Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

Case Study Input

Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

Invasive Species of the Chesapeake Bay

Mostly caused by human interaction by ships, pets, and gardening etc..

Affect current wildlife by competing with resources

Economic Problems

Vulnerabilities

Conditions of the bay/ecosystem

- Temperature, Ph, salinity, etc…
- Wide range of areas to inhabit

Biodiversity of the bay

- How organisms react with one another
- Organism’s specific life cycle

Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

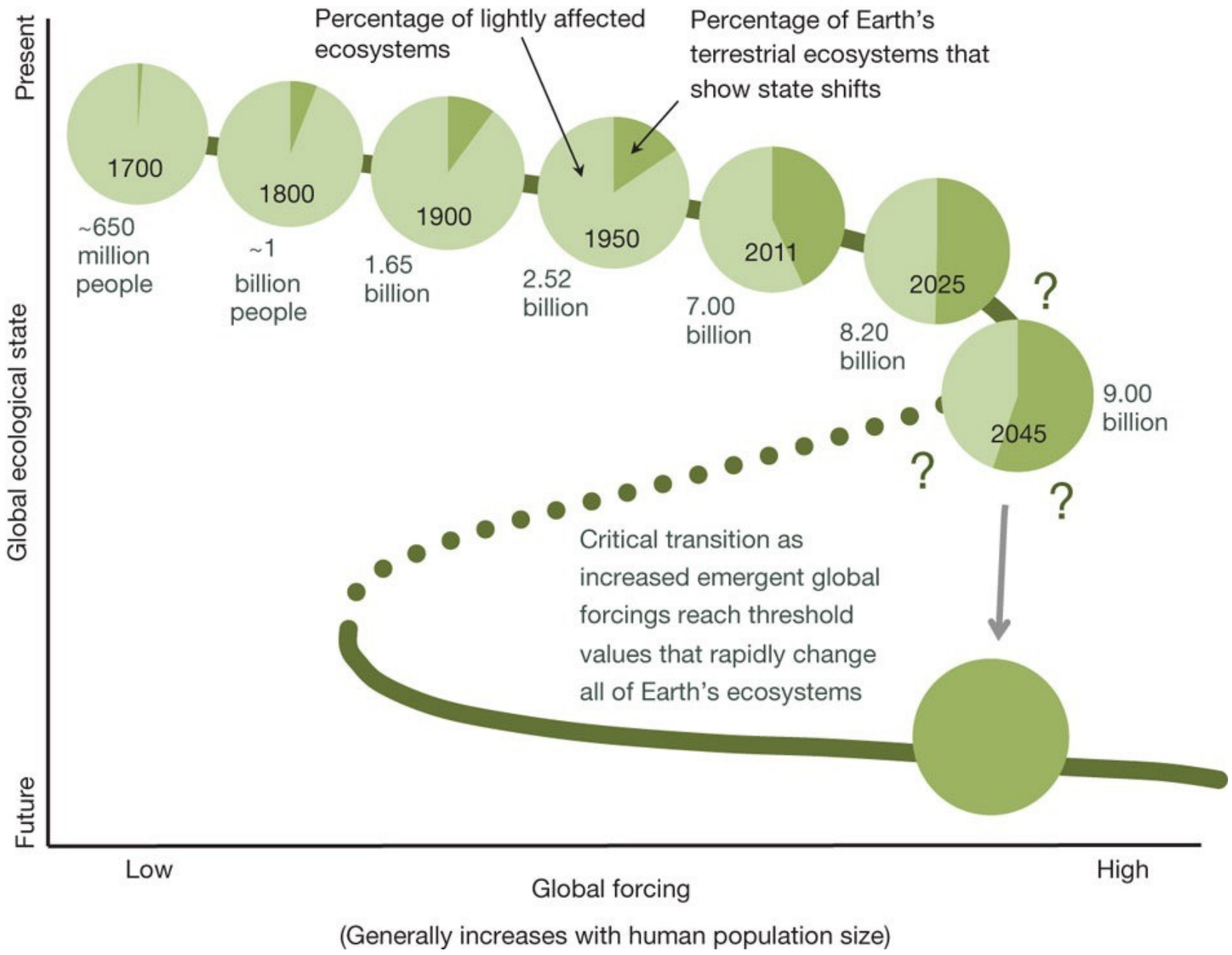
Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

Land Cover Changes

Barnosky et al., 2012, Nature, 486.

Land Cover Changes



Barnosky et al., 2012, Nature, 486.

Land Cover Changes

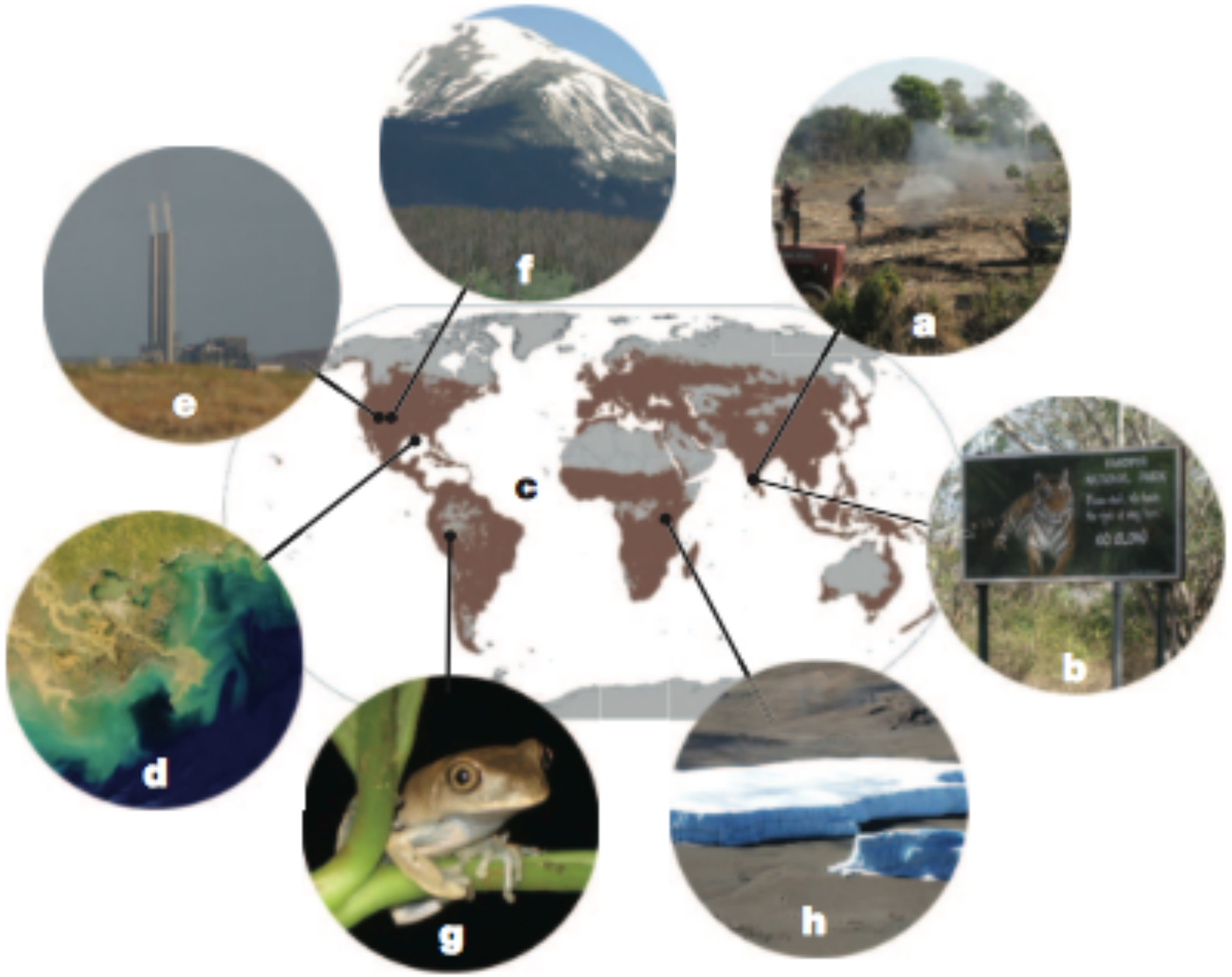
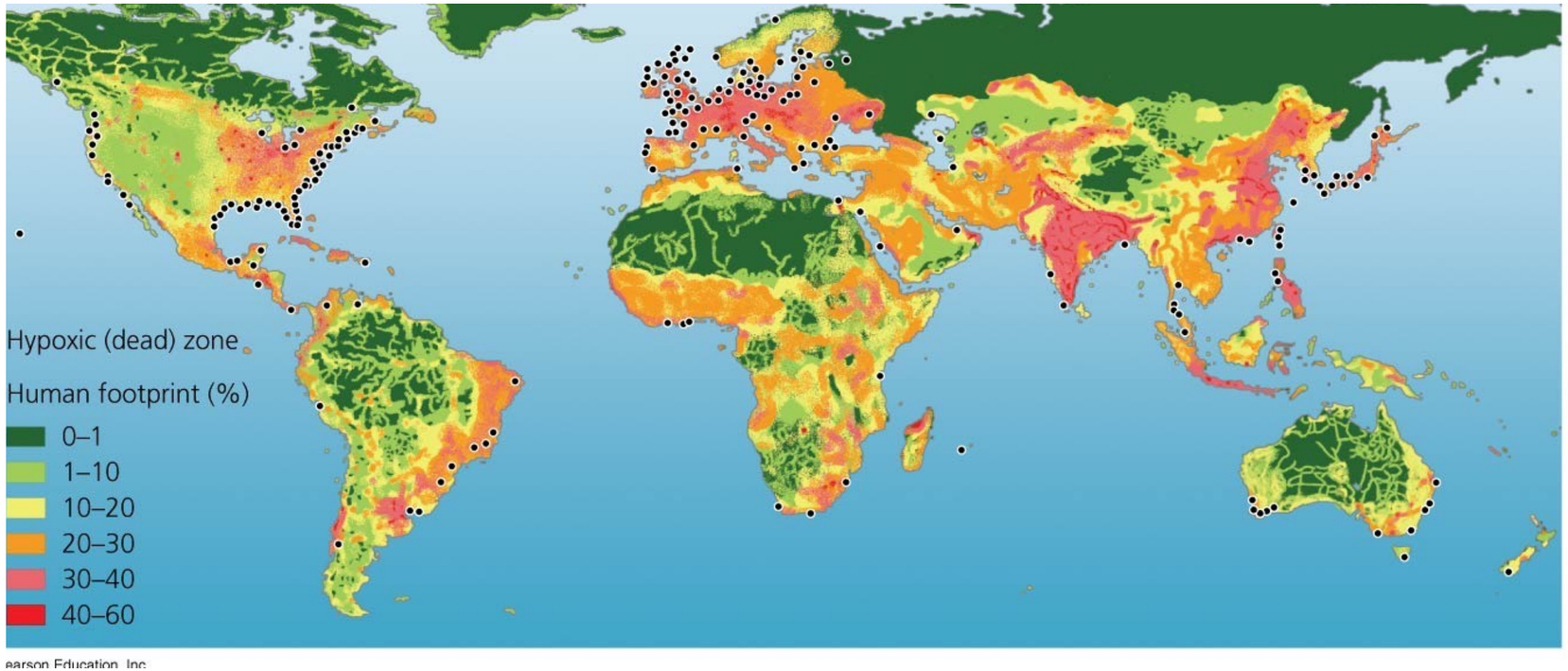


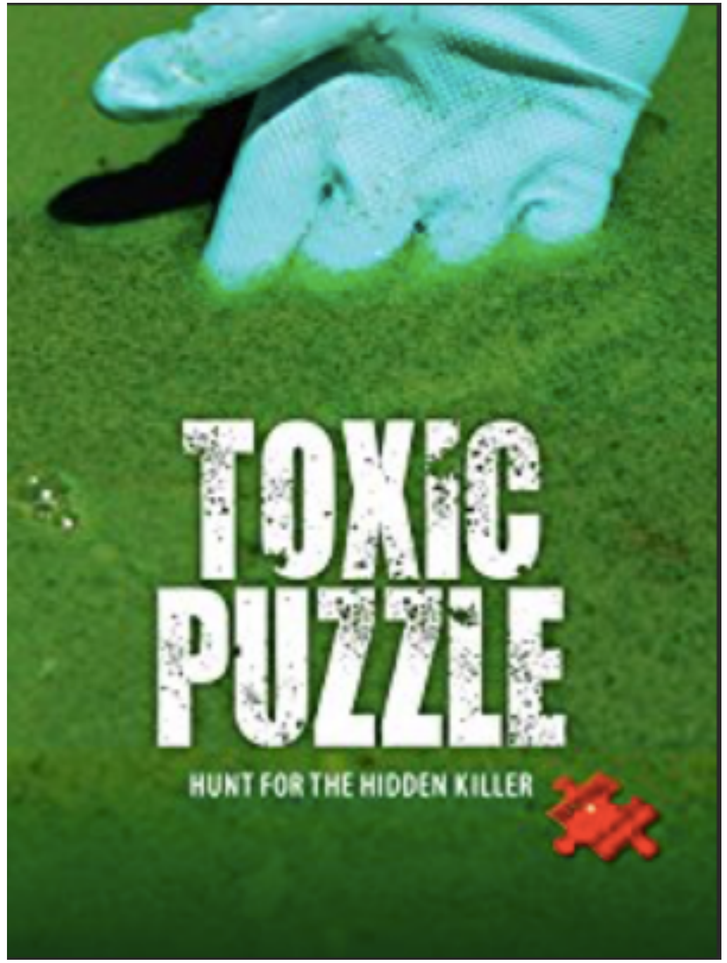
Figure 1 | Drivers of a potential planetary-scale critical transition. **a**, Humans locally transform and fragment landscapes. **b**, Adjacent areas still harbouring natural landscapes undergo indirect changes. **c**, Anthropogenic local state shifts accumulate to transform a high percentage of Earth's 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.

Land Use Changes

Toxic products …





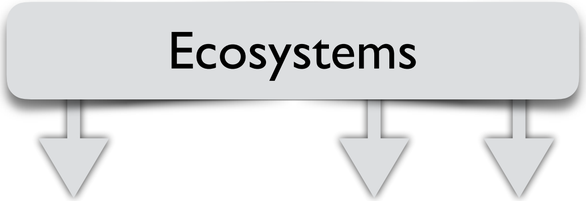
… about toxic substances produced by cyanobacteria …

Land Cover Changes

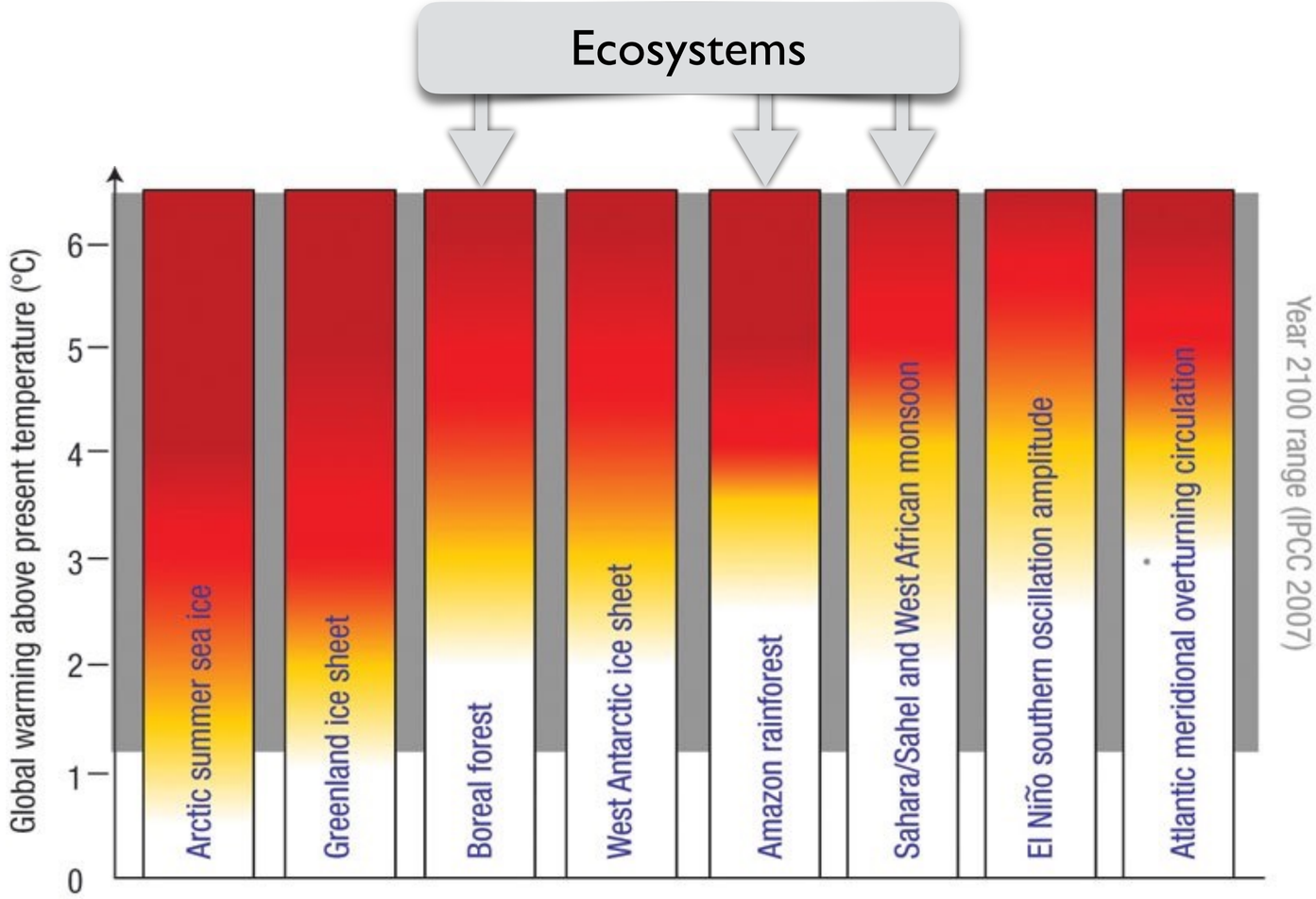
Segmentation/Fragmentation

Land Cover Changes

Cascading land cover changes



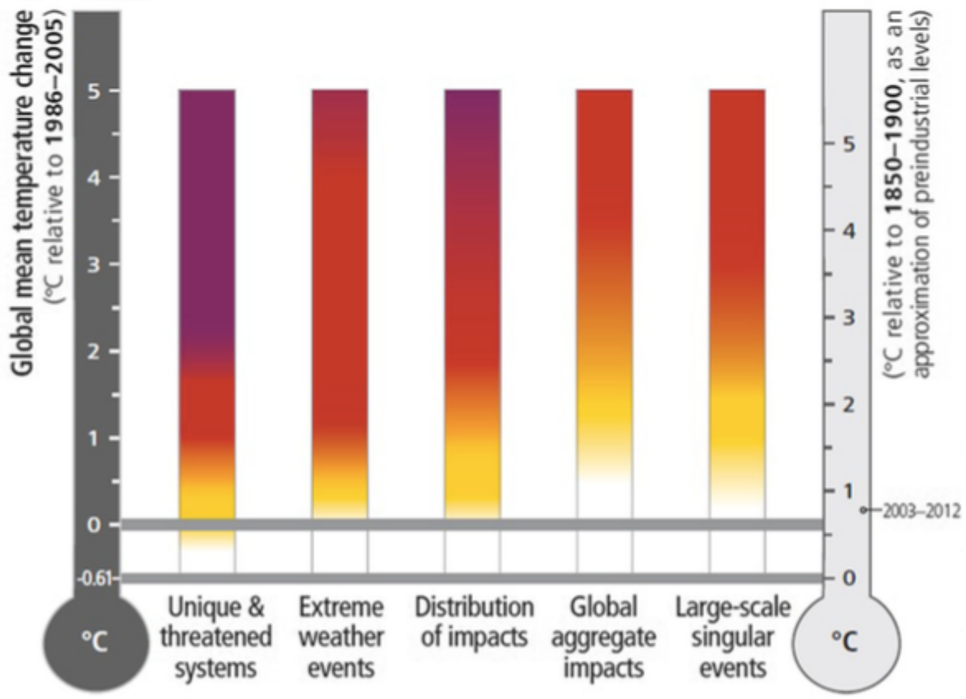
Cascading land cover changes

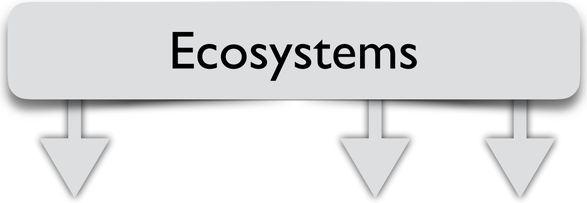


Lenton & Schellnhuber (2007) *Nature Reports Climate Change*

Land Cover Changes

Cascading land cover changes





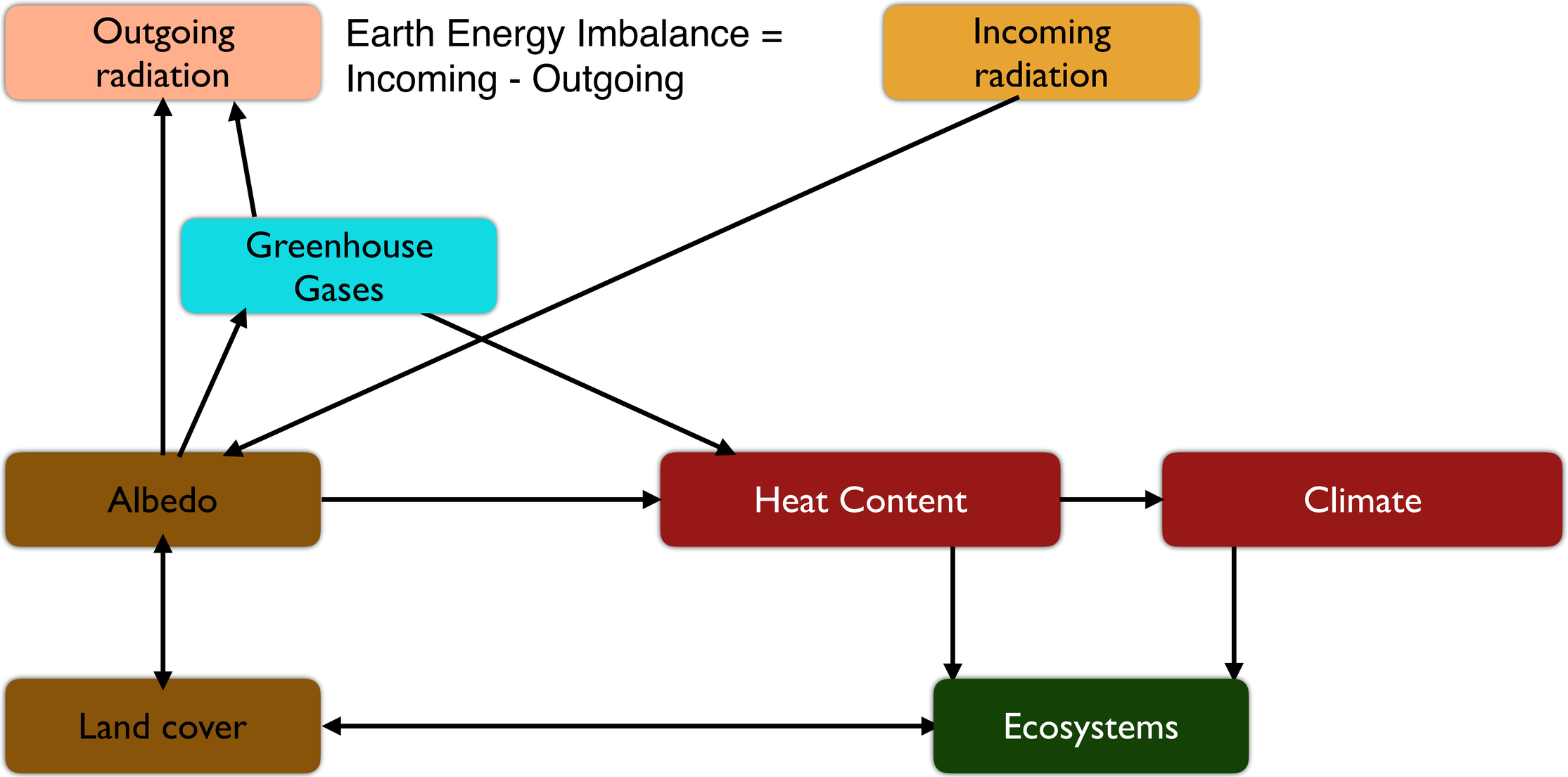
Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

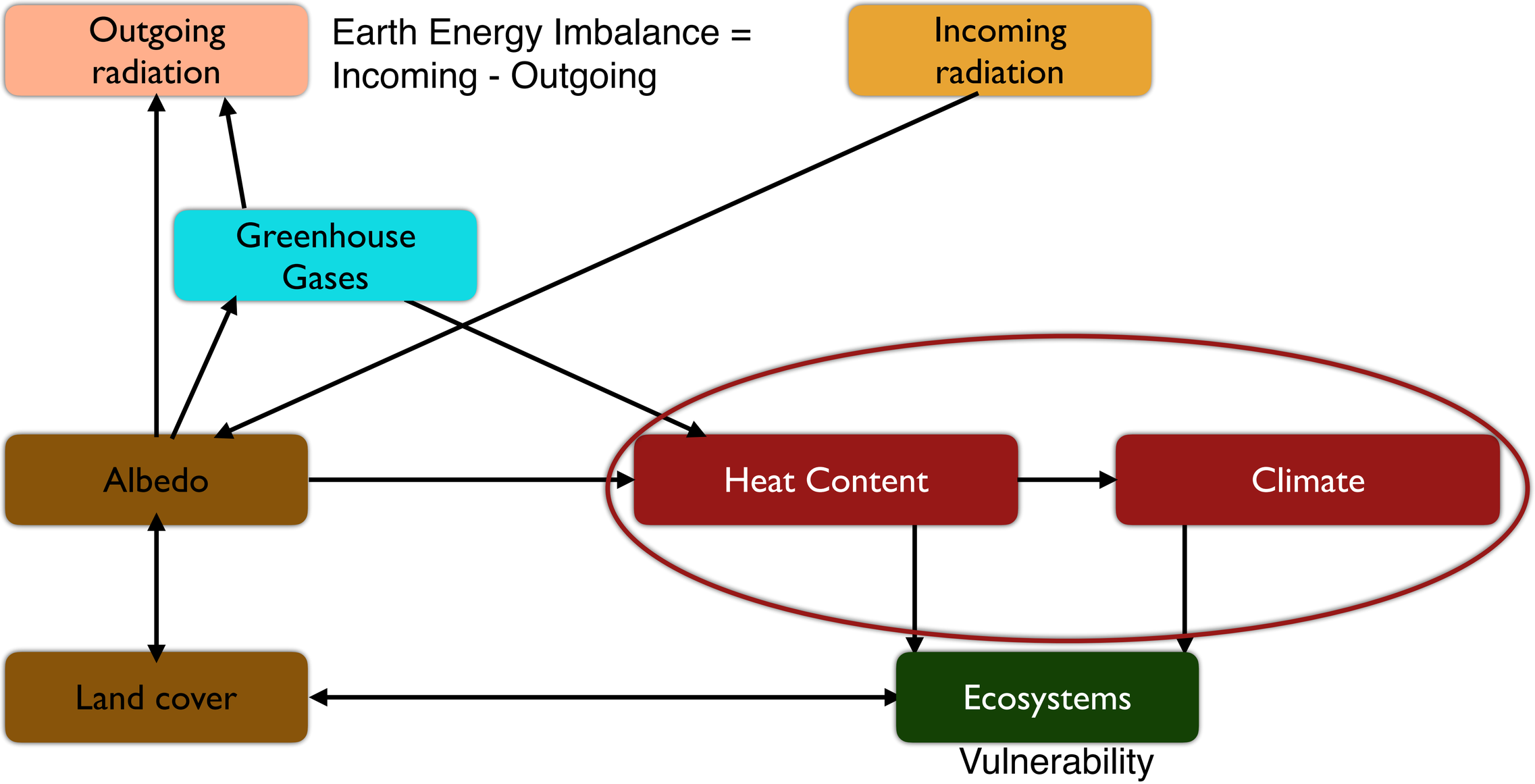
Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

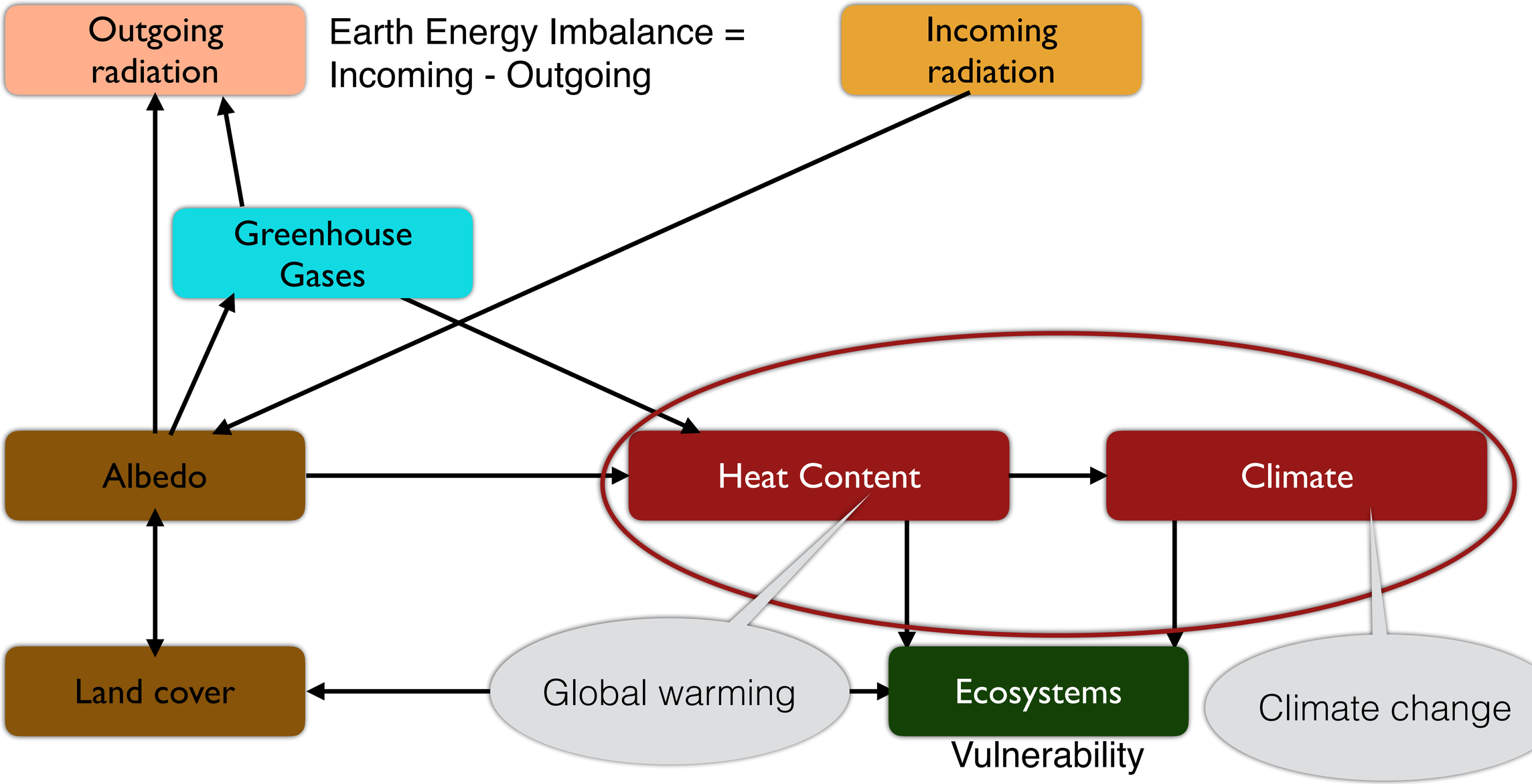
Global Warming: Earth Energy Imbalance



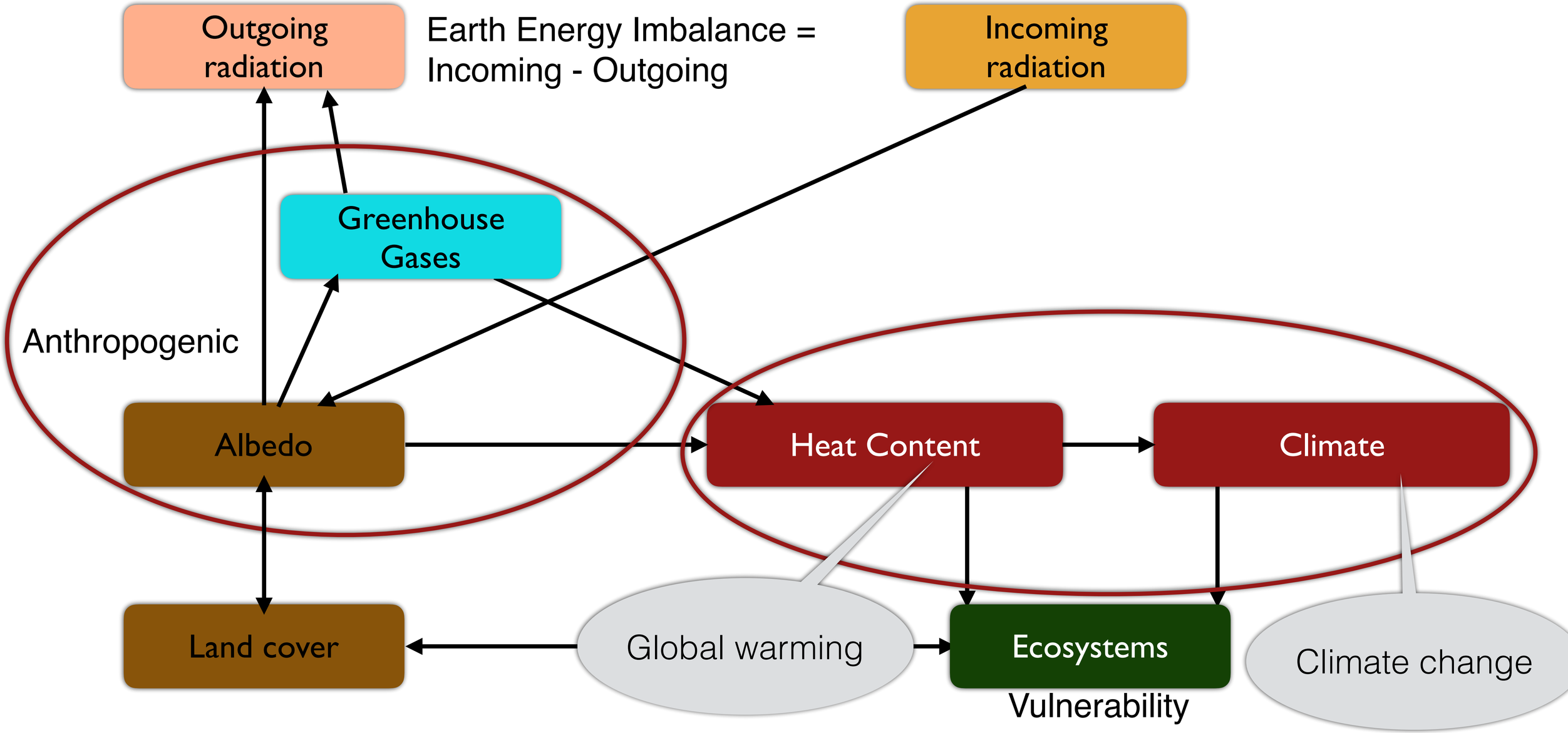
Global Warming: Earth Energy Imbalance



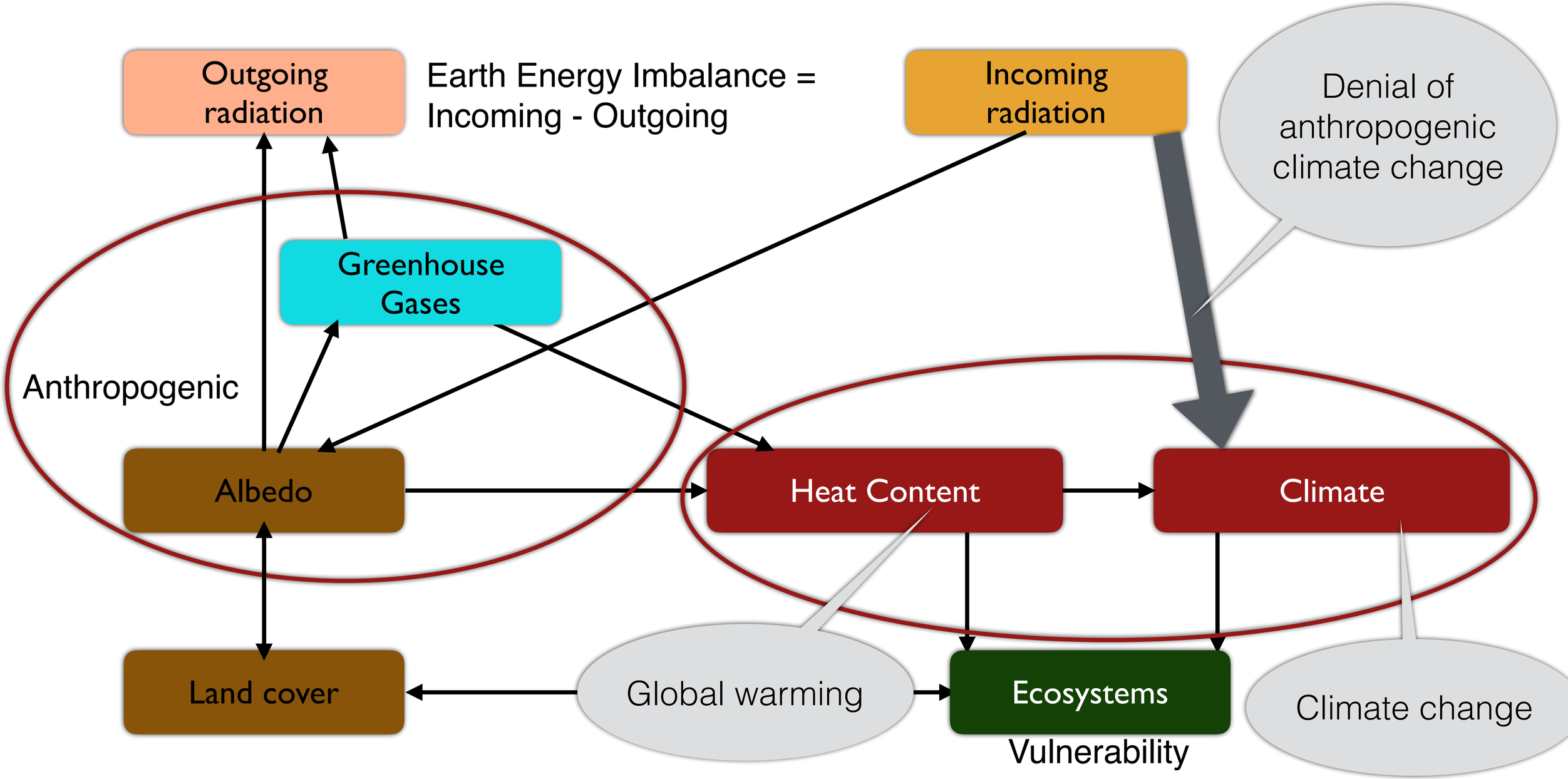
Global Warming: Earth Energy Imbalance



Global Warming: Earth Energy Imbalance



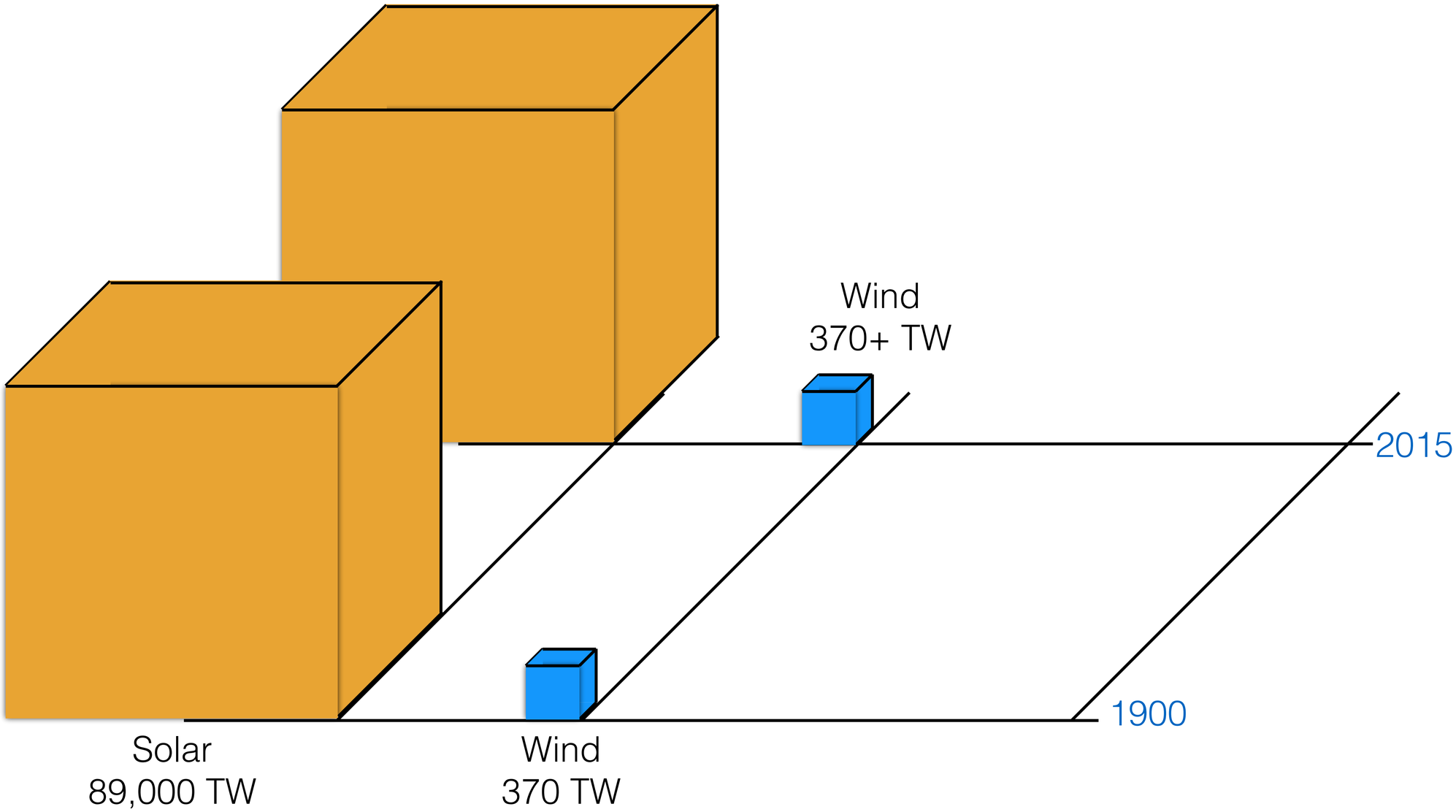
Global Warming: Earth Energy Imbalance



Earth Energy Imbalance

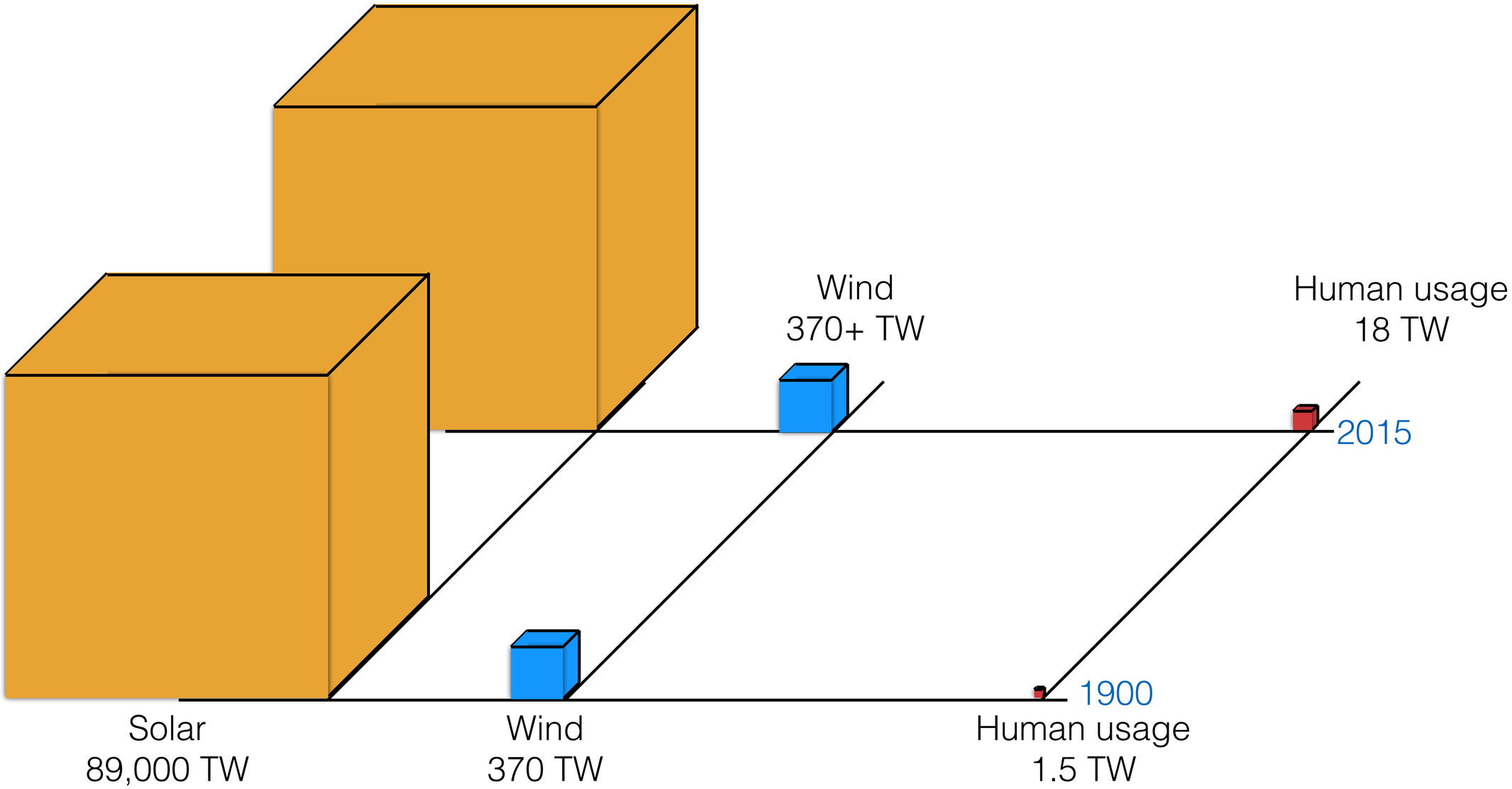
Plag, 2016, unpublished

Earth Energy Imbalance



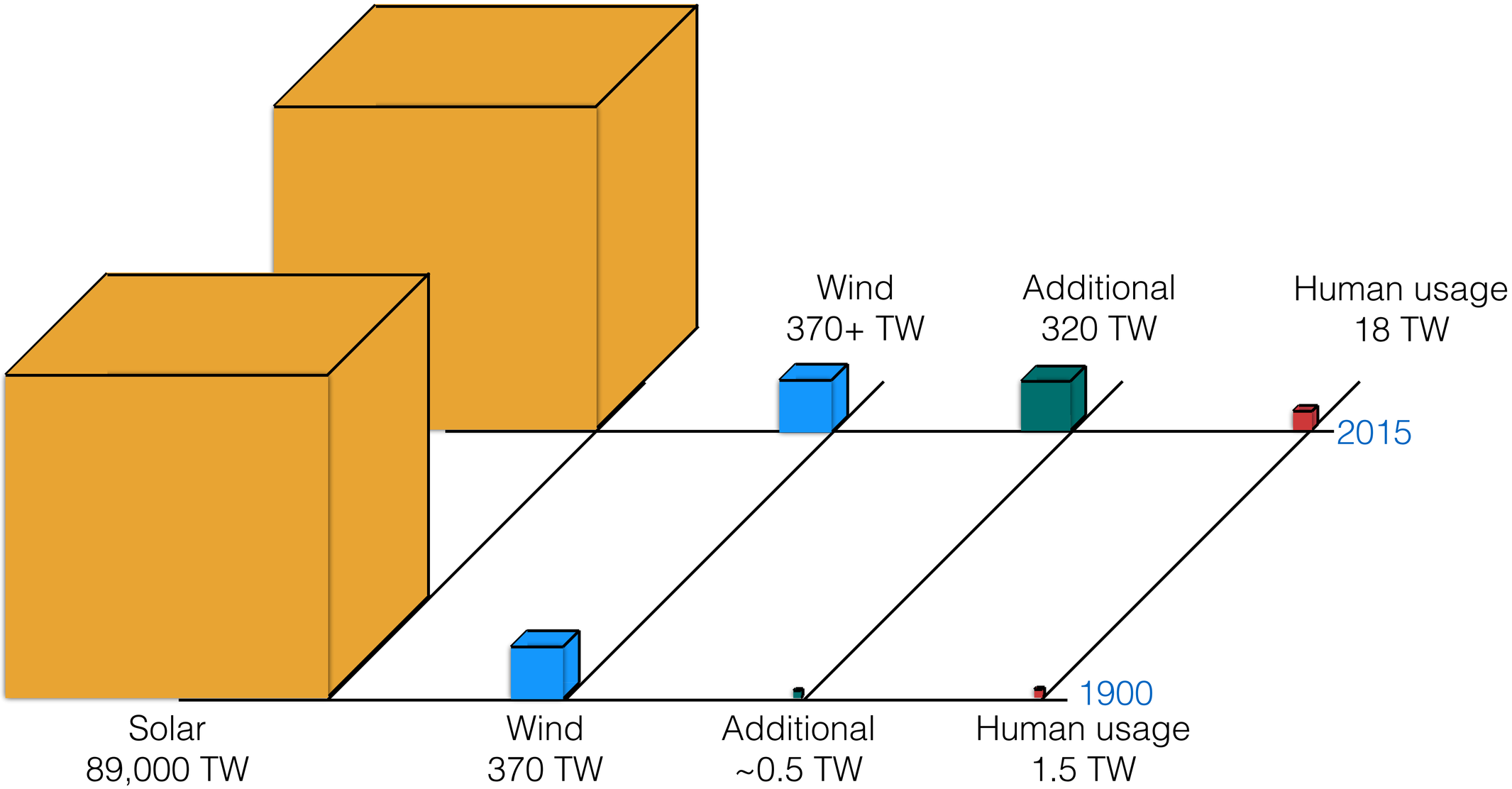
Plag, 2016, unpublished

Earth Energy Imbalance



Plag, 2016, unpublished

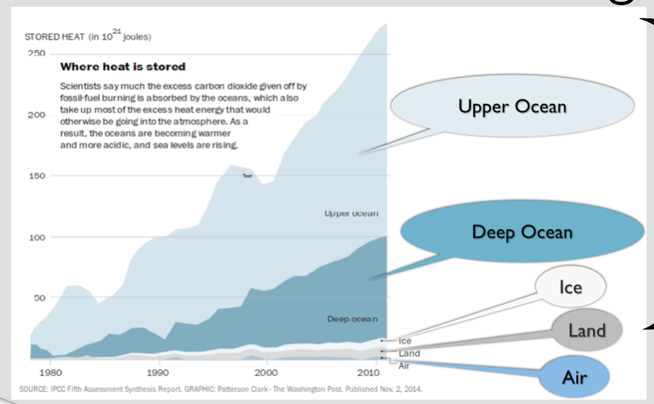
Earth Energy Imbalance



Plag, 2016, unpublished

Earth Energy Imbalance

Additional heat storage:



93% in the ocean

Wind
370+ TW

Additional
320 TW

Human usage
18 TW

2015

1900

Solar
89,000 TW

Wind
370 TW

Additional
~0.5 TW

Human usage
1.5 TW

Plag, 2016, unpublished

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

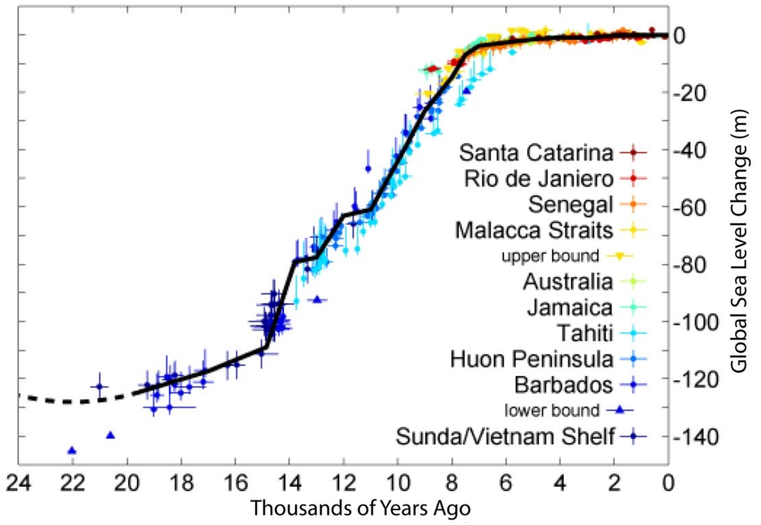
Mitigation and Adaptation Studies

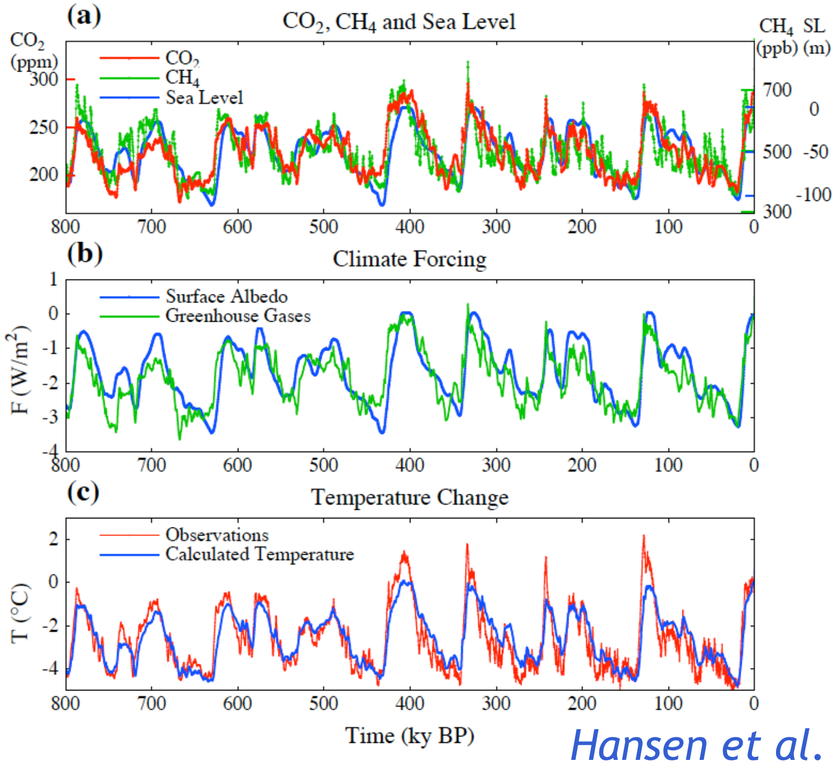
Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

Contents

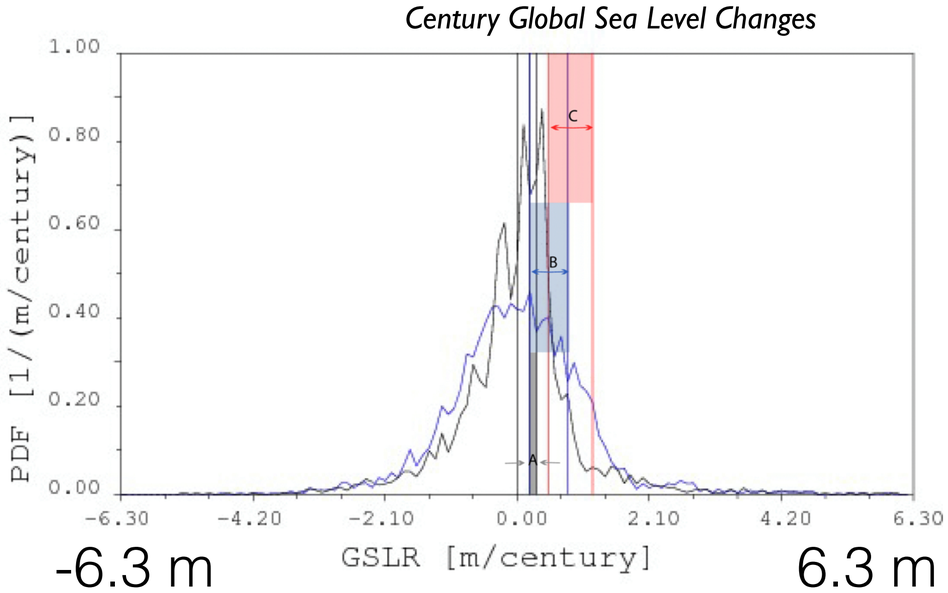
- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

Sea Level Changes

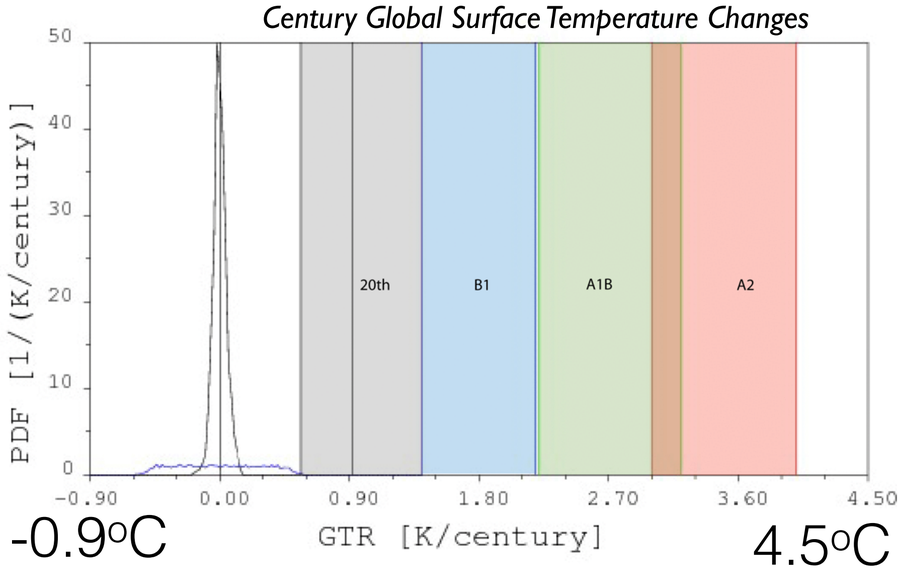




Hansen et al. (2008)



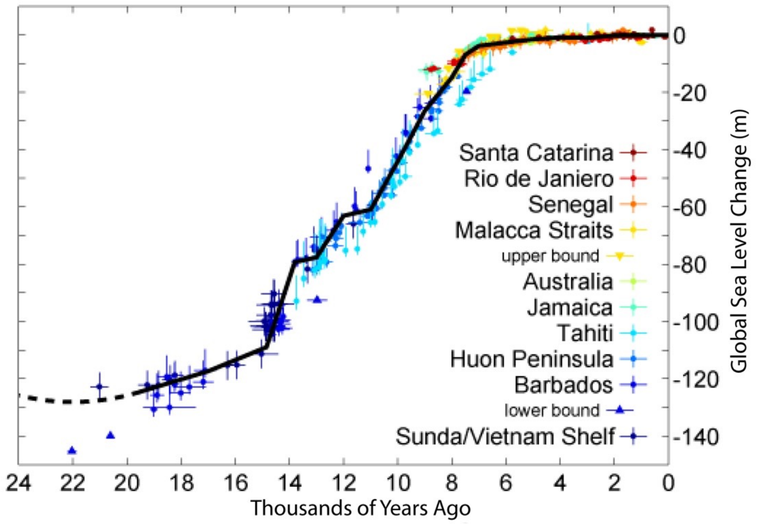
-6.3 m 6.3 m

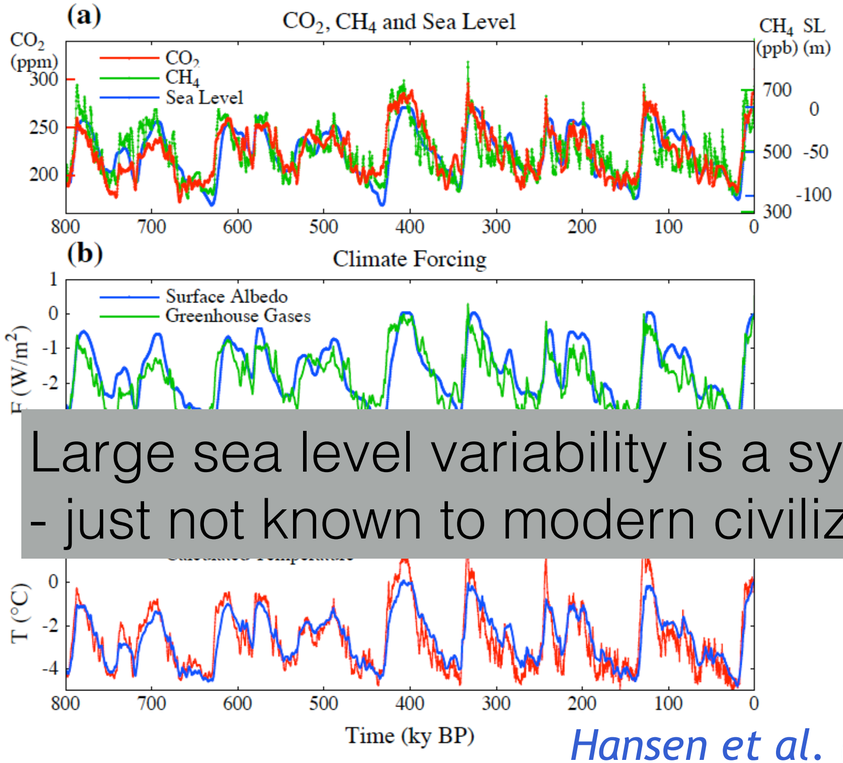


-0.9°C 4.5°C

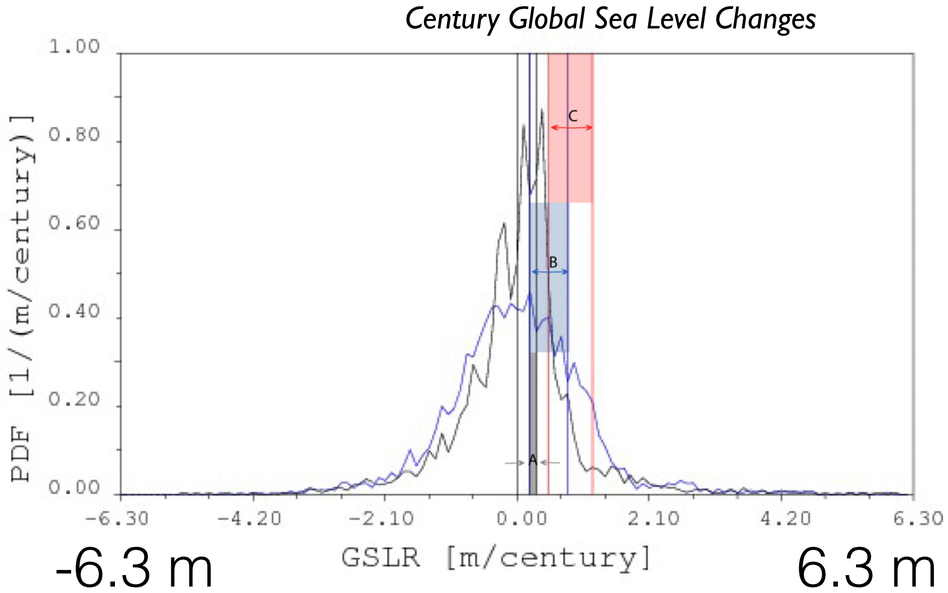
Plag and Jules-Plag (2013)

Sea Level Changes

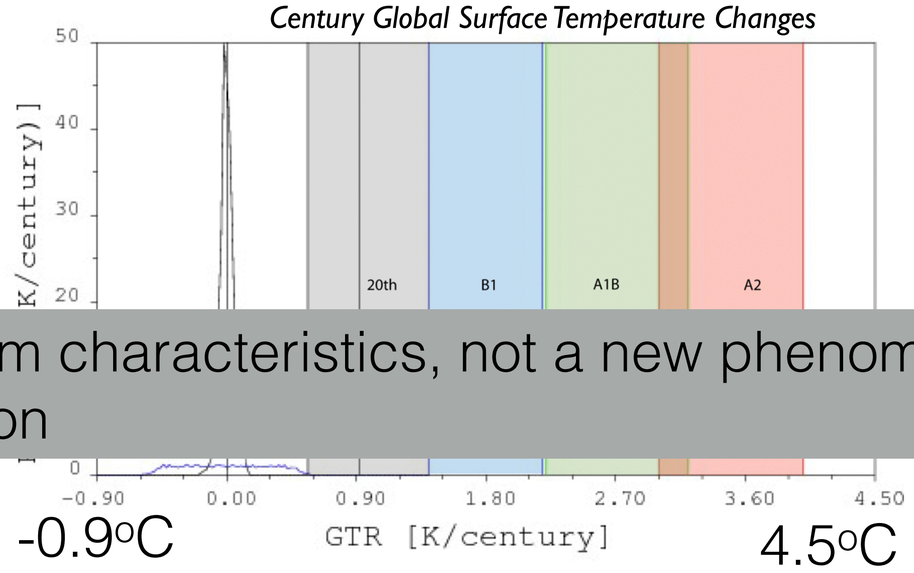




Hansen et al. (2008)



-6.3 m 6.3 m

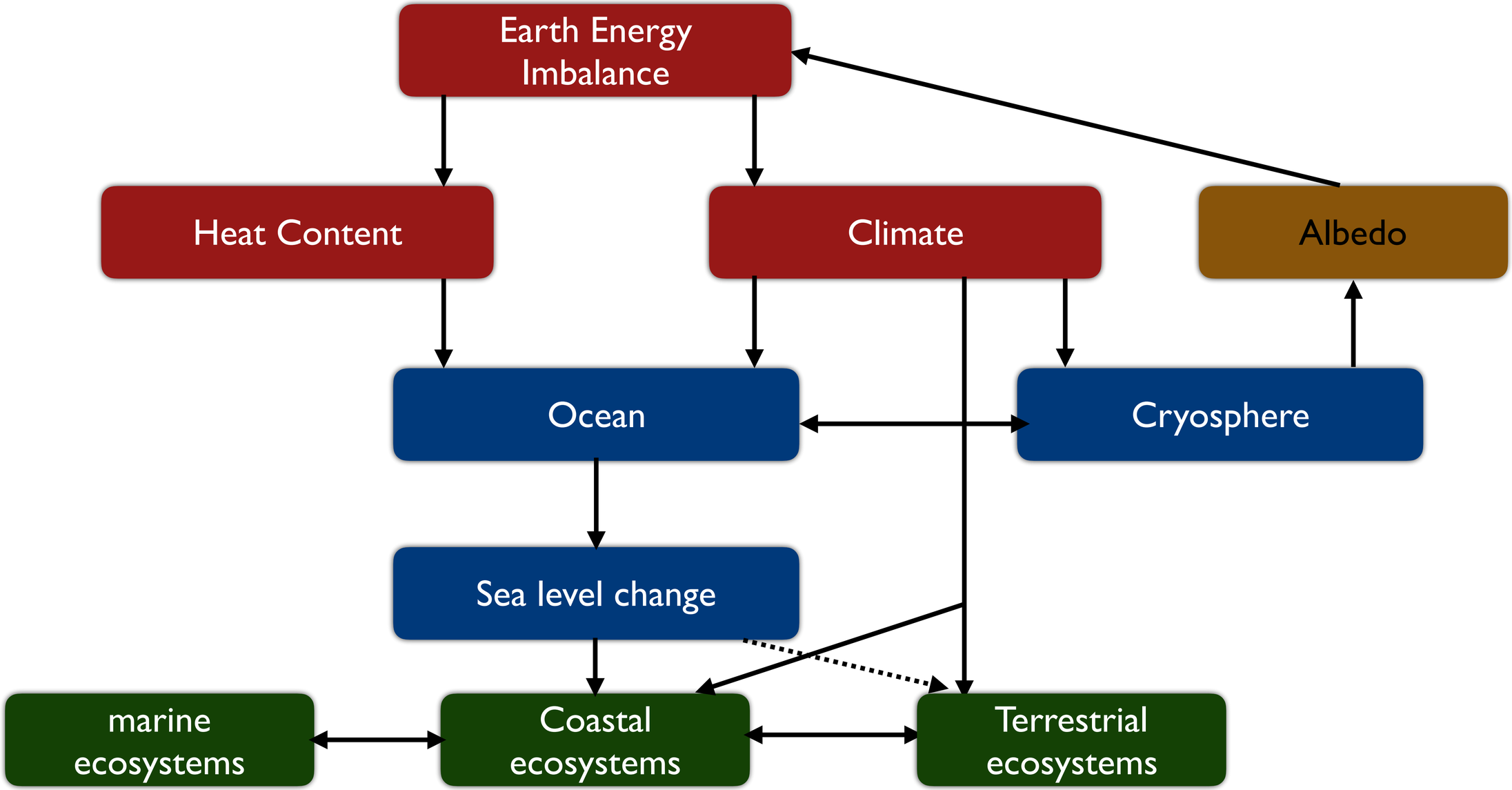


-0.9°C 4.5°C

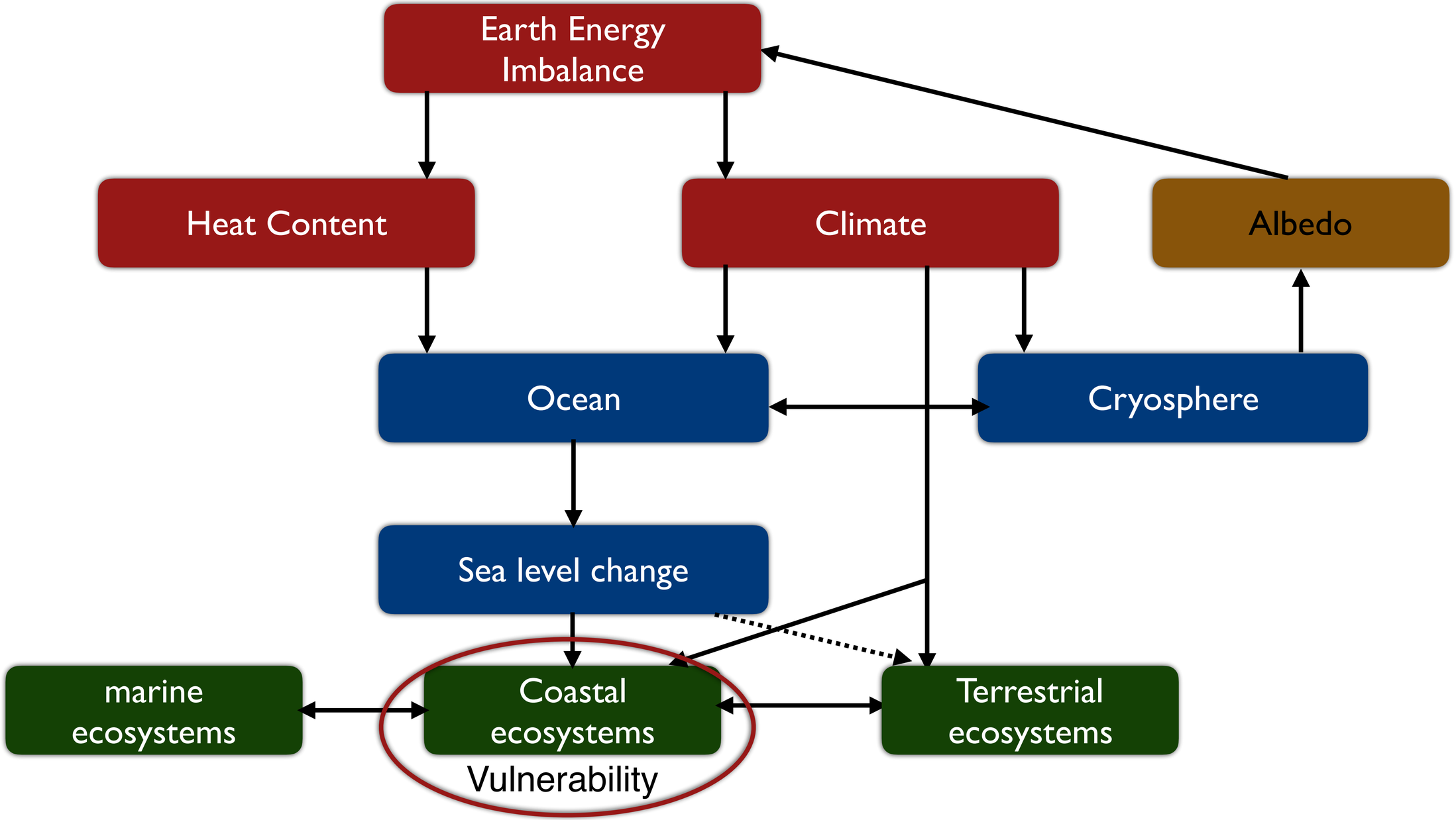
Plag and Jules-Plag (2013)

Large sea level variability is a system characteristics, not a new phenomenon, not a problem - just not known to modern civilization

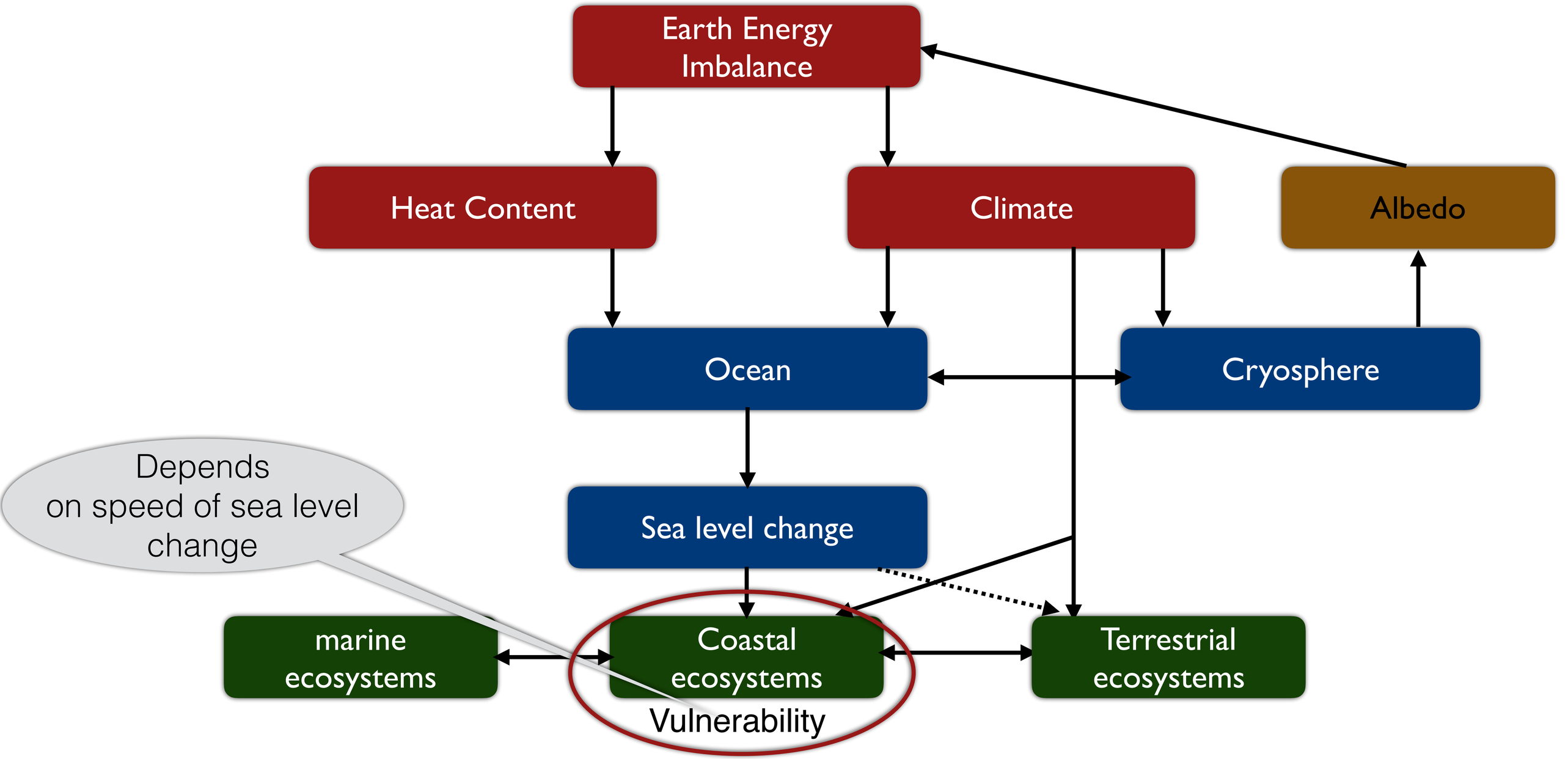
Sea Level Changes



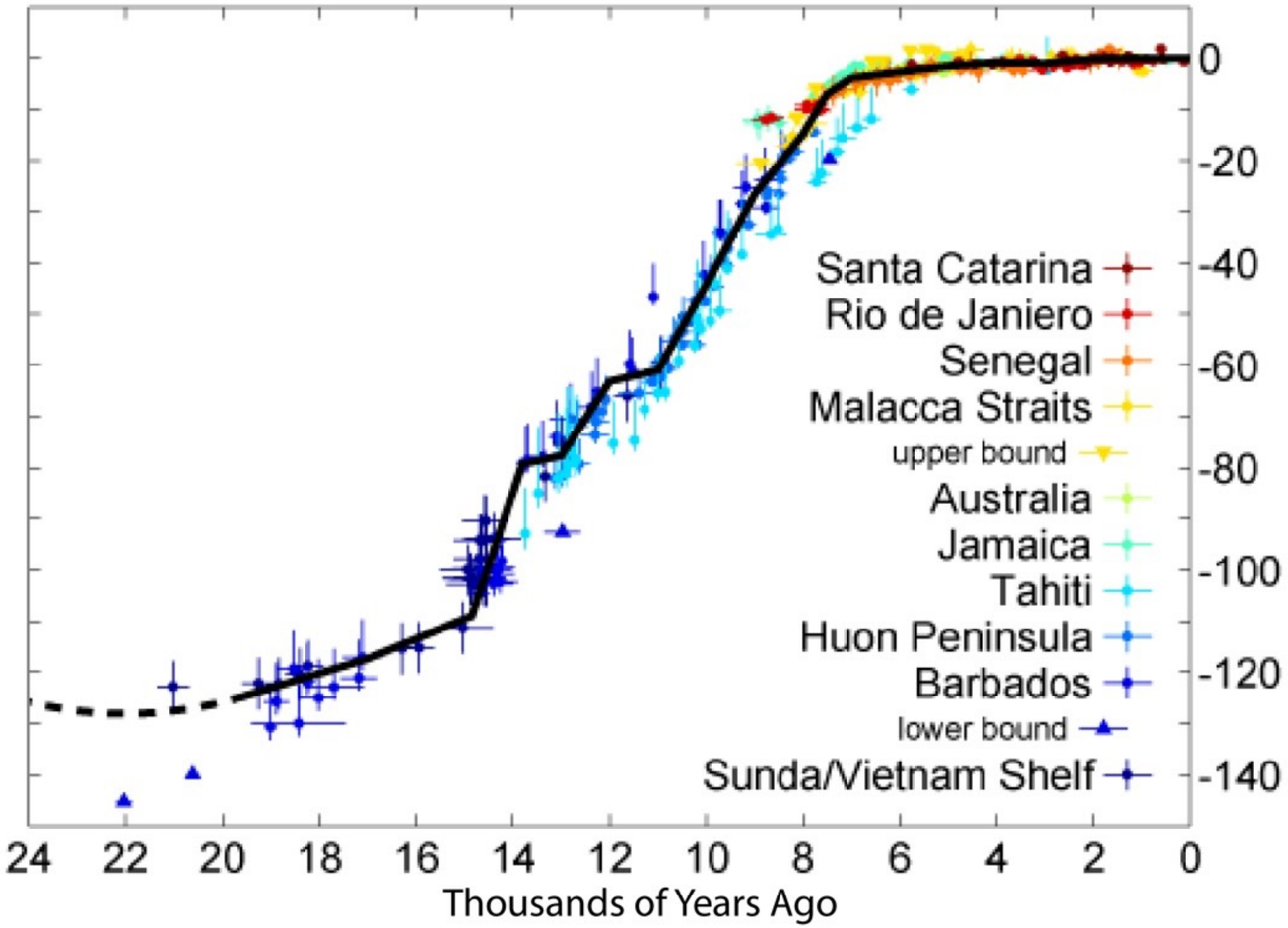
Sea Level Changes



Sea Level Changes



Sea Level Changes



Heat Co

Albedo

ere

Depends
on speed of sea level
change

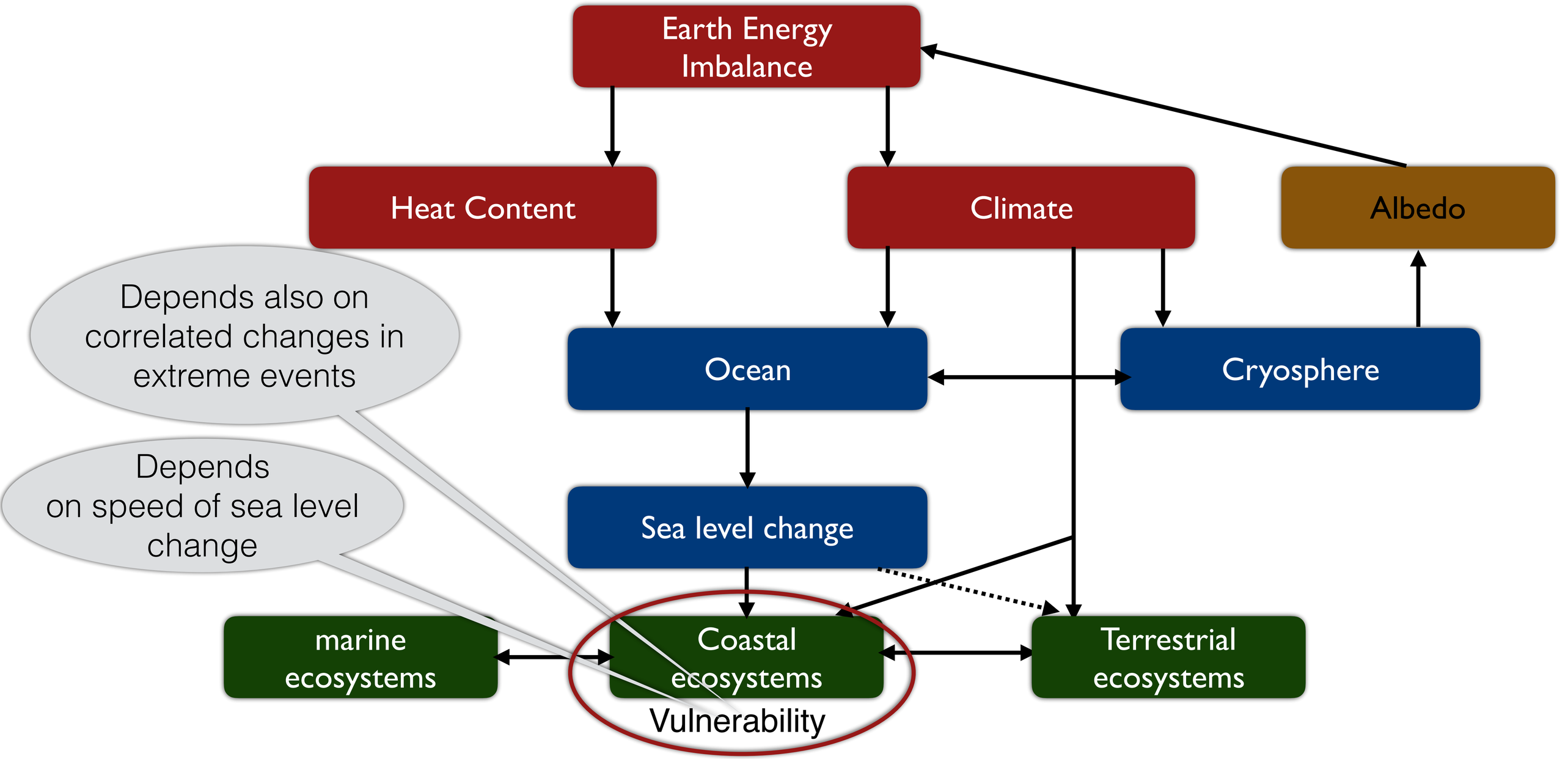
marine
ecosystems

Coastal
ecosystems

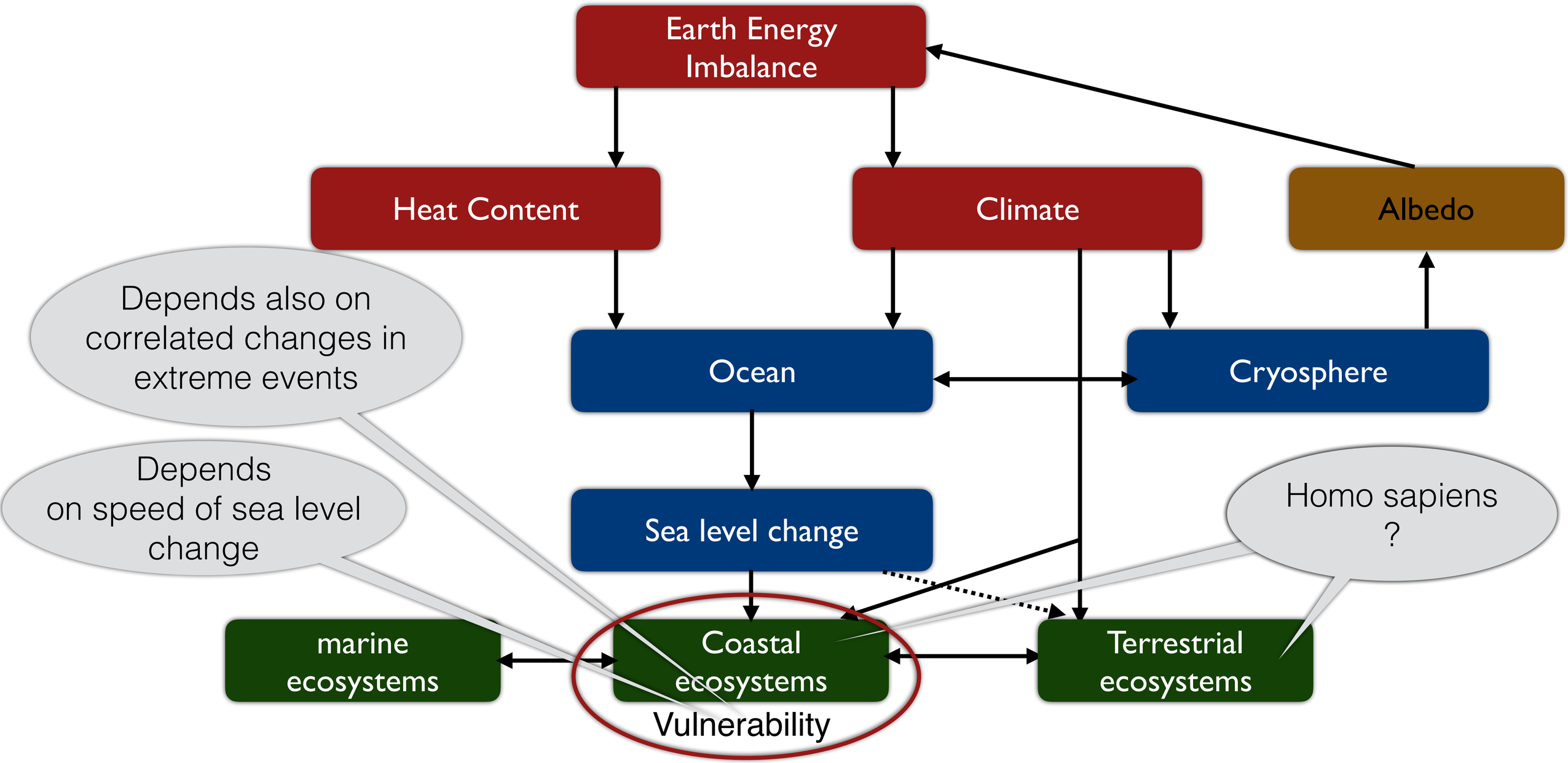
Terrestrial
ecosystems

Vulnerability

Sea Level Changes



Sea Level Changes



Homo sapiens: a coastal species?

Sea Level Changes

Sea Level Changes

Sea Level Changes

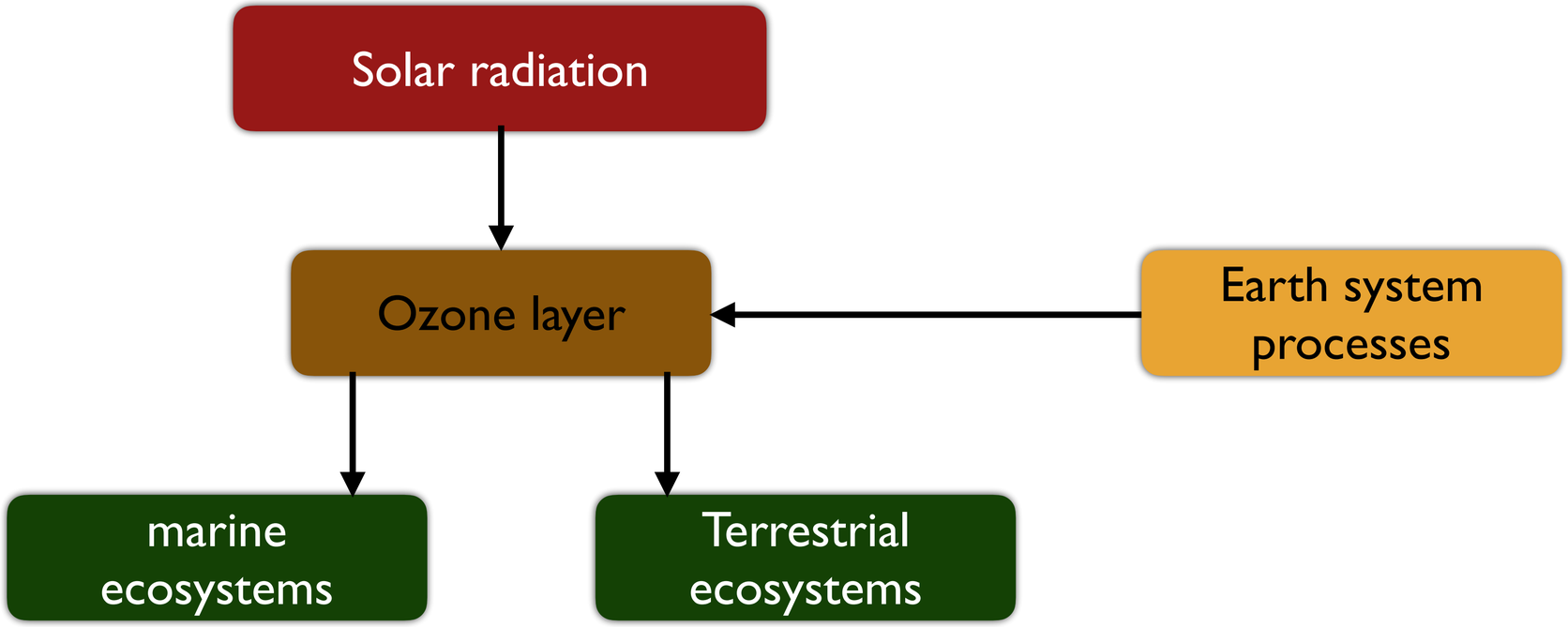
Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

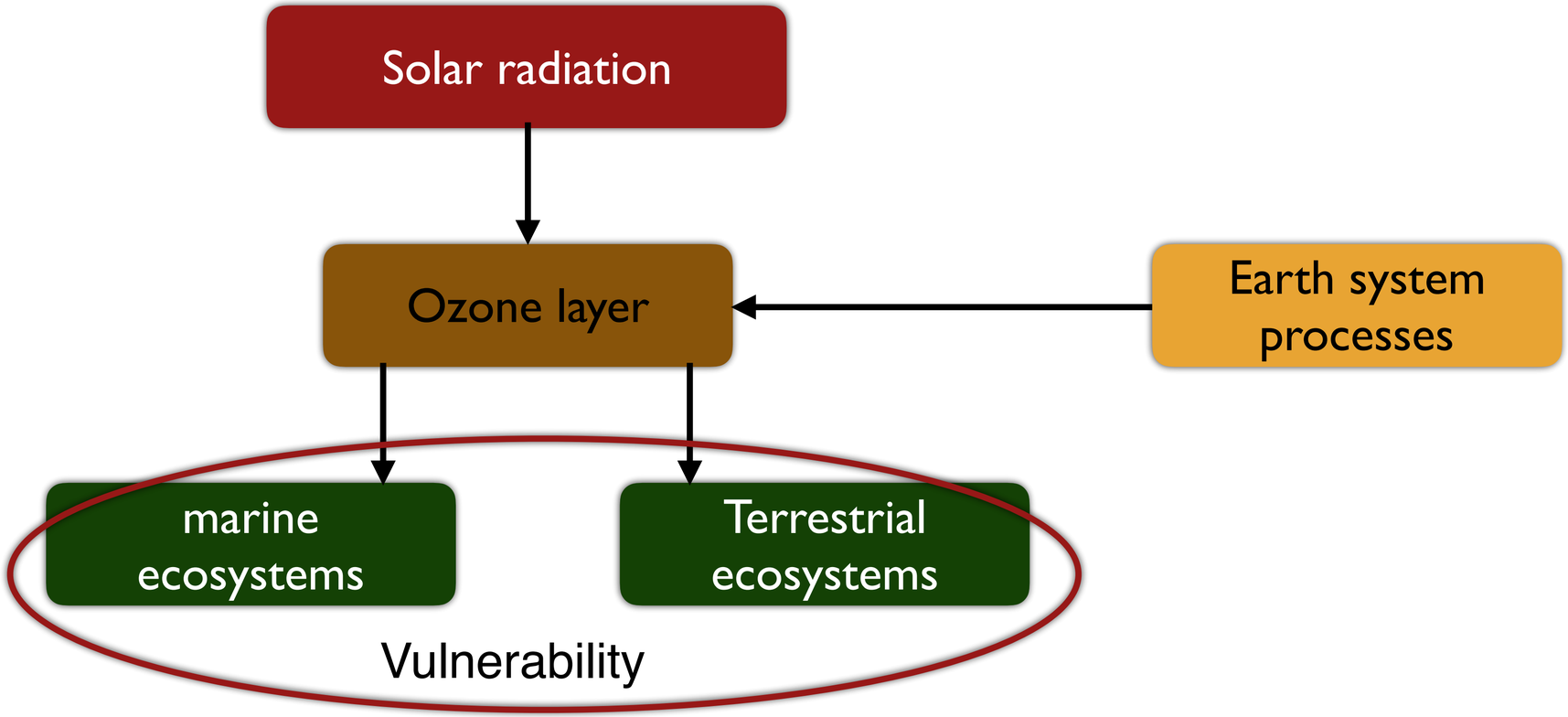
Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

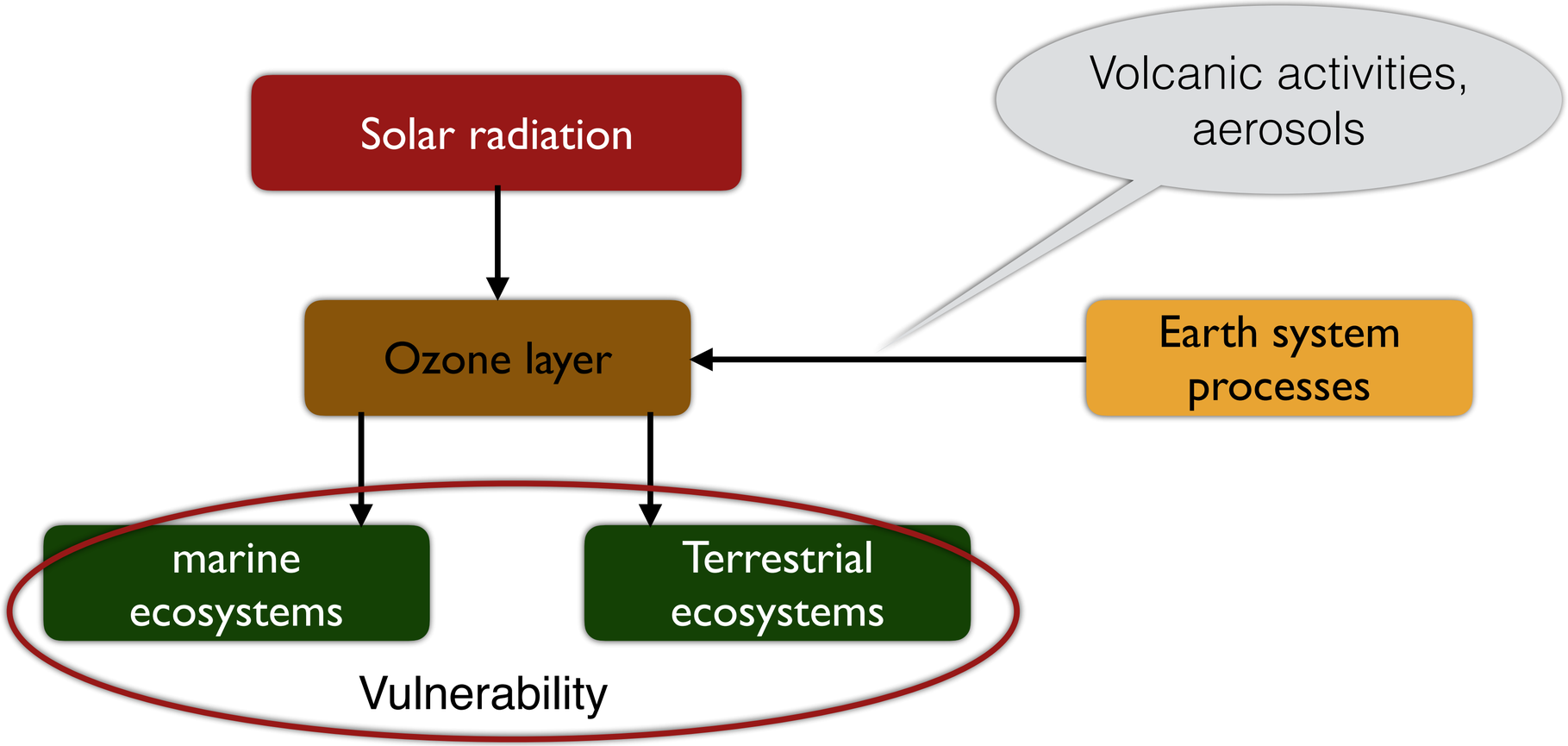
Pollution


Solar radiation
Ozone layer
Earth system processes
marine ecosystems
Terrestrial ecosystems

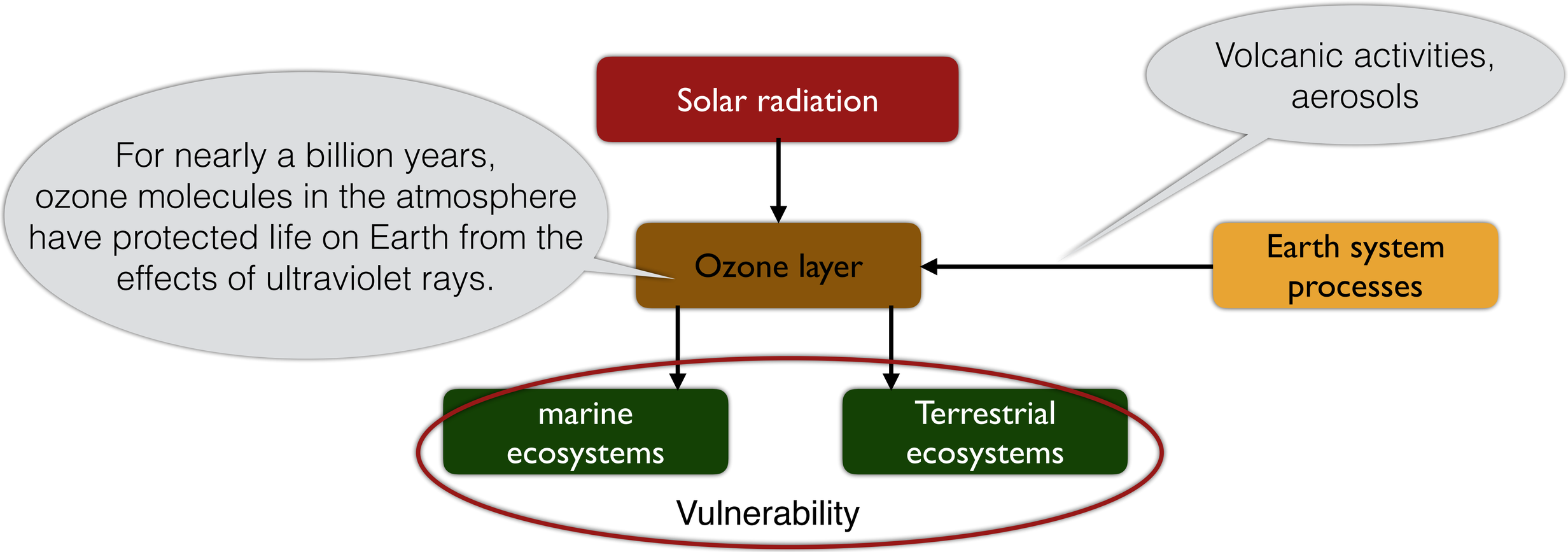
Pollution


Solar radiation
Ozone layer
Earth system processes
marine ecosystems
Terrestrial ecosystems
Vulnerability

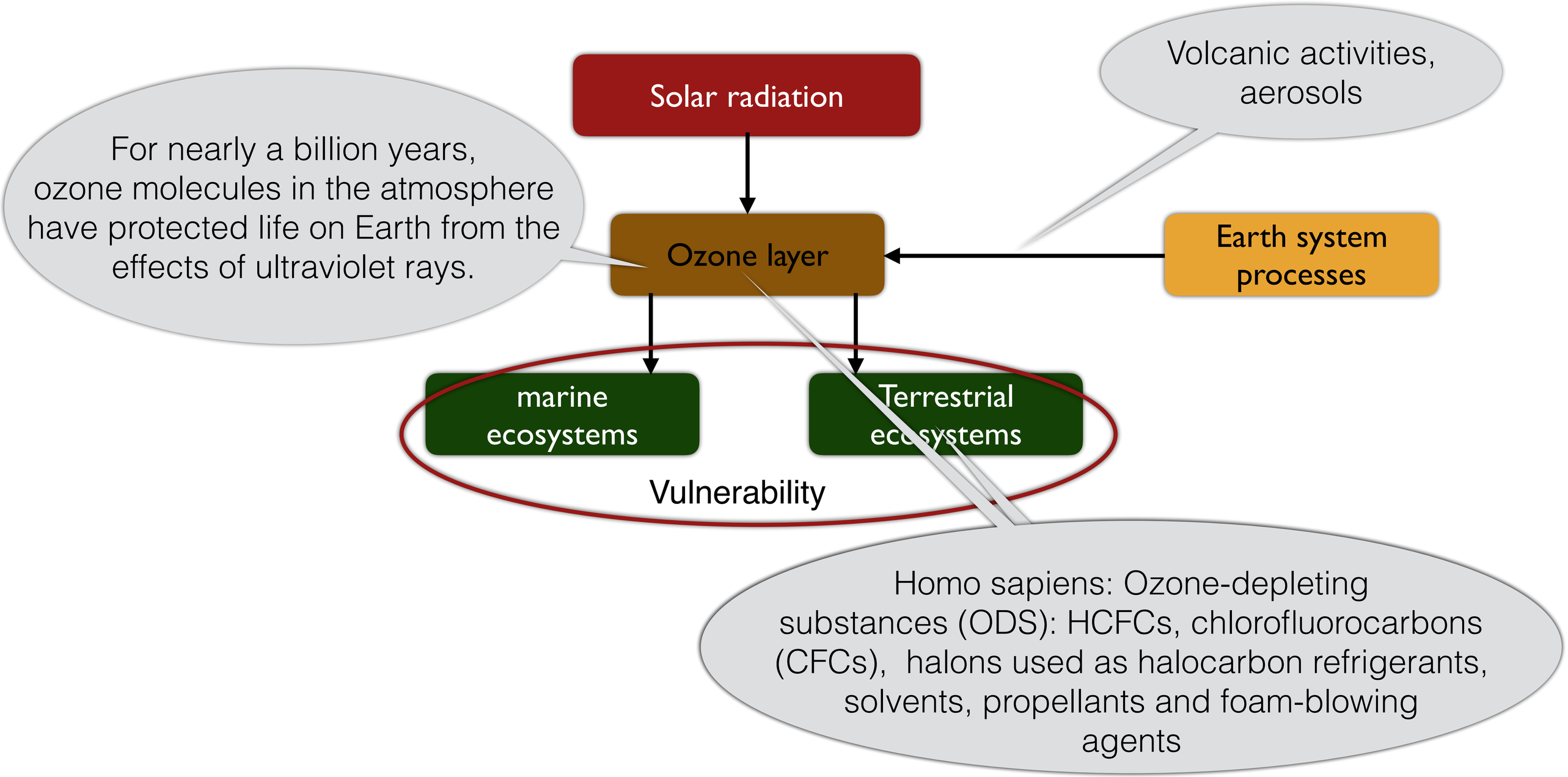
Pollution


Solar radiation
Volcanic activities, aerosols
Ozone layer
Earth system processes
marine ecosystems
Terrestrial ecosystems
Vulnerability

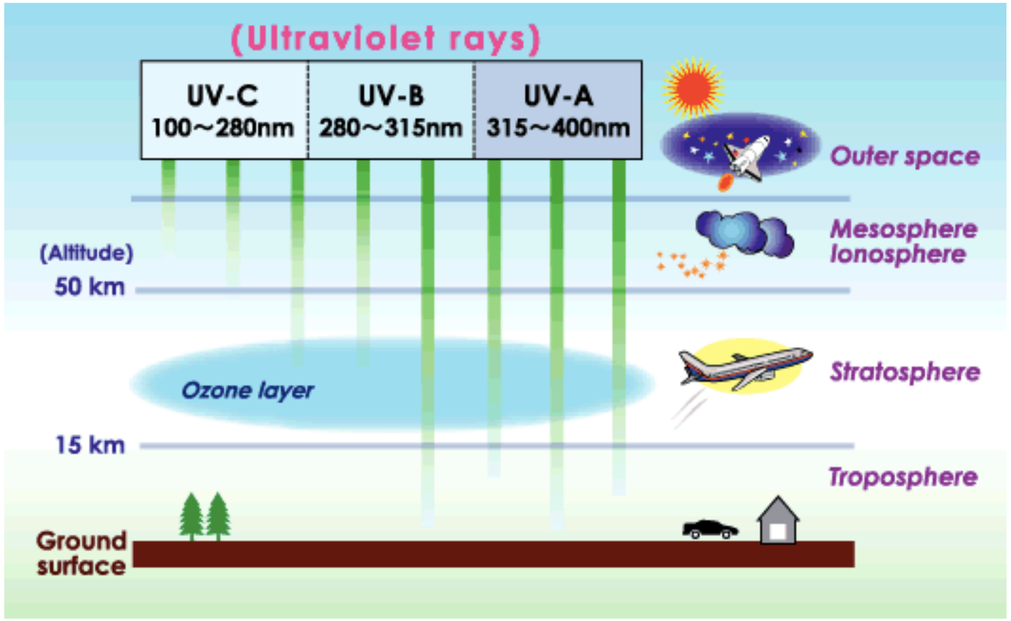
Pollution

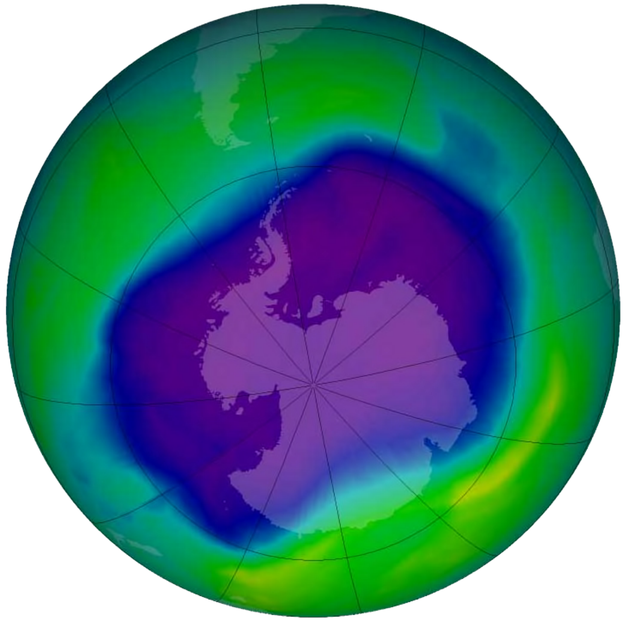

For nearly a billion years, ozone molecules in the atmosphere have protected life on Earth from the effects of ultraviolet rays.
Solar radiation
Volcanic activities, aerosols
Ozone layer
Earth system processes
marine ecosystems
Terrestrial ecosystems
Vulnerability

Pollution

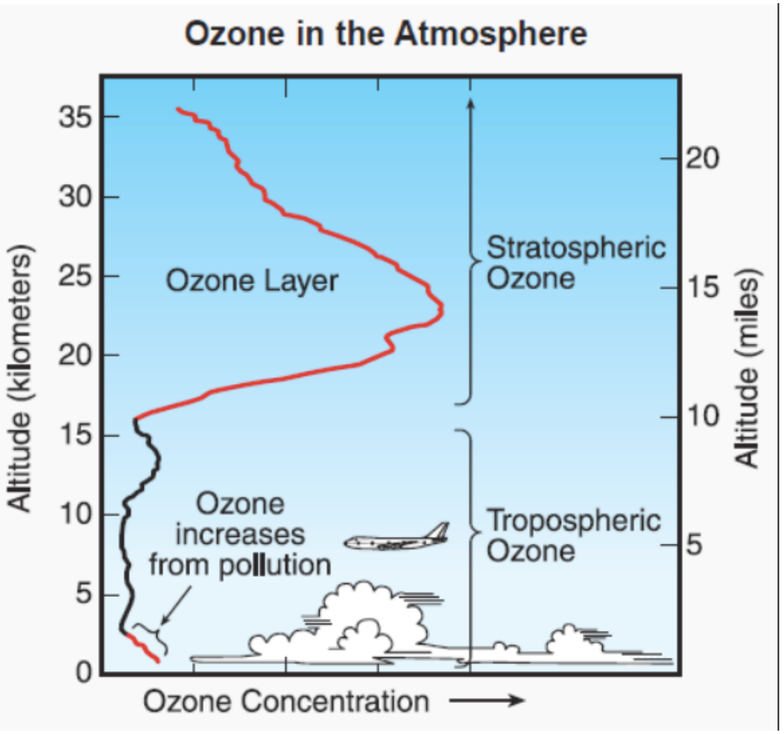

Volcanic activities, aerosols
Solar radiation
For nearly a billion years, ozone molecules in the atmosphere have protected life on Earth from the effects of ultraviolet rays.
Ozone layer
Earth system processes
marine ecosystems
Terrestrial ecosystems
Vulnerability
Homo sapiens: Ozone-depleting substances (ODS): HCFCs, chlorofluorocarbons (CFCs), halons used as halocarbon refrigerants, solvents, propellants and foam-blowing agents

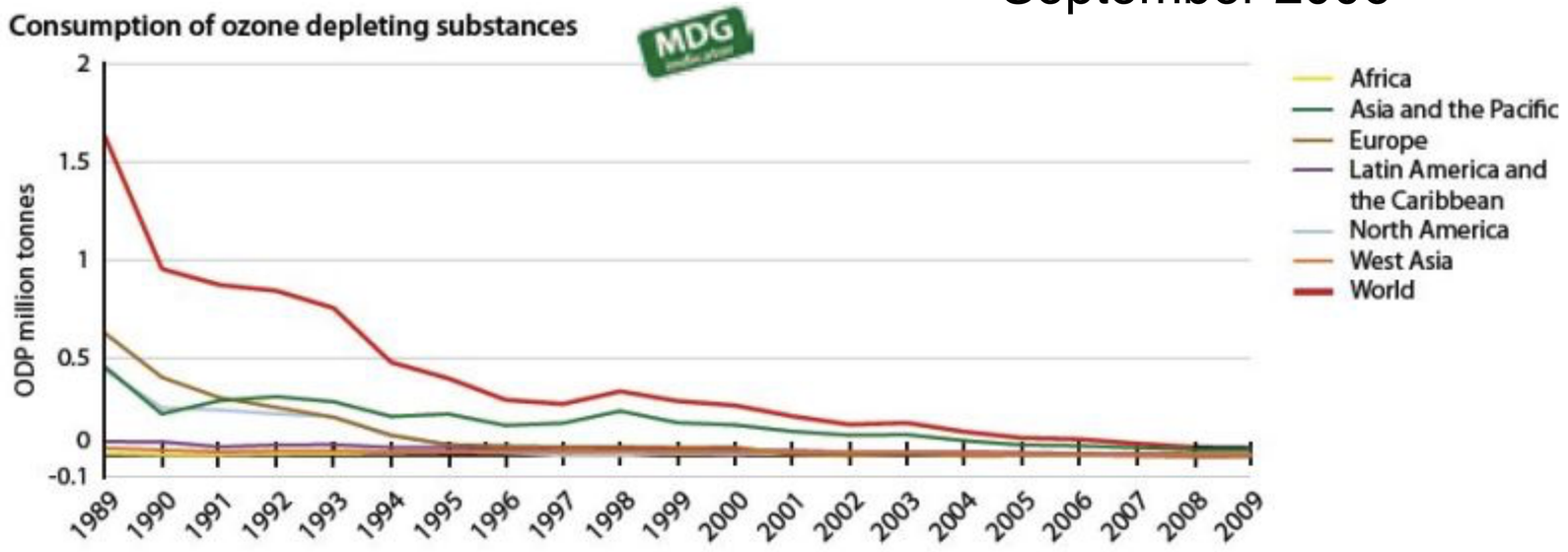
Pollution



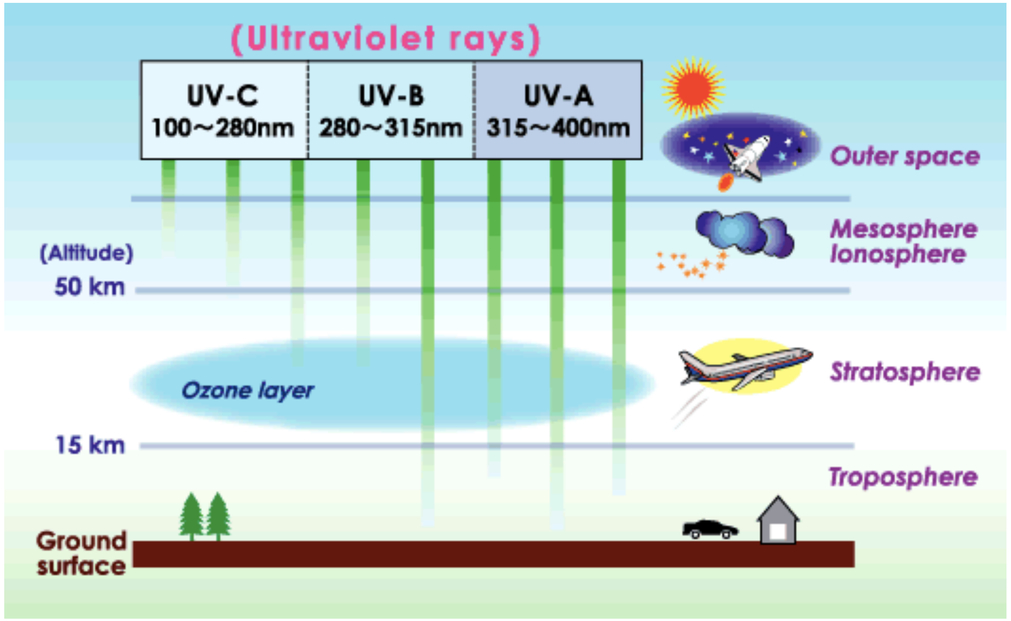


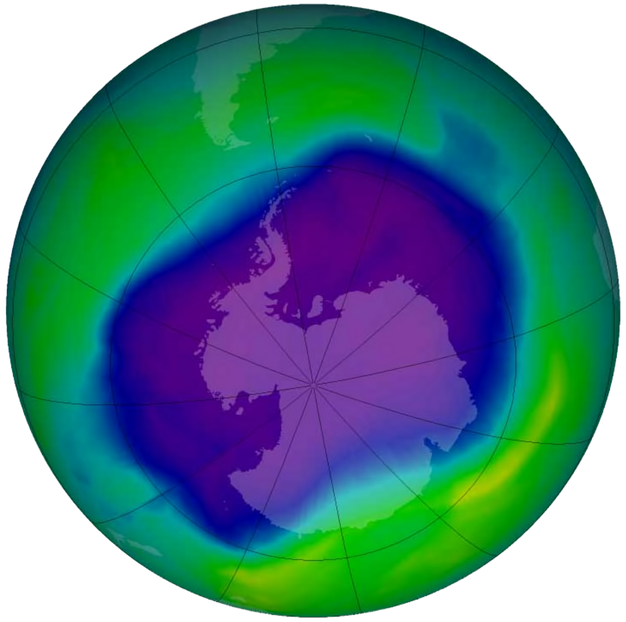
Largest recorded hole in September 2006



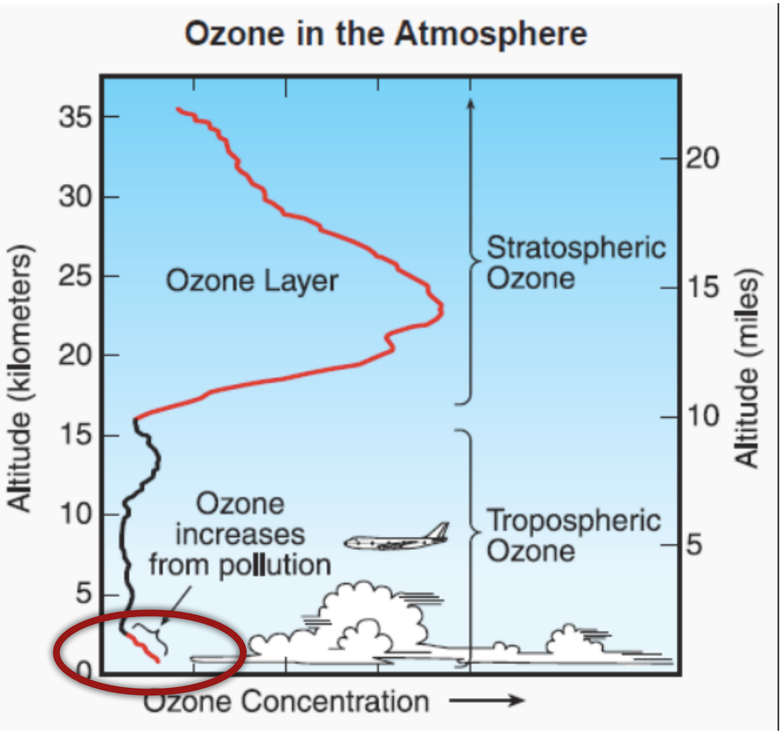


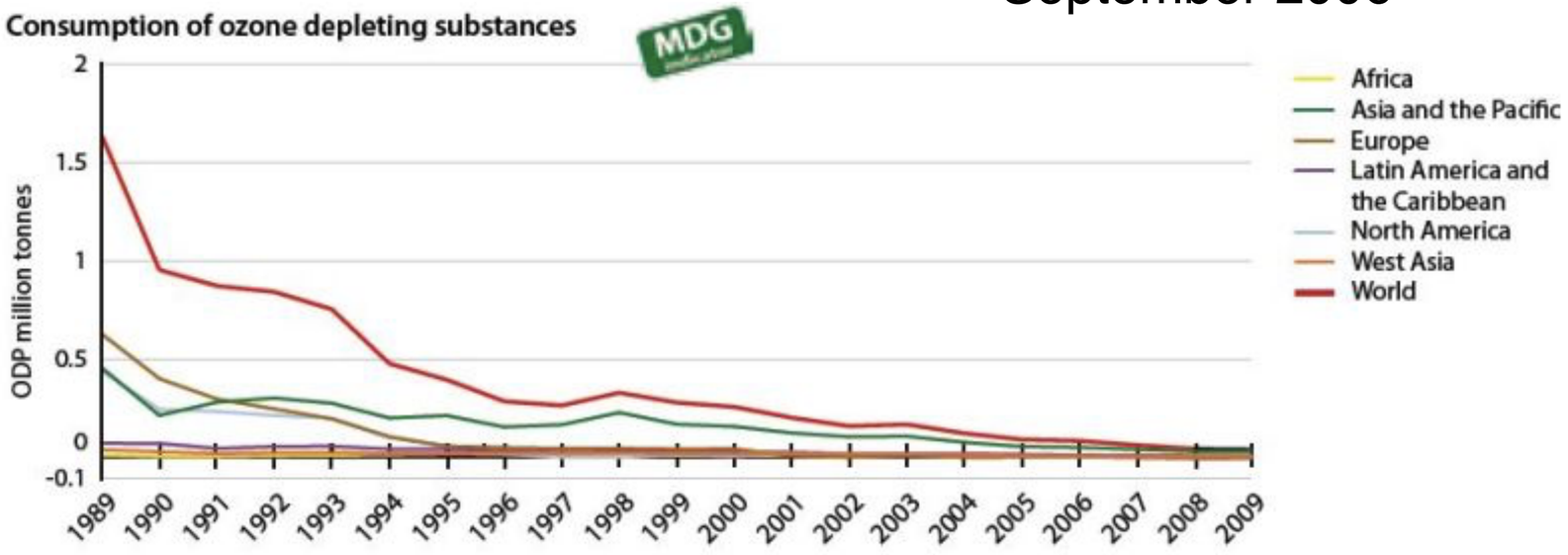
Pollution



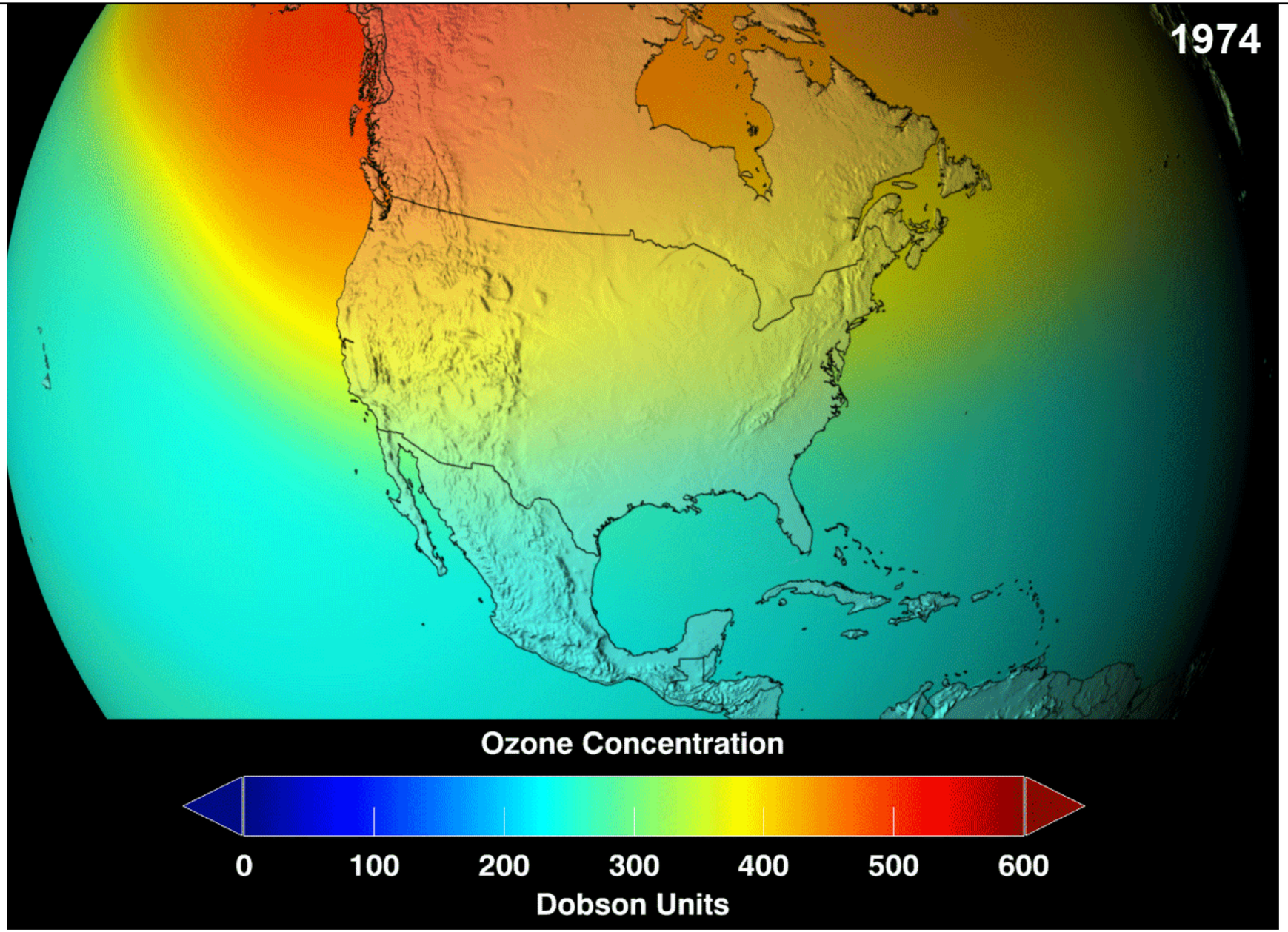


Largest recorded hole in September 2006



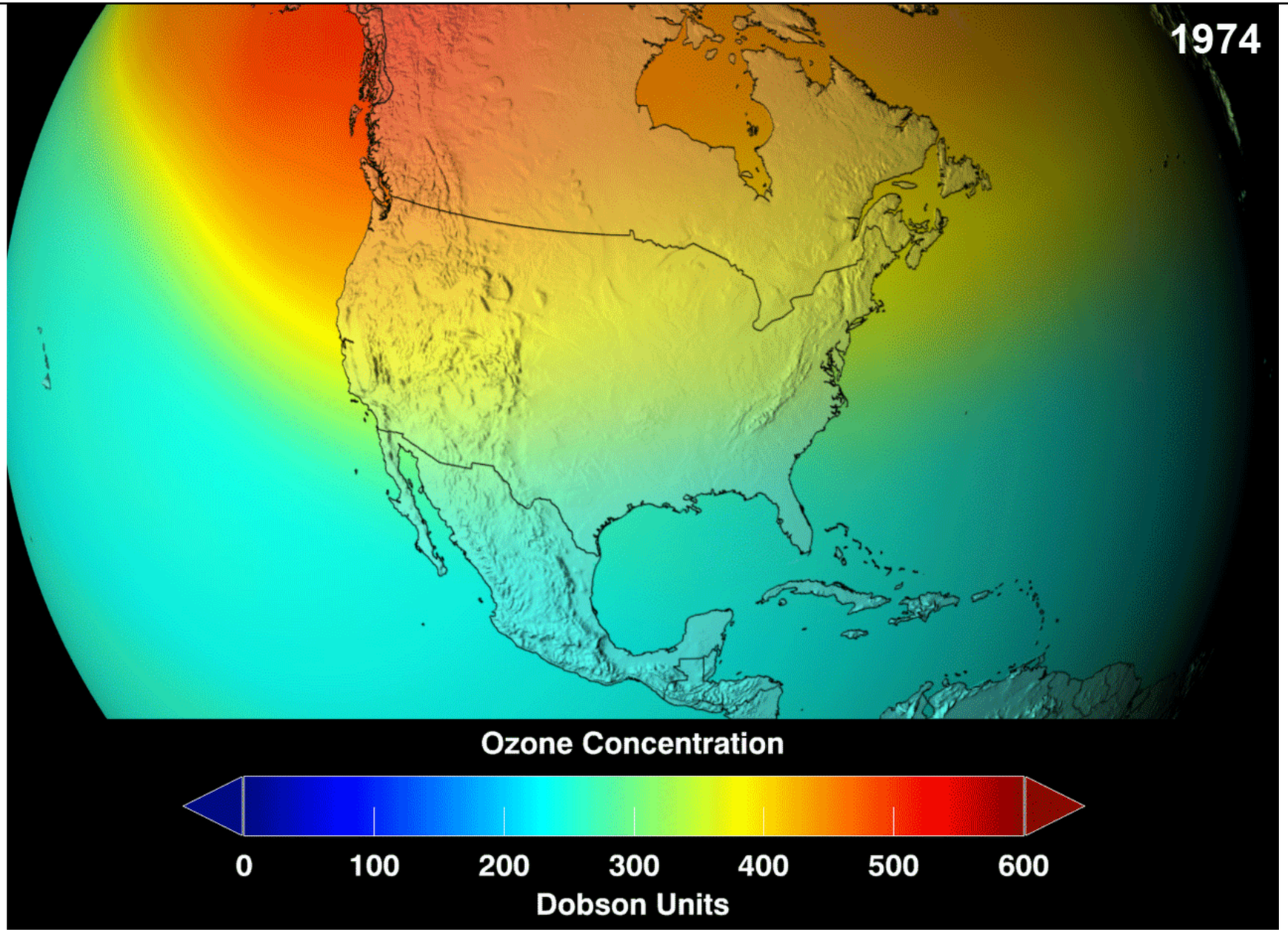


Pollution



System trajectory without human action

Pollution



System trajectory without human action

Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

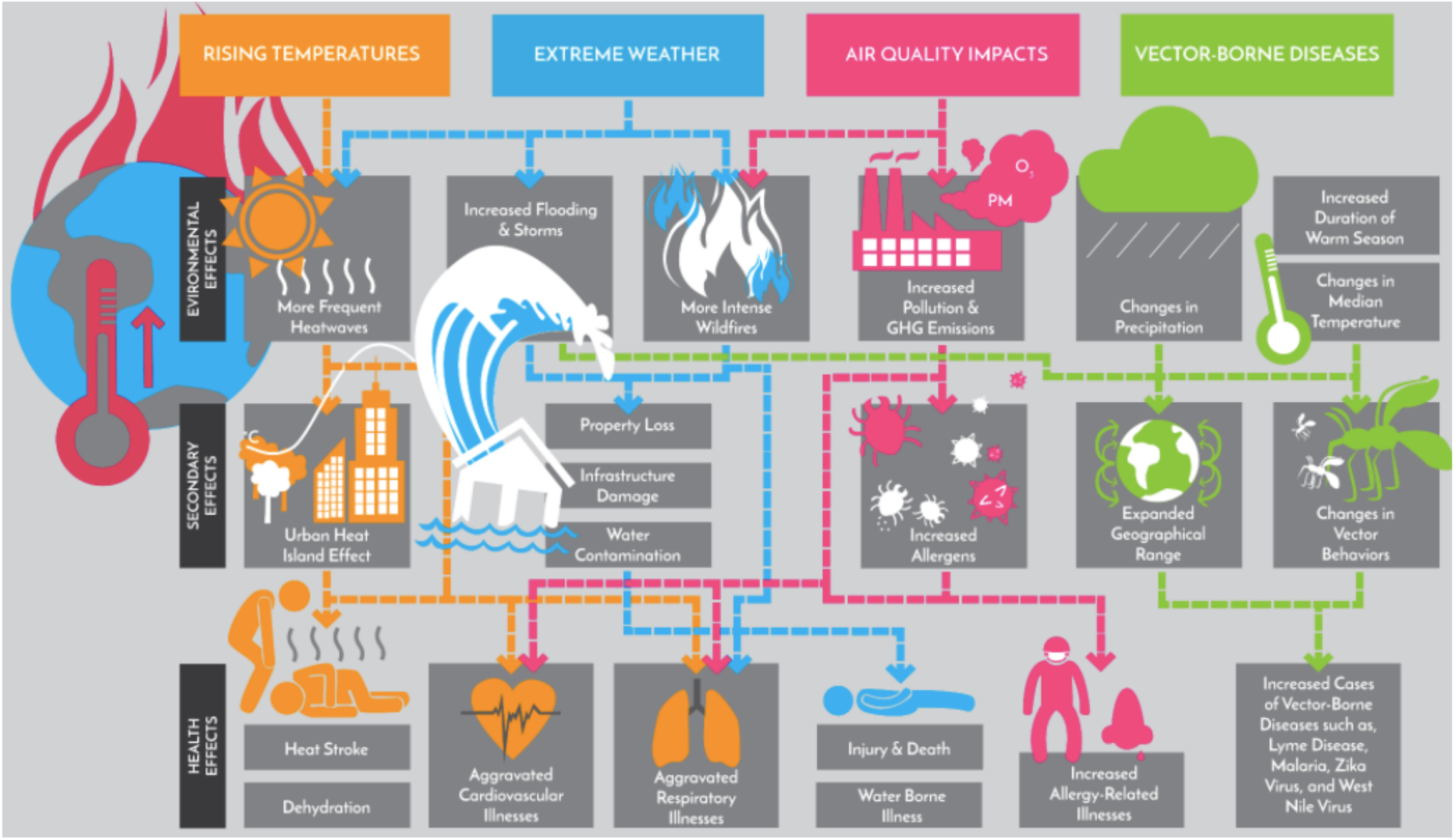
Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

Health


RISING TEMPERATURES
EXTREME WEATHER
AIR QUALITY IMPACTS
VECTOR-BORNE DISEASES
EVIRONMENTAL EFFECTS
SECONDARY EFFECTS
HEALTH EFFECTS
More Frequent Heatwaves
Increased Flooding & Storms
More Intense Wildfires
Increased Pollution & GHG Emissions
O3
PM
Changes in Precipitation
Increased Duration of Warm Season
Changes in Median Temperature
Urban Heat Island Effect
Property Loss
Infrastructure Damage
Water Contamination
Increased Allergens
Expanded Geographical Range
Changes in Vector Behaviors
Heat Stroke
Dehydration
Aggravated Cardiovascular Illnesses
Aggravated Respiratory Illnesses
Injury & Death
Water Borne Illness
Increased Allergy-Related Illnesses
Increased Cases of Vector-Borne Diseases such as, Lyme Disease, Malaria, Zika Virus, and West Nile Virus

Health

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.

Health

Table 1 Vulnerability to

Hazard or impact	*tructure*
Catastrophic coastal floodinç	ces interruption, availability of
	ff, transportation disruption,
	d other supplies
Flood-induced pollution	degradation of health service
	ture
Reduced water quality and re	ter supply for health services
to potable water due to sa	
and/or pollution	
Impairment of food quality (t	
of farmland and fisheries)	
food supply (e.g., loss of	
decreasing productivity of	
Change in transmission inter	
vector-borne disease, abu	
Population displacements, d	ss on health services because of
livelihoods	nges in demands

Modified from Nicholls, R. J., P. F
areas. *Climate Change 2007: Impa*
M. L. Parry, O. F. Canziani, J. P.

2007b: Coastal systems and low-lying
overnmental Panel on Climate Change,
5–356.

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]

Vulnerablity to Infectious Diseases

Biological Hazards: Sources of biological hazards may include **bacteria, viruses, insects, plants, birds, animals**, and humans. These sources can cause a variety of health effects ranging from skin irritation and allergies to infections (e.g., tuberculosis, AIDS), cancer and so on.

Figure 6.1: Four main types of transmission cycle for infectious diseases (referenc

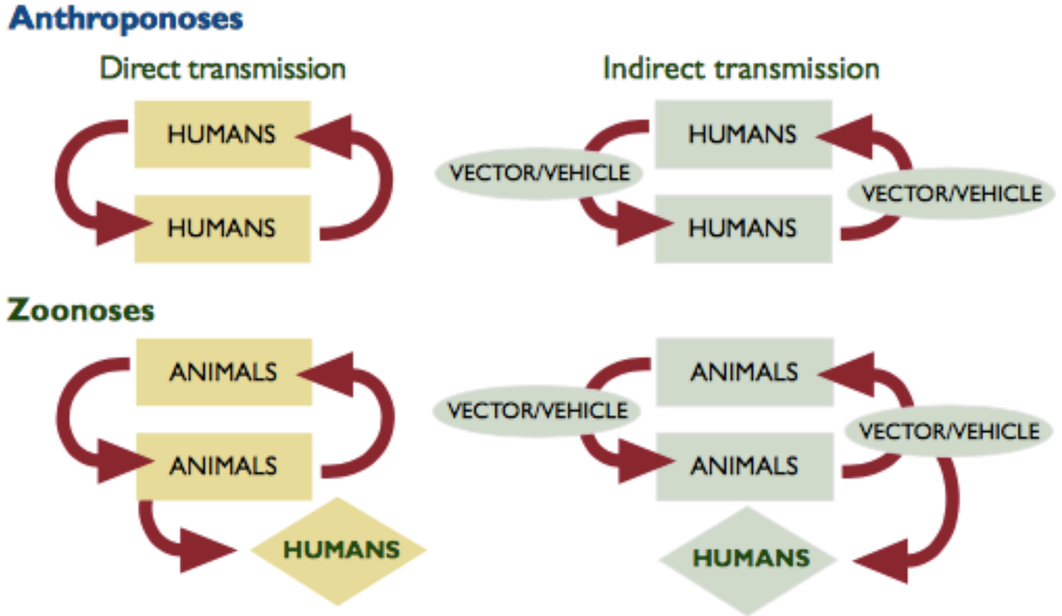


Table 6.1: Examples of how diverse environmental changes affect the occurrence of various infectious diseases in humans (Refernce 5)

Environmental changes	Example diseases	Pathway of effect
Dams, canals, irrigation	Schistosomiasis	▲ Snail host habitat, human contact
	Malaria	▲ Breeding sites for mosquitoes
	Helminthiasies	▲ Larval contact due to moist soil
	River blindness	▼ Blackfly breeding, ▼ disease
Agricultural intensification	Malaria	Crop insecticides and ▲ vector resistance
	Venezuelan haemorraghic fever	▲ rodent abundance, contact
Urbanization, urban crowding	Cholera	▼ sanitation, hygiene; ▲ water contamination
	Dengue	Water-collecting trash, ▲ *Aedes aegypti* mosquito breeding sites
	Cutaneous leishmaniasis	▲ proximity, sandfly vectors
Deforestation and new habitation	Malaria	▲ Breeding sites and vectors, immigration of susceptible people
	Oropouche	▲ contact, breeding of vectors
	Visceral leishmaniasis	▲ contact with sandfly vectors
Reforestation	Lyme disease	▲ tick hosts, outdoor exposure
Ocean warming	Red tide	▲ Toxic algal blooms
Elevated precipitation	Rift valley fever	▲ Pools for mosquito breeding
	Hantavirus pulmonary syndrome	▲ Rodent food, habitat, abundance

▲ increase ▼ reduction

http://www.who.int/globalchange/environment/en/chapter6.pdf

Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

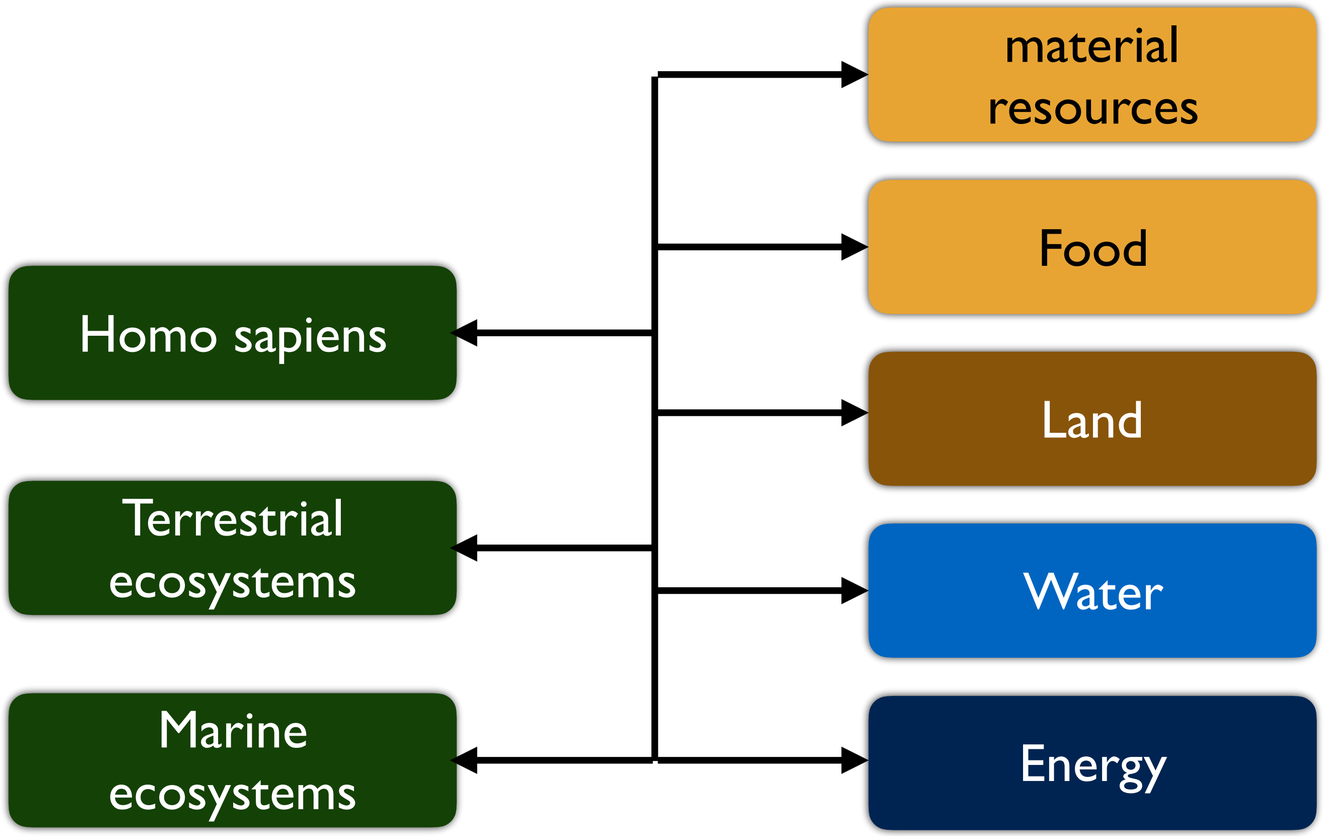
Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

Nexus

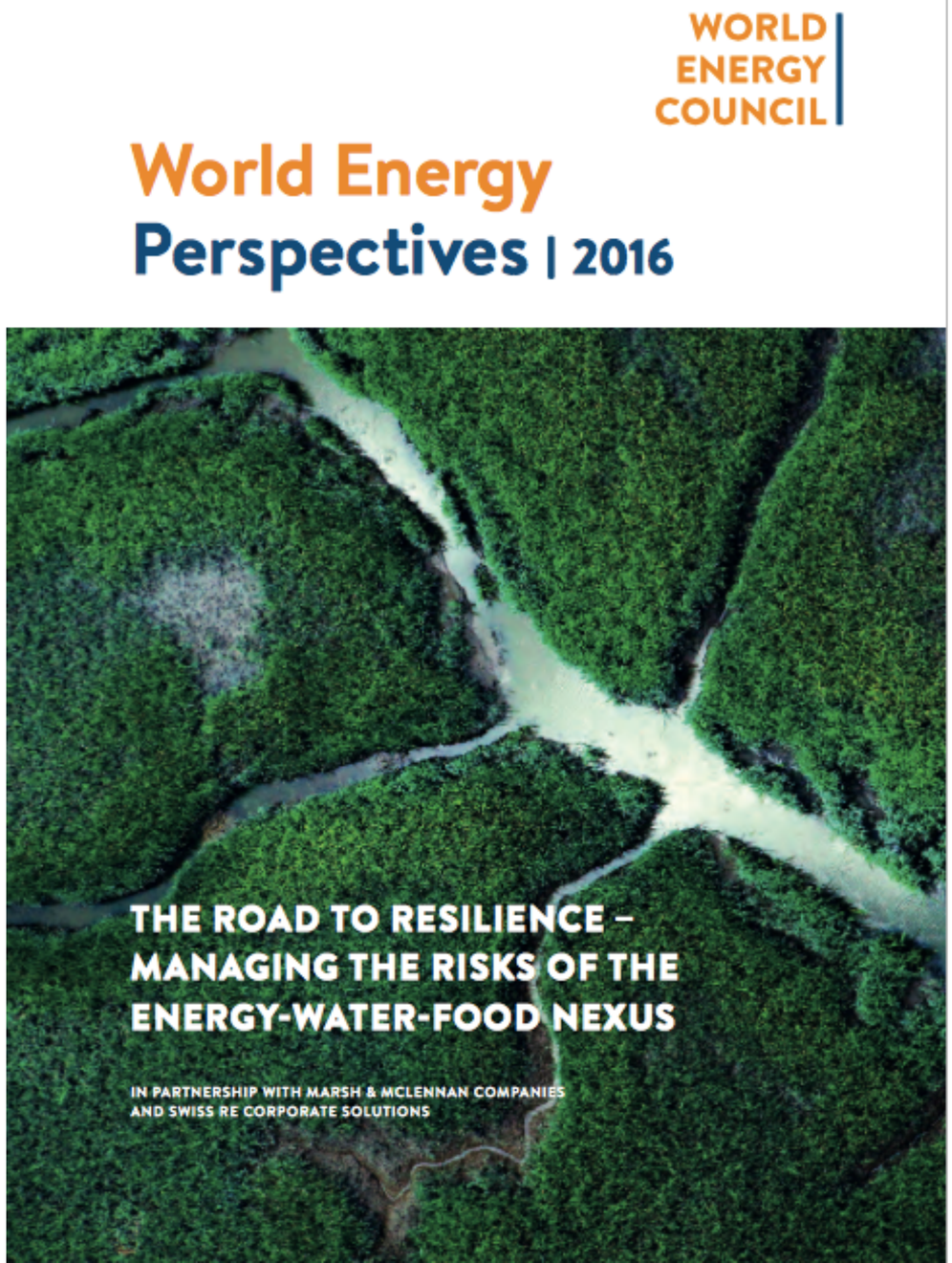
Nexus:

- a means of connection
- a connected series of group
- the core or center



Nexus

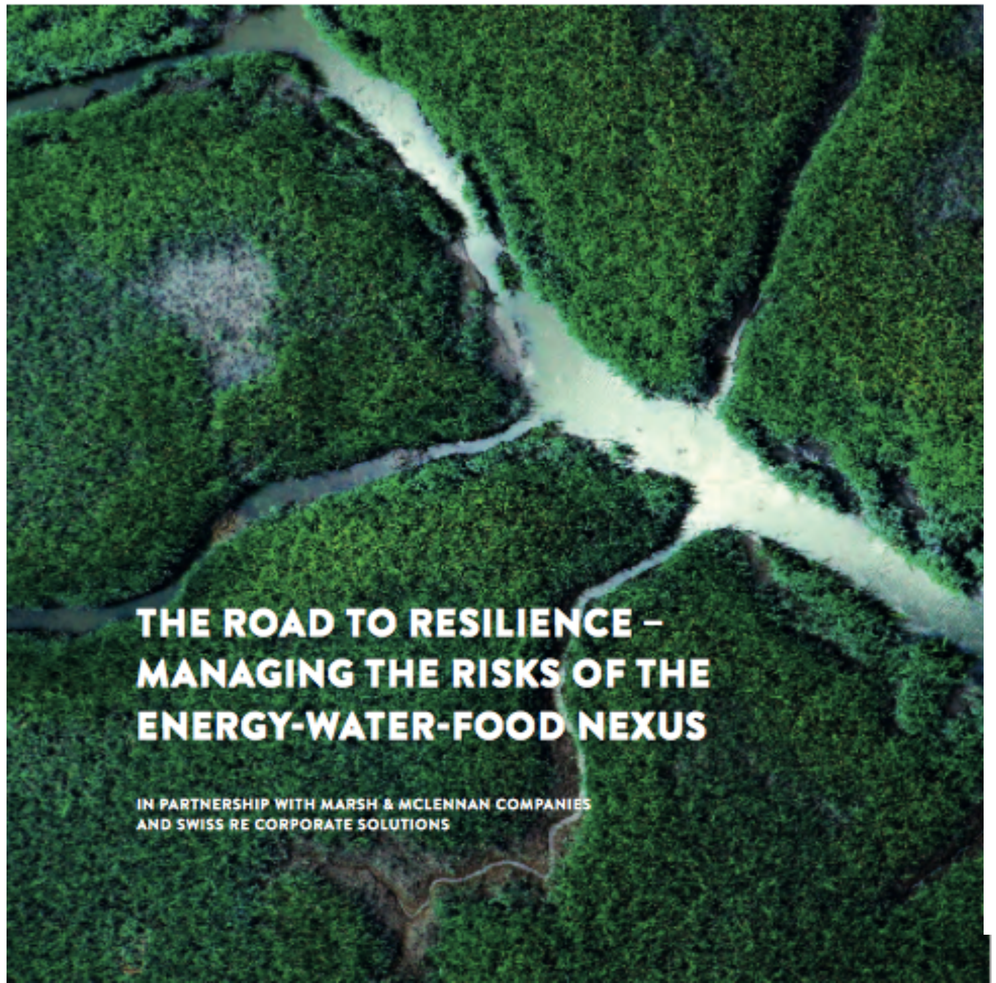
Nexus


WORLD
ENERGY
COUNCIL
World Energy
Perspectives | 2016
THE ROAD TO RESILIENCE –
MANAGING THE RISKS OF THE
ENERGY-WATER-FOOD NEXUS
IN PARTNERSHIP WITH MARSH & MCLENNAN COMPANIES
AND SWISS RE CORPORATE SOLUTIONS

Nexus

WORLD ENERGY COUNCIL

World Energy Perspectives | 2016



KEY FINDINGS

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

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

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

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

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

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

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

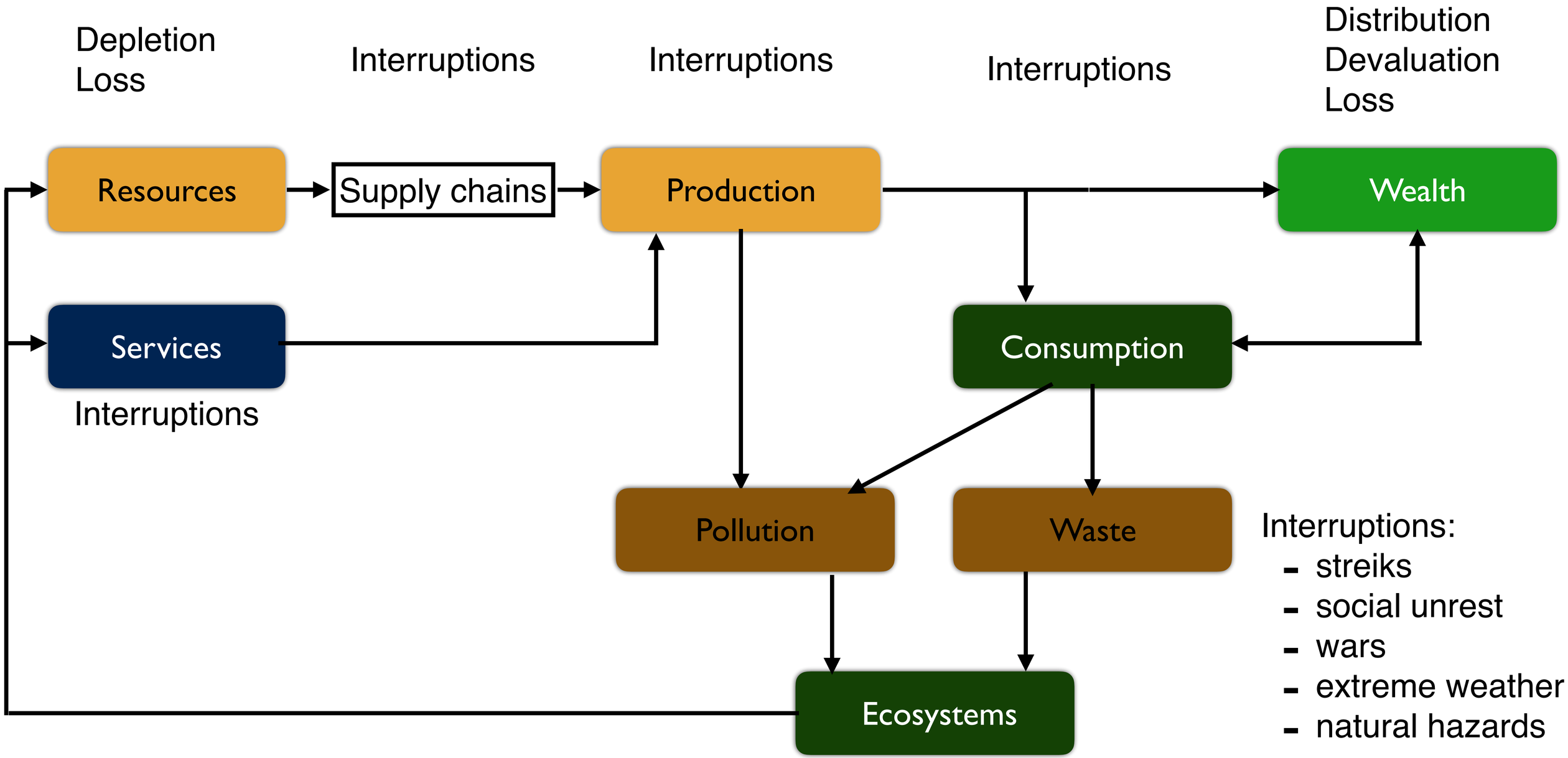
Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

Economic vulnerabilities



Economic vulnerabilities

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

Economic vulnerabilities

Will a rising tide sink all homes?

Zil

Nationwide, almost 1.9 million homes (or roughly 2 percent of all U.S. homes) worth a combined $882 billion a 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 Pot Underwater Prop
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

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

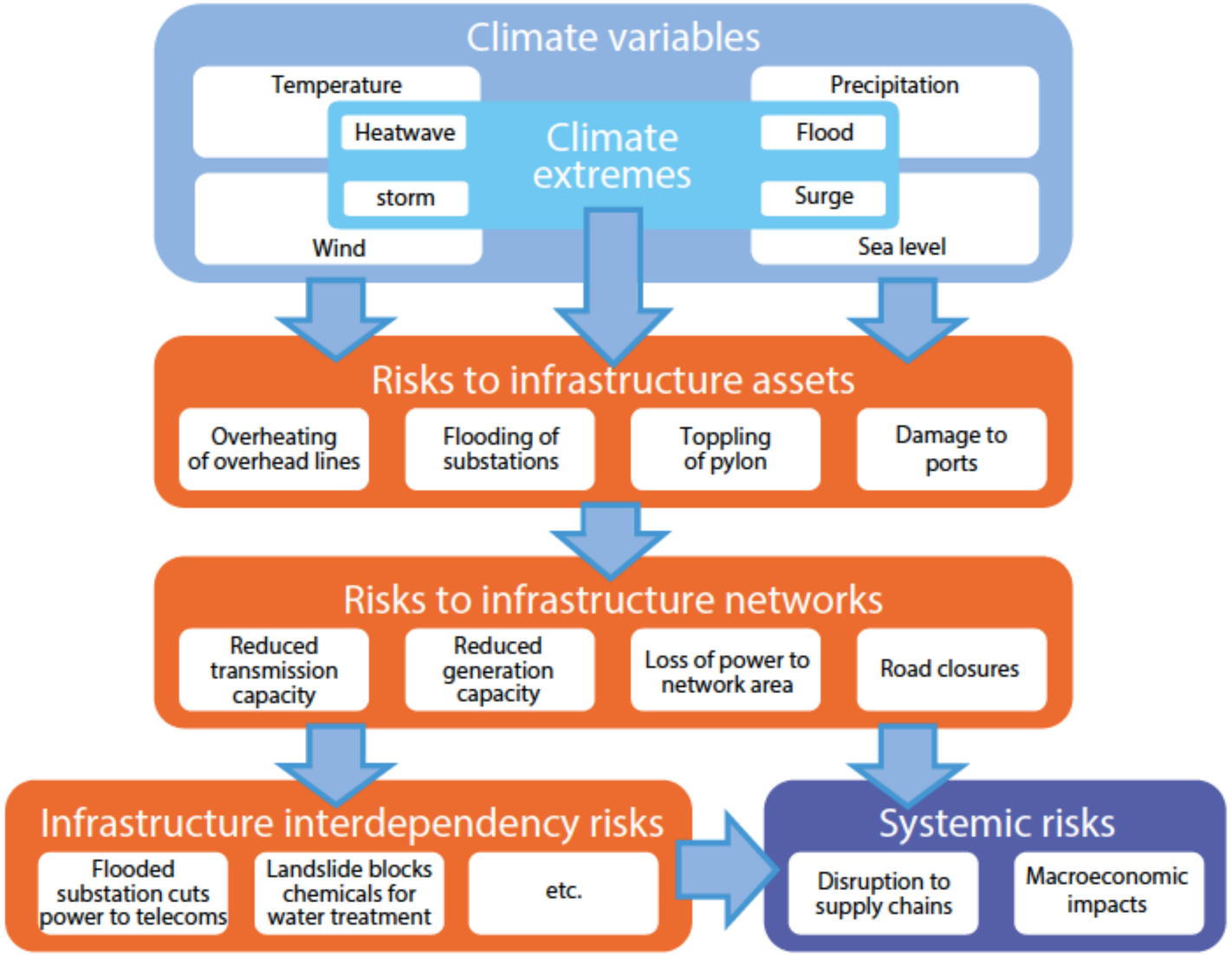
The U.S. is about to lose a trillion dollars in coastal property values

Trump isn't helping.

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

Economic vulnerabilities

Figure SR.A2: Example relationships between climate variables and infrastructure impacts



Source: CCRA2 Evidence report, Chapter 4.

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

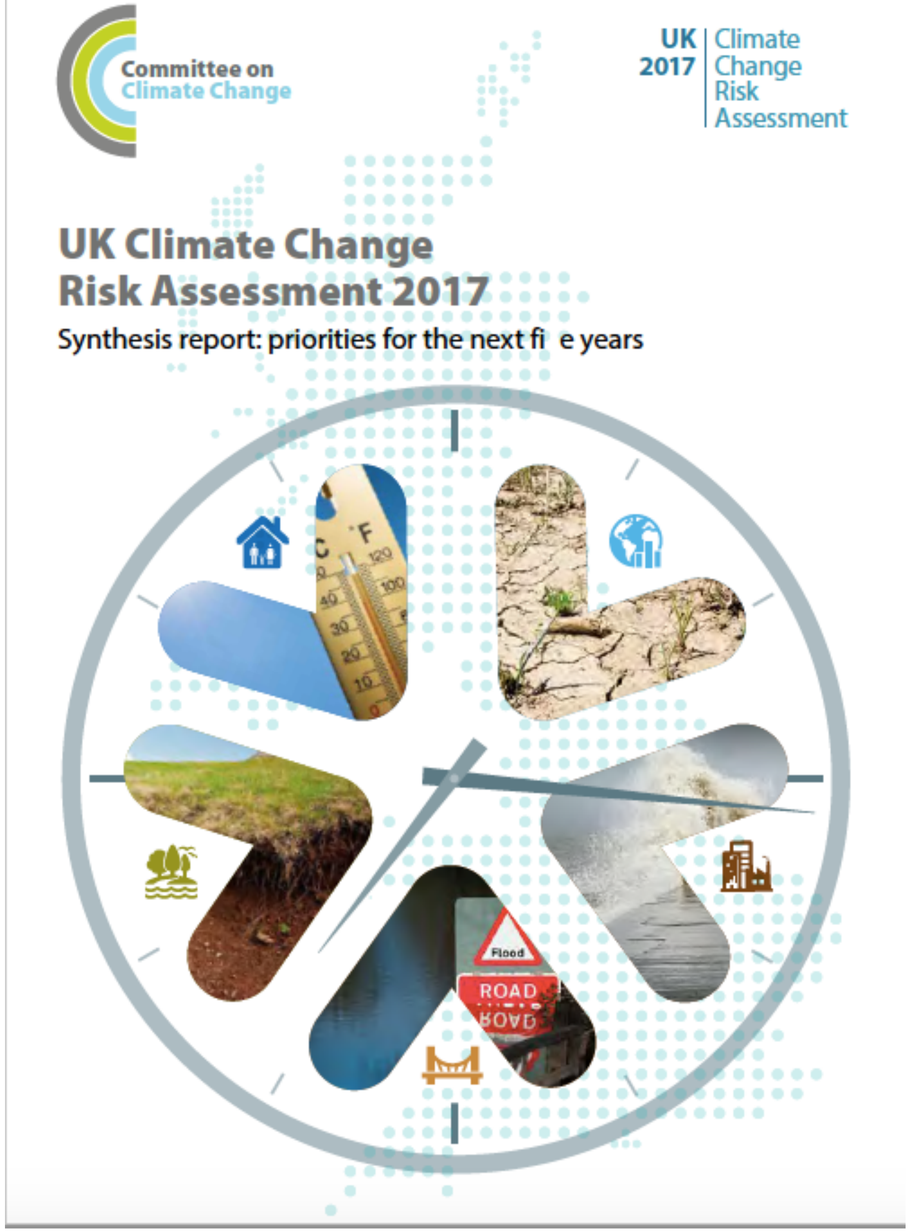
3.7.2: Natural Carbon Stores

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.



Mitigation and Adaptation Studies

Class 15: Understanding Vulnerabilities:
Non-Human & Human Built Environment; Economy, Inequality & Injustice

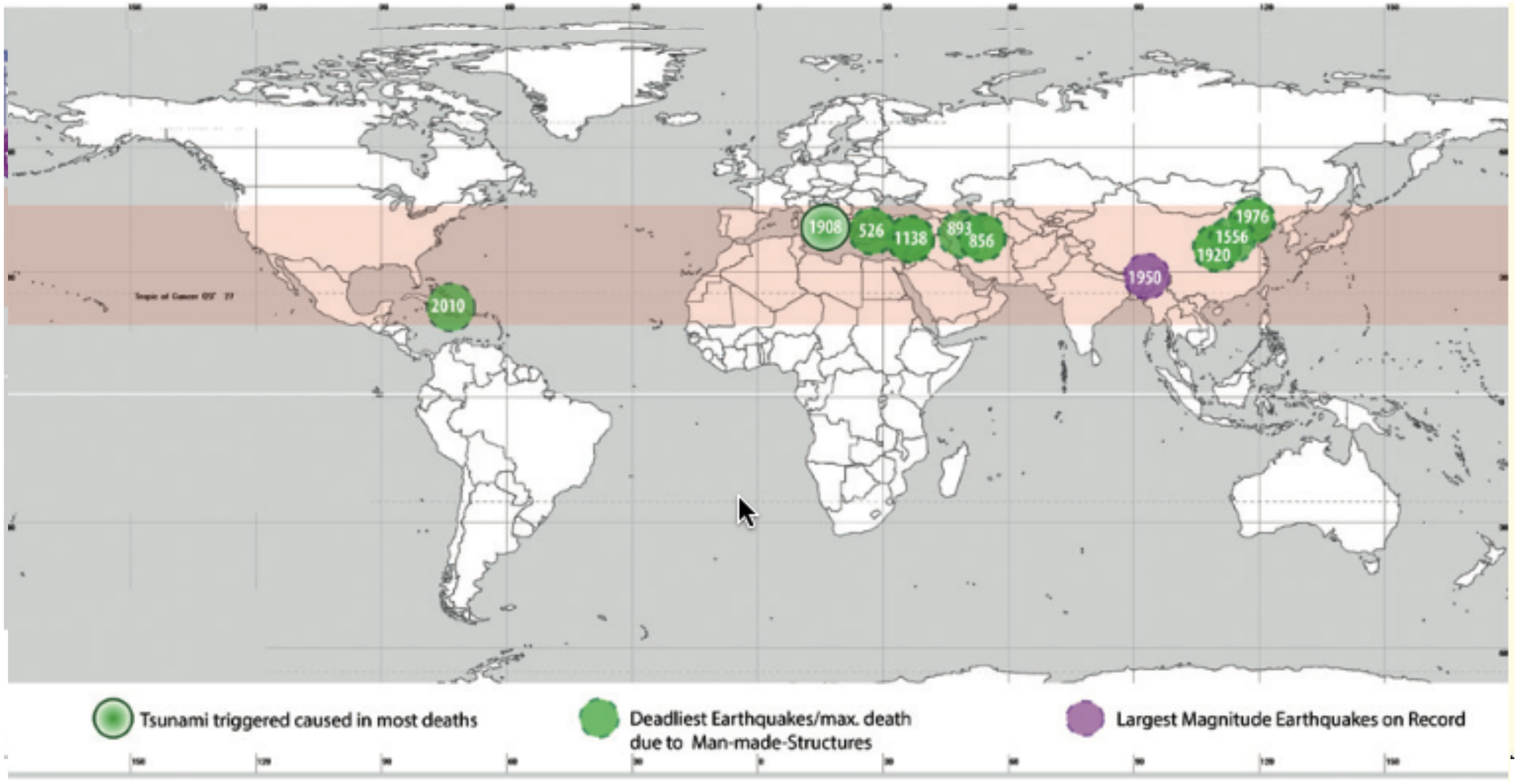
Contents

- *More on Risk, Vulnerability, Resilience, Adaptation (class 14)*
- *Vulnerabilities of the Planetary System (class 14)*
  - *Systemic vulnerabilities (class 14)*
  - Land Cover Changes
  - Earth Energy Imbalance
  - Sea Level Changes
  - Pollution
- Vulnerabilities of Homo Sapiens/the Anthroposphere
  - Health
  - Nexus (e.g., food-water-energy)
  - Economic vulnerabilities
  - Social vulnerabilities: inequality, injustice, unrest

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space

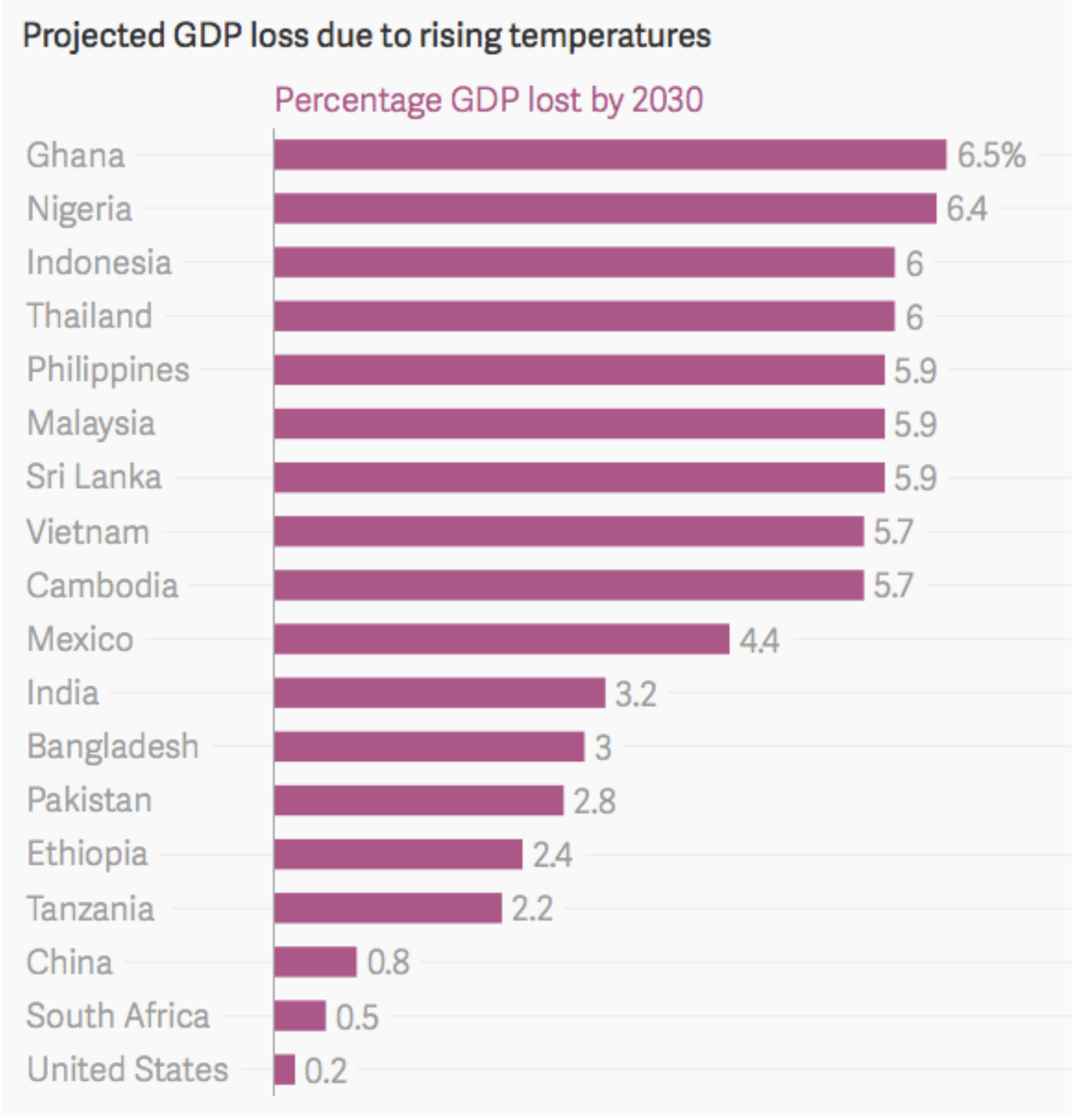


Inequality in Climate and Global Change Impacts

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space



Inequality in Climate and Global Change Impacts

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

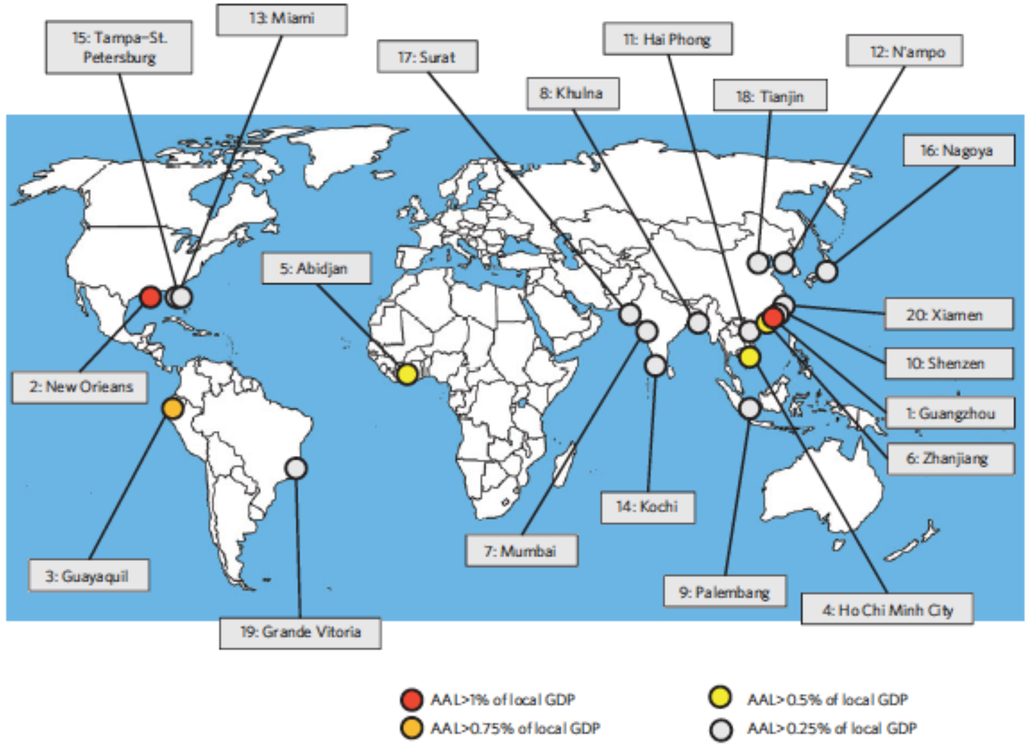
- uneven in space

Inequality in Climate and Global Change Impacts

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space



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 vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space

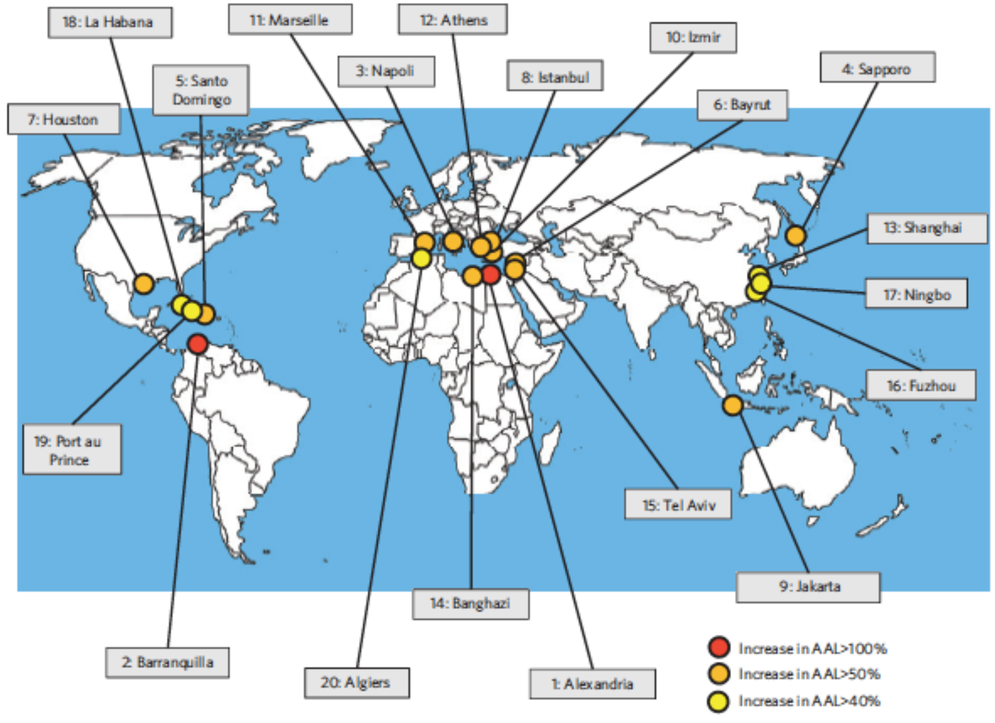


Figure 2 | The 20 cities where AAL increase most (in relative terms in 2050 compared with 2005) in the case of optimistic sea-level rise, if adaptation only maintains present defence standards or flood probability (PD). More information in Supplementary Table S7.

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.

Inequality in Climate and Global Change Impacts

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space

MENU nature International journal of science

Search E-alert Submit Login

NEWS FEATURE · 07 MARCH 2018

Attack of the extreme floods

As the oceans rise, researchers aim to forecast where severe storms will trigger the worst flooding.

Alexandra Witze

THE COMING FLOODS

Mean sea levels are rising around the globe, which is affecting the rate of floods in various locations. By 2050, some places (darker red dots) can expect to see what is currently considered a 100-year flood event recur as often as every one or five years on average. In other areas, today's 100-year events will not become more common or may even become rarer (light-blue dots), such as along Scandinavian coasts where the land is rising relative to the sea. Low-lying Pacific islands are among the most vulnerable to increased coastal flooding.

Estimated frequency by 2050 of today's 100-year floods (years)

● 1–2 ● 2–5 ● 5–10 ● 10–20 ● 20–50 ● 50–100 ● 100–10,000

T. Wahl *et al. Nature Commun.* http://dx.doi.org/10.1038/ncomms16075 (2017).

Inequality in Climate and Global Change Impacts

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space
- uneven in time

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

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space
- uneven in time
- uneven across societal groups

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

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.

Social vulnerabilities: inequality, injustice, unrest

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space
- uneven in time
- uneven across societal groups
- uneven across generations

The Virginian-Pilot
PilotOnline.com

GUEST COLUMNIST

Plag: A talk with a younger self

By Hans-Peter Plag
Apr 20, 2014

The fifth assessment of the Intergovernmental Panel on Climate Change has a cogent message: The planet is on a path to a much warmer state.

This may not be very convenient for us. In fact, it may be catastrophic. Are there signs that we will make the changes necessary to mitigate climate change by any discernible amount? I am afraid there are not many.

Recently, after I had presented a talk on climate change, a young woman in the audience asked me: "What would you like to tell your 20-year-old self?" Of course, I have been thinking a lot about what "we" could do, but I never looked at it from this angle: What would I tell my 20-year-old self?

Social vulnerabilities: inequality, injustice, unrest

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space
- uneven in time
- uneven across societal groups
- uneven across generations

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 impact of climate change, such as heat waves, droughts, storms, food and water shortages, new sicknesses and pandemics, migration of large populations, civil unrest like in North Africa and Syria, and wars. If you worry about anything and want to do something to reduce your worries, you should focus on causes that can worsen climate change. Do everything you can to mitigate climate change and prepare for what cannot be mitigated. Even using conservative predictions of global warming, scientists have estimated that as many as 2 billion people could die prematurely because of climate change - mainly from extreme food scarcity - by 2050. Of course, the risk is not distributed evenly over the globe, and people living in the poorer part of the world have a much higher chance to die prematurely. Such is the environmental justice of climate change.

Social vulnerabilities: inequality, injustice, unrest

Inequality in vulnerability and exposure

Vulnerabilities are distributed:

- uneven in space
- uneven in time
- uneven across societal groups
- uneven across generations

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:

cause of premature death for young people today is an impact of climate change, storms, food and water shortages, new sicknesses and pandemics, vil unrest like in North Africa and Syria, and wars. If you worry about to reduce your worries, you should focus on causes that can worsen an to mitigate climate change and prepare for what cannot be predictions of global warming, scientists have estimated that as many naturely because of climate change - mainly from extreme food scarcity - s not distributed evenly over the globe, and people living in the poorer part of higher chance to die prematurely. Such is the environmental justice of climate

global

The most likely single cause of premature death for young people today is an impact of climate change, such as heat waves, droughts, storms, food and water shortages, new sicknesses and pandemics, migration of large populations, civil unrest like in North Africa and Syria, and wars.

+ extinction

Social vulnerabilities: inequality, injustice, unrest

Inequality and injustice between Species

Social vulnerabilities: inequality, injustice, unrest

Inequality and injustice between Species

Social vulnerabilities: inequality, injustice, unrest

Inequality and injustice between Species

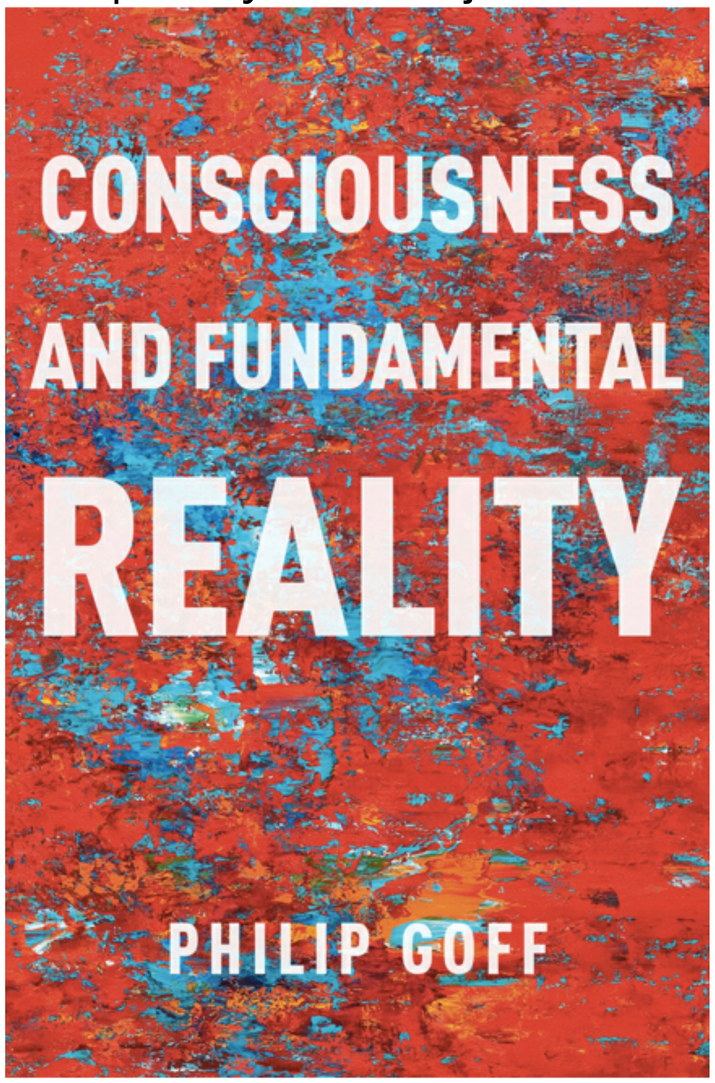
SCIENTIFIC AMERICAN

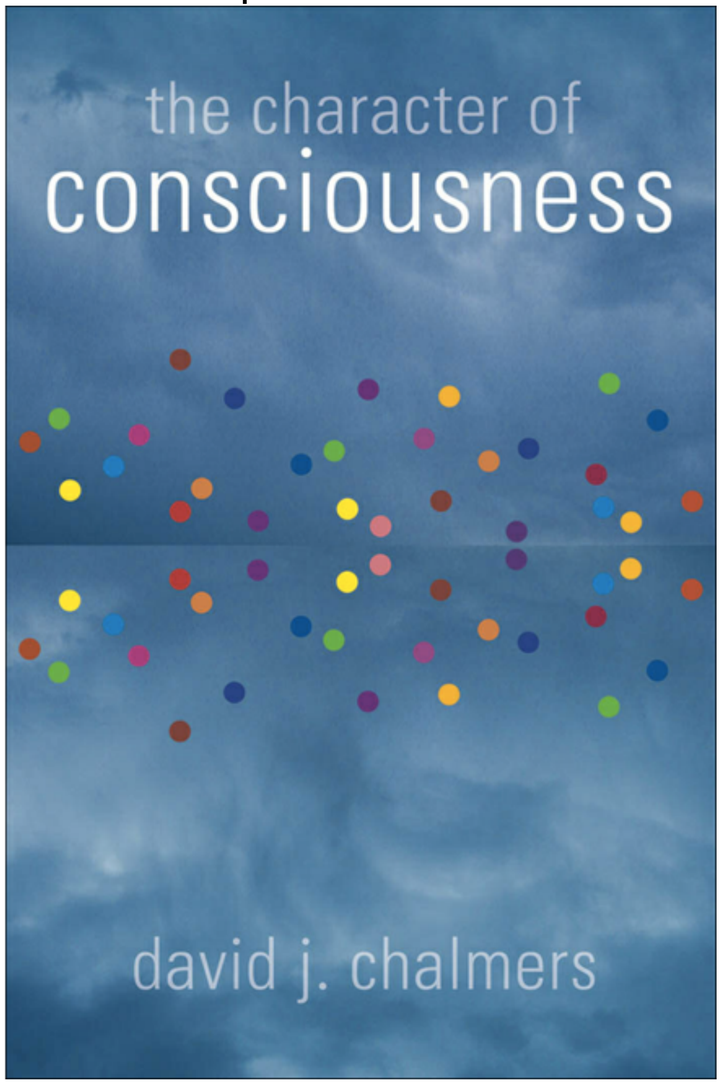
Chimps May Be Capable of Comprehending the Minds of Others

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

By Catherine Caruso on October 6, 2016 Véalo en español

Inequality and injustice between Species





What is consciousness? How can it be explained? Can there be a science of consciousness? What is the neural basis of consciousness? What is the place of consciousness in nature? Is consciousness physical or nonphysical? How do we know about consciousness? How do we think about consciousness? What are the contents of consciousness? How does consciousness relate to the external world? What is the unity of consciousness?

Chalmers, David J.. The Character of Consciousness (Philosophy of Mind) (p. xi). Oxford University Press. Kindle Edition.