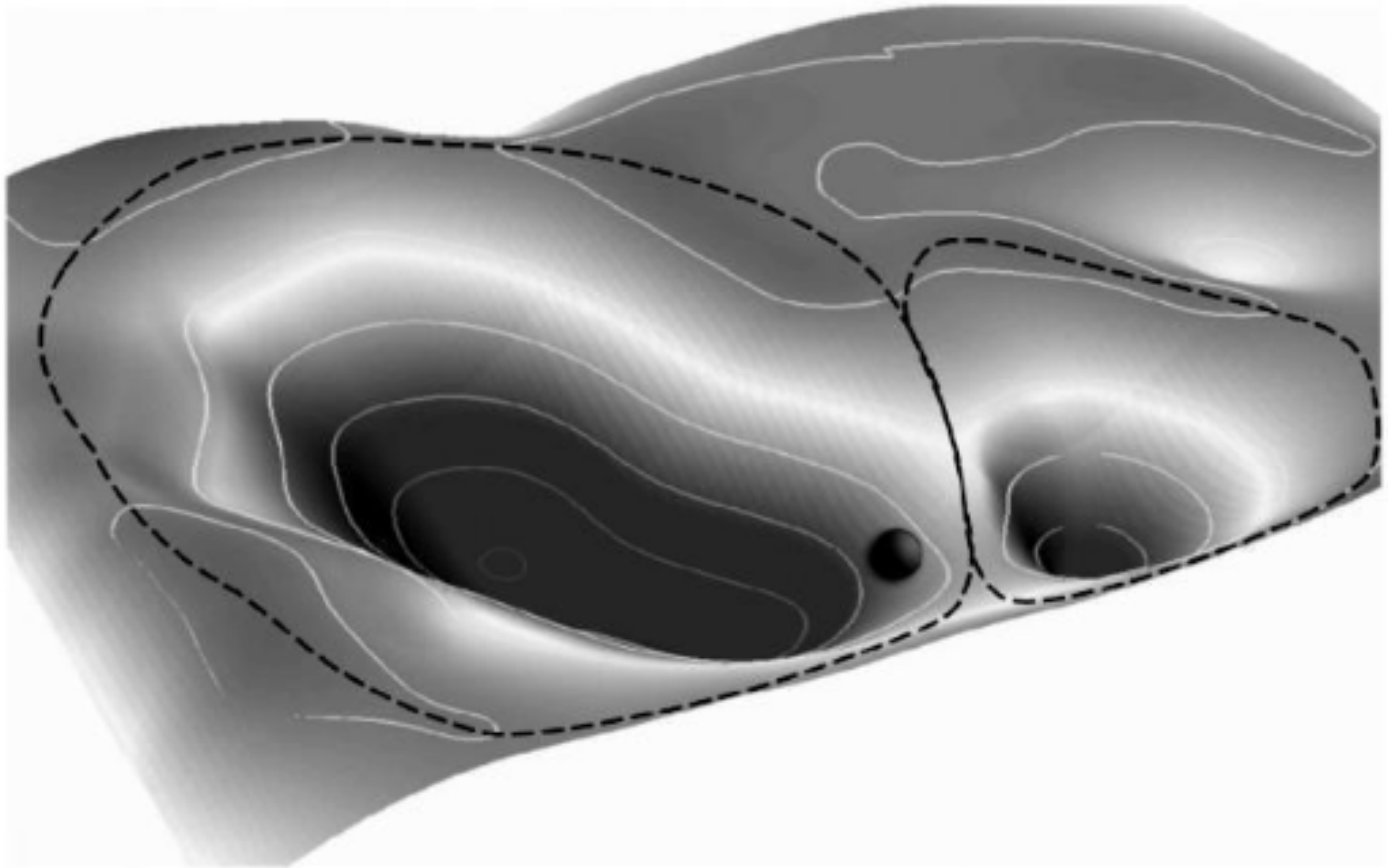


FIGURE 4 The Basin Changes Shape

This this is the same system as in figure 3. The state of the system (position of the ball) has not changed, but as conditions change, so too does the shape of the basin and the behavior of the system. *(From Walker et al , 2004.)*

Terminology

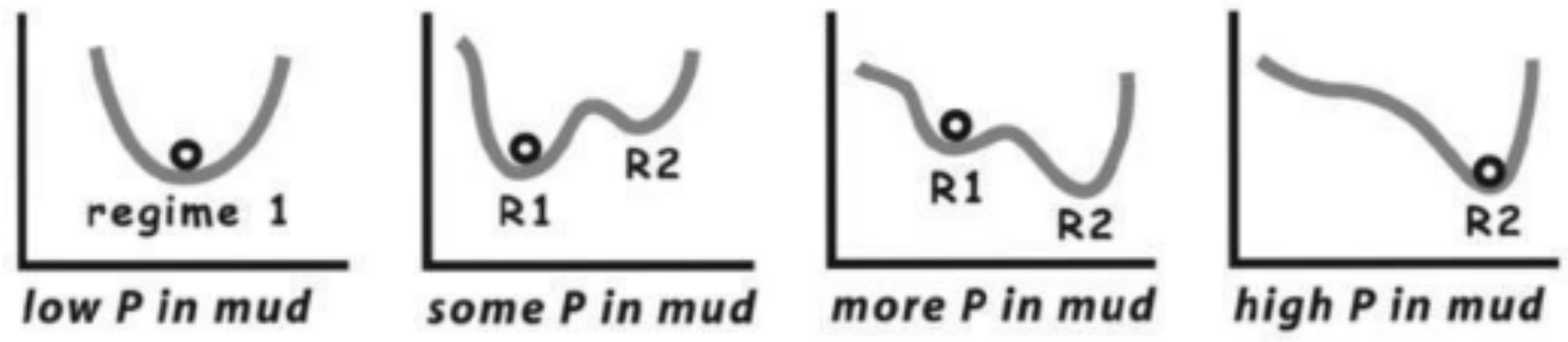
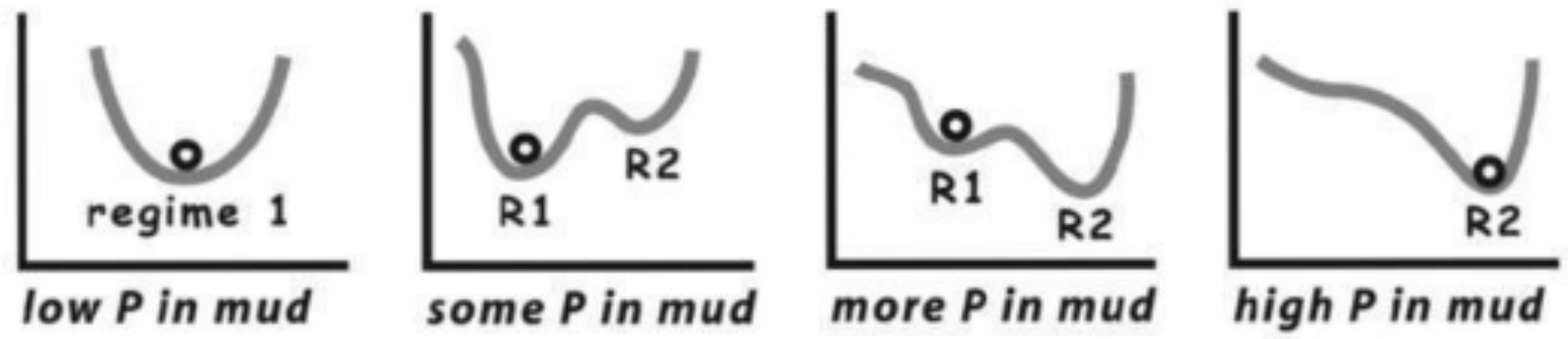


FIGURE 5 A Two-Dimensional Representation of a Ball-in-a-Basin Model of a Lake Ecosystem Changing over Time with Continued Phosphorus Inputs

Thresholds



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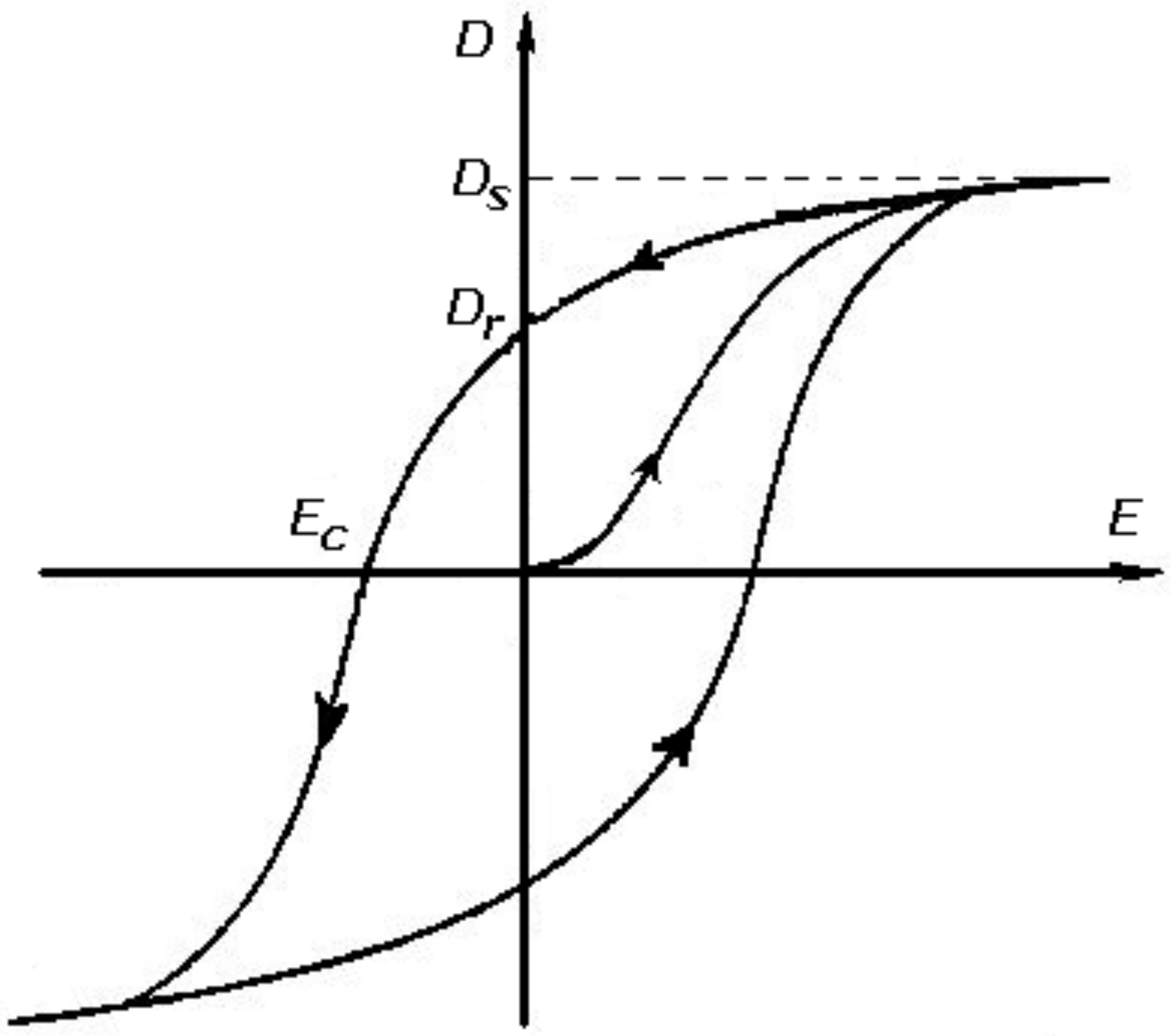
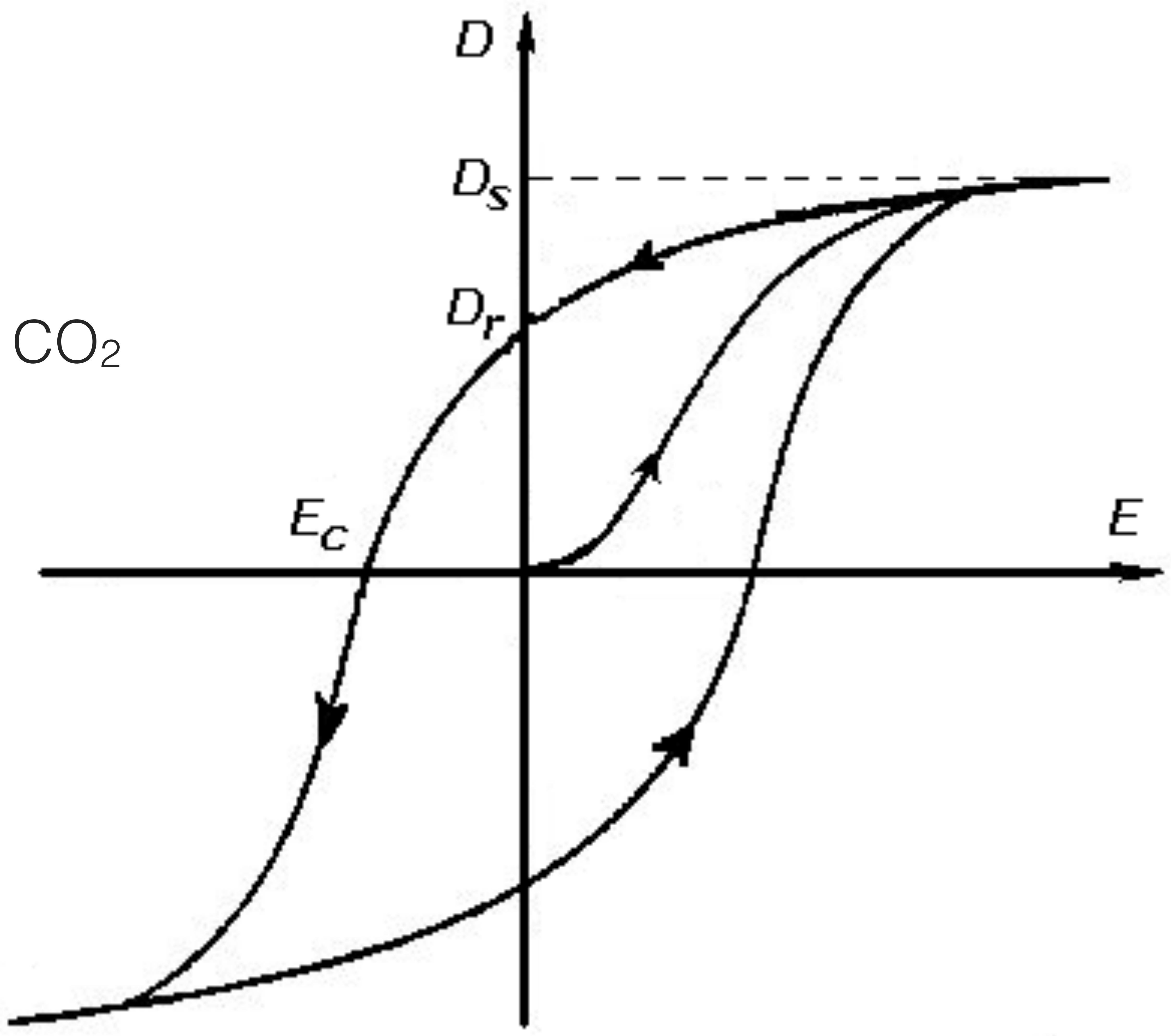


Terminology

Hysteresis: state of the system depends on both the presence and the past history.

Examples:

- post-glacial deformation as function of ice load
- global air temperature as function of atmospheric CO_2
- ecosystem as function of disturbances



Electromagnetic Displacement Field *D* as function of the electrical field *E*.

Terminology

Terminology

Thresholds

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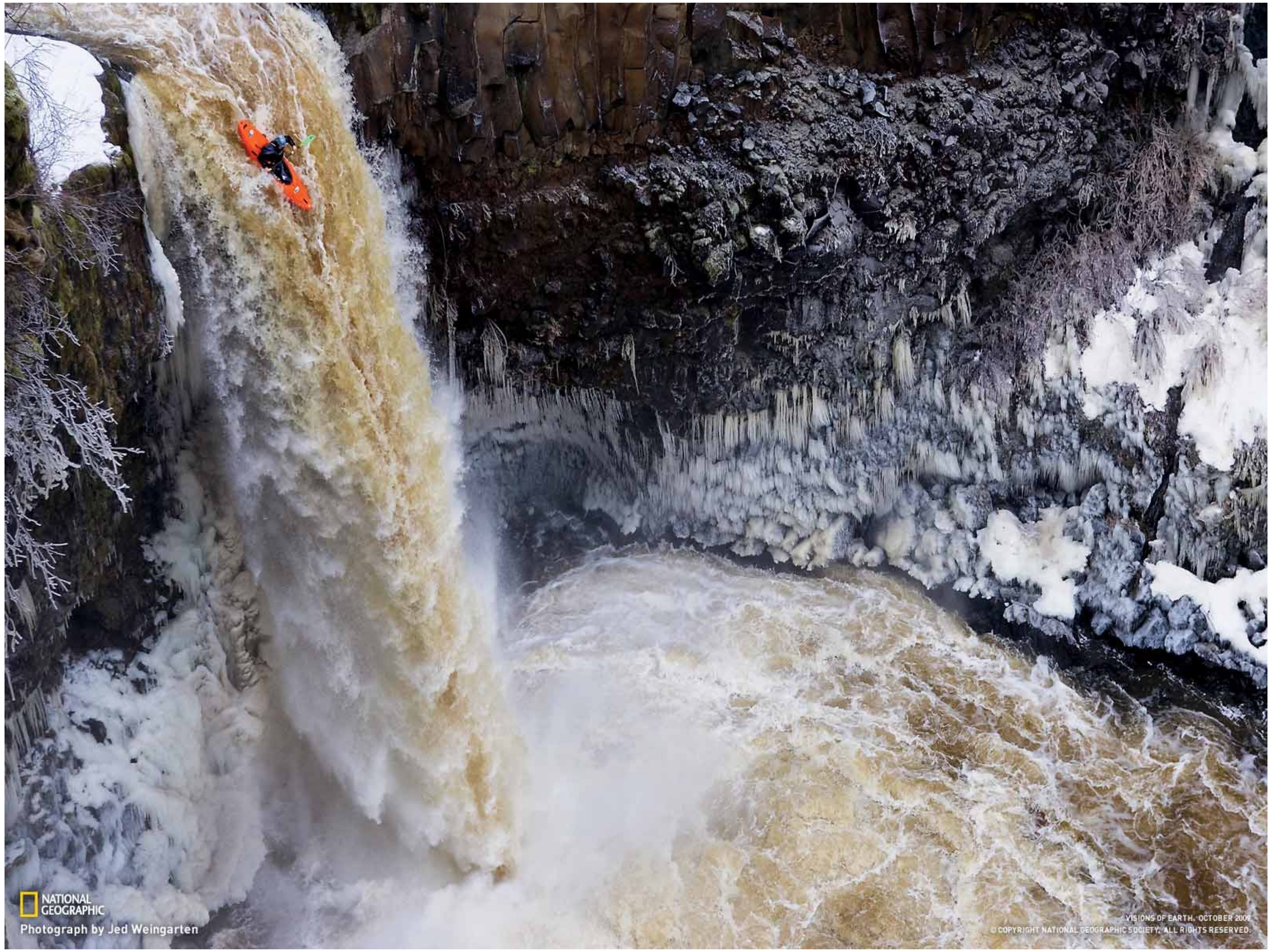
The threshold is not where the boat goes over the edge, it is far up the river, when the people in the boat lose the option to get to the shore



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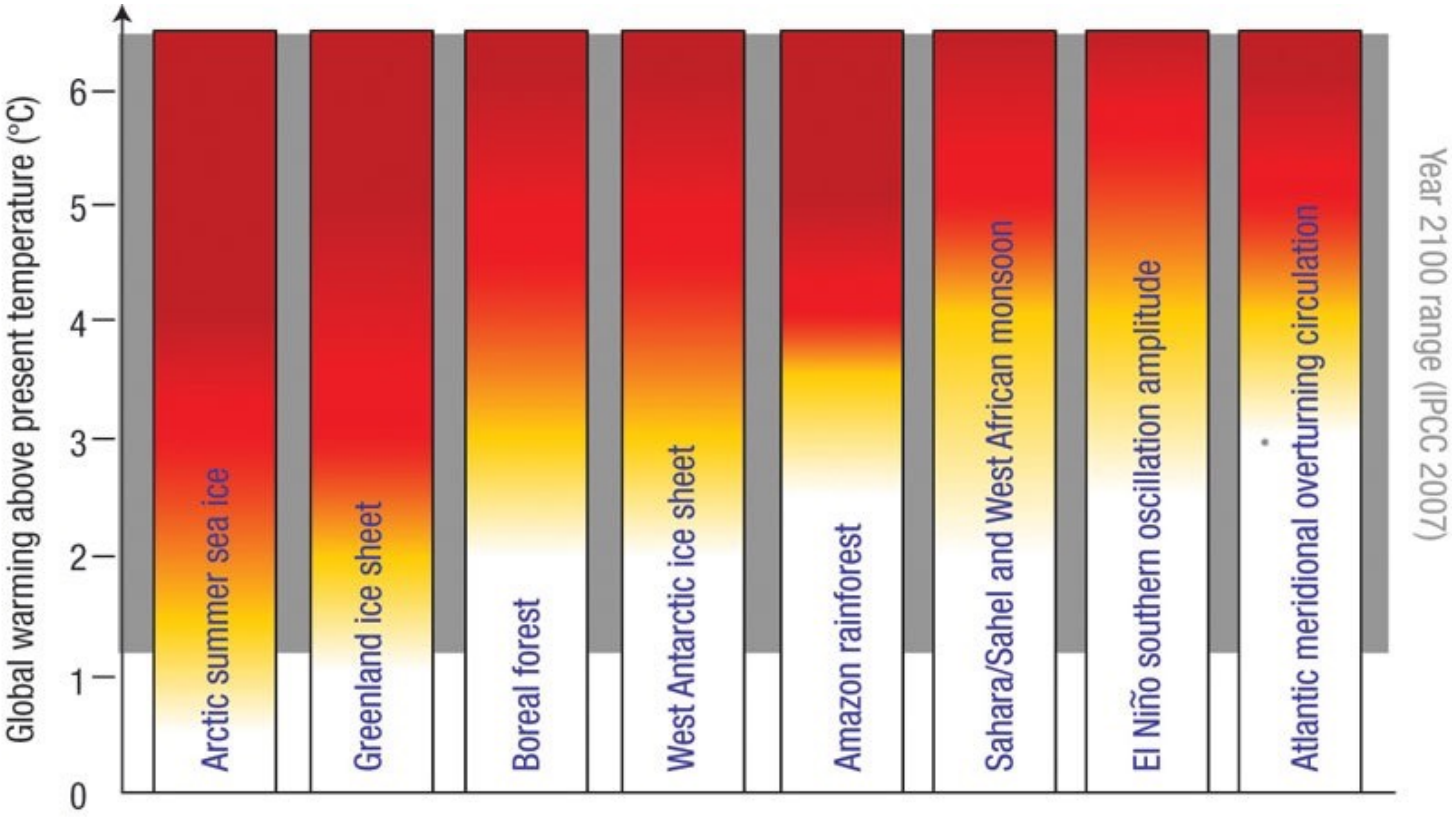

Lenton & Schellnhuber (2007) *Nature Reports Climate Change*

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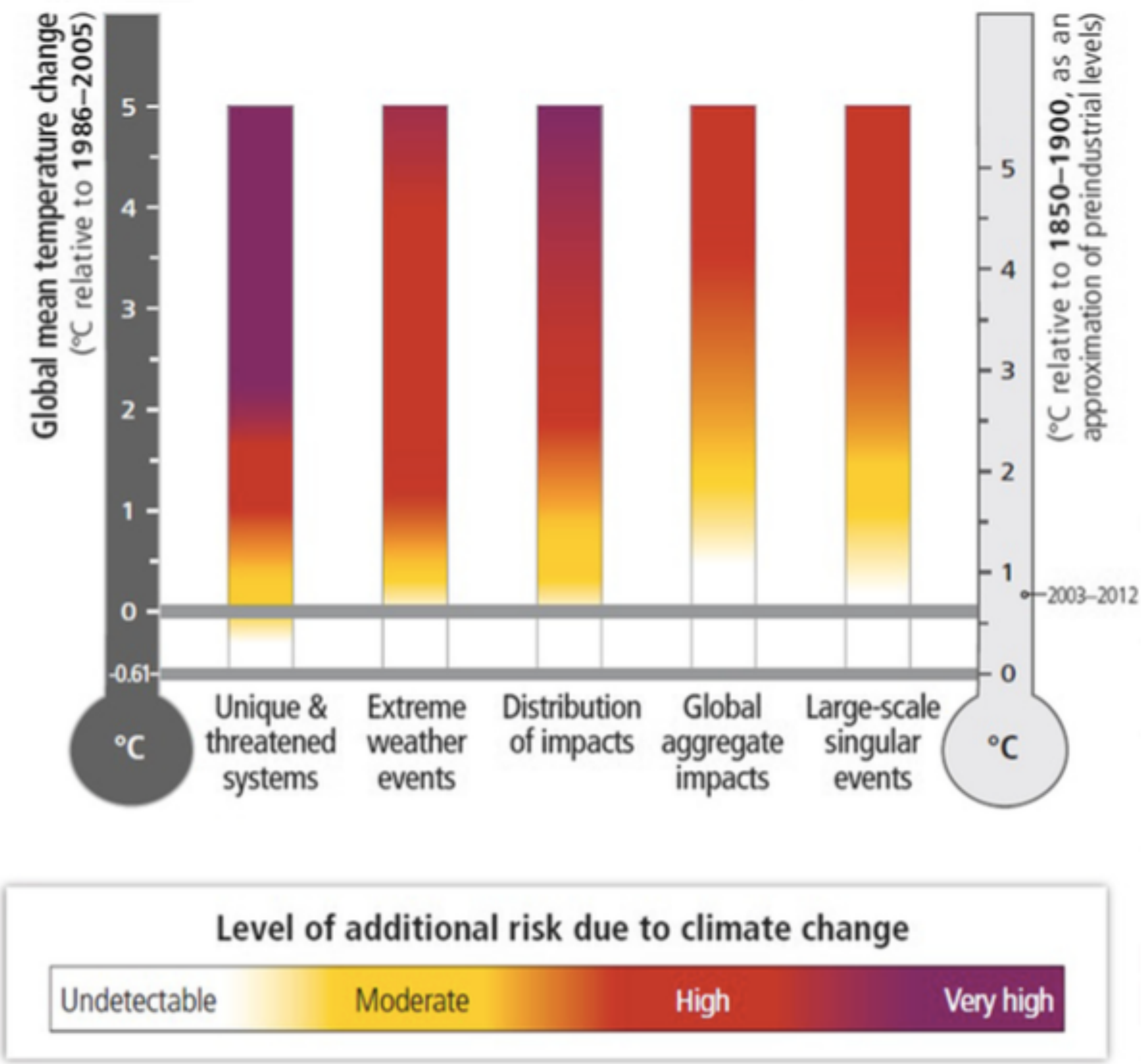

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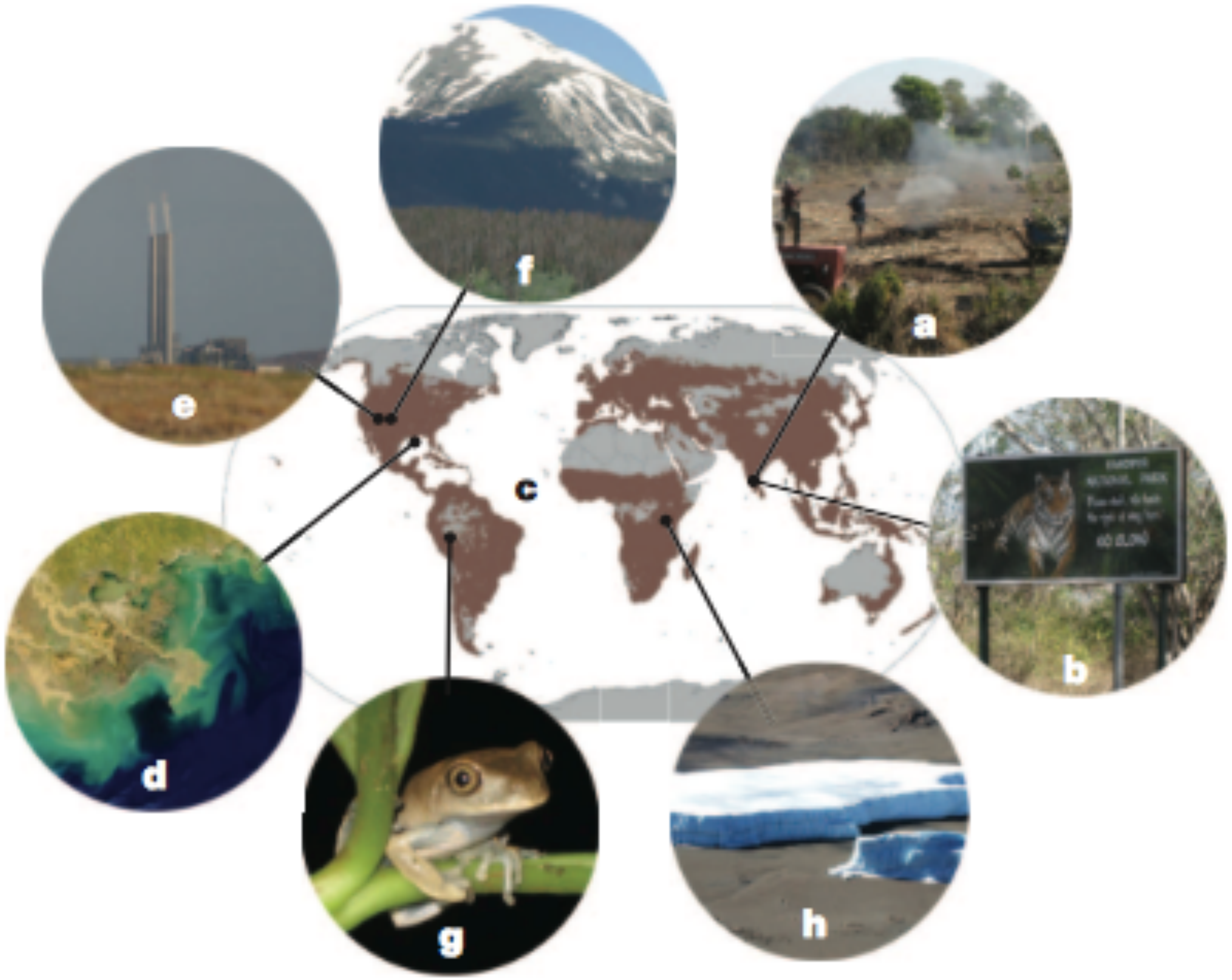

Figure 1 | Drivers of a potential planetary-scale critical transition. **a**, Humans locally transform and fragment landscapes. **b**, Adjacent areas still harbouring natural landscapes undergo indirect changes. **c**, Anthropogenic local state shifts accumulate to transform a high percentage of Earth's surface drastically; brown colouring indicates the approximately 40% of terrestrial ecosystems that have now been transformed to agricultural landscapes, as explained in ref. 34. **d**, Global-scale forcings emerge from accumulated local human impacts, for example dead zones in the oceans from run-off of agricultural pollutants. **e**, Changes in atmospheric and ocean chemistry from the release of greenhouse gases as fossil fuels are burned. **f–h**, Global-scale forcings emerge to cause ecological changes even in areas that are far from human population concentrations. **f**, Beetle-killed conifer forests (brown trees) triggered by seasonal changes in temperature observed over the past five decades. **g**, Reservoirs of biodiversity, such as tropical rainforests, are projected to lose many species as global climate change causes local changes in temperature and precipitation, exacerbating other threats already causing abnormally high extinction rates. In the case of amphibians, this threat is the human-facilitated spread of chytrid fungus. **h**, Glaciers on Mount Kilimanjaro, which remained large throughout the past 11,000 yr, are now melting quickly, a global trend that in many parts of the world threatens the water supplies of major population centres. As increasing human populations directly transform more and more of Earth's surface, such changes driven by emergent global-scale forcings increase drastically, in turn causing state shifts in ecosystems that are not directly used by people. Photo credits: E.A.H. and A.D.B. (**a–c**, **e–h**); NASA (**d**).

Barnosky et al., 2012, Nature, 486.

Thresholds

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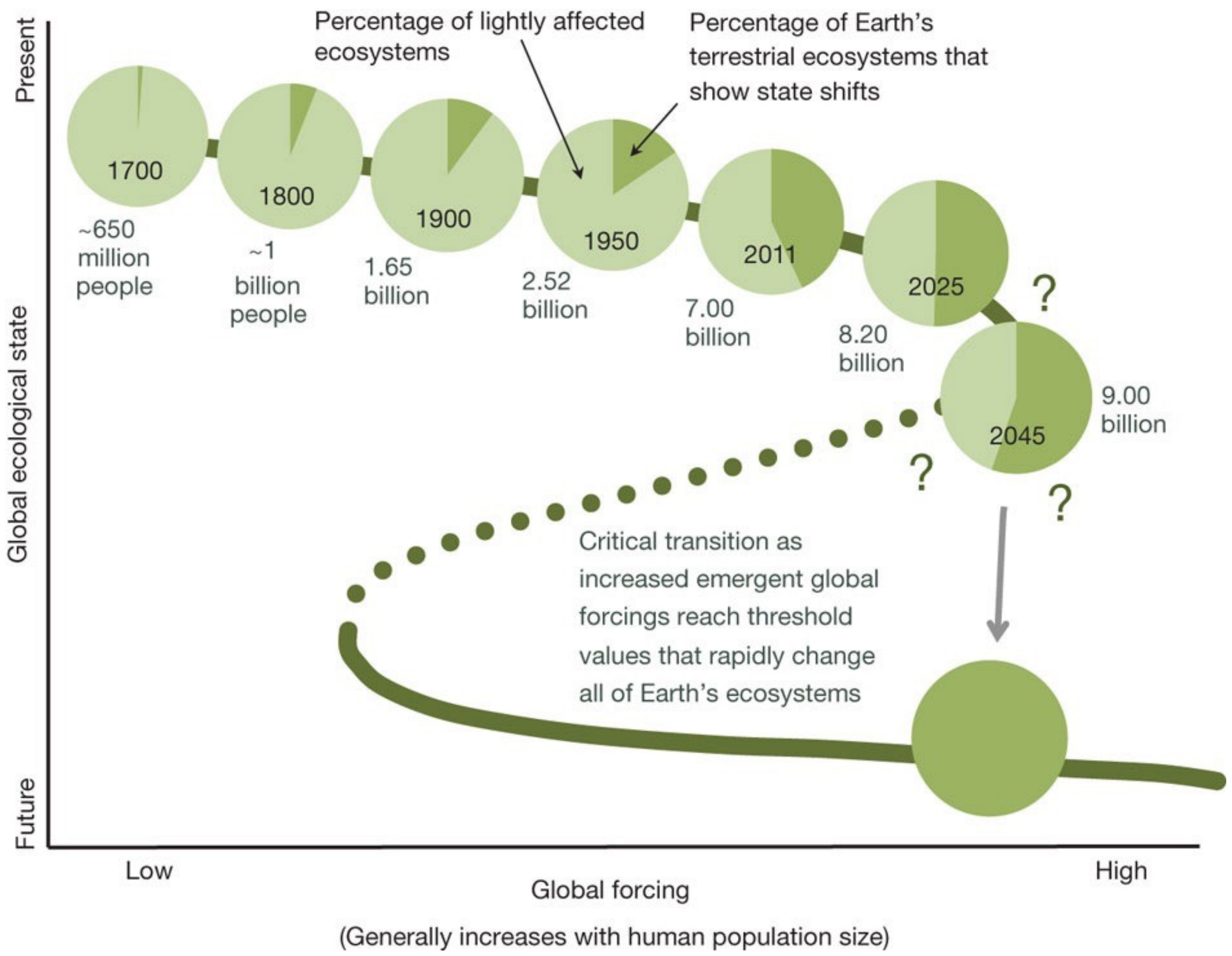

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Vulnerabilities

Vulnerabilities

Figure 2 presents the full list of climate change risks and opportunities considered in the assessment. These include the exposure of interdependent infrastructure networks to multiple, correlated hazards (e.g. flooding and high winds), as well as the vulnerability of certain infrastructure types to specific hazards (e.g. road surfaces to high temperatures). Air quality in both urban and rural areas could deteriorate further though climate change will have less influence than pollution from transport, industry and farming. Risks will arise for culturally-valued buildings and landscapes from a combination of higher temperatures and rainfall intensities. There are also uncertain but potentially very significant international risks arising from climate-related human displacement, and the possibility of violent inter state conflict over scarce natural resources.

Figure 2: Urgency categories for climate change risks and opportunities for the UK

MORE ACTION NEEDED	RESEARCH PRIORITY	SUSTAIN CURRENT ACTION	WATCHING BRIEF
Ne1: Risks to species and habitats from changing climate space	Ne3: Changes in suitability of land for agriculture & forests	Ne9: Risks to agriculture, forestry, landscapes & wildlife from pests/pathogens/invasive species	Ne14: Risks & opportunities from changes in landscape character
Ne2: Opportunities from new species colonisations	Ne7: Risks to freshwater species from high water temperatures	Ne10: Extreme weather/wildfire risks to farming, forestry, wildlife & heritage	In7: Low/high riverflow risks to hydroelectric generation
Ne4: Risks to soils from increased seasonal aridity and wetness	Ne13: Ocean acidification & higher water temperature risks for marine species, fisheries and marine heritage	Ne11: Saltwater intrusion risks to aquifers, farmland & habitats	In8: Subsidence risks to buried/ surface infrastructure
Ne5: Risks to natural carbon stores & carbon sequestration	In5: Risks to bridges and pipelines from high river flows/erosion	In13: Extreme heat risks to rail, road, ICT and energy infrastructure	In10: Risks to electricity generation from drought and low flows
Ne6: Risks to agriculture & wildlife from water scarcity & flooding	In11: Risks to energy, transport & ICT from high winds & lightning	In14: Benefits for infrastructure from reduced extreme cold events	PB3: Opportunities for increased outdoor activity in warmer weather
Ne8: Risks of land management practices exacerbating flood risk	In12: Risks to offshore infrastructure from storms and high waves	PB13: Risks to health from poor water quality	PB12: Risks of food-borne disease cases and outbreaks
Ne12: Risks to habitats & heritage in the coastal zone from sea level rise; loss of natural flood protection	PB2: Risks to passengers from high temperatures on public transport	PB14: Risk of household water supply interruptions	Bu4: Risks to business from reduced access to capital
In1: Risks of cascading infrastructure failures across interdependent networks	PB6: Risks to viability of coastal communities from sea level rise	Bu3: Risks to business operations from water scarcity	Bu7: Business risks /opportunities from changing demand for goods & services
In2: Risks to infrastructure from river, surface/groundwater flooding	PB7: Risks to building fabric from moisture, wind, and driving rain	Bu6: Risks to business from disruption to supply chains	It7: Opportunities from changes in international trade routes
In3: Risks to infrastructure from coastal flooding & erosion	PB8: Risks to culturally valued structures and historic environment		
In4: Risks of sewer flooding due to heavy rainfall	PB10: Risks to health from changes in air quality		
In6: Risks to transport networks from embankment failure	PB11: Risks to health from vector-borne pathogens		
In9: Risks to public water supplies from drought and low river flows	Bu2: Risks to business from loss of coastal locations & infrastructure		
PB1: Risks to public health and wellbeing from high temperatures	Bu5: Employee productivity impacts in heatwaves and from severe weather infrastructure disruption		
PB4: Potential benefits to health & wellbeing from reduced cold	It2: Imported food safety risks		
PB5: Risks to people, communities & buildings from flooding	It3: Long-term changes in global food production		
PB9: Risks to health and social care delivery from extreme weather	It5: Risks to the UK from international violent conflict		
Bu1: Risks to business sites from flooding	It6: Risks to international law and governance		
It1: Weather-related shocks to global food production and trade			
It4: Risks from climate-related international human displacement			

KEY TO CHAPTERS:

- Chapter 3: Natural environment and natural assets
- Chapter 4: Infrastructure
- Chapter 5: People and the built environment
- Chapter 6: Business and industry
- Chapter 7: International dimensions

Note: Individual risks and opportunities are presented in the order they are discussed in the chapters (not in priority order).

www.theccc.org.uk/uk-climate-change-risk-assessment-2017

Figure SR.2: Urgency of risks and opportunities identified and discussed in the vidence Report

MORE ACTION NEEDED	RESEARCH PRIORITY	SUSTAIN CURRENT ACTION	WATCHING BRIEF
from drought and low river flows	Bu2: Risks to business from loss of coastal locations & infrastructure		
PB1: Risks to public health and wellbeing from high temperatures	Bu5: Employee productivity impacts in heatwaves and from severe weather infrastructure disruption		
PB4: Potential benegts to health & wellbeing from reduced cold	It2: Imported food safety risks		
PB5: Risks to people, communities & buildings from flooding	It3: Long-term changes in global food production		
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Source: ASC judgement in discussion with lead contributors, based on the evidence of magnitude, current and potential adaptation, and benefits of further action in the next five years, presented within the Evidence Report chapters.
Notes: Individual risks and opportunities are presented in the order they are discussed in the chapters (not in priority order). The urgency categories are defined as follows:
- **More action needed:** New, stronger or different government policies or implementation activities– over and above those already planned – are needed to reduce long-term vulnerability to climate change.
- **Research priority:** Research is needed to fill significant evidence gaps or reduce the uncertainty in the current level of understanding in order to assess the need for additional action.
- **Sustain current action:** Current or planned levels of activity are appropriate, but continued implementation of these policies or plans is needed to ensure that the risk continues to be managed in the future. This includes any existing plans to increase or change the current level of activity.
- **Watching brief:** The evidence in these areas should be kept under review, with long-term monitoring of risk levels and adaptation activity so that further action can be taken if necessary.

See Chapter 2 of the Evidence Report for more details of the urgency scoring methodology used.

Vulnerabilities

Figure SR.A1: Climate change risks and opportunities for the natural environment

Natural Assets

3.2: Terrestrial

Ne1: Risks to species and habitats due to inability to respond to changing climatic conditions

Ne2: Opportunities from new species colonisations

3.3: Soils and Land

Ne3: Risks and opportunities from changes in agricultural and forestry productivity and land suitability

Ne 4: Risks to soils from seasonal aridity and wetness

Ne8: Risks of land management practices exacerbating flood risk

Ne10: Risks to agriculture, forestry, wildlife and heritage from change in frequency and/or magnitude of extreme weather and wildfire events

3.4: Freshwater

Ne6: Risks to agriculture and wildlife from water scarcity and flooding

Ne7: Risks to freshwater species from higher water temperatures

3.5: Coasts

Ne11: Risks to aquifers, agricultural land and habitats from salt water intrusion

Ne12: Risks to habitats and heritage in the coastal zone from sea-level rise; and loss of natural flood protection

3.6: Marine

Ne13: Risks to, and opportunities for, marine species, fisheries and marine heritage from ocean acidification and higher water temperatures

3.7: Cross-Cutting Issues

3.7.1: Pests and Diseases

Ne9: Risks to agriculture, forestry, landscapes and wildlife from pests, pathogens and invasive species

3.7.2: Natural Carbon Stores

Ne5: Risks to natural carbon stores and carbon sequestration

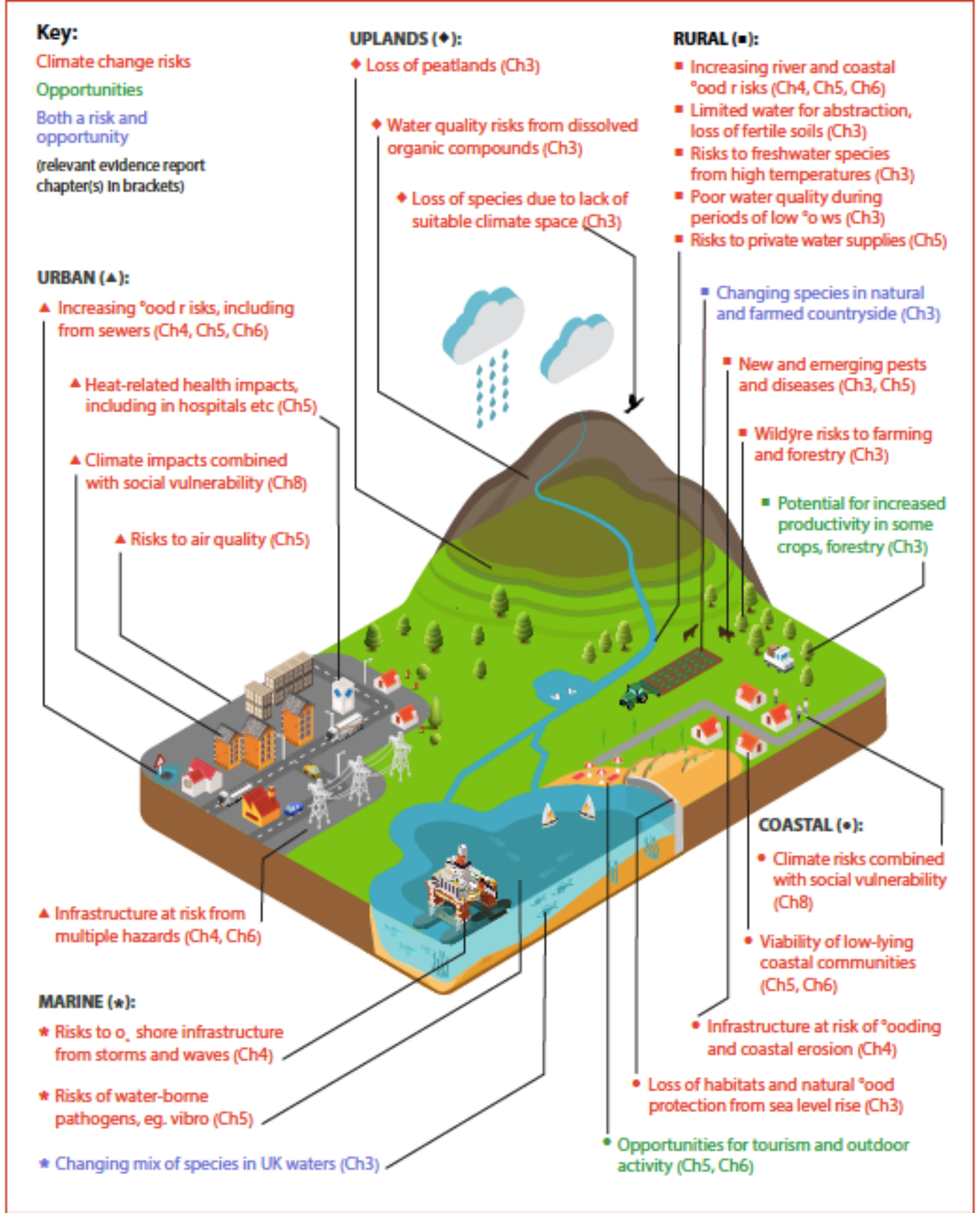
3.7.3: Landscape and Sense of Place

Ne14: Risks and opportunities from changes in landscape character

Source: CCRA2 Evidence Report, Chapter 3.
Notes: Numbers denote the sections of Chapter 3 discussing the issues presented.

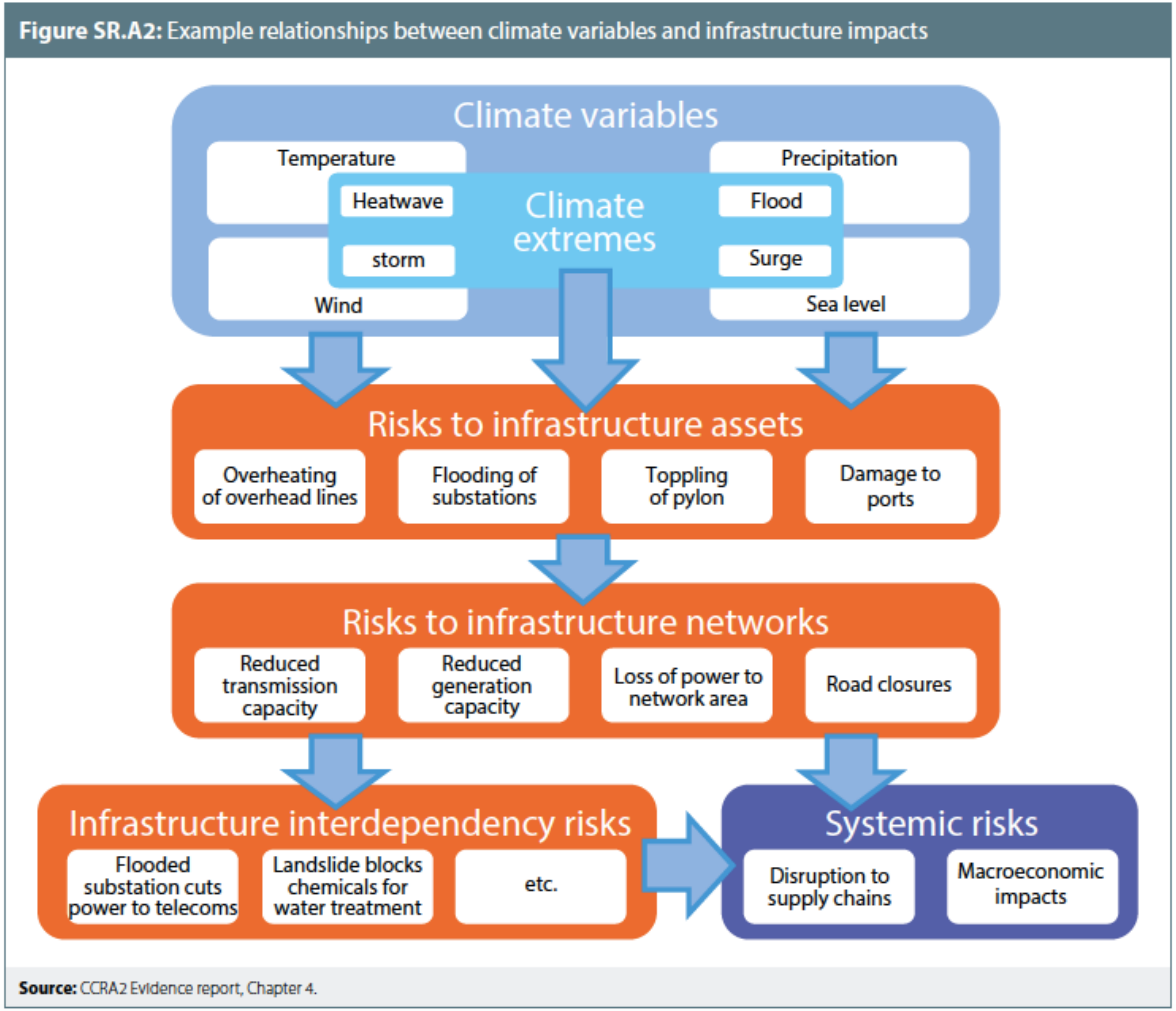
Vulnerabilities

Figure SR.10: UK climate change risks and opportunities for different types of area



Source: ASC synthesis of the Evidence Report chapters.
Notes: The risks presented are not exhaustive and will not be confined to the types of area shown. See chapters of the Evidence Report for more details.

Vulnerabilities



Vulnerabilities

Figure SR.1: Top six areas of inter-related climate change risks for the United Kingdom

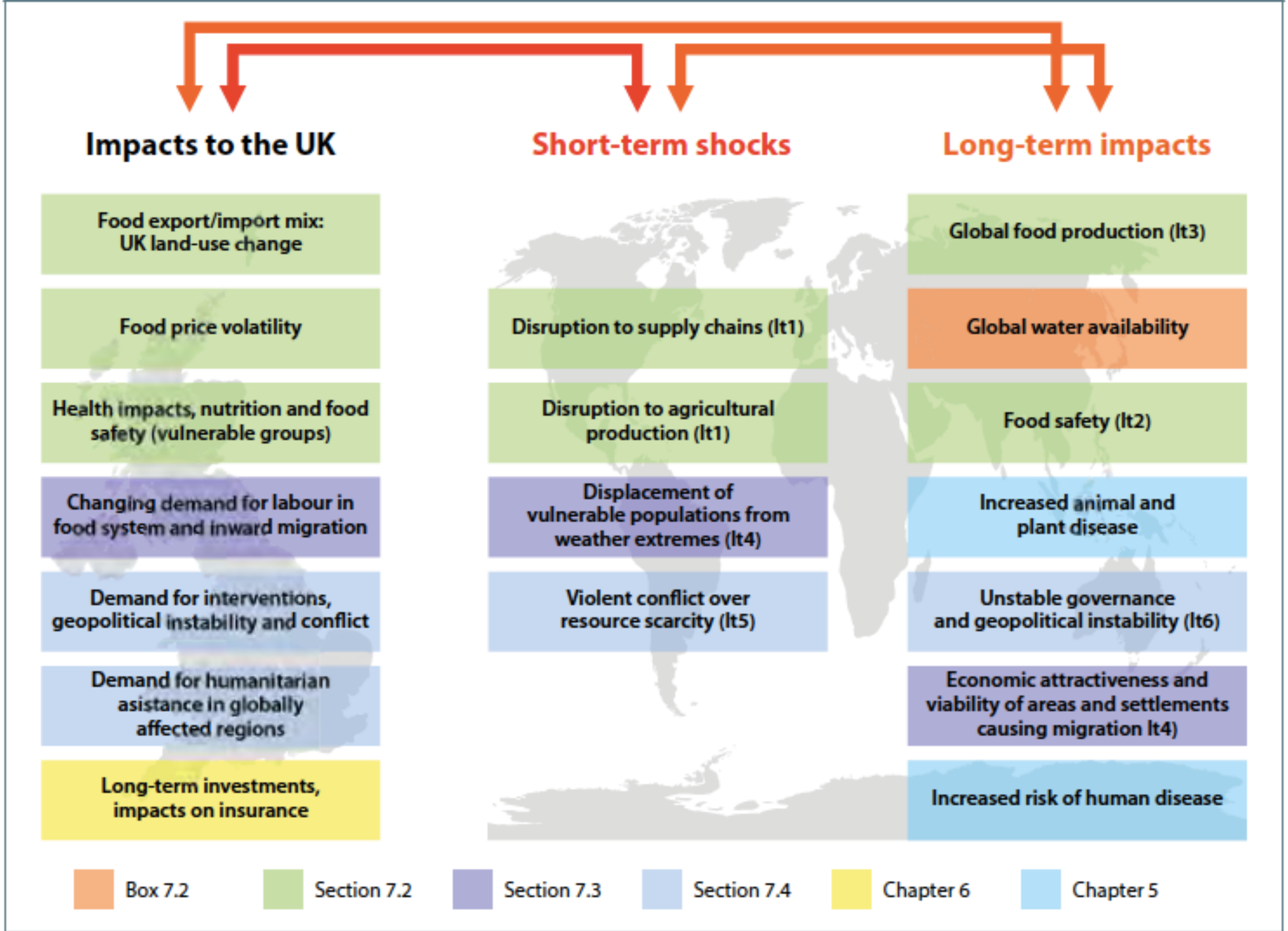
Flooding and coastal change risks to communities, businesses and infrastructure (Ch3, Ch4 **Ch5**, Ch6)	**MORE ACTION NEEDED**
Risks to health, well-being and productivity from high temperatures (**Ch5**, Ch6)	
Risk of shortages in the public water supply, and for agriculture, energy generation and industry (Ch3, **Ch4**, Ch5, Ch6)	
Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity (**Ch3**)	
Risks to domestic and international food production and trade (Ch3, Ch6, **Ch7**)	
New and emerging pests and diseases, and invasive non-native species, affecting people, plants and animals (Ch3, **Ch5**, Ch7)	**RESEARCH PRIORITY**

NOW -----> RISK MAGNITUDE -----> **FUTURE** LOW MEDIUM HIGH

Source: ASC synthesis of the main areas of risk and opportunity within the chapters of the Evidence Report.
Notes: Future magnitude is based on a combination of climate change and other drivers of risk (e.g. demographic change), taking account of how current adaptation policies and plans across the UK are likely to reduce risks.

Vulnerabilities

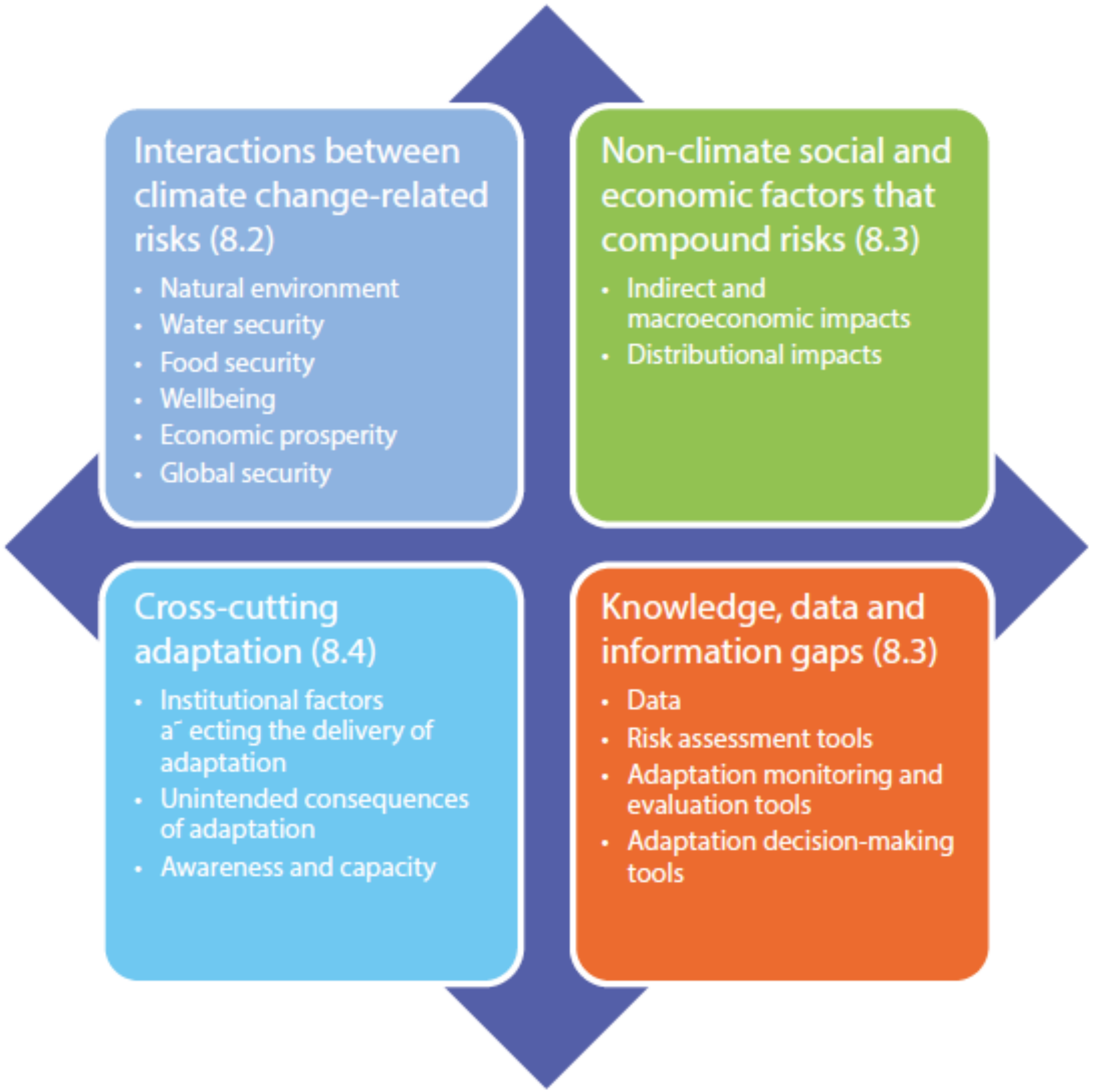
Figure SR.A5: International dimensions of climate change risk



Source: CCRA2 Evidence Report, Chapter 7.

Vulnerabilities

Figure SR.A6: Cross-cutting issues affecting climate change risks



Source: CCRA2 Evidence Report, Chapter 8.

1. To what extent does the IPCC thoroughly address the drivers behind climate change, and how are these reflected in the Assessment Report?
2. Summarize the core challenges of climate change and sea level rise for public health.
3. Explain the main issues of the food-water-energy nexus.

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3 Explain the main issues of the food-water-energy nexus.

Table 1 Vulnerability to and impacts of LSLR

Hazard or impact	*Direct health impacts*	*Health infrastructure*
Catastrophic coastal flooding	Deaths through drowning and other causes, injuries, infectious diseases (respiratory, intestinal, skin), mental health disorders	Health services interruption, availability of health staff, transportation disruption, energy and other supplies
Flood-induced pollution	Infectious diseases, allergies	Long-lasting degradation of health service infrastructure
Reduced water quality and reduced access to potable water due to salinification and/or pollution	Diarrheal diseases (giardia, cholera), hepatitis, other water borne diseases	Reduced water supply for health services
Impairment of food quality (through pollution of farmland and fisheries) and reduction of food supply (e.g., loss of farmland and decreasing productivity of fisheries)	Malnutrition; shellfish poisoning, marine bacteria proliferation	Food safety
Change in transmission intensity, distribution of vector-borne disease, abundance of vectors	Changes in malaria and other mosquito-borne infectious diseases	
Population displacements, degradation of livelihoods	Less well defined; can include increased social conflicts; increased crime rate; prostitution to replace lost income	General stress on health services because of rapid changes in demands

Modified from Nicholls, R. J., P. P. Wong, V. R. Burkett, J. O. Codignotto, J. E. Hay, R. F. McLean, S. Ragoonaden, and C. D. Woodroffe, 2007b: Coastal systems and low-lying areas. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. Hanson, Eds., Cambridge University Press, Cambridge, UK, 315–356.

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Executive summary

Climate change currently contributes to the global burden of disease and premature deaths (very high confidence).
Human beings are exposed to climate change through changing weather patterns (temperature, precipitation, sea-level rise and more frequent extreme events) and indirectly through changes in water, air and food quality and changes in ecosystems, agriculture, industry and settlements and the economy. At this early stage the effects are small but are projected to progressively increase in all countries and regions. [8.4.1]

Emerging evidence of climate change effects on human health shows that climate change has:

- altered the distribution of some infectious disease vectors (medium confidence) [8.2.8];
- altered the seasonal distribution of some allergenic pollen species (high confidence) [8.2.7];
- increased heatwave-related deaths (medium confidence) [8.2.1].

Projected trends in climate-change-related exposures of importance to human health will:

- increase malnutrition and consequent disorders, including those relating to child growth and development (high confidence) [8.2.3, 8.4.1];
- increase the number of people suffering from death, disease and injury from heatwaves, floods, storms, fires and droughts (high confidence) [8.2.2, 8.4.1];
- continue to change the range of some infectious disease vectors (high confidence) [8.2, 8.4];
- have mixed effects on malaria; in some places the geographical range will contract, elsewhere the geographical range will expand and the transmission season may be changed (very high confidence) [8.4.1.2];
- increase the burden of diarrhoeal diseases (medium confidence) [8.2, 8.4];
- increase cardio-respiratory morbidity and mortality associated with ground-level ozone (high confidence) [8.2.6, 8.4.1.4];
- increase the number of people at risk of dengue (low confidence) [8.2.8, 8.4.1];
- bring some benefits to health, including fewer deaths from cold, although it is expected that these will be outweighed by the negative effects of rising temperatures worldwide, especially in developing countries (high confidence) [8.2.1, 8.4.1].

Adaptive capacity needs to be improved everywhere; impacts of recent hurricanes and heatwaves show that even high-income countries are not well prepared to cope with extreme weather events (high confidence). [8.2.1, 8.2.2]

Adverse health impacts will be greatest in low-income countries. Those at greater risk include, in all countries, the urban poor, the elderly and children, traditional societies, subsistence farmers, and coastal populations (high confidence). [8.1.1, 8.4.2, 8.6.1.3, 8.7]

Economic development is an important component of adaptation, but on its own will not insulate the world's population from disease and injury due to climate change (very high confidence).
Critically important will be the manner in which economic growth occurs, the distribution of the benefits of growth, and factors that directly shape the health of populations, such as education, health care, and public-health infrastructure. [8.3.2]

Risk Distribution

Risk Distribution

- There are always risks
- Risk distribution is uneven in space

Inequality in Climate and Global Change Impacts

Risk Distribution

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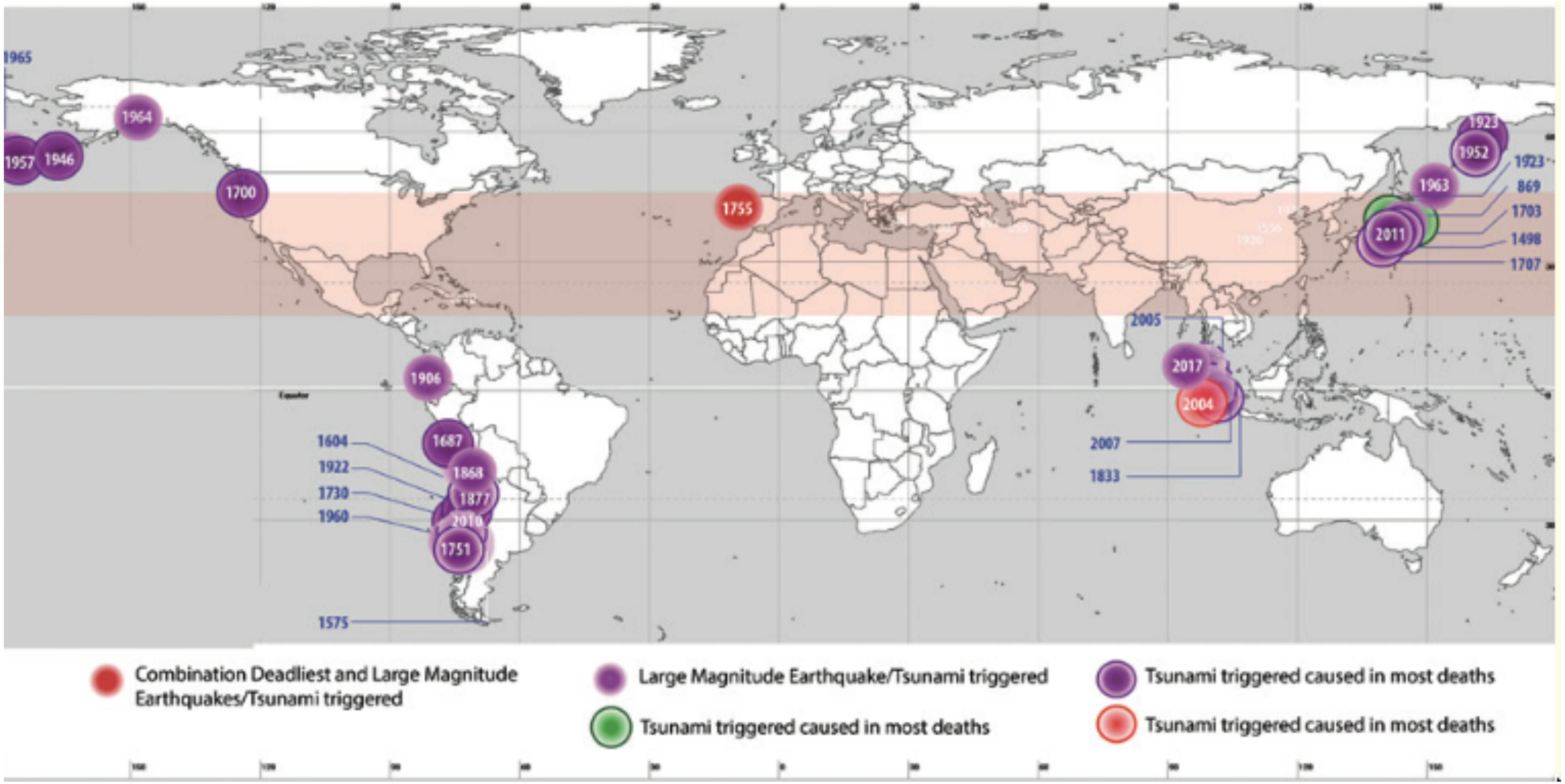

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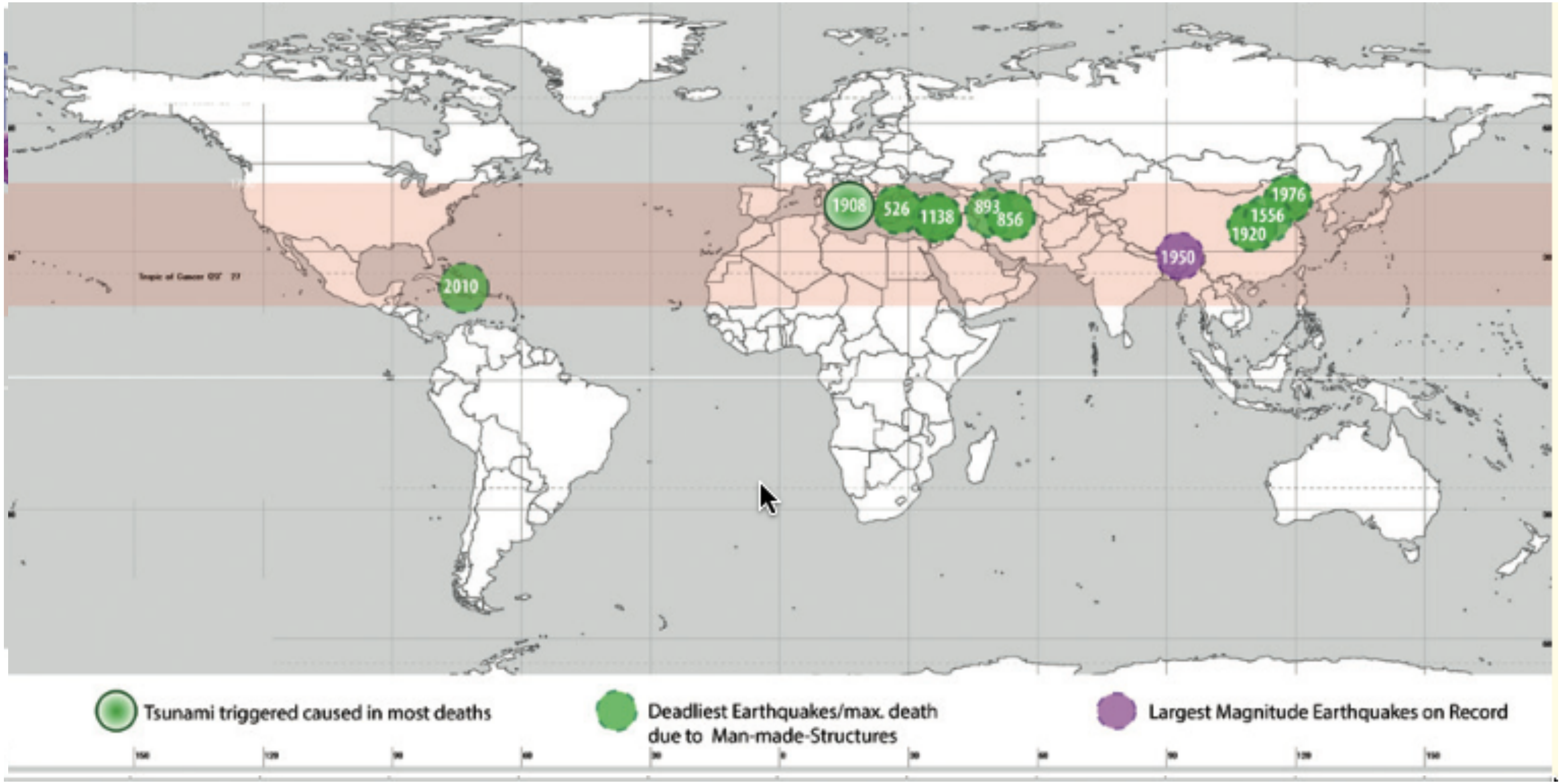

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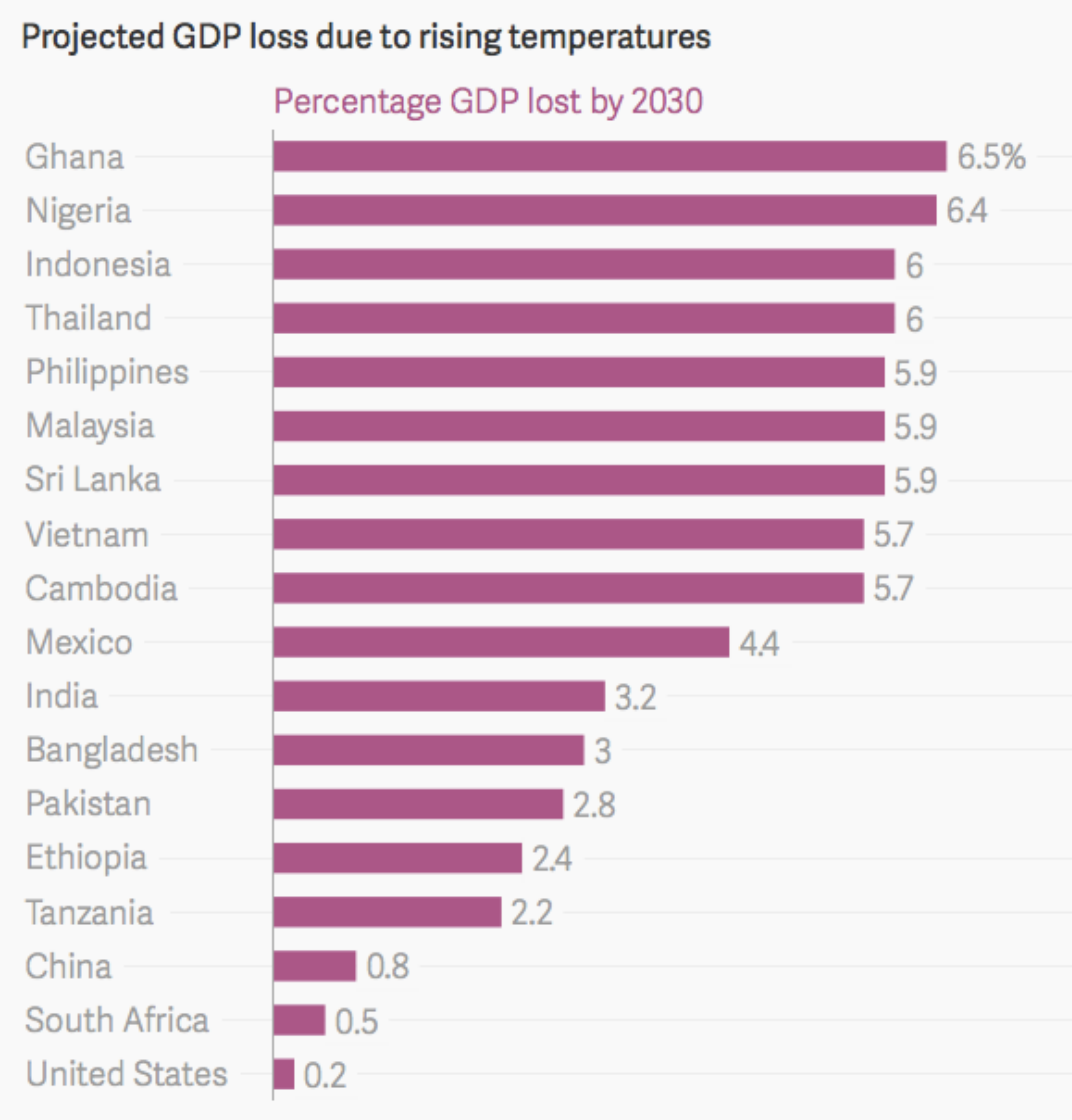

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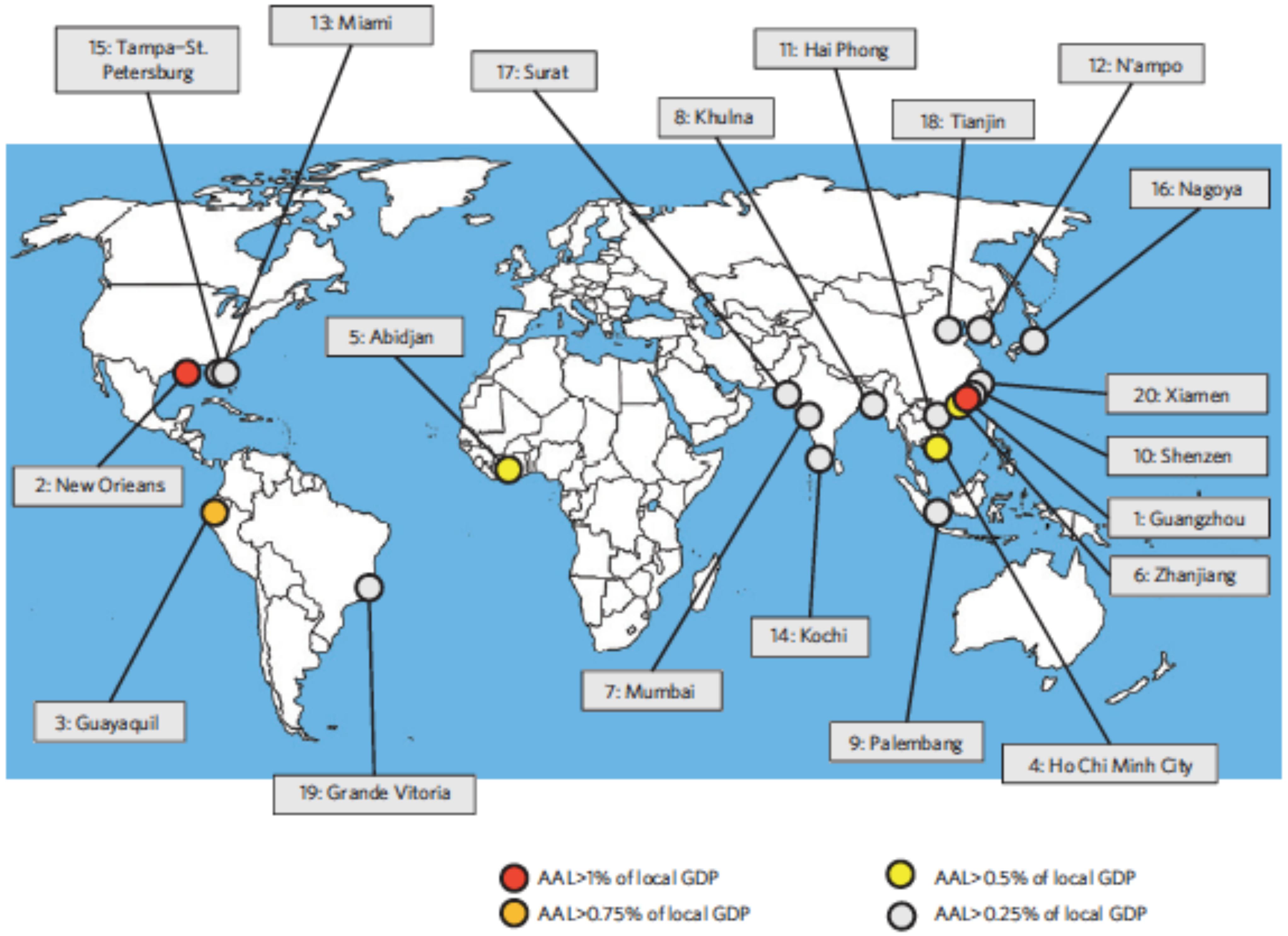

LETTERS NATURE CLIMATE CHANGE DOI: 10.1038/NCLIMATE1979

Table 1 | City ranking by risk (AAL) and relative risk (AAL in percentage of GDP) for 2005.

Ranking by AAL (US$ million)					Ranking by relative AAL (percentage of city GDP)				
	Urban agglomeration	100 year exposure	AAL, with protection (US$ million)	AAL, with protection (percentage of GDP)		Urban agglomeration	100 year exposure	AAL, with protection (US$ million)	AAL, with protection (percentage of GDP)
1	Guangzhou	38,508	687	1.32%	1	Guangzhou	38,508	687	1.32%
2	Miami	366,421	672	0.30%	2	New Orleans	143,963	507	1.21%
3	New York—Newark	236,530	628	0.08%	3	Guayaquil	3,687	98	0.95%
4	New Orleans	143,963	507	1.21%	4	Ho Chi Minh City	18,708	104	0.74%
5	Mumbai	23,188	284	0.47%	5	Abidjan	1,786	38	0.72%
6	Nagoya	77,988	260	0.26%	6	Zhanjiang	2,780	46	0.50%
7	Tampa—St. Petersburg	49,593	244	0.26%	7	Mumbai	23,188	284	0.47%
8	Boston	55,445	237	0.13%	8	Khulna	2,073	13	0.43%
9	Shenzen	11,338	169	0.38%	9	Palembang	1,161	27	0.39%
10	Osaka—Kobe	149,935	120	0.03%	10	Shenzen	11,338	169	0.38%
11	Vancouver	33,456	107	0.14%	11	Hai Phòng	6,348	19	0.37%
12	Tianjin	11,408	104	0.24%	12	N'ampo	507	6	0.31%
13	Ho Chi Minh City	18,708	104	0.74%	13	Miami	366,421	672	0.30%
14	Kolkata	14,769	99	0.21%	14	Kochi	855	14	0.29%
15	Guayaquil	3,687	98	0.95%	15	Tampa—St. Petersburg	49,593	244	0.26%
16	Philadelphia	22,132	89	0.04%	16	Nagoya	77,988	260	0.26%
17	Virginia Beach	61,507	89	0.15%	17	Surat	3,288	30	0.25%
18	Fukuoka—Kitakyushu	39,096	82	0.09%	18	Tianjin	11,408	104	0.24%
19	Baltimore	14,042	76	0.08%	19	Grande_Vitória	6,738	32	0.23%
20	Jakarta	4,256	73	0.14%	20	Xiamen	4,486	33	0.22%

A comparison with a ranking by exposure is proposed in the Supplementary Information.

Inequality in Climate and Global Change Impacts

Risk Distribution

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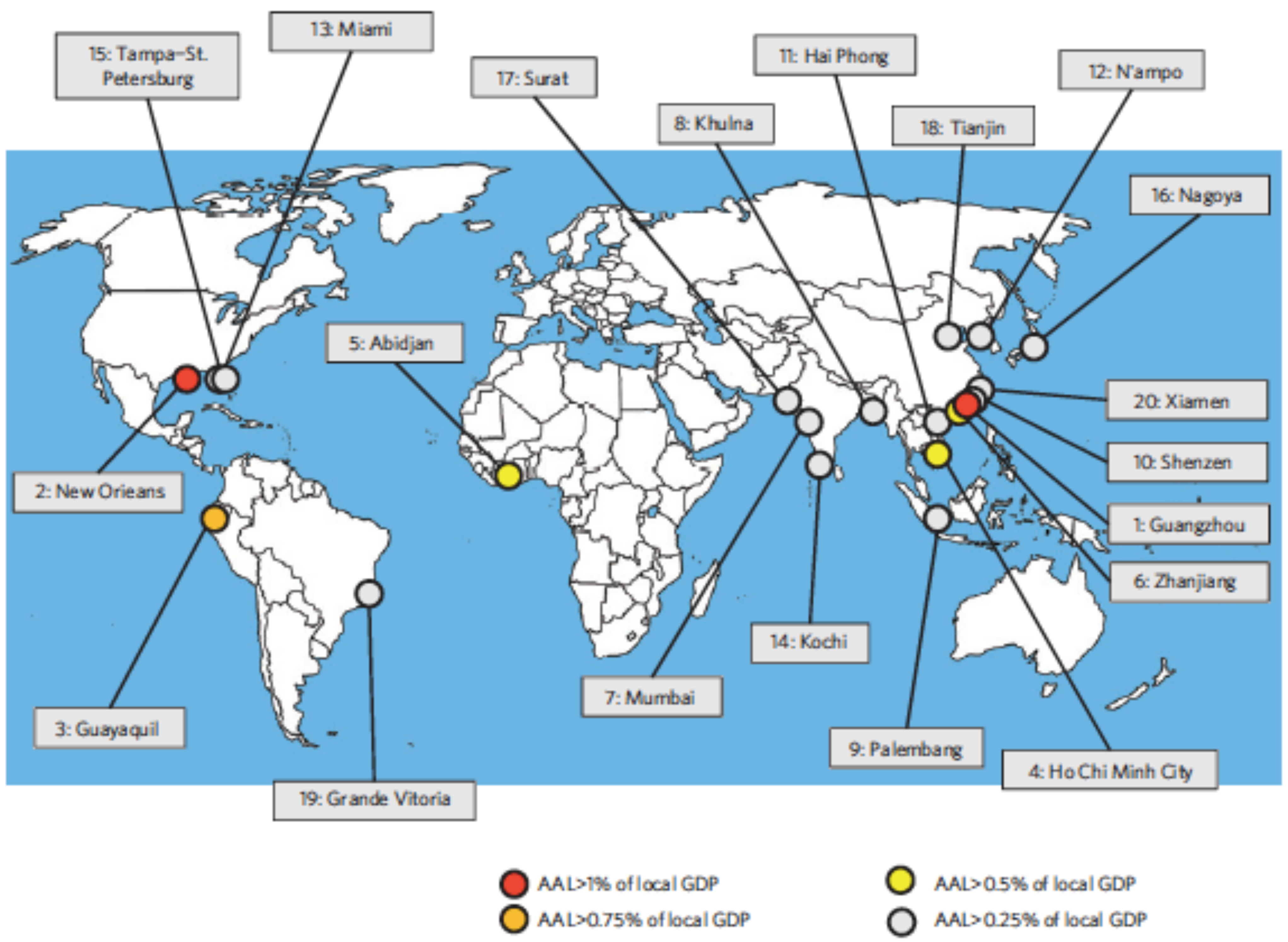

Table 2 | The 20 cities with the highest loss in 2050, assuming scenario SLR-1 and adaptation option that maintains flood probability (option PD).

	Scenarios with socio-economic change alone (SEC)		Scenarios with socio-economic change, subsidence, sea-level rise and adaptation to maintain flood probability (scenarios SLR-1, and adaptation option PD)		
Urban agglomeration	AAL (US$ million)	AAL (percentage of city GDP)	AAL (US$ million)	Increase in AAL compared with 2005 (%)	AAL (percentage of city GDP)
Guangzhou (S)	11,928	1.32%	13,200	11%	1.46%
Mumbai	6,109	0.47%	6,414	5%	0.49%
Kolkata (S)	2,704	0.21%	3,350	24%	0.26%
Guayaquil (S)	2,813	0.95%	3,189	13%	1.08%
Shenzen	2,929	0.38%	3,136	7%	0.40%
Miami	2,099	0.30%	2,549	21%	0.36%
Tianjin (S)	1,810	0.24%	2,276	26%	0.30%
New York—Newark	1,960	0.08%	2,056	5%	0.08%
Ho Chi Minh City (S)	1,743	0.74%	1,953	12%	0.83%
New Orleans (S)	1,583	1.21%	1,864	18%	1.42%
Jakarta (S)	1,139	0.14%	1,750	54%	0.22%
Abidjan	826	0.72%	1,023	24%	0.89%
Chennai (Madras)	825	0.12%	939	14%	0.14%
Surat	905	0.25%	928	3%	0.26%
Zhanjiang (S)	806	0.50%	891	11%	0.55%
Tampa—St. Petersburg	763	0.26%	859	13%	0.29%
Boston	741	0.13%	793	7%	0.14%
Bangkok (S)	596	0.07%	734	23%	0.09%
Xiamen (S)	572	0.22%	729	27%	0.29%
Nagoya (S)	564	0.26%	644	14%	0.30%

'S' indicates that the city is prone to significant subsidence. Most of these cities are located in deltaic regions, where subsidence influences local sea level in 2050.

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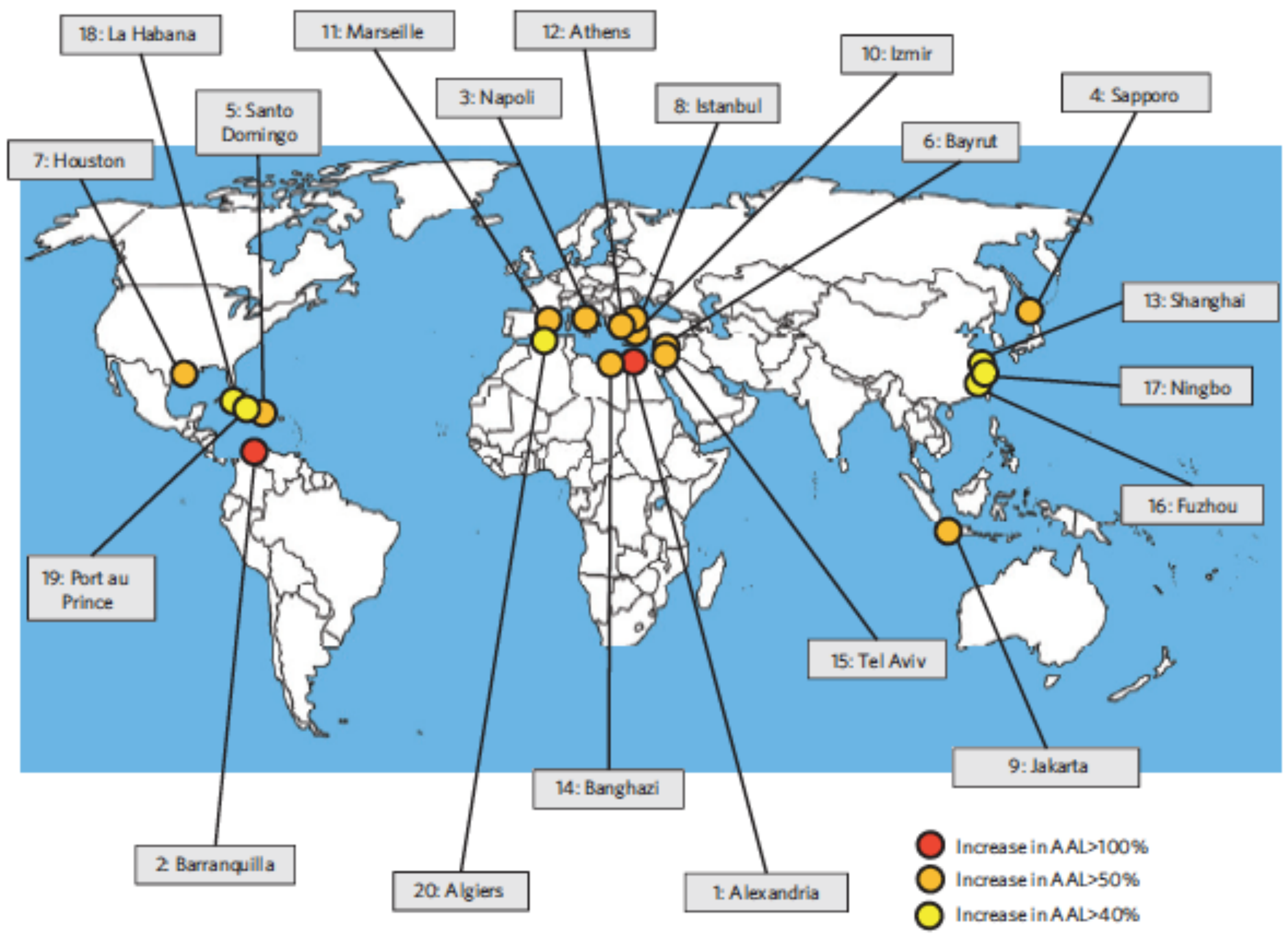

Figure 2 | The 20 cities where AAL increase most (in relative terms in 2050 compared with 2005) in the case of optimistic sea-level rise, if adaptation only maintains present defence standards or flood probability (PD). More information in Supplementary Table S7.

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Inequality in Climate and Global Change Impacts

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Example:
Since 1970, the number of people exposed to floods and tropical cyclones has doubled.

172 OXFAM BRIEFING PAPER 21 MAY 2013

People in a waterside house raised on stilts in a slum in Manila. © Robin Hammond / Panos

NO ACCIDENT

Resilience and the inequality of risk

We need a new approach to risk and poverty reduction. Major external risks, such as climate change and food price volatility, are increasing faster than attempts to reduce them. Many risks are dumped on poor people, and women face an overwhelming burden. In many places of recurrent crises, the response of governments and the international aid sector is not good enough. A new focus on building resilience offers real promise to allow the poorest women and men to thrive despite shocks, stresses, and uncertainty – but only if risk is more equally shared globally and across societies. This will require a major shift in development work, which for too long has avoided dealing with risk. More fundamentally, it will require challenging the inequality that exposes poor people to far more risk than the rich.

Inequality in Climate and Global Change Impacts

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None of the consequences of these shocks and stresses are equal. Poor people and poor countries suffer immeasurably more than others. In relative terms, the financial impact of disasters is far higher in developing countries. For example, South Asia suffers flood losses that are 15 times greater, as a percentage of GDP, than OECD countries.
Those who are hit hardest are always the poorest, because they do not have access to welfare or social protection schemes, insurance, or „something in the kitty" to help them withstand an emergency.

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- Risk can be socialized through insurance

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97 per cent of people on low incomes have no insurance cover, and 90 per cent of workers in least developed countries have no social security

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Inequality in Time

Inequality in Time

19.20.21.org:
19 cities in the world with 20 million people in the 21st century

Inequality in Time

Inequality in Time

19.20.21.org:
19 cities in the world with 20 million people in the 21st century

"..., almost all of the cities to be studied in 19.20.21 are cities that border the oceans of the world, and will be affected by the rise in sea levels

Risk (in $) = Hazard Probability * Vulnerability * Exposed Assets

$$r_h^T(I,x,t) = p_h^T(I,t) \cdot V_h^{a(x,t)}(I,t) \cdot a(x,t)$$

Application of equation suffers from:

- underestimation of probability, particularly for infrequent, large events
- worst cases are more frequent and worse than estimated

Risk defined as above:

- does not consider short-term induced and post-event processes
- does not consider cascading hazards
- does not consider cascading effects
- does not consider long-term post-event processes

Inequality in Time

Inequality in Time

“What would you like to tell your 20 year old self?”

Eva Wilkerson, 2013

Inequality in Time

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Separating the **Signal** from all the **Noise**

The Virginian-Pilot

PilotOnline.com

GUEST COLUMNIST

Plag: A talk with a younger self

By Hans-Peter Plag

Apr 20, 2014

The things I always want to hear are the truth, the facts, the options:

n The most likely single cause of premature death for young people today is an i... he planet
such as heat waves, droughts, storms, food and water shortages, new sickn...
migration of large populations, civil unrest like in North Africa and Syr...
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Inequality in Time

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+ extinction

Inequality between Species

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Inequality between Species

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Chimps May Be Capable of Comprehending the Minds of Others

A gorilla-suit experiment reveals our closest animal relatives may possess "theory of mind"

By Catherine Caruso on October 6, 2016 Véalo en español

Will a rising tide sink all homes?

Zillow

Nationwide, almost 1.9 million homes (or roughly 2 percent of all U.S. homes) worth a combined $882 billion are at risk of being underwater by 2100 if sea levels rise by six feet. Some states will be hit harder than others.

State	Number of Potentially Underwater Properties	Fraction of Total Housing Stock Underwater	Total Value of Potentially Underwater Properties
California	42,353	0.44%	$49.2B
Texas	46,804	0.61%	$12B
New York	96,708	2.10%	$71B
Florida	934,411	12.56%	$413B
Pennsylvania	2,661	0.06%	$730M
Georgia	24,379	0.75%	$10.2B
North Carolina	57,259	1.64%	$20.6B
New Jersey	190,429	7.35%	$93.1B
Virginia	46,287	1.77%	$14.4B
Washington	31,235	1.32%	$13.7B
Massachusetts	62,069	3.10%	$51.2B
Maryland	64,299	3.09%	$19.6B
Alabama	12,735	0.77%	$3.8B
South Carolina	83,833	4.42%	$45B
Louisiana	80,080	5.88%	$13.2B
Oregon	4,959	0.37%	$1B
Connecticut	18,173	1.61%	$13.2B
Mississippi	5,572	0.72%	$1B
Hawaii	37,556	9.07%	$25.3B
Maine	5,412	0.98%	$3.1B
New Hampshire	4,064	0.71%	$1.7B
Rhode Island	4,853	1.47%	$2.9B
Delaware	11,670	3.09%	$3.6B

Source: National Oceanic and Atmospheric Administration (NOAA); Zillow data

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Joe Romm Follow
Dr. Joe Romm is Founding Editor of Climate Progress, "the indispensable blog," as NY Times co...

4 days ago · 6 min read

The U.S. is about to lose a trillion dollars in coastal property values

Trump isn't helping.

Florida Coastal flooding. Credit: Florida Sea Grant, Dorothy Zimmerman/Flickr

Mitigation and Adaptation Studies

Mitigation and Adaptation Studies

Class 15: Foresight: Understanding Uncertainty

Contents

- Uncertainty
- Foreseeability
- Decision Making and Foreseeability

Uncertainty

Uncertainty

“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**.”

Nature Clim. Change, Editorial, 2013

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including knowledge gaps

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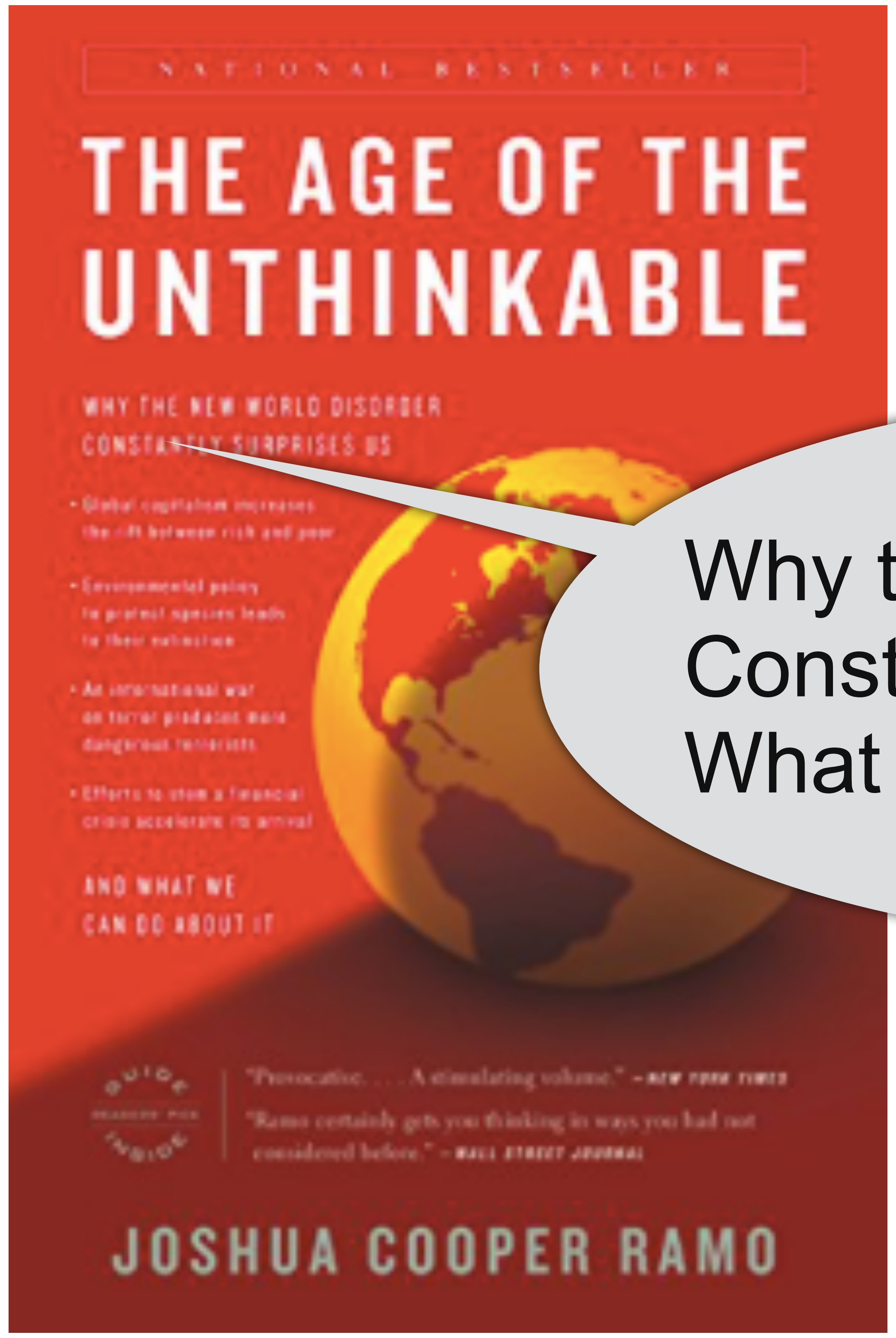
Complex systems:
Aiming at understanding what the system might do, instead of trying to predict what it will do …



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

Uncertainty

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

SUPPORT STAFF:
Liz Wiig, Beau Driver, Mark Ferrara

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

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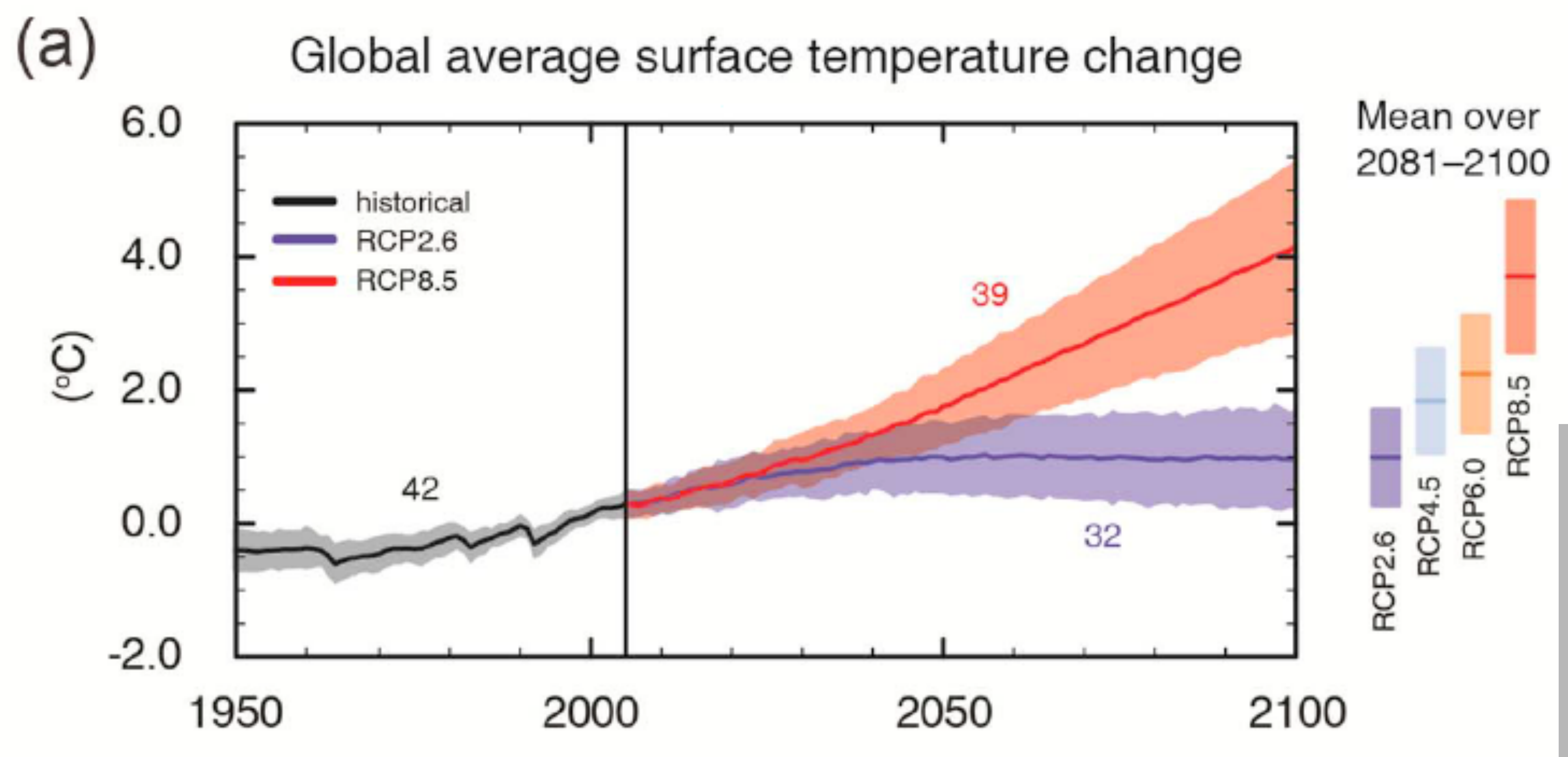
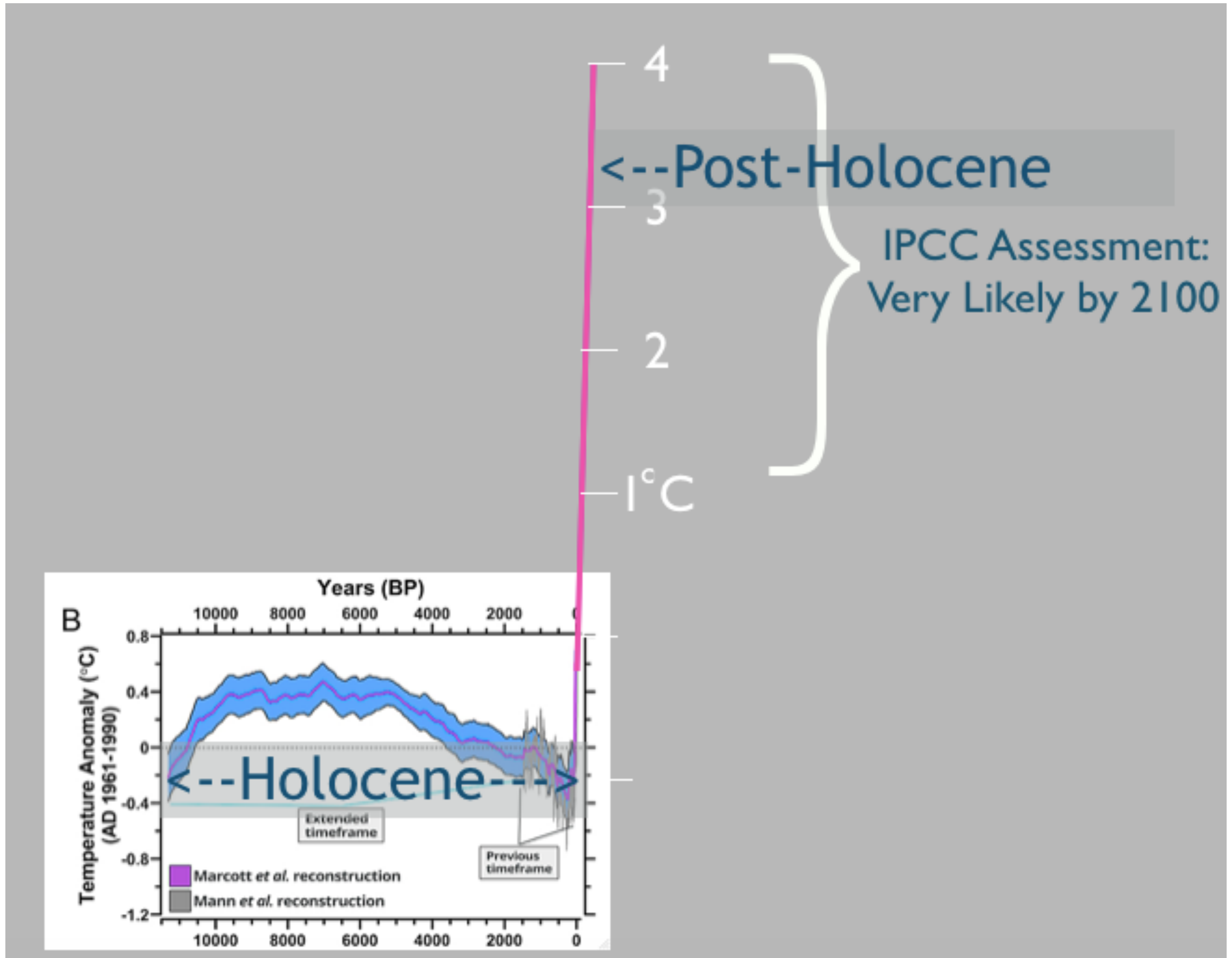
source: www.forbes.com

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

Uncertainty

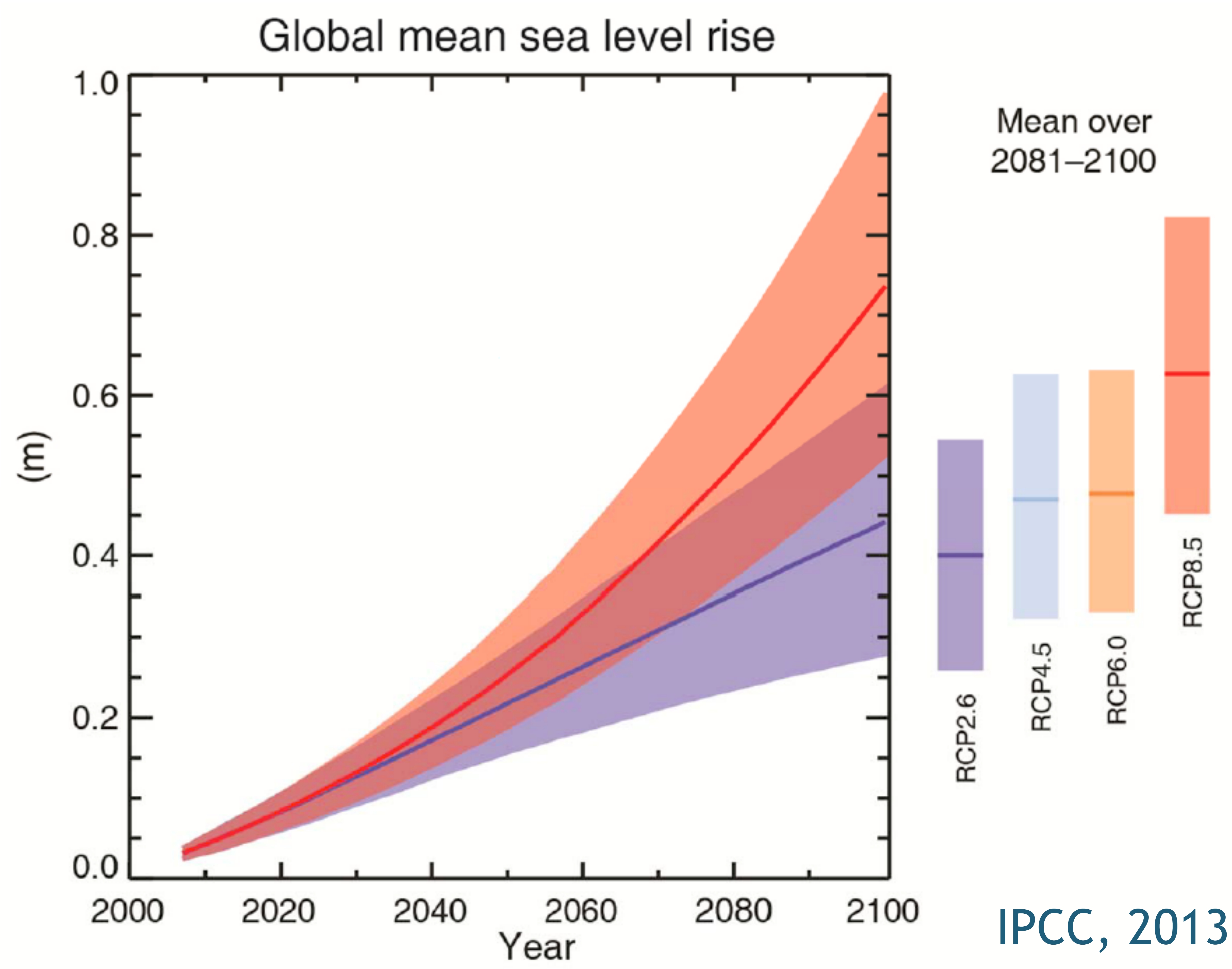


IPCC, 2013

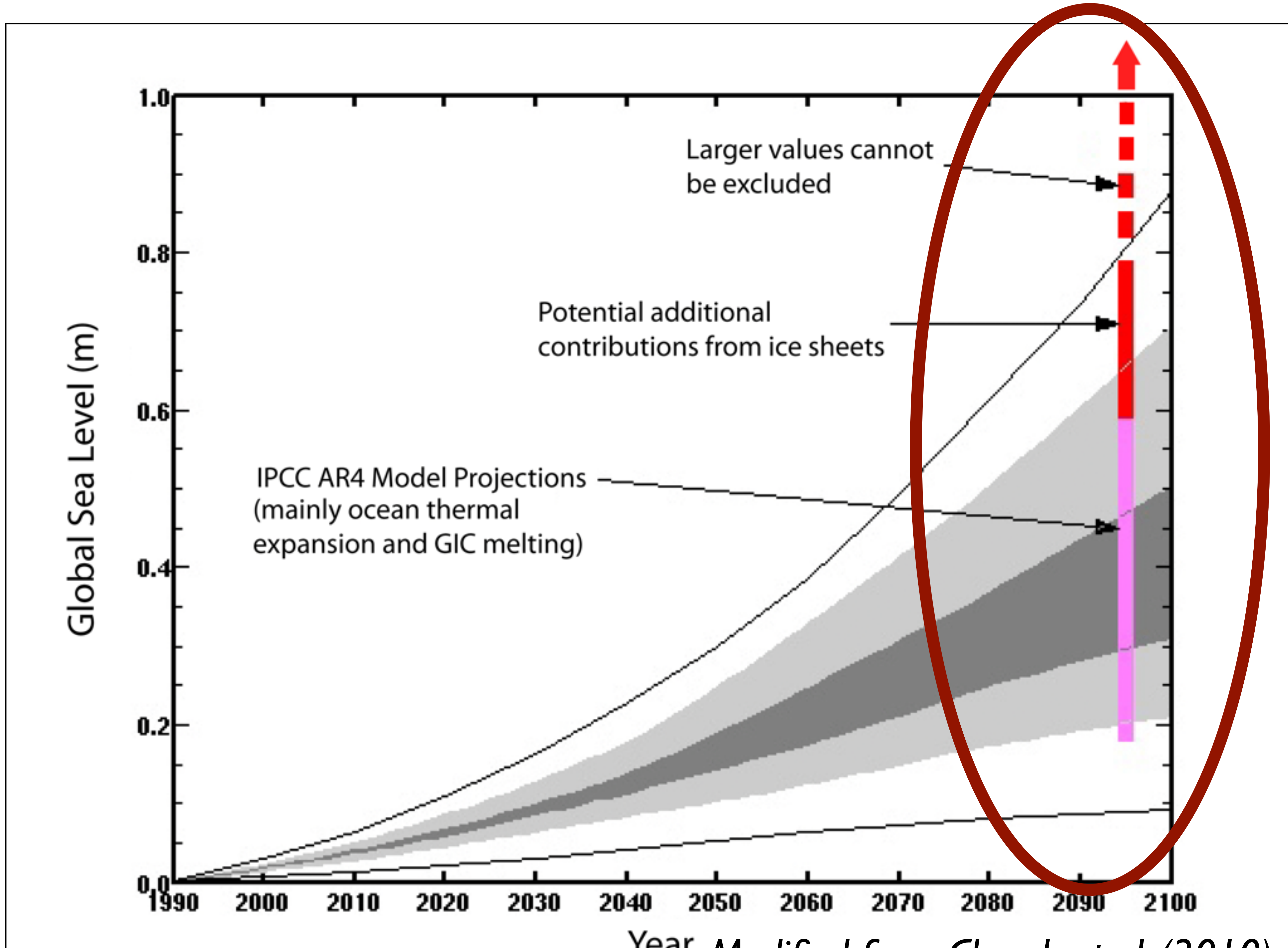


Marcott et al., 2013

Uncertainty

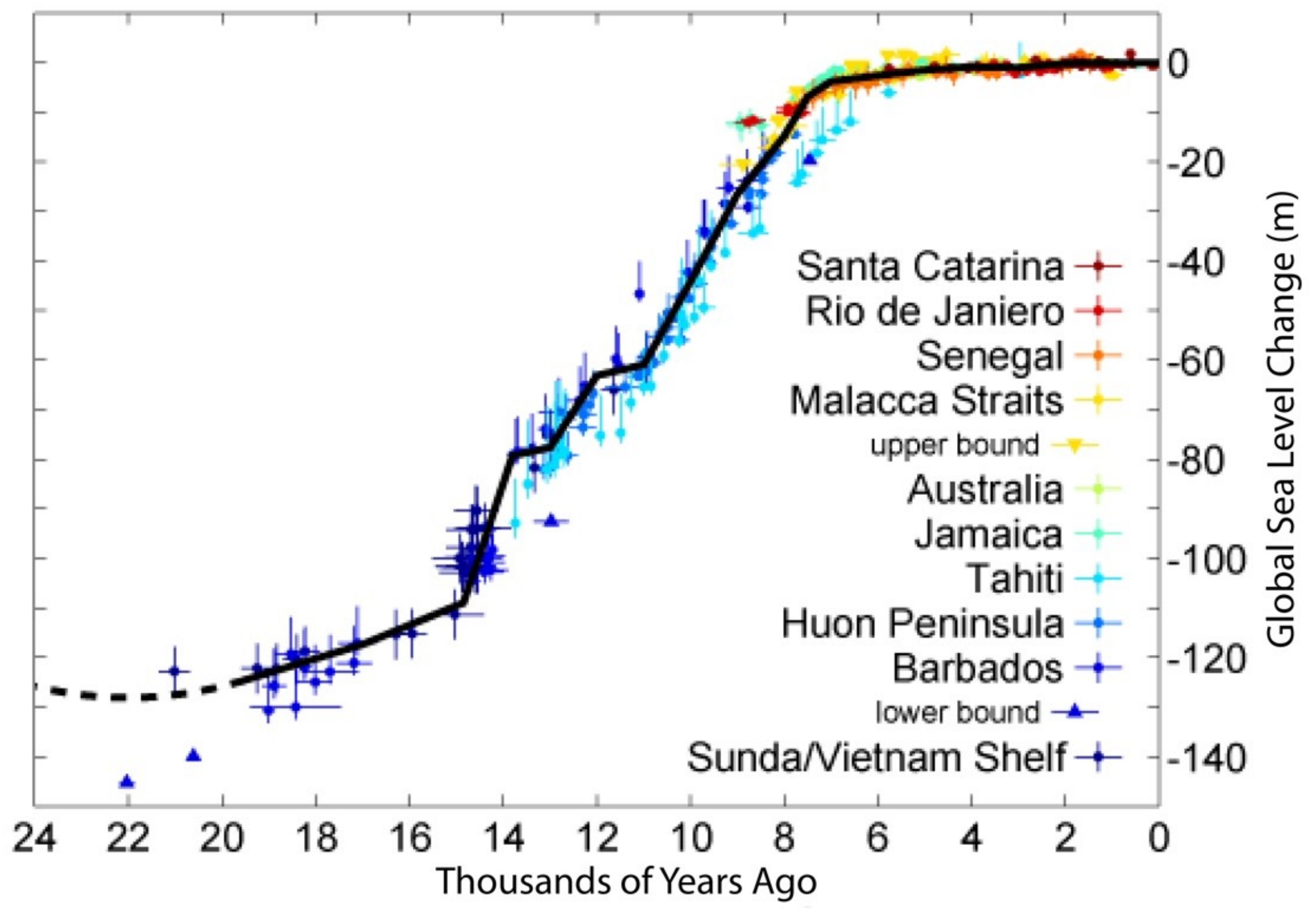


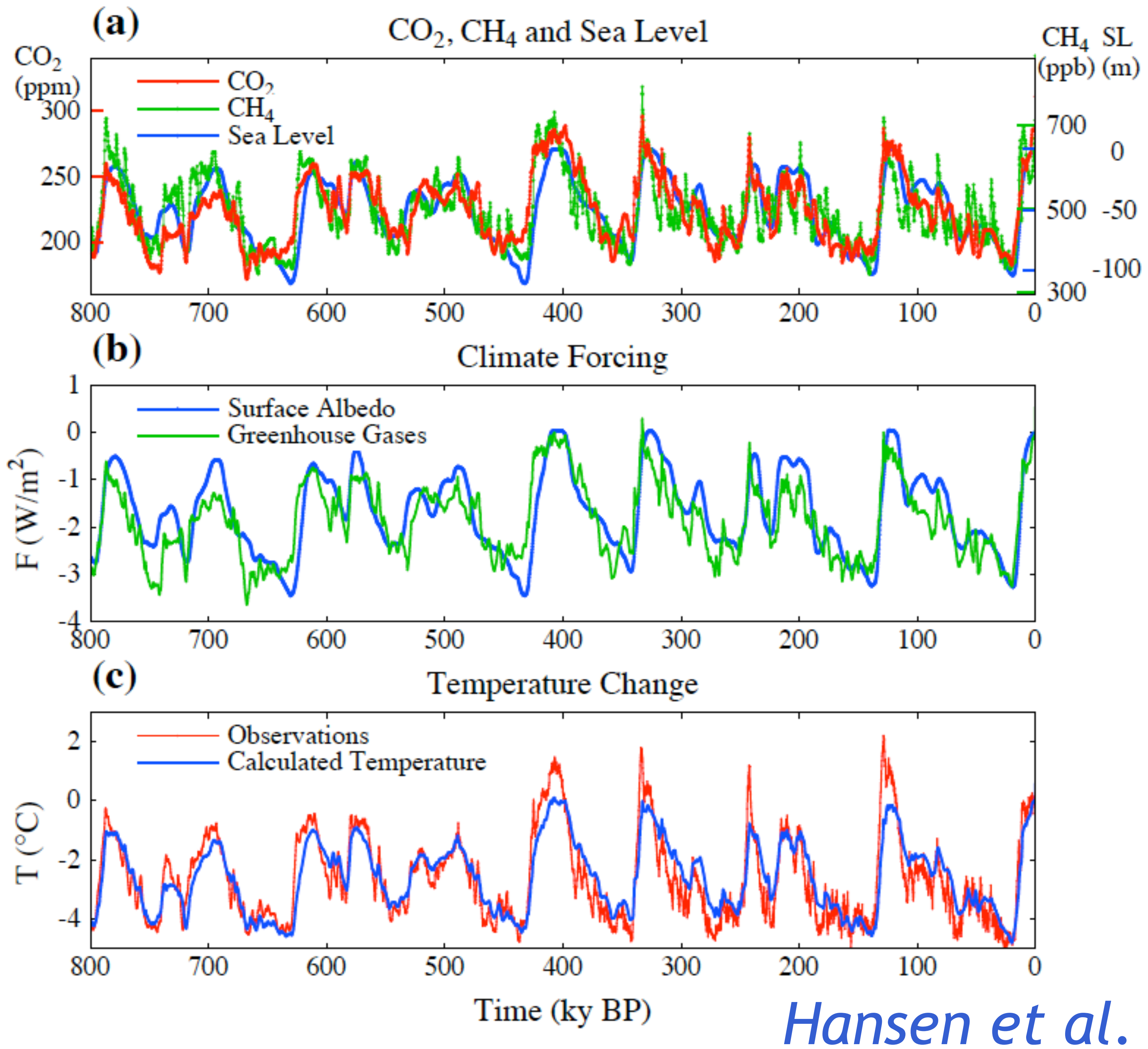
IPCC, 2013



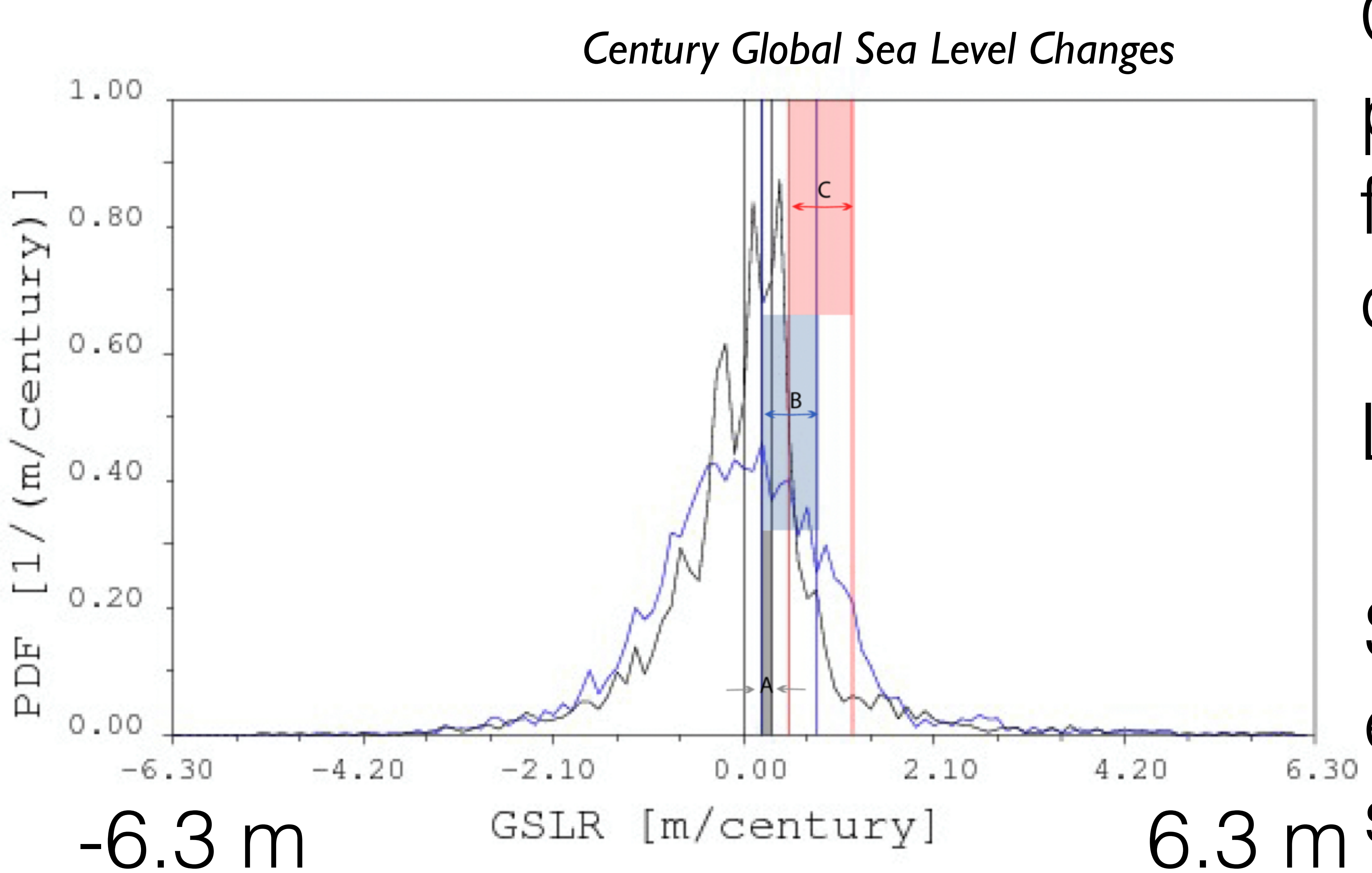
Modified from Church et al. (2010)

Sea Level Change

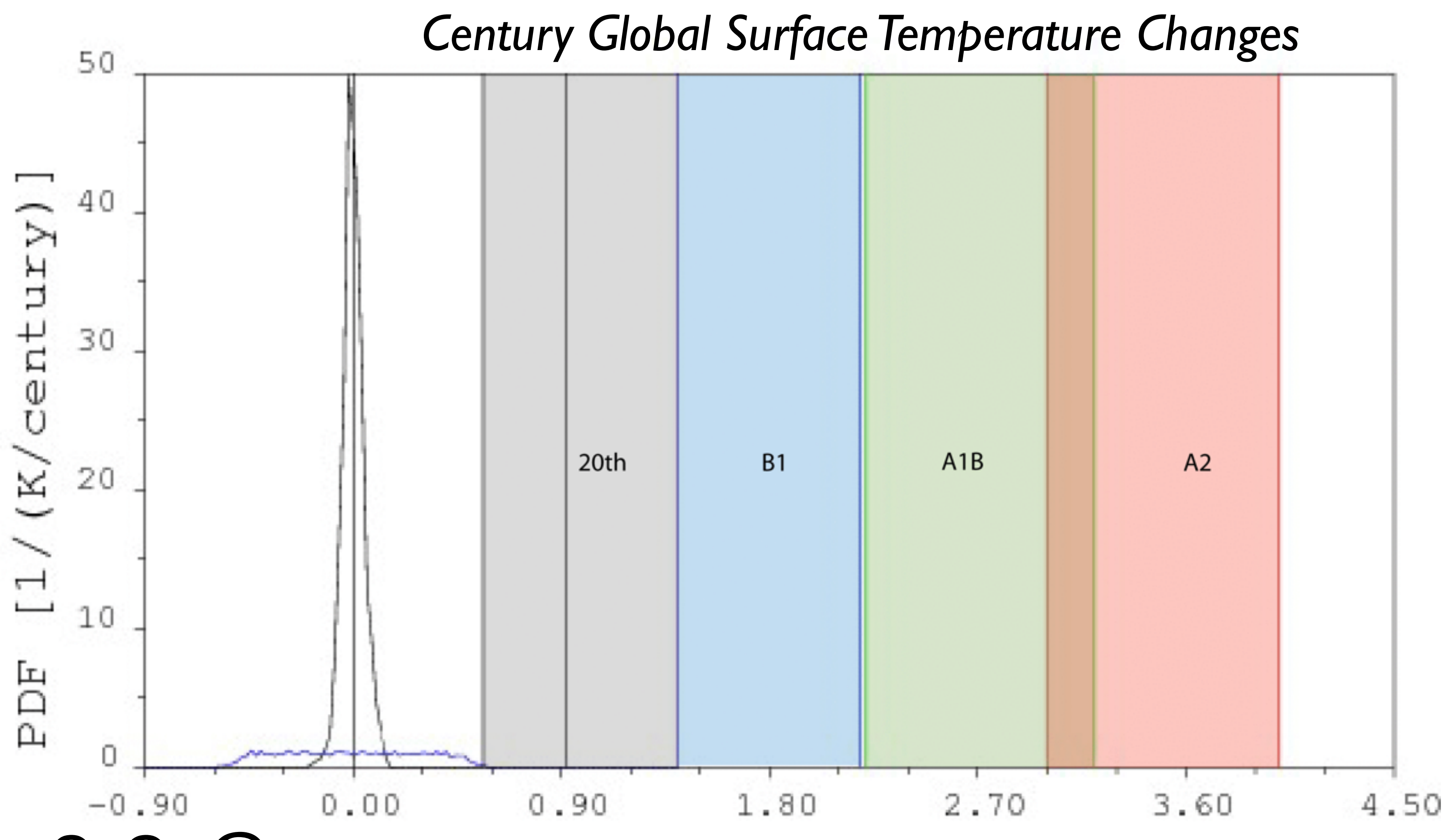




Hansen et al. (2008)



-6.3 m 6.3 m



-0.9^{o}C 4.5^{o}C

Plag and Jules-Plag (2013)

Question: What is the probability density function for sea level change per century?

Look at paleo-data …

Scientifically, we cannot exclude a large, rapid global sea level rise with large spatial variability in local sea level rise.

Foreseeability

Source: www.uowblogs.com

Foreseeability

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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.

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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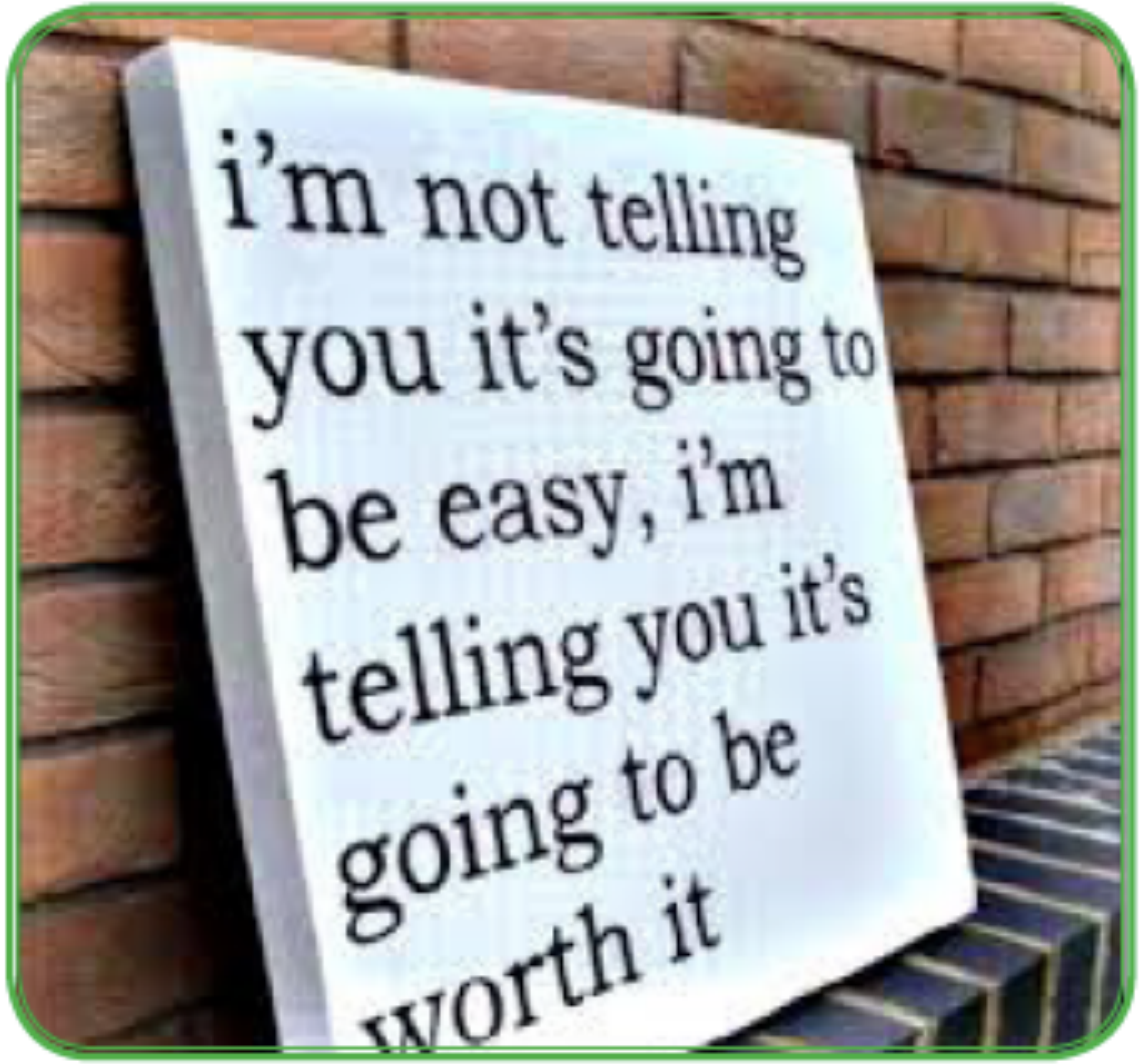

Foreseeability

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.