Overgrazing the Earth

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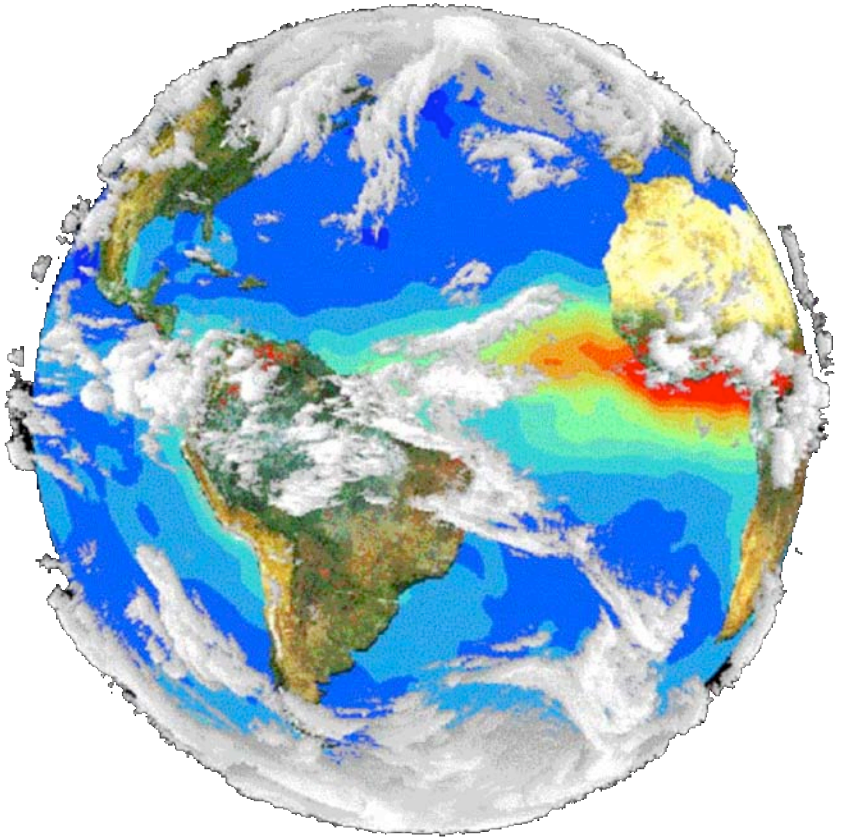
Overview

- *Overgrazing the earth*
- **iPAT**
- *Peak everything*
  - An era of limits
  - Era of consequences
- *Spaceship earth*
  - A new mission?
  - New business models



iPAT

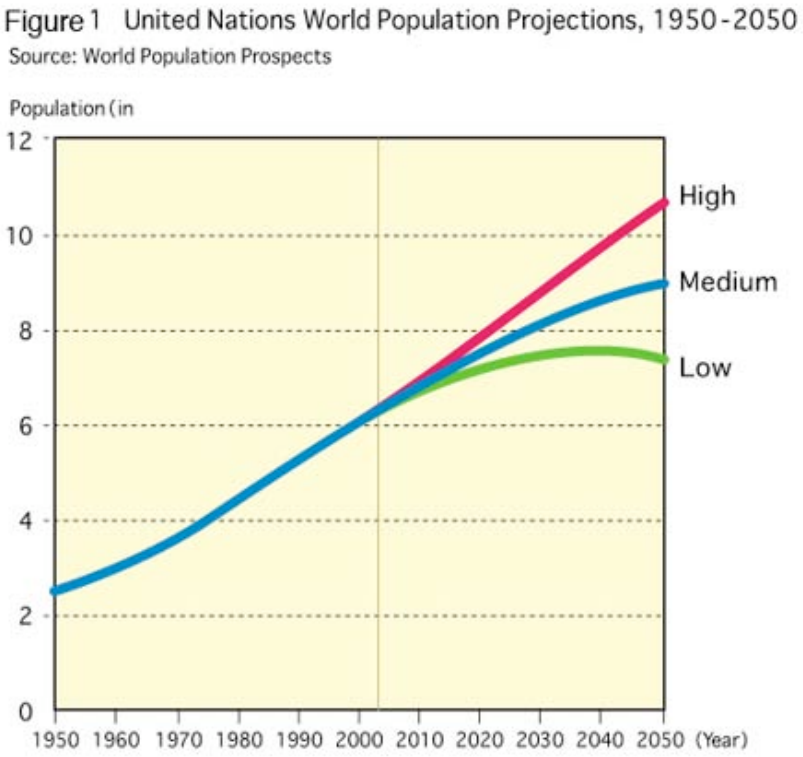
- *I = P*A*T* ***[1]***
- where *I is environmental impact*
- *P is population*
- *A is affluence*
- *T is technology*

- *[1] Proc. Natl. Acad. Sci. USA* Vol. 94, pp. 175–179, January 1997
- *The Sustainable Scale Project* - http://www.sustainablescale.org/

Population

Population Growth

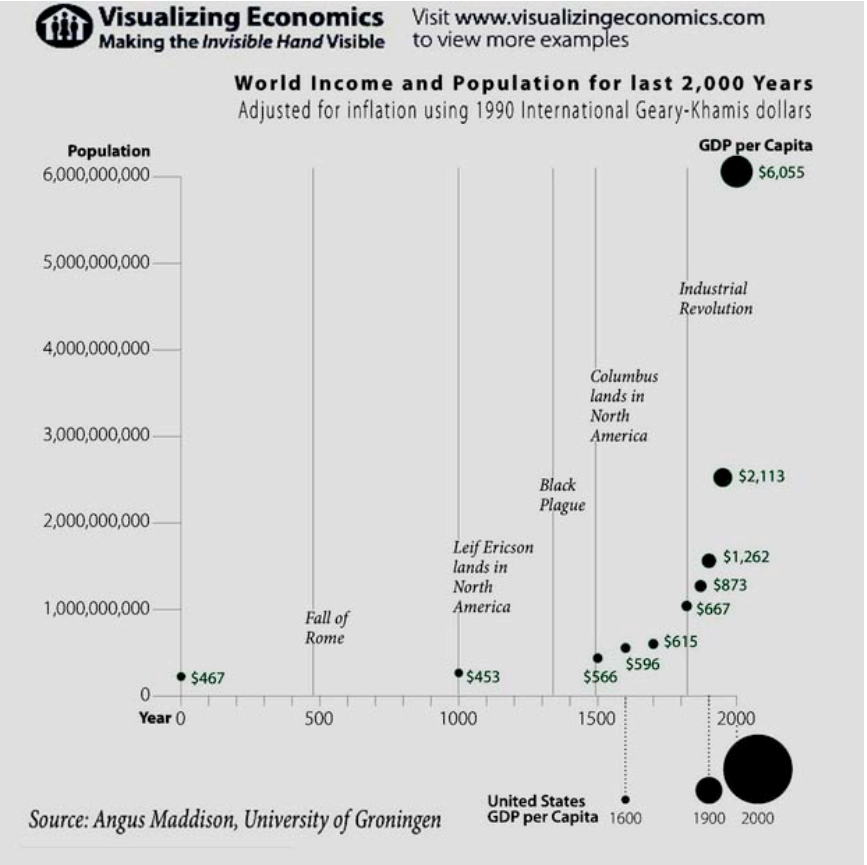
- Population growth has started a process
- Once the developing world gains income to purchase technology,
  - Consumption skyrockets
  - We would need ‘five earths’ to meet demand



Affluence

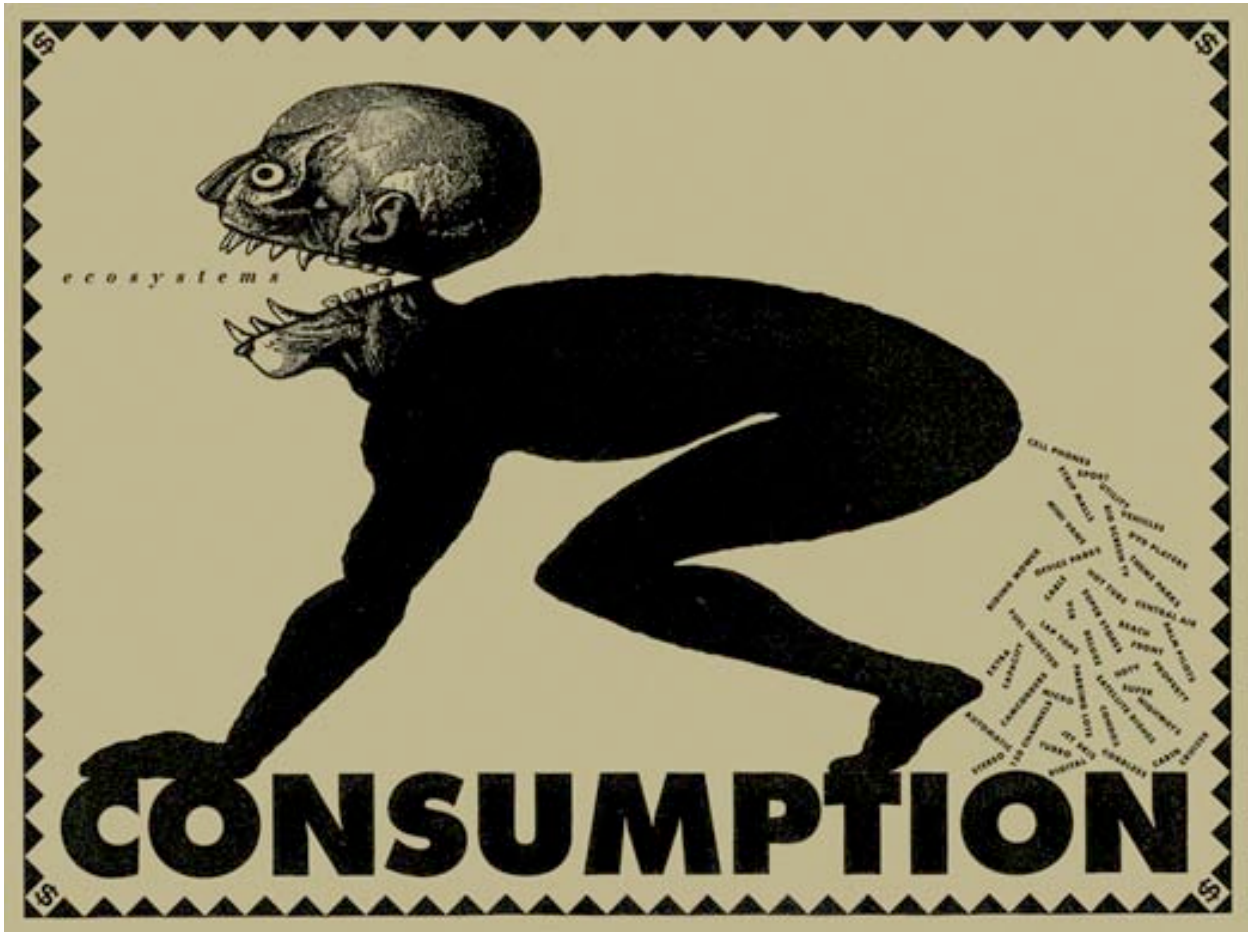
Population / GDP Growth

- Since 1950
  - Average GDP per capita grew by 3x
  - Population grew by 3x
- *Affluence (PPP) has increased almost 10x*
- ***This is the driver of global consumption***



http://www.visualizingeconomics.com/

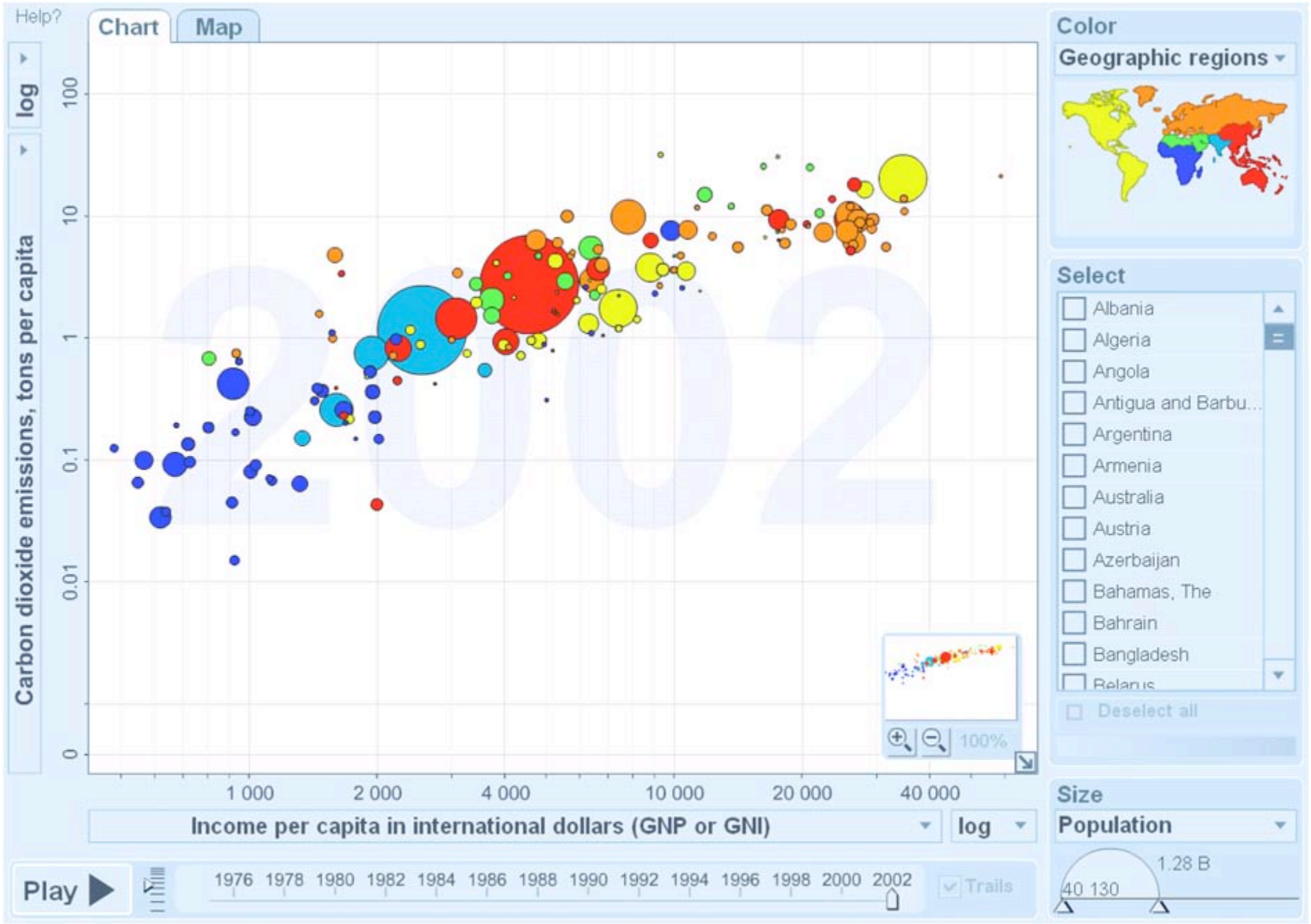
Technology



http://www.wildriverreview.com/

Gapminder

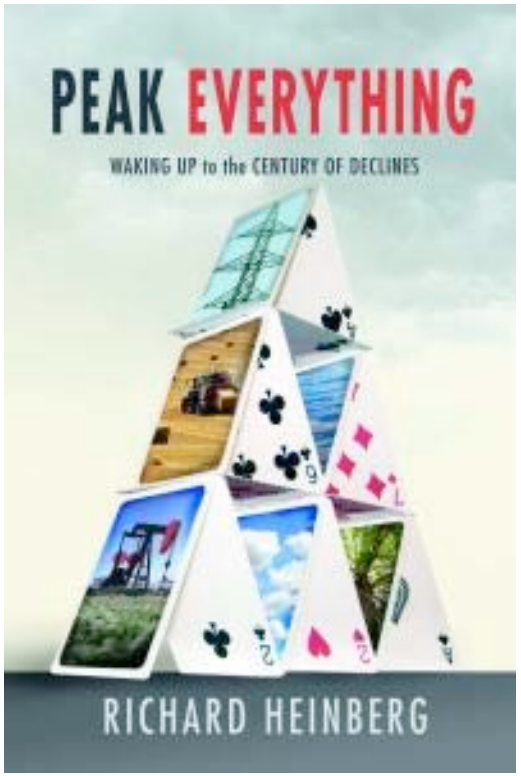
- Trendalyzer data tool
- UN data (160+ nations)
- Logistic plots (log-log)
- Development statistics
  - Indexed against PPP
  - Scroll year by year
  - Compare countries
- ***http://www.gapminder.org/world/***



http://www.gapminder.org/gapminder-world.html

Peak Everything

- Era of limits
- Era of consequences
- Logistic curves
- Population growth
- Development
- iPAT effects
  - energy



http://www.richardheinberg.com/

Peak Oil

- M. King Hubbert's famous 1956 prediction!
  - ***Peak oil production*** around 2004 - 2010
  - After that, more expensive to ***find / refine***
- Economies built on oil / gas will ***struggle***
- ***Not the end of oil, the end of easy oil!***
  - More expensive to find
  - Technically challenging
  - Environmentally damaging
- ***http://en.wikipedia.org/wiki/Peak_oil***

Oil ***Production – Reserves***

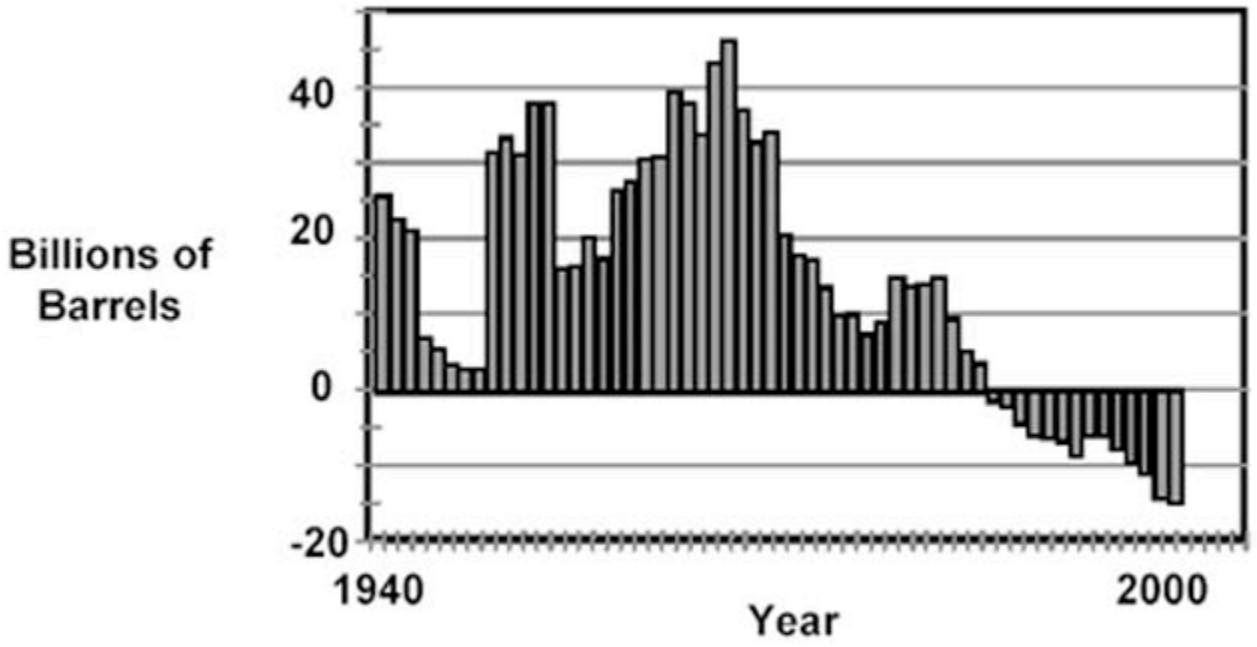
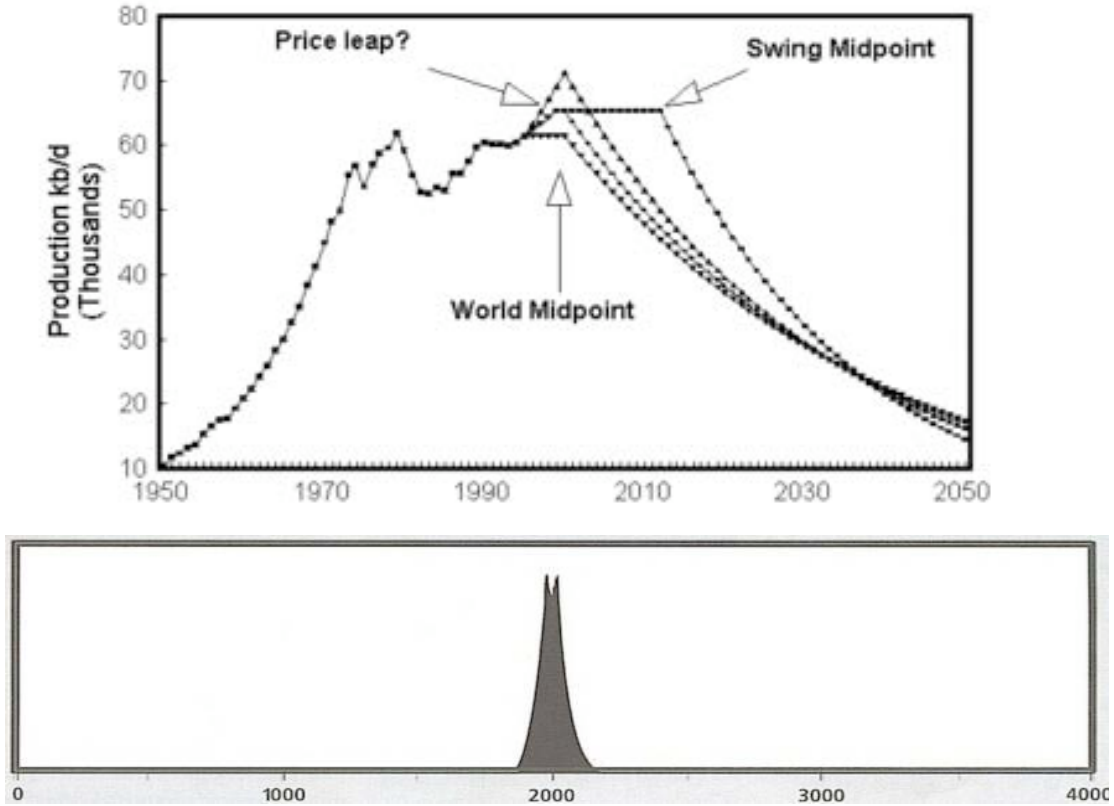


Figure II-1. Net Difference Between Annual World Oil Reserves Additions and Annual Consumption

Data from 'The Inevitable Peaking of World Oil Production', Hirsch, 2005

Peak Oil – ***'After the Crash'***



http://www.lifeaftertheoilcrash.net/

Peak Oil

- Peak oil production is estimated to occur between 2004 – 2011.
- 85 – 90 M barrels / day
- Extended hydrocarbon extraction can occur well into 2025 (if we choose).
- Width of ‘plateau’ is 20-25 years (2007-2030), but tension between demand and supply is significant.

Peak Everything: 8 Things We Are Running Out Of And Why

Peak Soil

- The world is losing soil 10 to 20 times faster than it is replenishing it.
- Soil productivity is in decline – and climate change is affecting soil ecology and chemistry.
- Agrifuel development has not been helpful, nor has poor farming practice, such as use of fertilizers.

Peak Everything: 8 Things We Are Running Out Of And Why

Peak Food

- We are reaching peak grain production in many regions across the globe.
- Rice, wheat, soy are in great demand, and corn to feed cattle (and cars).
- Rising affluence drives consumption of protein.
- Aquiculture is still fairly new, but a good solution to land farming.

Peak Everything: 8 Things We Are Running Out Of And Why

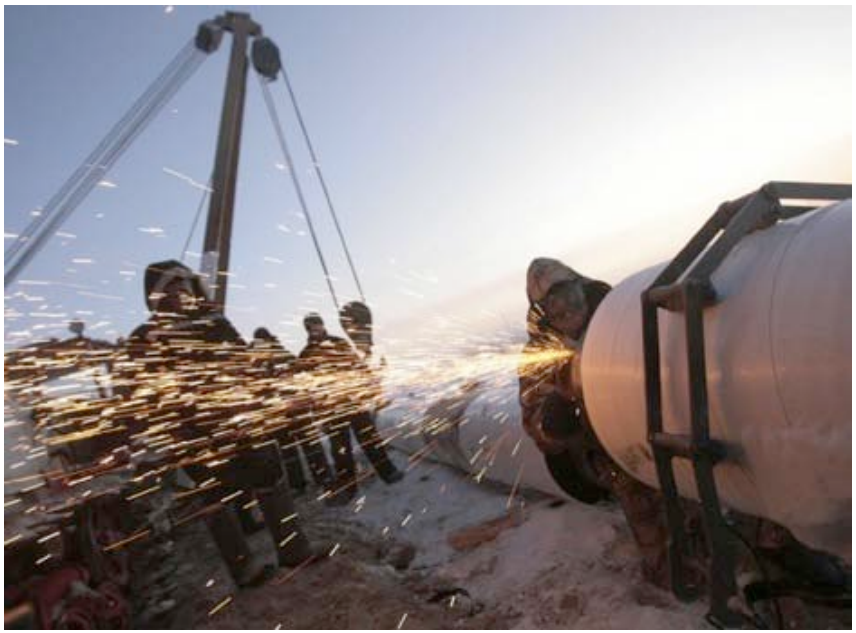
Peak Water

- In parts of the US, aquifers are depleted, and reservoirs are not refilling. The rate of water demand is greater than the filling rate of dams.
- 40% of the world depends on glaciers for over 50% of fresh water

Peak Everything: 8 Things We Are Running Out Of And Why

Peak (natural) Gas

- Natural gas (methane) is a clean fossil fuel, with ‘heat from hydrogen’.
- There are significant amounts of methane, but they aren’t developed.
- Methane is controlled by nation states (Russia) and remote: deep under the sea, and requires pipelines and liquefying.



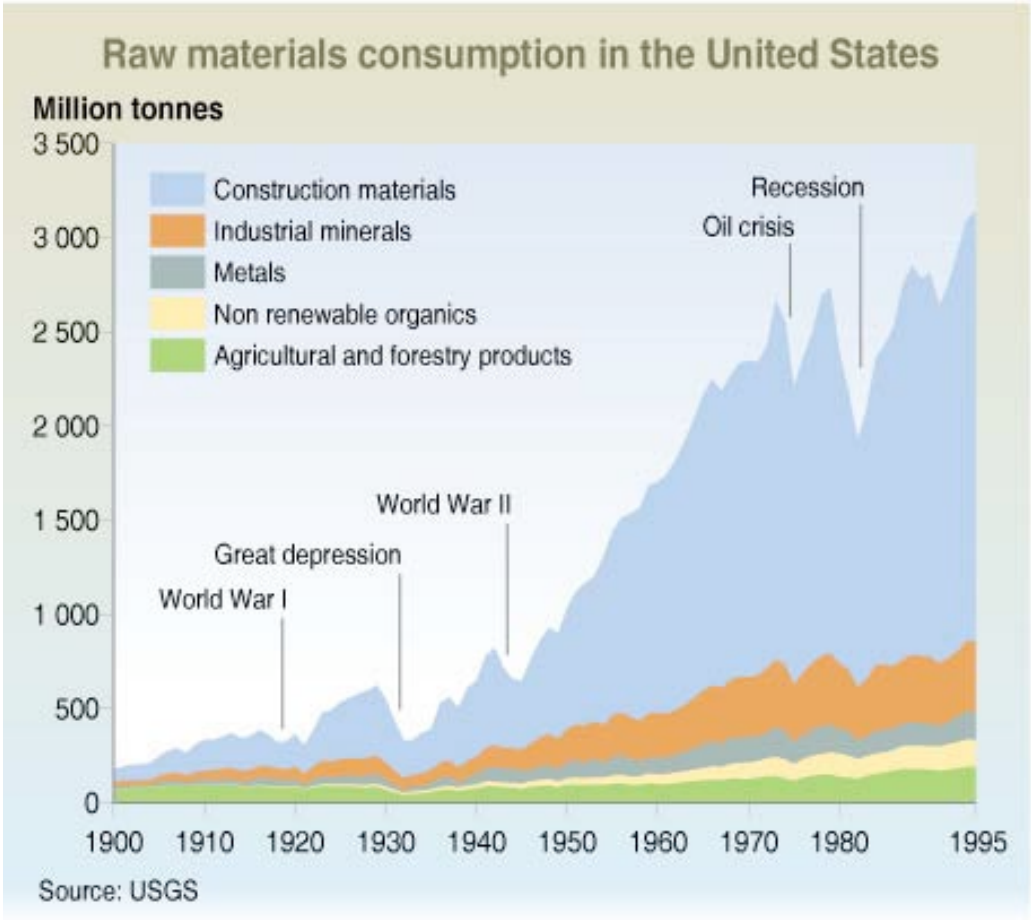
Peak Everything: 8 Things We Are Running Out Of And Why

Peak Corn

- 1 billion tons of corn goes to feed cattle, and more cattle (globally) puts strain on 2 billion tons
- 5% of corn now ‘diverted’ to feed cars (agrifuels)
- Water, soil, and energy requirements for corn are not insignificant
- Global corn stocks are decreasing (5% last year)

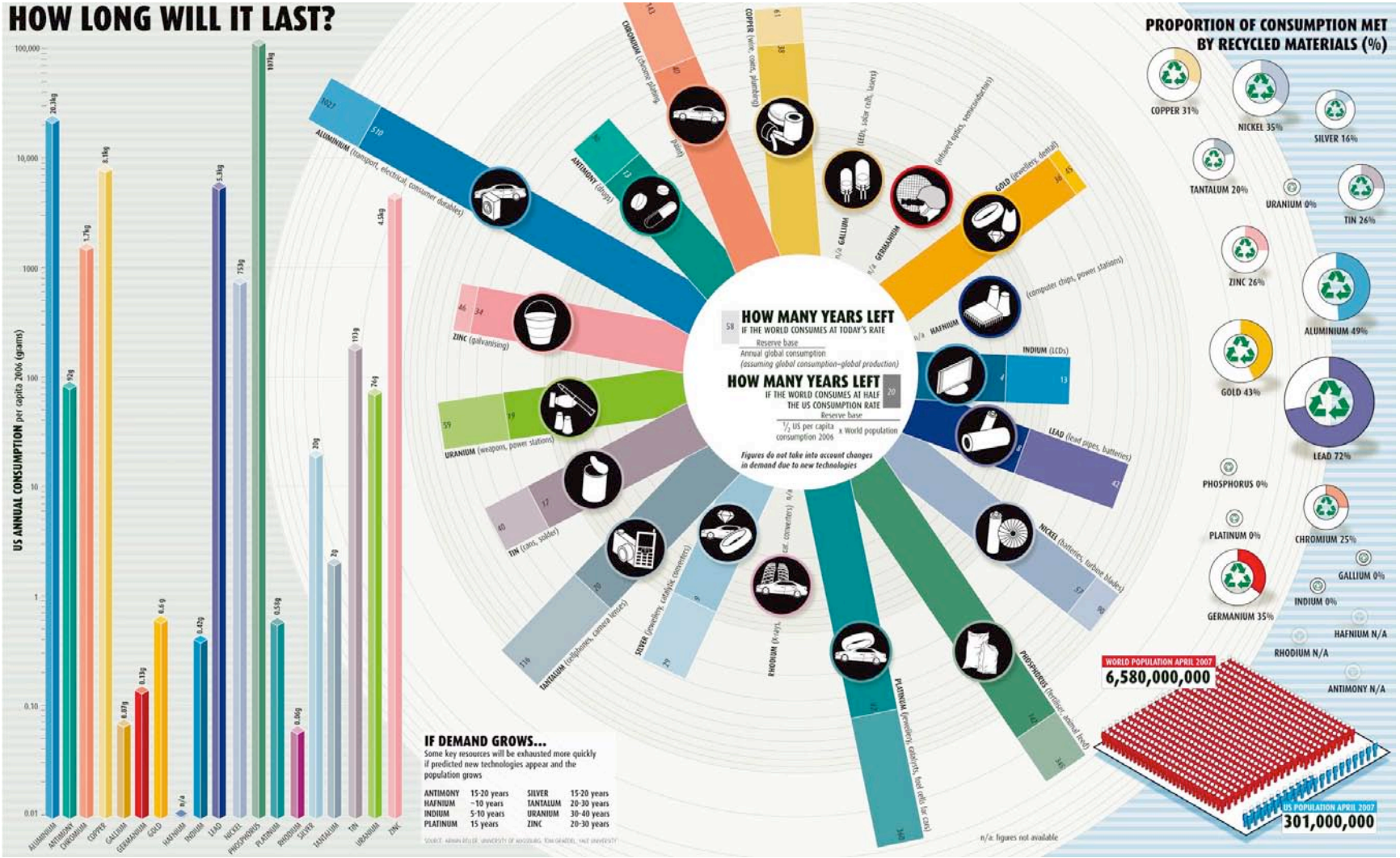
Peak Everything: 8 Things We Are Running Out Of And Why

Raw Materials Consumption



http://maps.grida.no/go/graphic/raw_materials_consumption_in_the_united_states

How Long Will it Last?



http://environment.newscientist.com/channel/earth/mg19426051.200-earths-natural-wealth-an-audit.html

Ecosystem Services

- Water purity
- Soil enrichment
- Vegetation
- Air filtration
- Fishing stocks
- Forest growth
- Pollination

Healthy ecosystems provide free "services" to human communities, including: water filtration, groundwater recharging, stormwater control, air purification, nutrient recycling, crop pollination, and soil enrichment.

Understanding Limits

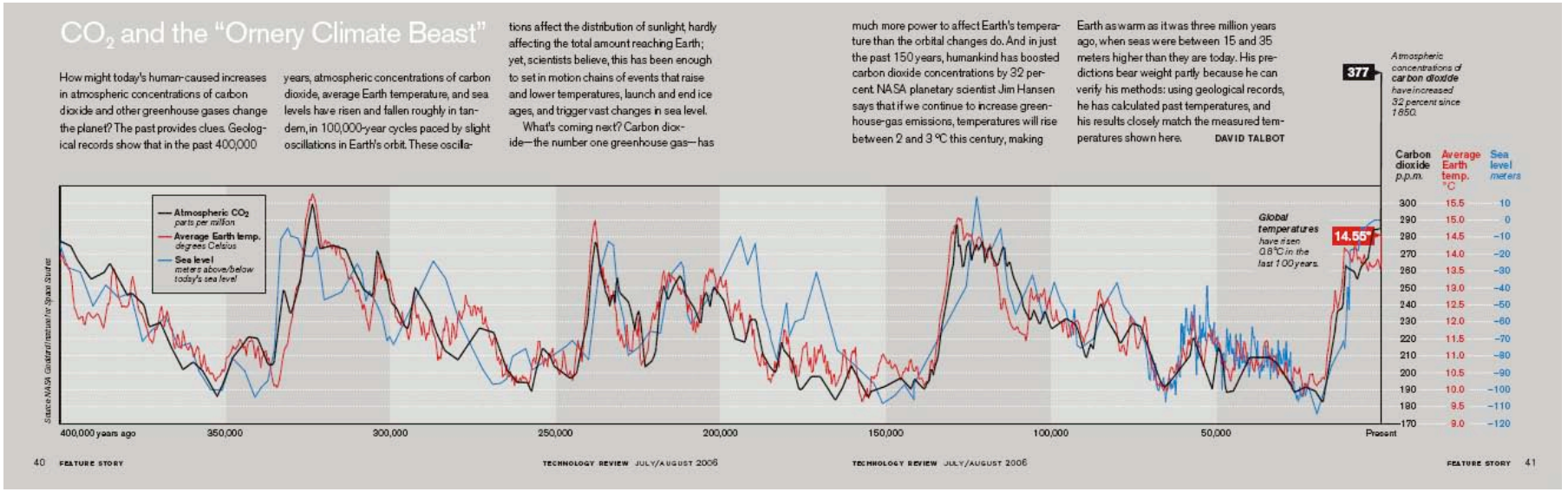
- The earth is an ***ecoSYSTEM***
- **Systems** are ***processes***, not **things**
- Higher order, ***emerging properties***
- Ecosystems can have ***multiple states***
  - They can be **'switched'**,
  - But may not be '**reversible**'
- Systems have **roles** and **dependencies**
  - Every part **exists for a reason**

Understanding ecosystem dynamics for conservation of biota *Journal of Animal Ecology* 2006 **75** , 64–79

Antarctic Ice Cores the Story of Vostok

Vostok Ice Core Data

- A perfect correlation between CO_2, temperature, and sea level
- For every one ppm CO_2, sea level rises 1 meter, temp rises .05 C (global)
- Process takes 100 years to add 1 ppm CO_2, and reach thermal equilibrium



CO_2 and the "Ornery Climate Beast"

How might today's human-caused increases in atmospheric concentrations of carbon dioxide and other greenhouse gases change the planet? The past provides clues. Geological records show that in the past 400,000 years, atmospheric concentrations of carbon dioxide, average Earth temperature, and sea levels have risen and fallen roughly in tandem, in 100,000-year cycles paced by slight oscillations in Earth's orbit. These oscillations affect the distribution of sunlight, hardly affecting the total amount reaching Earth; yet, scientists believe, this has been enough to set in motion chains of events that raise and lower temperatures, launch and end ice ages, and trigger vast changes in sea level.

What's coming next? Carbon dioxide—the number one greenhouse gas—has much more power to affect Earth's temperature than the orbital changes do. And in just the past 150 years, humankind has boosted carbon dioxide concentrations by 32 percent. NASA planetary scientist Jim Hansen says that if we continue to increase greenhouse-gas emissions, temperatures will rise between 2 and 3 °C this century, making Earth as warm as it was three million years ago, when seas were between 15 and 35 meters higher than they are today. His predictions bear weight partly because he can verify his methods: using geological records, he has calculated past temperatures, and his results closely match the measured temperatures shown here. DAVID TALBOT

Source: NASA Goddard Institute for Space Studies

Atmospheric CO_2 — parts per million
Average Earth temp. — degrees Celsius
Sea level — meters above/below today's sea level

377 — Atmospheric concentrations of carbon dioxide have increased 32 percent since 1850.

Global temperatures have risen 0.8 °C in the last 100 years.

14.55°

Carbon dioxide p.p.m.	Average Earth temp. °C	Sea level meters
300	15.5	10
290	15.0	0
280	14.5	−10
270	14.0	−20
260	13.5	−30
250	13.0	−40
240	12.5	−50
230	12.0	−60
220	11.5	−70
210	11.0	−80
200	10.5	−90
190	10.0	−100
180	9.5	−110
170	9.0	−120

400,000 years ago · 350,000 · 300,000 · 250,000 · 200,000 · 150,000 · 100,000 · 50,000 · Present

40 FEATURE STORY TECHNOLOGY REVIEW JULY/AUGUST 2006

TECHNOLOGY REVIEW JULY/AUGUST 2006

FEATURE STORY 41

This is not just a correlation, *this is a complex and dynamic process*, with multiple inputs. *Touching one input affects all other inputs*, and increases in temperature becomes a further feedback and *multiplier* of these inputs.

GHGs and Vostok Data

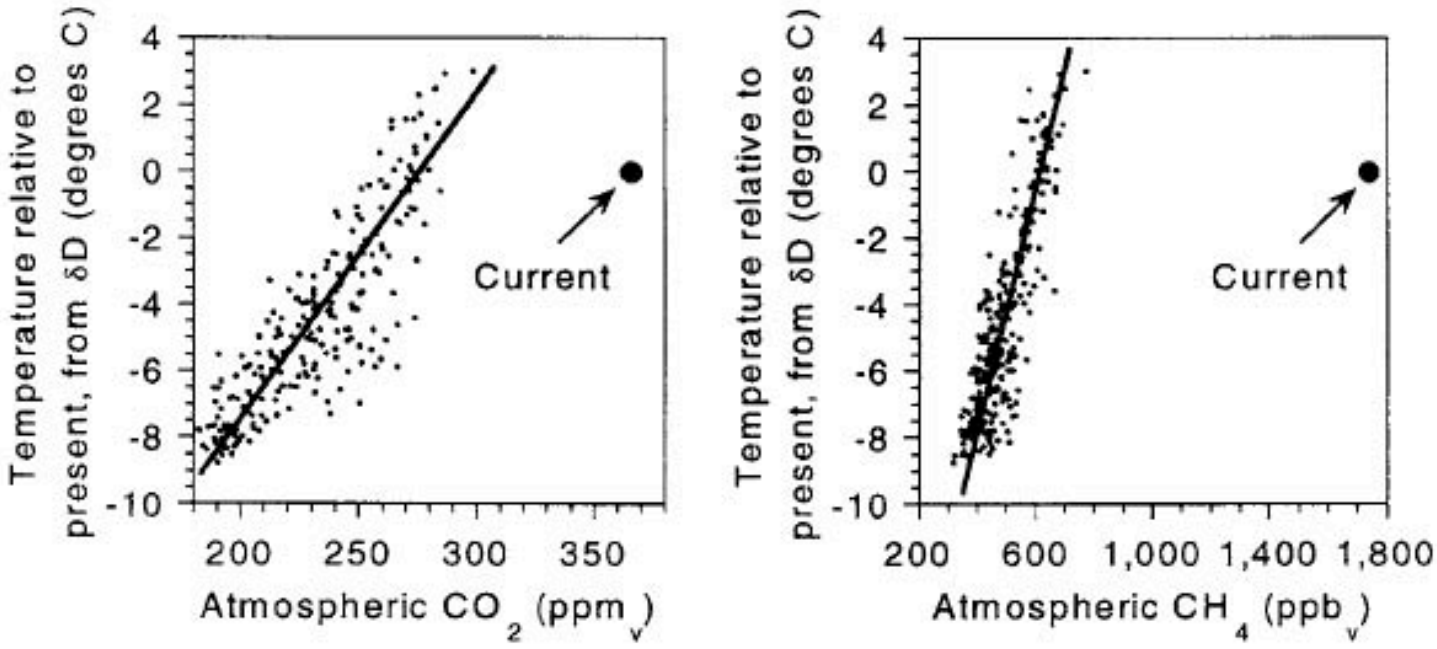
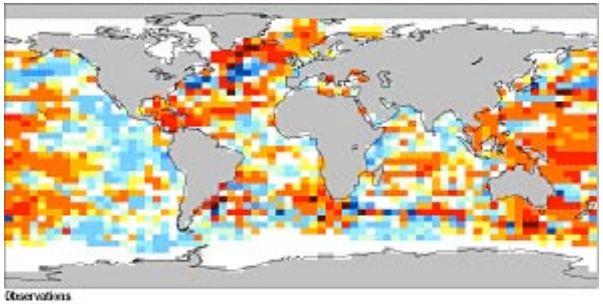
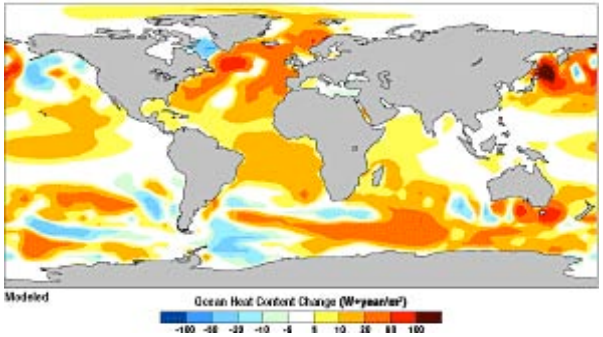
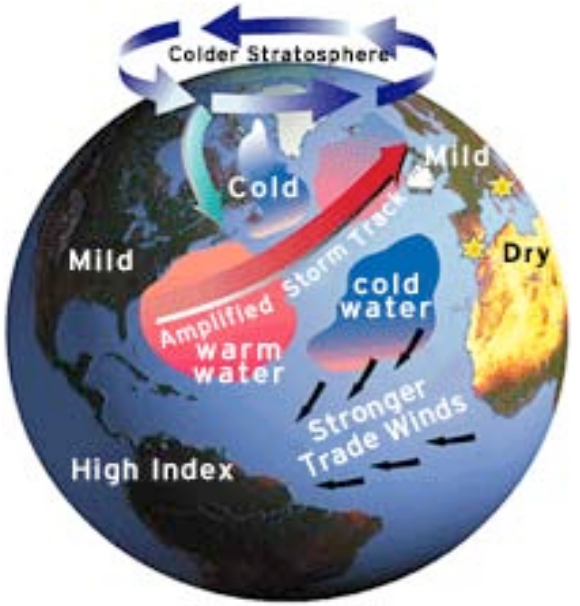


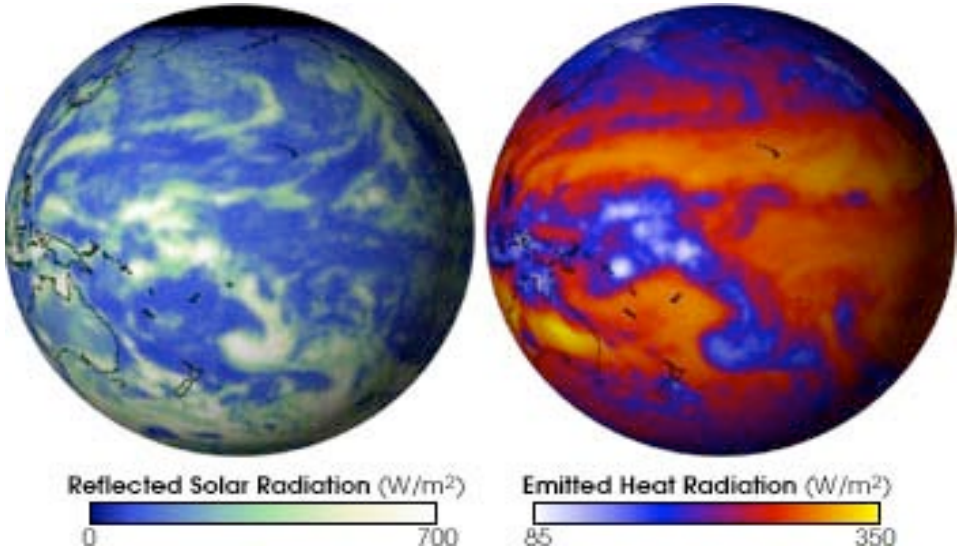
Figure 3. Correlations between atmospheric CO_2, methane, and temperature over the last 400,000 years, from Figure 1, compared to current conditions. Current conditions lie far outside the envelope of the prehistoric data, and far below any extrapolation from them.

James Kirchner Department of Earth and Planetary Science, University of California, Berkeley







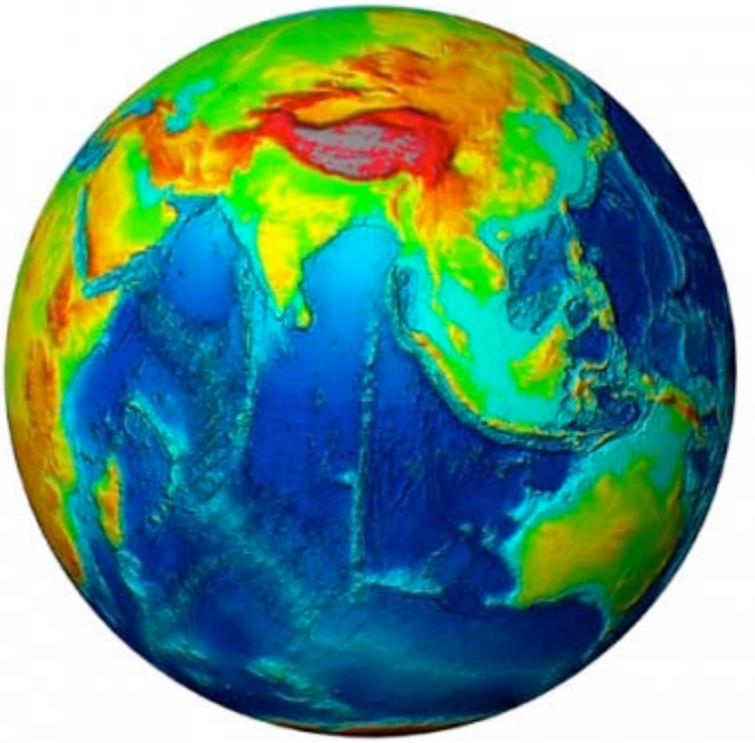


Modeling and preparing the planet and biosphere for climate change

Finding Equilibrium

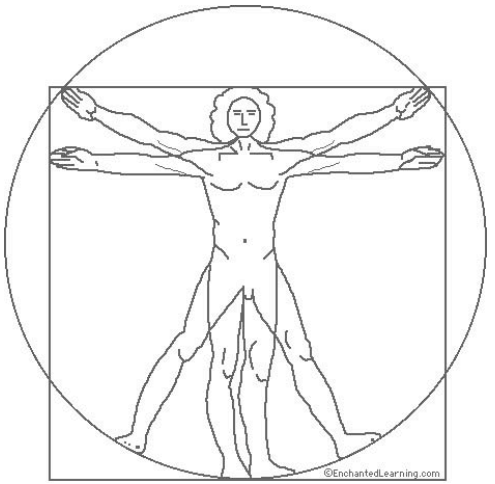
- We need new 'business models'
  - *Extraction*
  - *Production*
  - *Consumption*
  - *Waste*

  Will not work!
- Biomimicry?



http://www.sos2006.jp/english/rsbs_summary_e/1-what-is-sustainability.html

Civilization 2.0



- A world in **balance**
- A planet in **harmony**
- Global **collaboration**
- How did we get there?
- ***What do humans do?***

Global Challenges

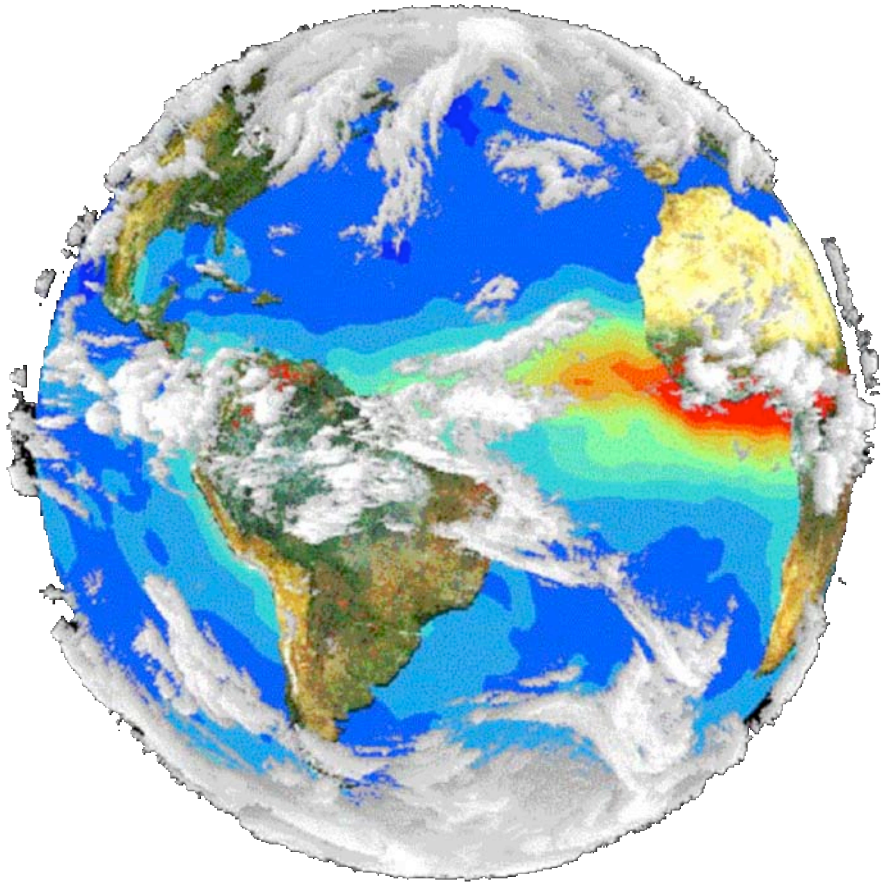
http://www.millenium-project.org/

Collaboration

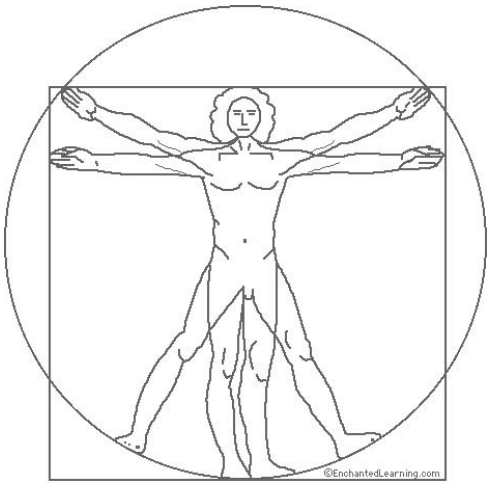
It's time that we got serious about working together to build a better world

Spaceship Earth

- ***This is our only ride***
- No real '2nd chance'
- ***Ecosystem services***
- *Redefining the mission –*
- ***- 500 year plan?***
- ***Sustainable Values***



Civilization 2.0



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- How did we get there?
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Sustainable Core Values

Environment

1. Ecosystem services – Eco-economy and valuing ecosystem services
2. Concept of limits – linear / exponential rates of extraction in a finite world. Peak Everything.
3. IPAT (Gapminder) – impacts from population, affluence (consumption) and technology
4. Waste = food and 'cradle to cradle' manufacturing / remanufacturing and recycling
5. Biomimicry – learning from nature – and employing 'natural' (biogenic) solutions
6. Diversity – how it works in nature – how it works in society – specialization of skills (economic)

Social

7. Social equity – healthy societies / social systems – foundation of sustainable societies
8. Environmental justice (more complex subset of industry, and social systems, class issues)
9. Cultural sustainability – awareness of cultural identity and cultural values, language, art
10. Personal sustainability – health, personal relationships, foundation for lifelong learning
11. Intergenerational impacts (economics and environmental – debt and resource depletion)
12. Civic engagement (interaction of individual and society) – healthy societies / social systems
13. Ethics (doing what's right when no one is looking)
14. Conflict resolution (at all levels – personal / interpersonal / organizational / political)

Economic

15. Sustainable development – building new innovation economies not tied to consumption
16. Built to last – design, build, and maintain for the long haul
17. Collaboration vs. individualism (as an ethic vs. individual wealth)
18. Collaborative value creation (personal, social and economic models) – Wikinomics
19. Value vs. wealth (new economic models and metrics)
20. Social production / Social capital (adding to information, knowledge and culture)

References

- ***Peak Everything: 8 Things We Are Running Out Of And Why***
- ***Effects of population and affluence on CO_2 emissions -*** *Proc. Natl. Acad. Sci. USA* Vol. 94,175–179, January 1997
- *Gapminder – http://www.gapminder.org/world*
- *The Sustainable Scale Project*
- *Plan B 3.0 – Lester Brown*
- *Capitalism 3.0 – http://www.capitalism3.com/*
- *Peak Everything - http://www.richardheinberg.com/*
- Peak Water – Wired 16:05 4/21/08
- Millennium Project - *http://www.millenium-project.org/*
- The Inevitable Peaking of World Oil Production' Hirsch 2005