What Are We Trying to Sustain, Anyway?

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SEFS Seminar

18 May 2016

Buzzword

- Robert Solow: “It is very hard to be against sustainability. In fact, the less you know about it, the better it sounds. The questions that come to be connected with sustainable development or sustainable growth or just sustainability are genuine and deeply felt and very complex. The combination of deep feeling and complexity breeds buzzwords.”

Sustainability is Like God (1)

- We can't really know what it is—Apophatic theology. Sustainability is *not:*
  - Using resources at a rate faster than we can replenish
  - Rendering things unusable by poisoning and polluting
  - Extinguishing species
- But what sustainability *is* is hard to say.

A New Word

- 1611: “Sustainable” meaning “bearable, endurable”
- 1845: “Sustainable” meaning “able to be upheld as a point of law,” as when the defense attorney shouts “objection” and the judge says “sustained”
- 1972: First use of “sustainability”
- 1972: First use of “sustainable development” but seems to be used in the sense of sustaining the development, rather than conserving the natural resources as one develops.

Oxford English Dictionary

Question: Why Now? Will return to that soon.

Some Negative Definitions

- OED: "Of, relating to, or designating forms of human economic activity and culture that do ***not*** lead to environmental degradation, esp. avoiding the long-term depletion of natural resources." Notice: "environmental degradation," "long-term depletion of natural resources." *What sustainable is not,* apophatic theology.
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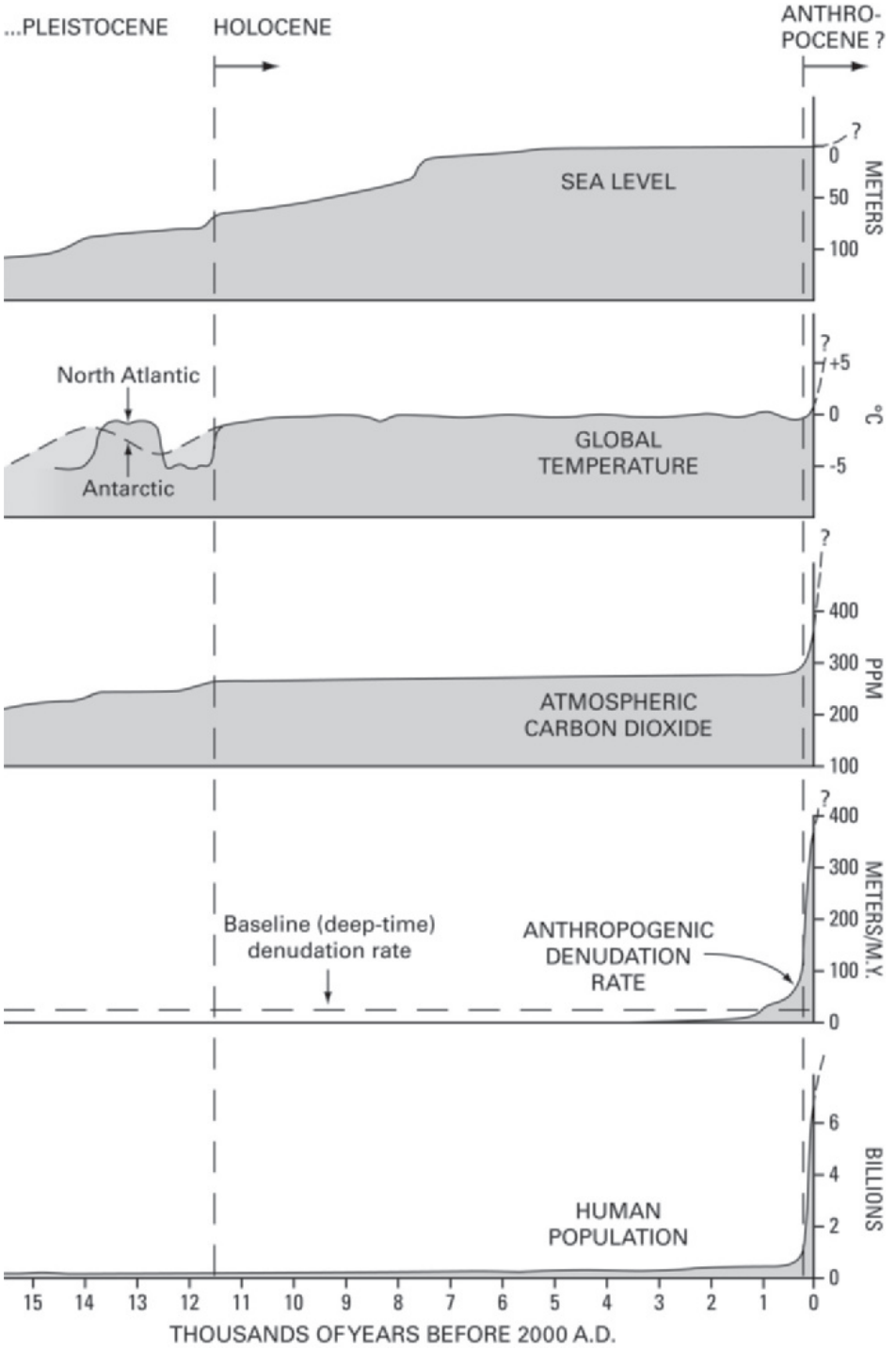
David Orr's Challenges: Thinking About What is not Sustainable and Why

- Ongoing militarization of the planet
  - Because it will eventually blow up
- A world with large numbers of desperately poor people
  - Because they will disrupt the social order
- The perpetual enlargement of the human estate
  - Because it will run up against carrying capacity
- Unrestricted development of any and all new technology
  - Because it brings unknown risks
- A world divided by narrow, exclusive, and intense allegiances to ideology or ethnicity
  - Because there is no compassion for common problems
- Unrestrained automobility, hedonism, individualism, and conspicuous consumption
  - Because they take more than they give back
- A spiritually impoverished world
  - Because it will corrode our belief that anything is worth sustaining
- So we know what we're supposed to be *not doing*. Is that enough? And why now?

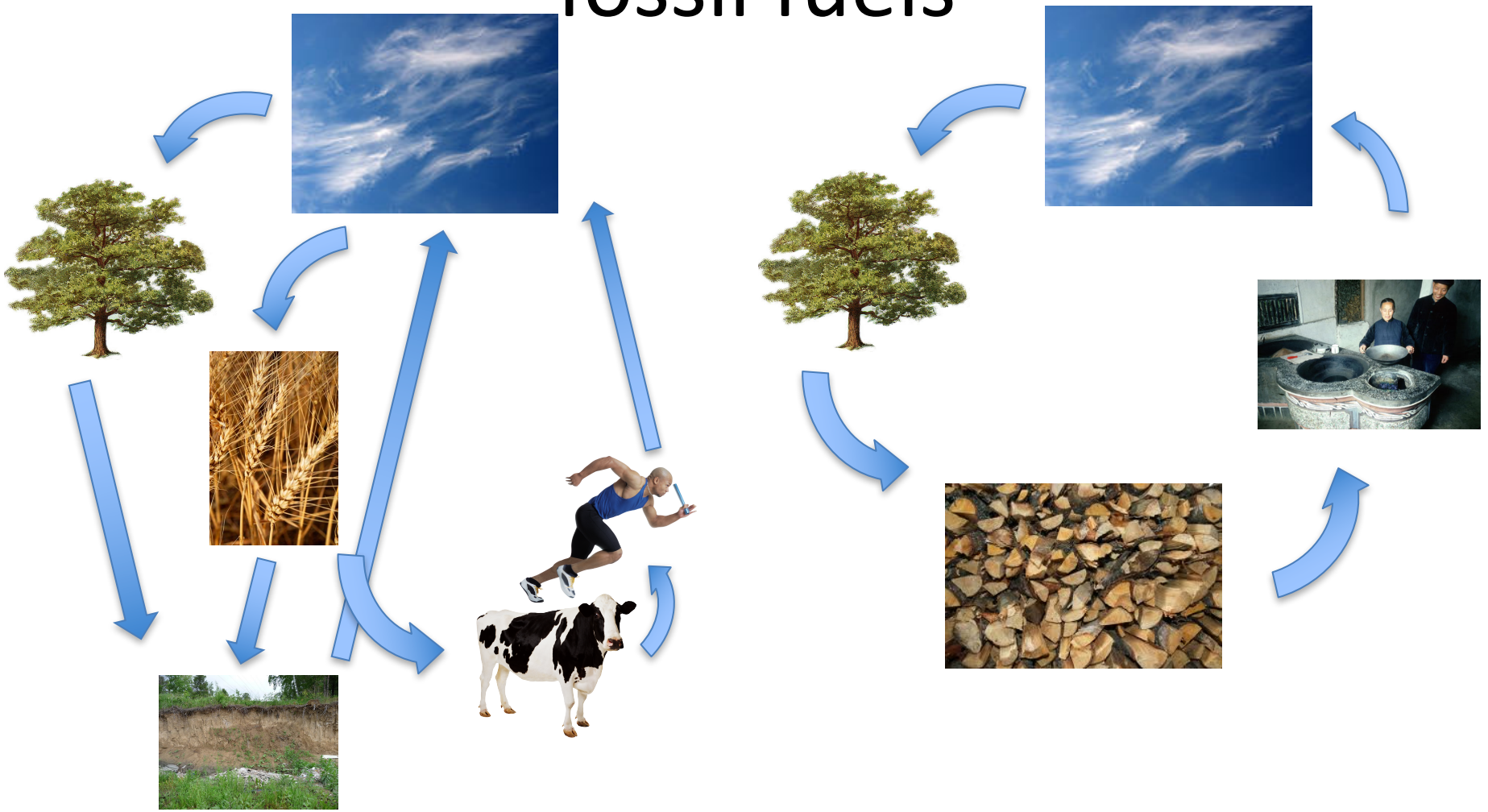
Why Now? The beginning of the anthropocene?

Orr: The perpetual enlargement of the human estate

Ehrlich and Holdren: I=PAT

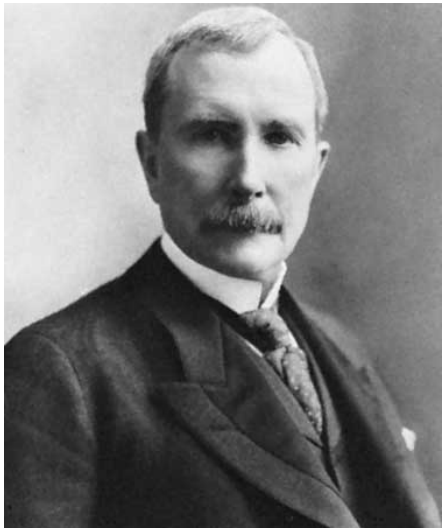


Energy Sources: Living biomass vs. fossil fuels



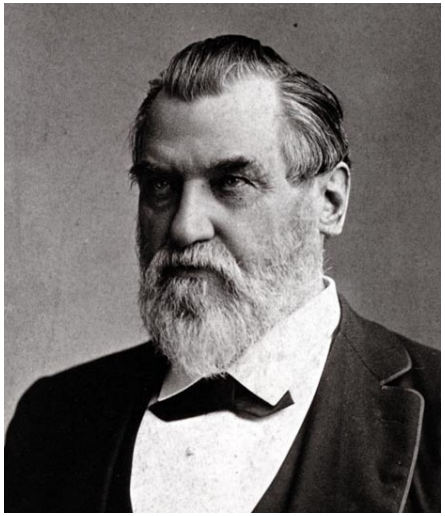
Living biomass vs. fossil fuels

What Fossil Fuels Allowed us to Have: Industrial Capitalism

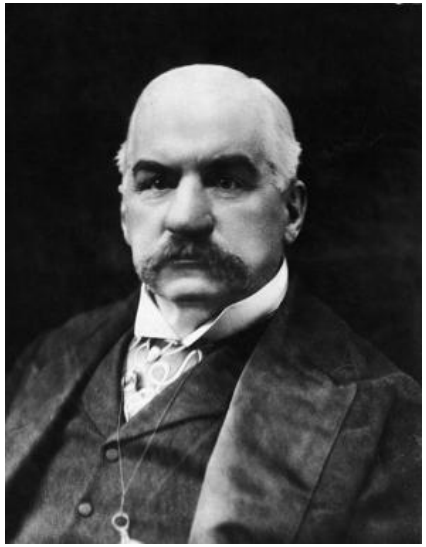


John D. Rockefeller

Andrew Carnegie



Leland Stanford

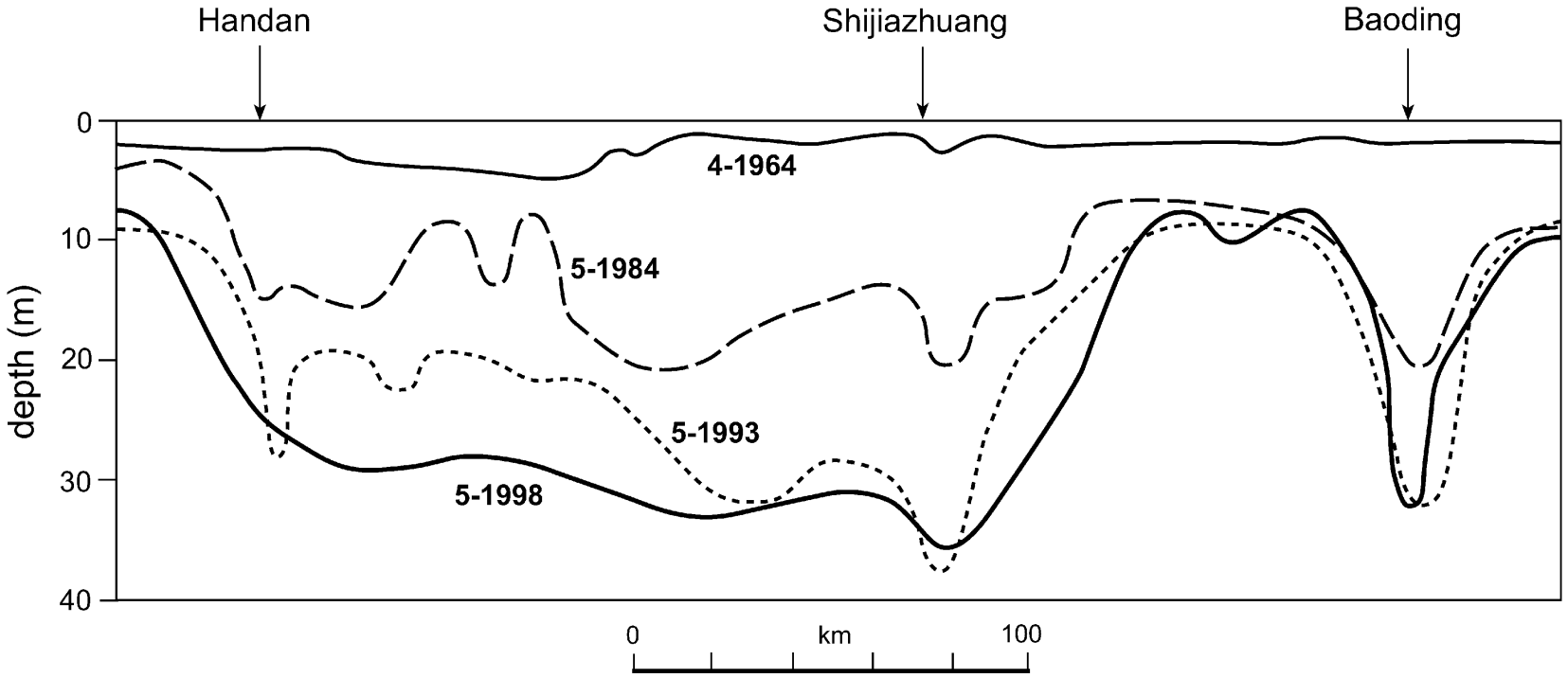


J. P. Morgan

Can you name any of these gentlemen before I give you the answers?

What fossil fuels also allowed us to have for awhile: state socialism

Global Scale Changes: Loss of Resources: Groundwater



Falling water table of the North China Aquifer

Others: Oglalla Aquifer in US Midwest,
North Saharan Aquifer System, etc

Loss of Resources: Biodiversity

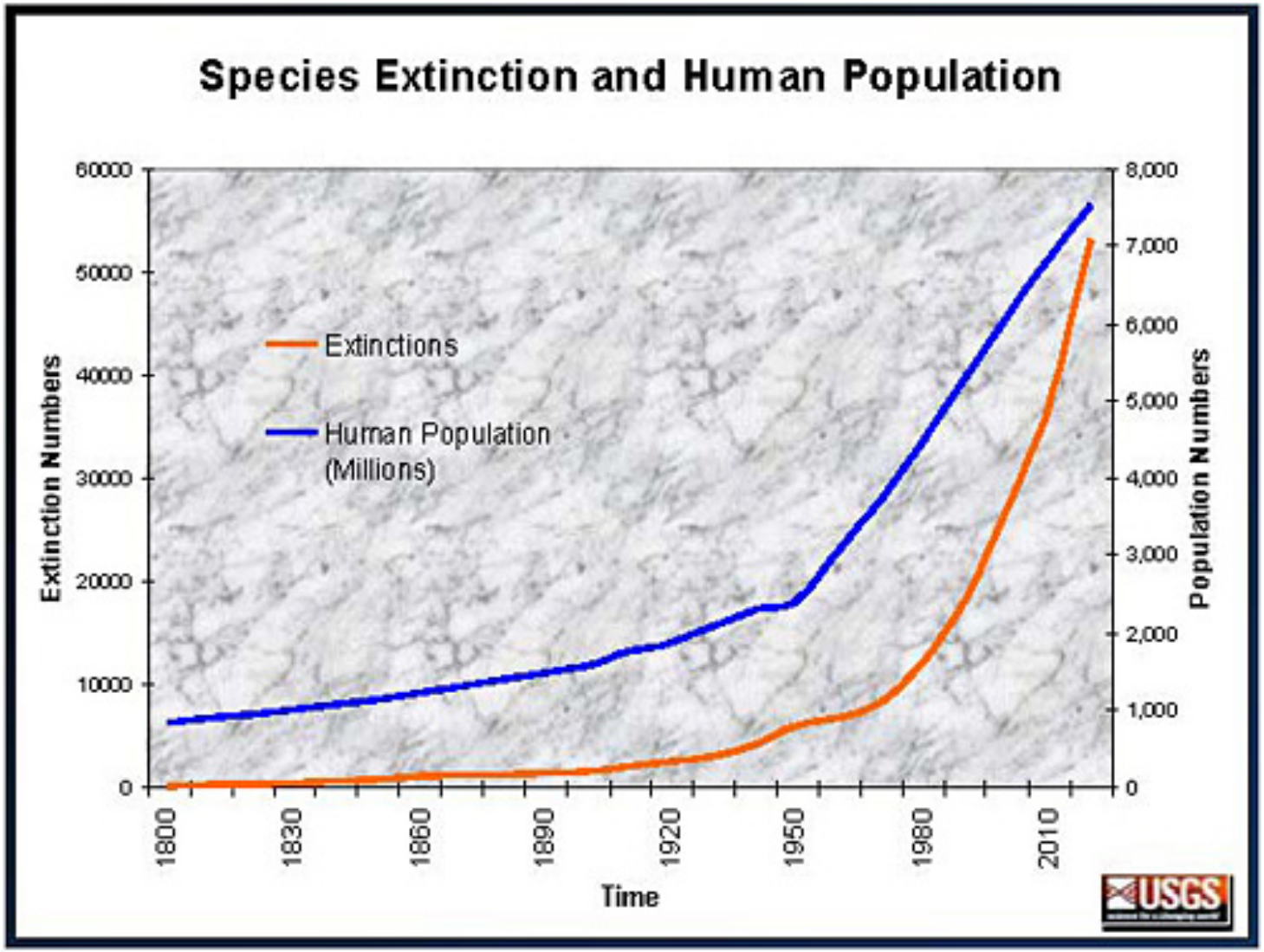
Baiji，白鱀豚，the Chinese River Dolphin, declared extinct 2006

Dodo

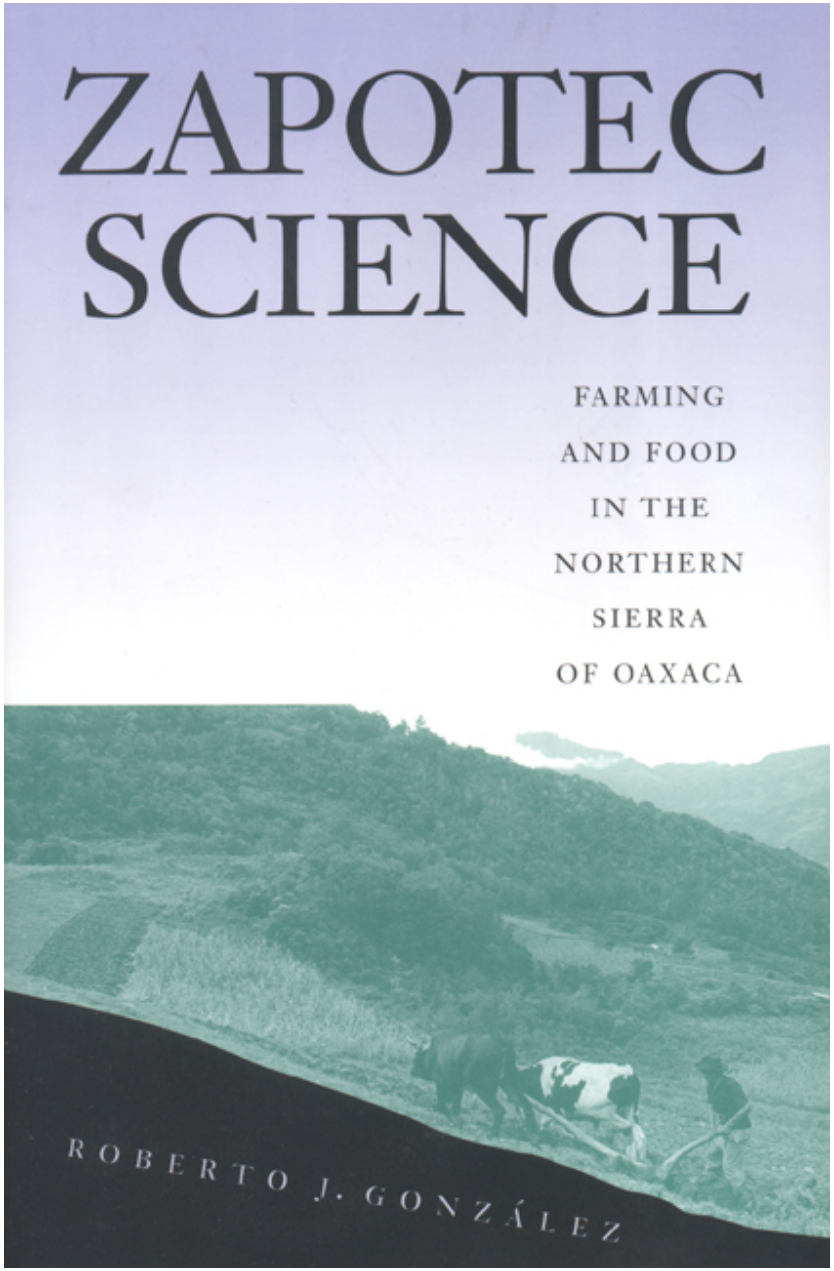
Passenger Pigeon

Anthropocene Extinctions

Extinctions in recent times



Loss of Resources: Knowledge



Turning from the negative to the positive: In this situation of rapid change, what are we trying to sustain, anyway?

- Some substantive candidates
  - Valuable or essential resources
  - The current state of the planet
  - Development or growth
  - Social ecological system resilience
  - A habitable earth
  - Human life
  - A just human world

- All of these are desirable by some criteria, but having them as goals involves different kinds of thinking

Sustainability is like a Water Weenie:
We still haven't defined what it is, but..

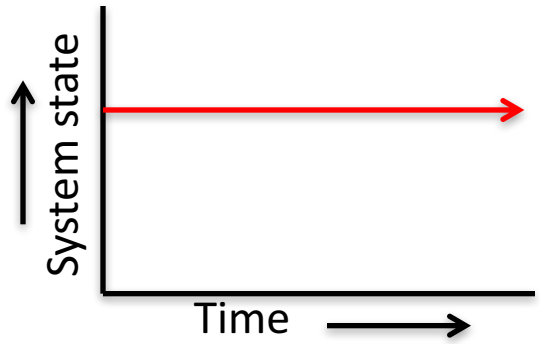
Sustainability is Like God (2)

- To paraphrase Voltaire:
- Si la durabilité n'existait pas, il faudrait l'inventer

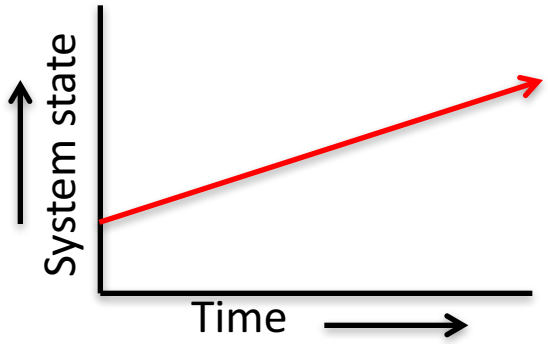
What Are We Trying to Sustain, Anyway?

Some Conceptual Categories

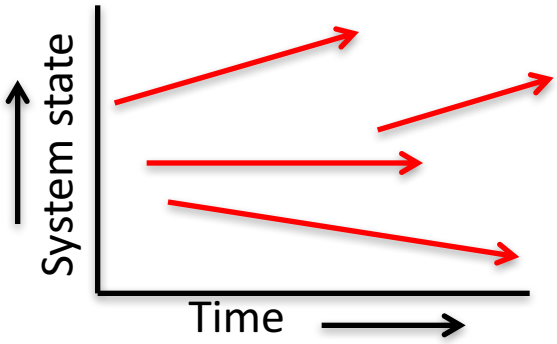
- A state of things
  - Renewable resource extraction
  - A social system
  - A range of planetary temperature



- A process
  - Development
  - Growth
  - Social progress



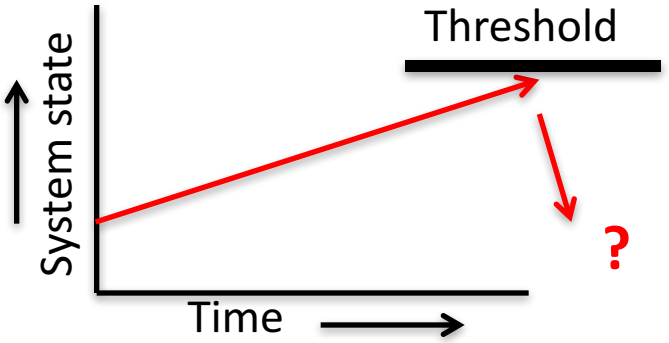
- A possibility
  - Options for the future
  - The ability to consider sustainability



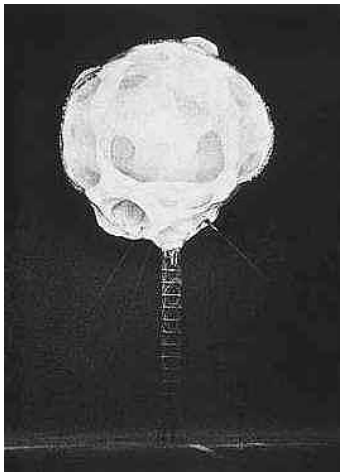
Two ways to think of sustainability

- Keeping the system intact (a state of things *or* a process)
  - Holocene stability domain (largest scale)
  - Sustainable quantities of renewable resources
  - Reasonable quantities of unrenewable resources
- Staying within boundaries (a set of possibilities)
  - Not crossing thresholds leading to abrupt change
  - We may not know until it is too late

Sustaining current processes, it is highly unlikely that we will be able to do either of these things for very long.



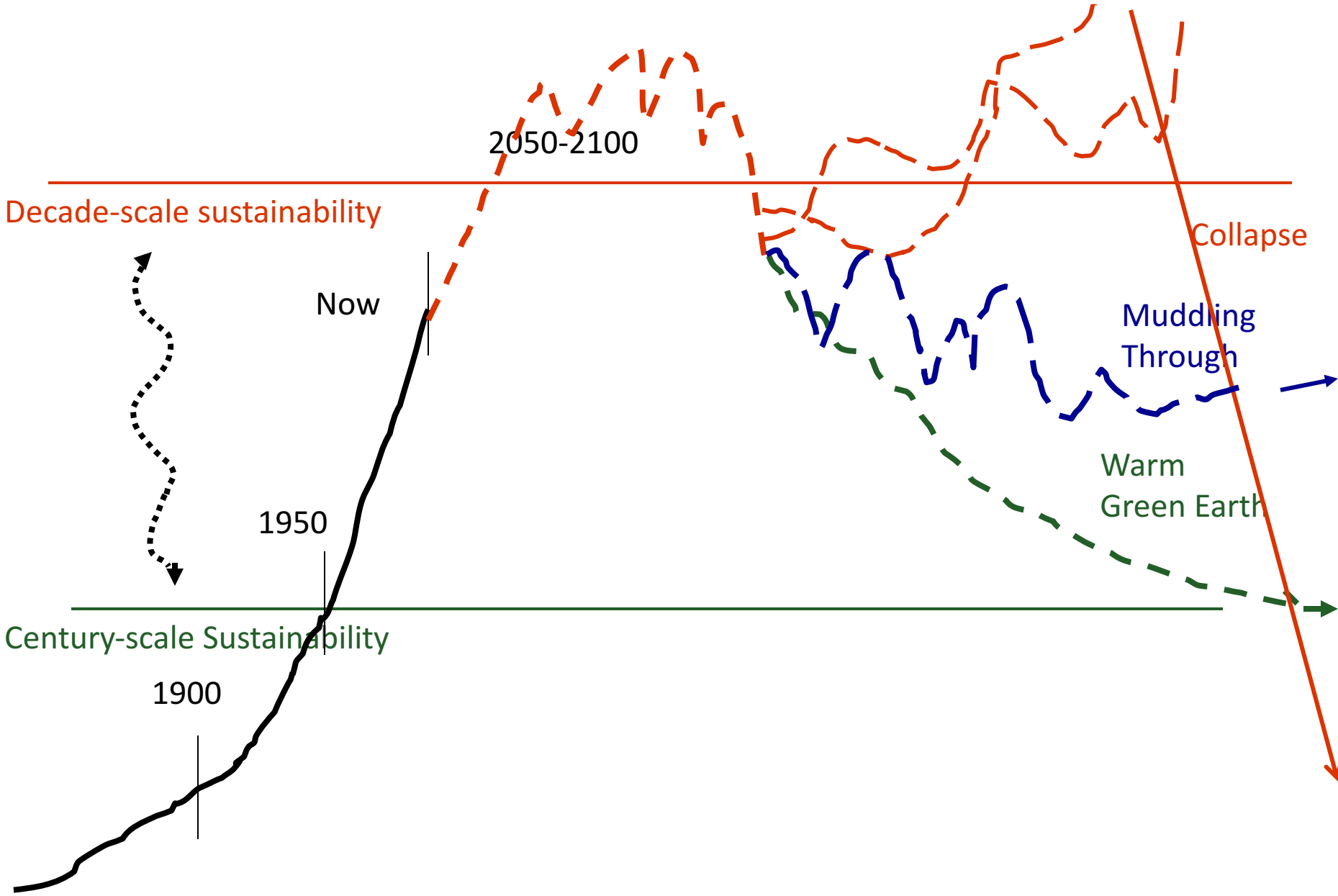
So how long is “very long”?



- Anything is sustainable for a short time:
  - The first burst of a nuclear weapon: 3 milliseconds

- Nothing is sustainable forever
  - Life on earth: another 1.75 to 4 billion years
- We need to think of a *meaningful* time scale [Ethical Time Horizon?]

Time horizons



Evidence for Century-Scale sustainability at the turn of the 20th century

- Population: 1.65 Billion
- Surface temperature
- Atmospheric CO_2
- Arctic Sea Ice and glacial change
- Ocean pH: no direct evidence, but well within Holocene range

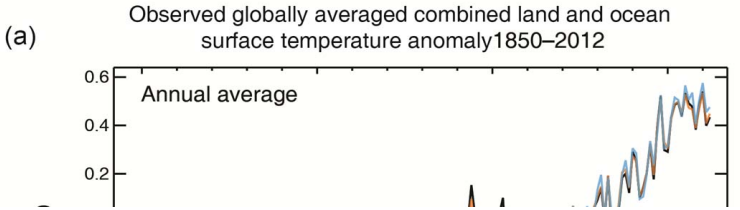
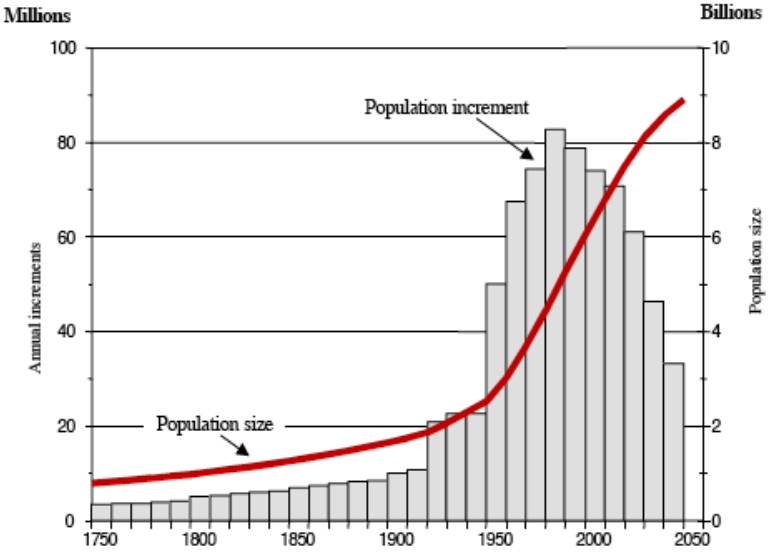
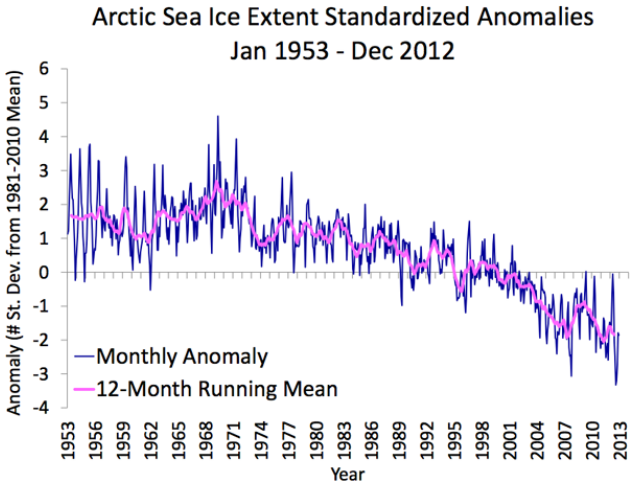
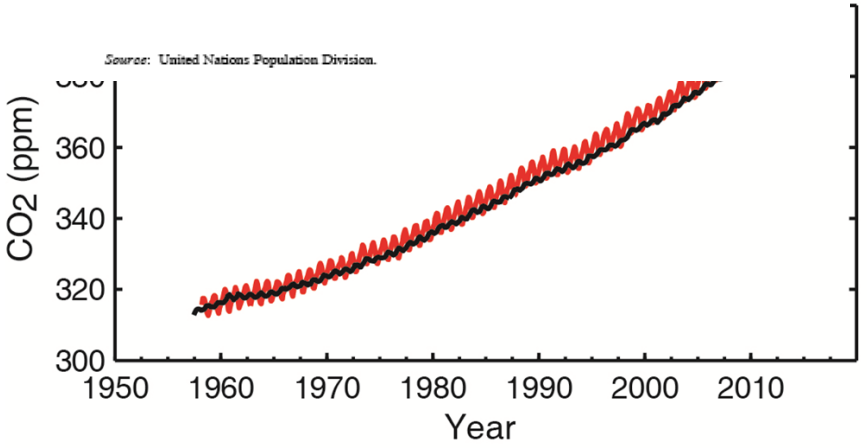


Figure 1. Long-term world population growth, 1750 to 2050



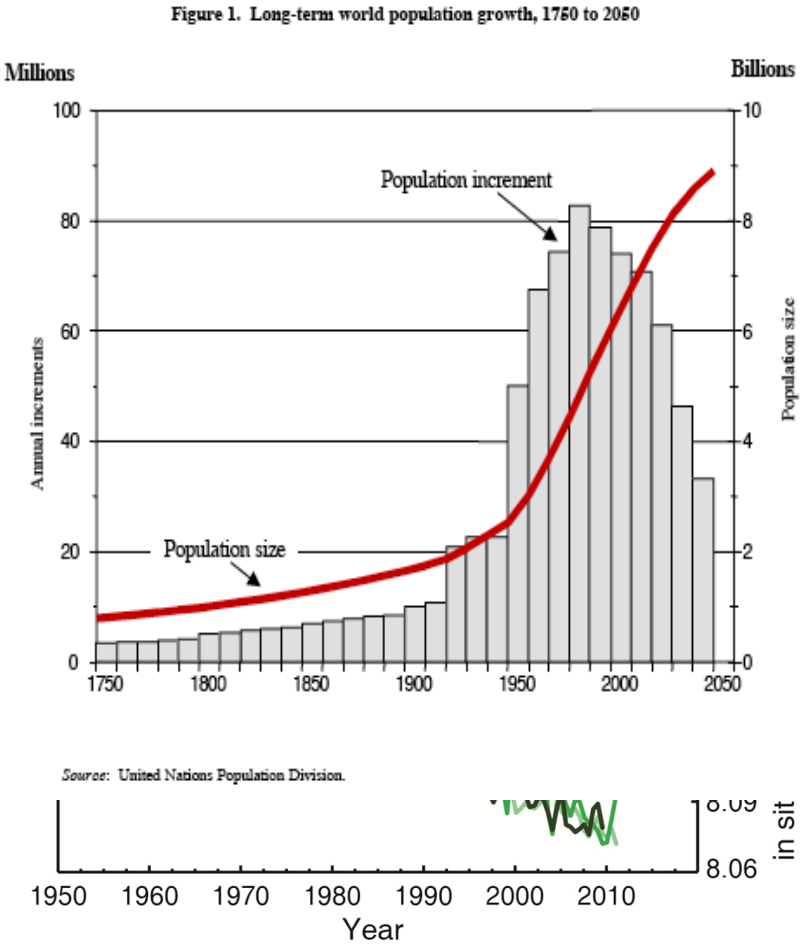
Source: United Nations Population Division.





Evidence for lack of Century-Scale sustainability at the turn of the 21st century

- Population: 7.4 Billion,
- Atmospheric CO_2
- Arctic Sea Ice and glacial change
- Ocean pH
  - Coordinated observations show decline since 1982, approximately -.1 (Bates et al. *Oceanography* 2014)
  - Projections of undersaturation in S. Oceans by 2050 (Orr et al. *Nature* 2005) "Our findings indicate that conditions detrimental to high-latitude ecosystems could develop within decades, not centuries as suggested previously."



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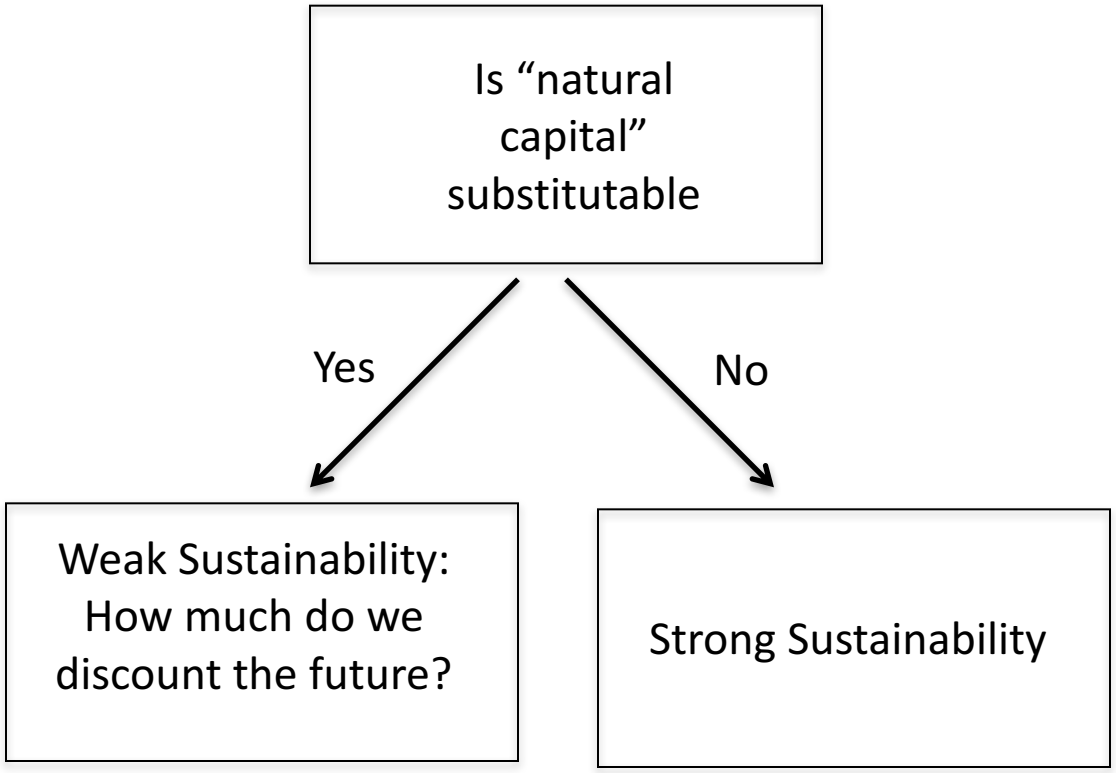
- Solow: sustainability is “An obligation to conduct ourselves so that we leave to the future the option or the capacity to be as well off as we are.”

So, how do we meet this obligation?


Robert Solow

Strong vs. Weak Sustainability: The Linear Mode

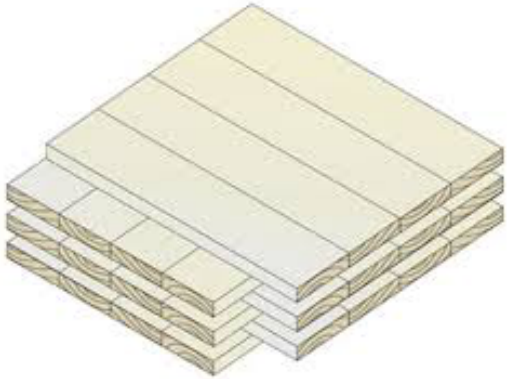
Eric Neumayer



Hold that thought for a minute while we go to resilience: the non-linear mode

Weak sustainability and substitution

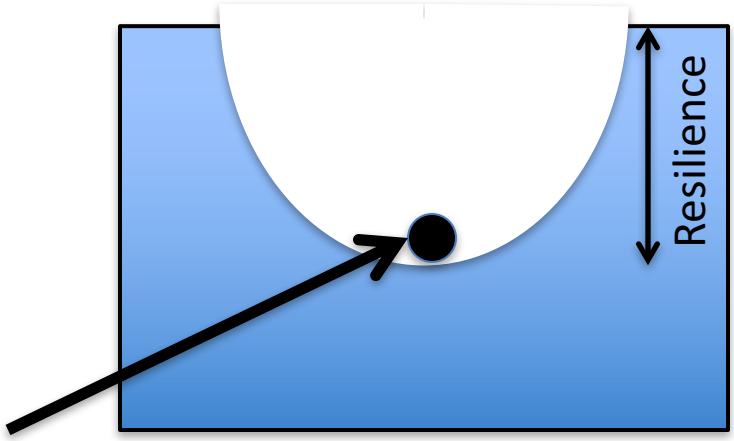
- CLT for regular boards
- Wind power for fossil fuels
- Plastics for minerals
- Vitamin pills for food

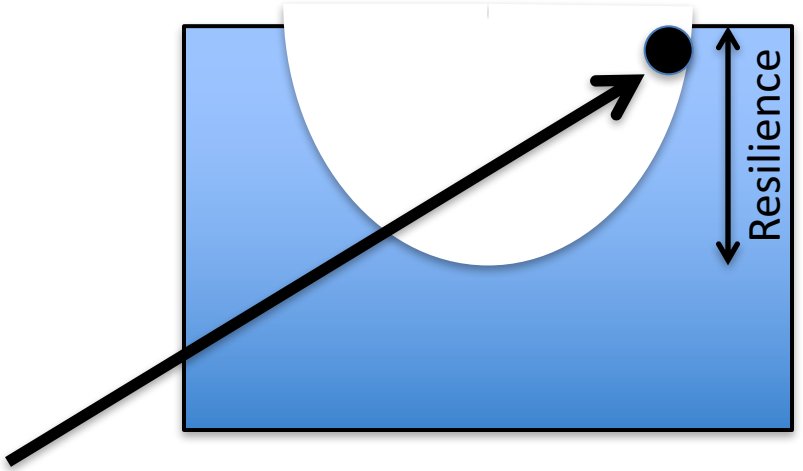


Linear vs. threshold worries

- Linear worries: Trying to keep some variable (global temperature, availability of food, availability of building materials) within a range where it
  - Does not affect the social-ecological system much
  - Can be restored to its previous value
- Threshold worries: trying to avoid crossing a line where there is abrupt, qualitative change and it
  - Has major systemic effects
  - Displays hysteresis
- Resilience as the ability to stay within a desirable range or avoid crossing a threshold

Resilience: Disturbance and slow variables





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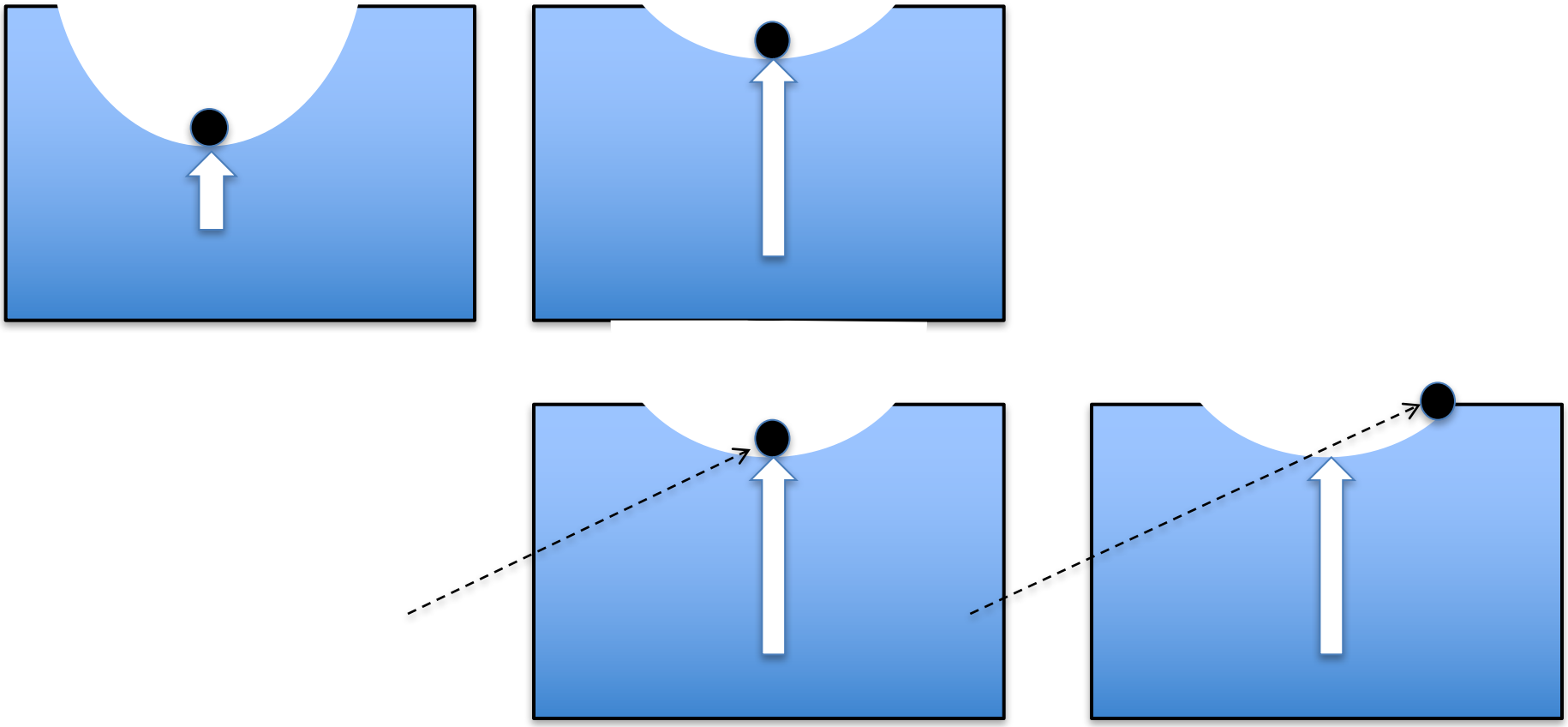
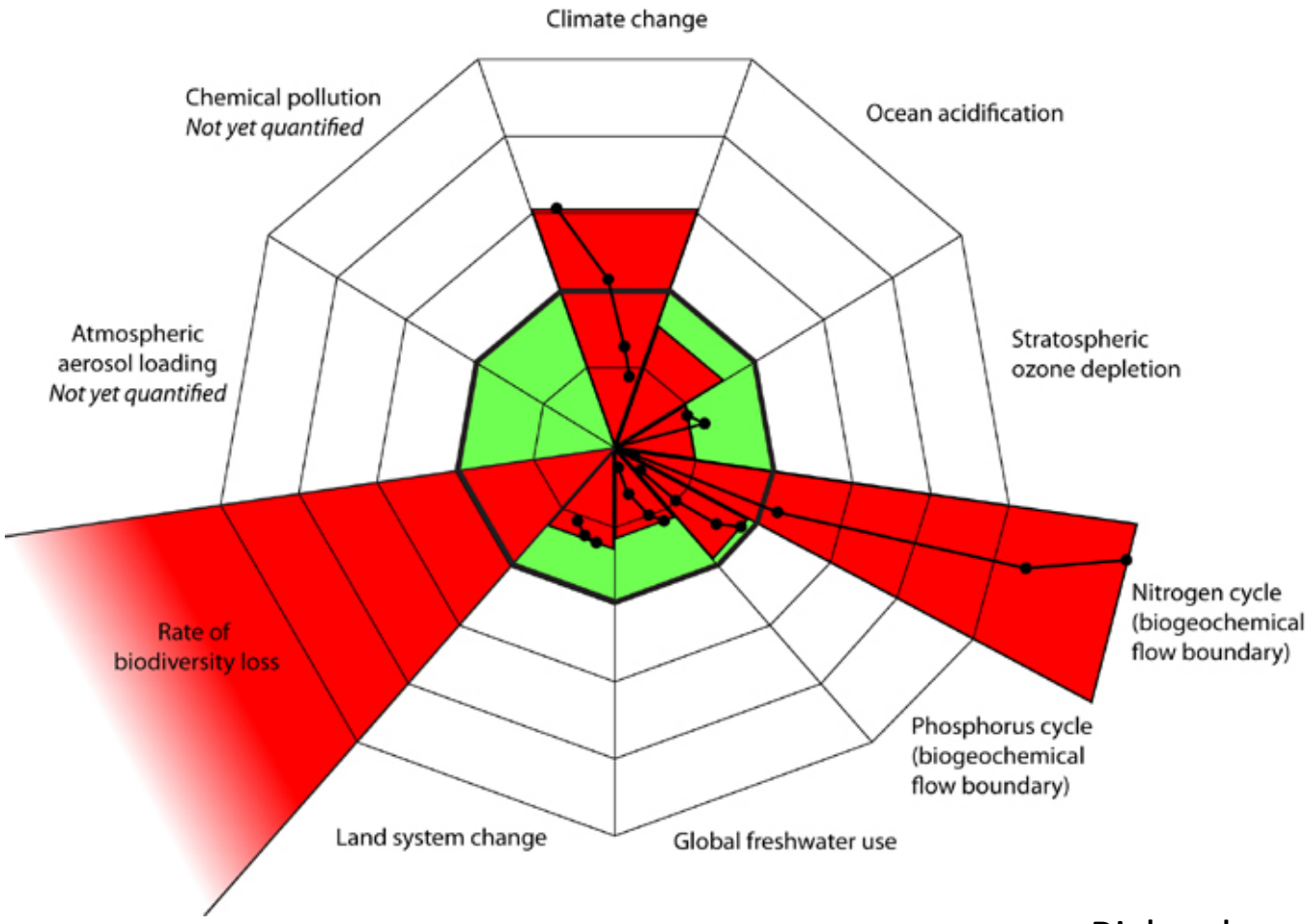


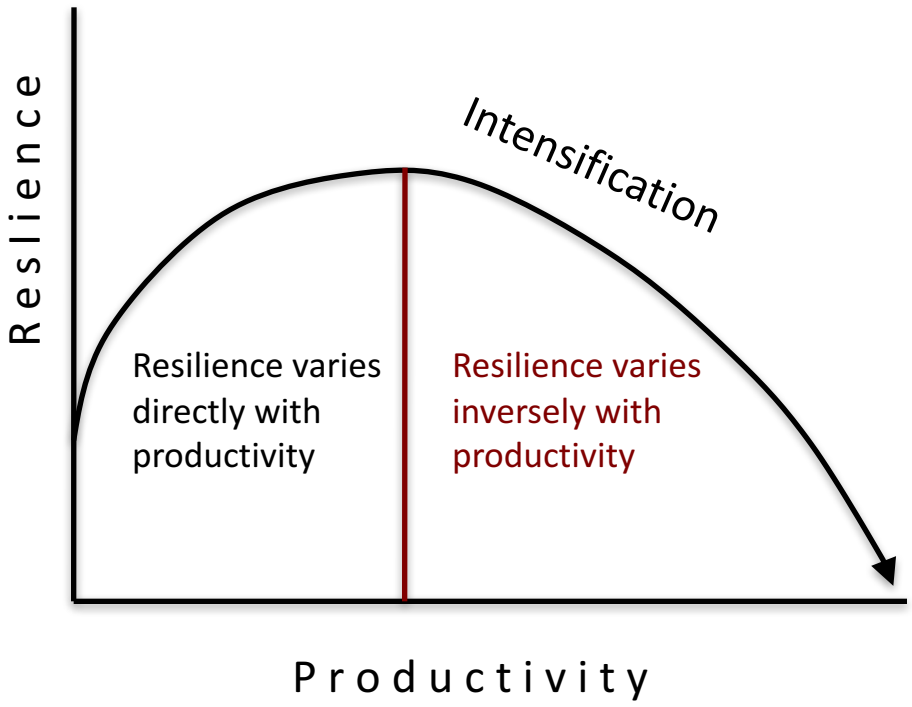
Planetary Boundaries: Another threshold approach



"Safe operating space for humanity

Richardson et al. 2009

Waterworks as illustration of the curvilinear relationship between productivity/intensification and resilience



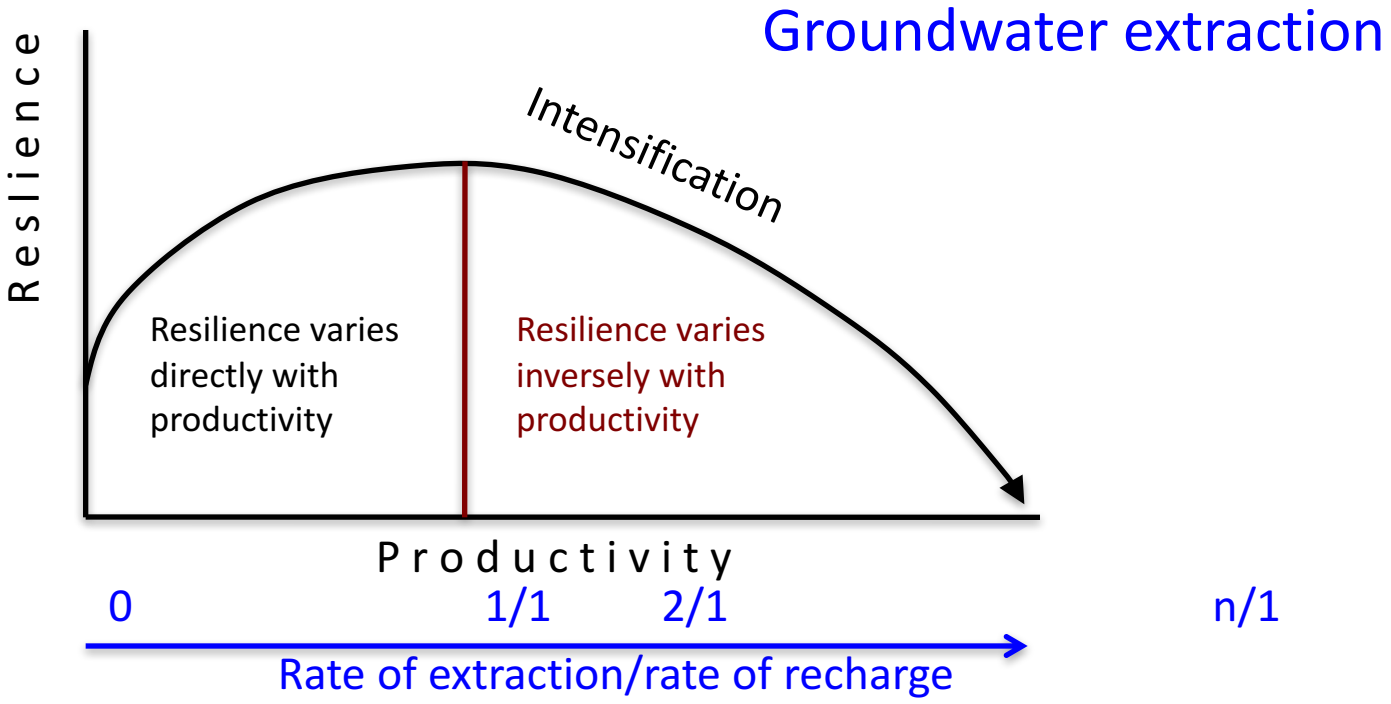
Start with irregular rainfall
Build a reservoir
Reservoir contains excess in big storms
Reservoir retains water in droughts
Natural events don't become disasters
Harvests become more reliable

Reclaim more land
Reservoir can't release water, exceeds capacity
Community more dependent on lands that will flood
Natural events become disasters

"Perpetual Enlargement of the Human Estate"

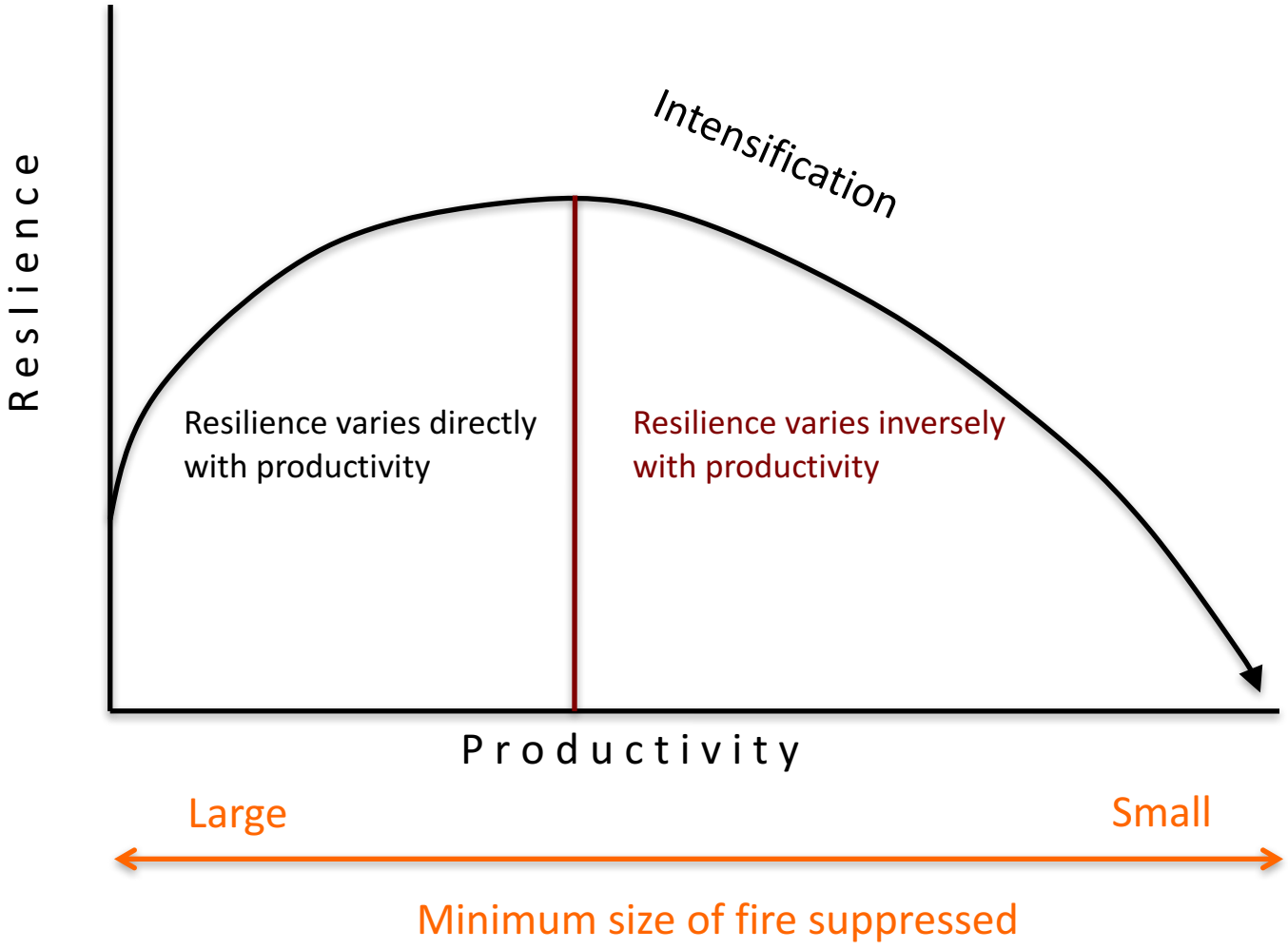
Renewable Resource Use: Tieing it together with an "Easy" Problem:

- Maximum sustainable yield = Strong sustainability
- But: We need to consider thresholds when figuring the maximum
- And: The more we exceed the maximum, the more likely we are to experience hysteresis.



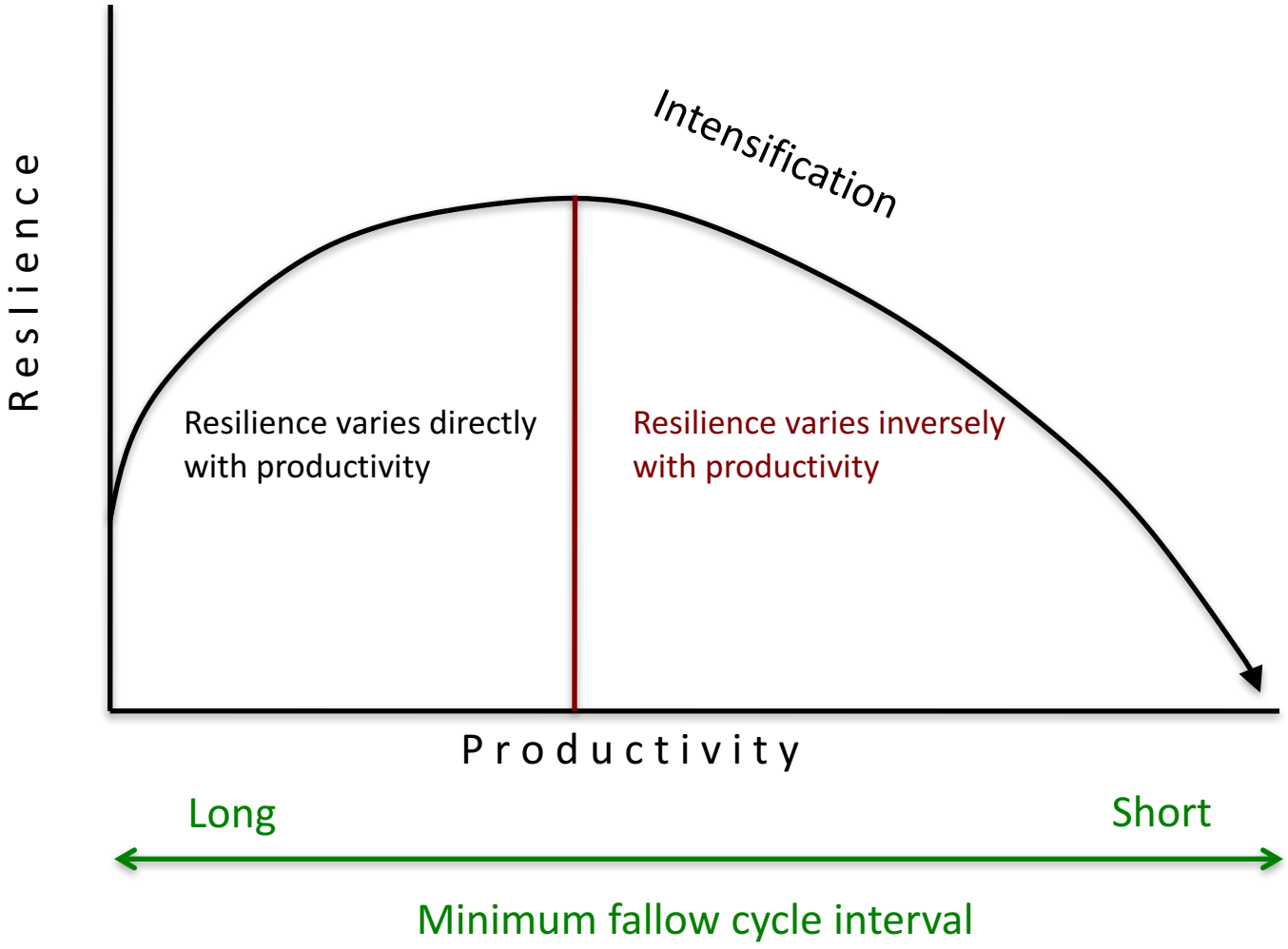
Discounting and thresholds

Fire suppression

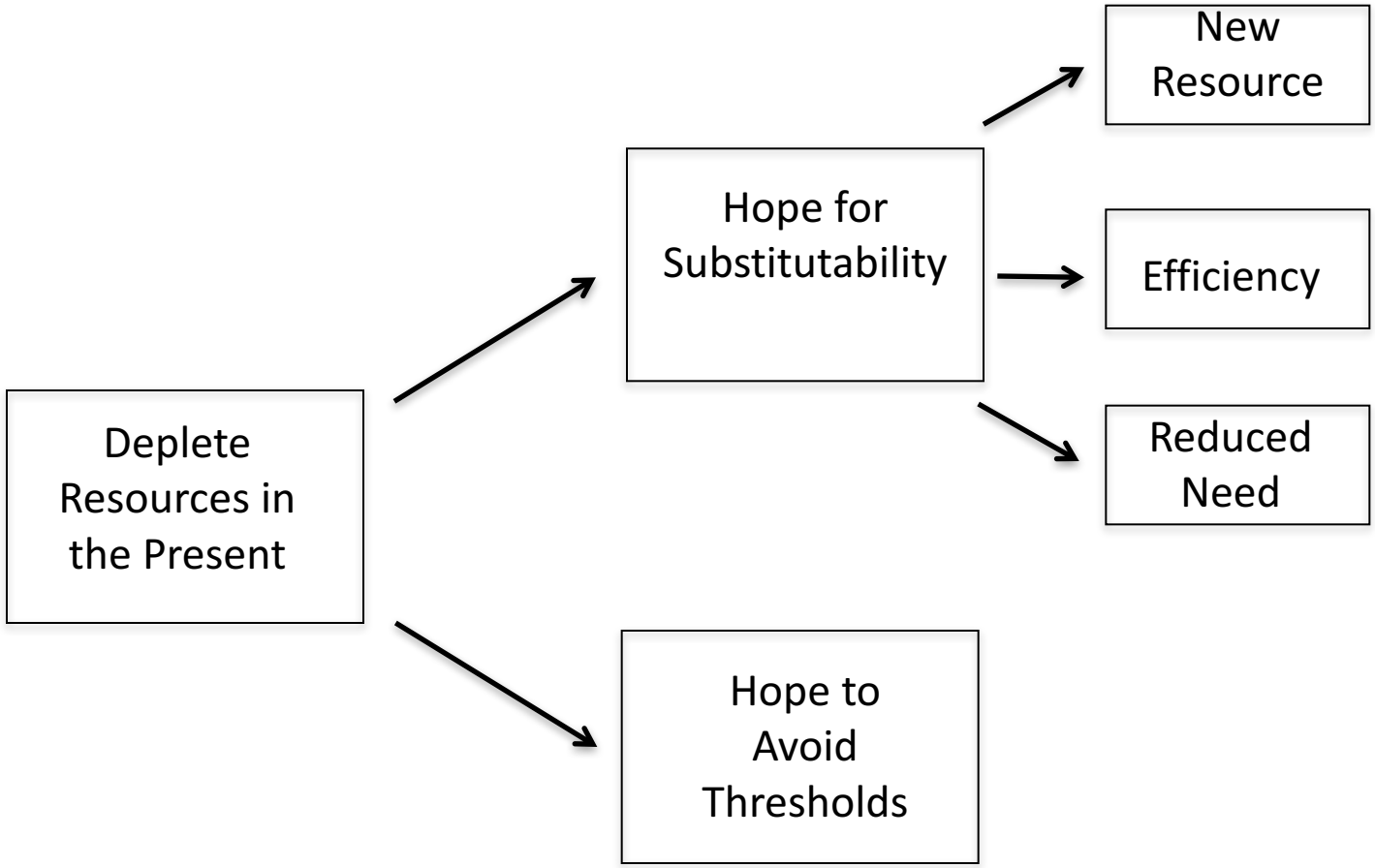


Discounting and thresholds

Swidden Agriculture

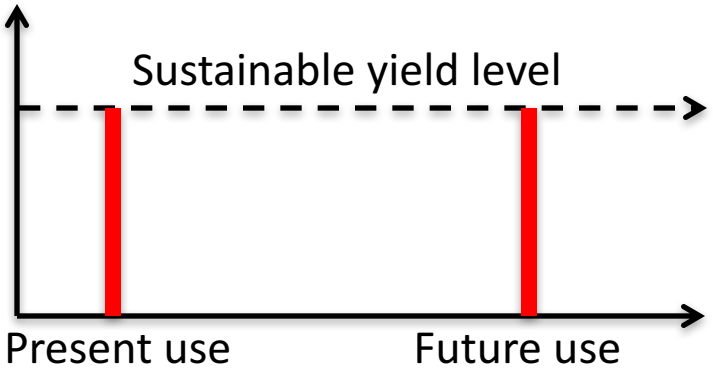


Temporal Tradeoffs



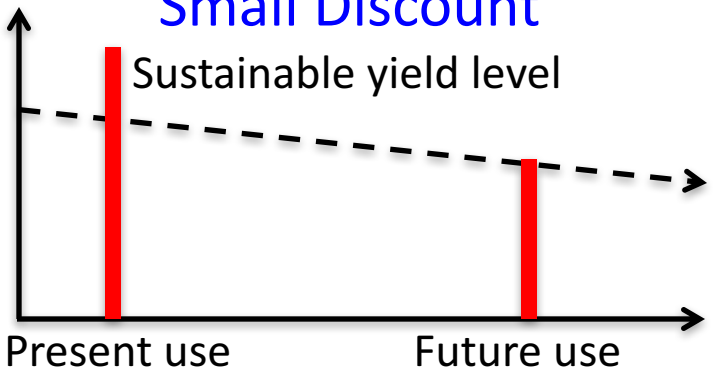
Temporal Tradeoffs (Discounting)

Strong Sustainability
No Discount

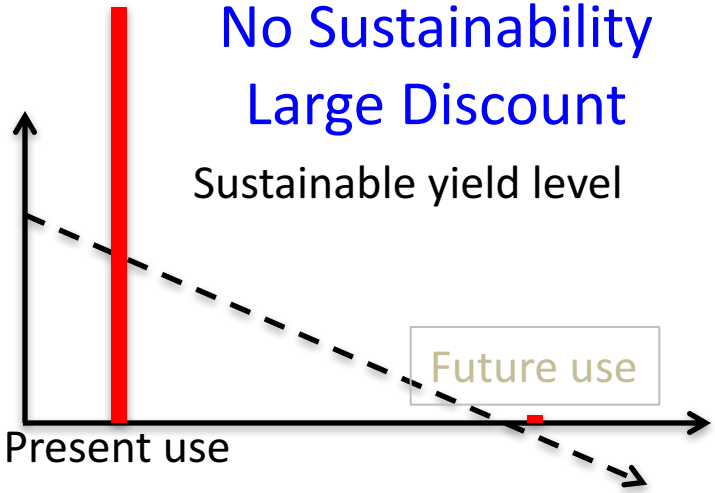


Brundtland Report, Sustainable development; "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

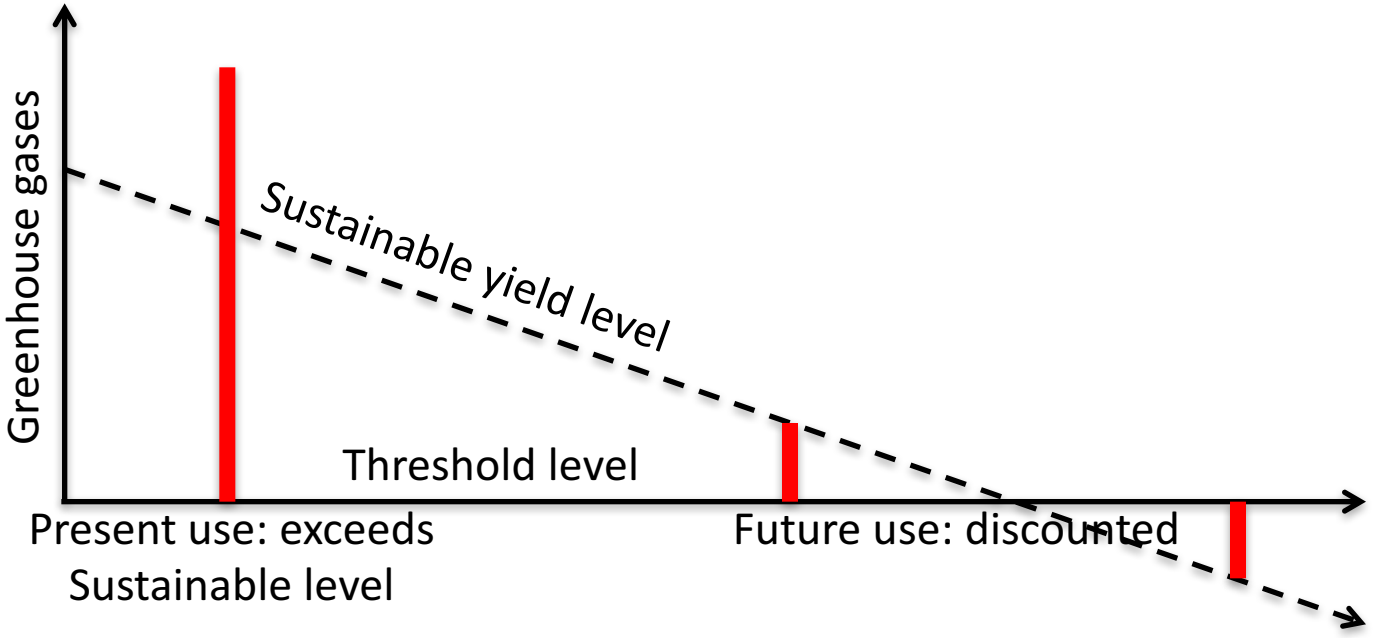
Weak Sustainability
Small Discount



No Sustainability
Large Discount



What we're doing to atmospheric temperature with fossil fuels



How do we know we're near a threshold?

- Critical slowing down
- Increasing variability

Table 1. Studies of early-warning indicators for critical transitions in different complex systems. (+) Cases in which early warning signals were detected by indicators; (0) cases in which transitions were not preceded by indicators; (–) cases of unknown or opposite effect.

Field	Phenomenon	Indicator	Signal	References
Chemistry	Critical slowing down	Recovery rate/ return time	+	(*39*)
Physics	Critical slowing down	Return time/ dominant eigenvalue	+	(*40*)
		Rate of change of amplitude	+	(*41*)
Engineering	Critical slowing down	Autocorrelation at lag 1	+	(*42*)
Tectonics	Not specified	Autocorrelation/ spatial correlation	+	(*43*)
Climate	Critical slowing down	Autocorrelation at lag 1	+	(*23, 44, 45*)
			0	(*44, 46*)
		Detrended fluctuation analysis	+	(*27, 44*)
			-	(*44*)
	Increasing variability	Variance	+	(*44*)
			0	(*44, 46*)
	Skewed responses	Skewness	0	(*47*)
Ecology	Critical slowing down	Return time/dominant eigenvalue	+	(*22, 48–50*)
		Autocorrelation at lag 1	+	(*22*)
		Spectral reddening	0	(*48*)
		Spatial correlation	+	(*48, 49, 51, 52*)
	Increasing variability	Variance	+	(*48, 49, 52, 53*)
			0	(*22, 54*)
		Spatial variance	+	(*48, 49, 55, 56*)
	Skewed responses	Skewness	+	(*48, 49*)
Microbiology	Critical slowing down	Autocorrelation at lag 1	+	(*57*)
		Variance	+	(*57*)
		Return time	+	(*57*)
		Skewness	0	(*57*)
Physiology	Critical slowing down	Recovery rate/ return time	+	(*58*)
Epilepsy	Critical slowing down	Correlation	+	(*59, 60*)
	Increasing variability	Variance	+	(*61*)
Behavior	Critical slowing down	Recovery rate/ return time	+	(*62, 63*)
Sociology	Critical slowing down	Autocorrelation at lag 1	+/0	(*64*)
		Variance	+/0	(*64, 65*)
		Fisher information	+	(*66*)
Finance	Not specified	Correlation	+	(*60*)
	Not specified	Shannon index	+	(*67*)
	Not specified	Variance	+	(*68*)

So what are lessons (if any) from all this agonizing amateur philosophizing?

- Precaution: steer clear of potential thresholds
- Research: try to find out how to predict precipices
- Socially responsibility: none of this will do any good unless it gets implemented

Maybe sustainability is "An obligation to conduct ourselves so that we leave to the future the option or the capacity to ~~be as well off as we are~~. Think about sustainability"

Sustainability is Like God (3)

- People worship it