Ecology III

Conservation & Sustainable Development

March 19, 2008

Sustainability defined

- **Sustainability:** Refers to longevity of vital human support systems, e.g. systems of agriculture, industry, forestry, and fisheries. The implied preference of a "sustainable" system would be to be productive indefinitely.

  ("system life expectancy" definition).

- **Sustainable development or use of resources:** development/use that meets the needs of the present without compromising the ability of future generations to meet their own needs.

  (United Nations' 1987 "ethical" definition).

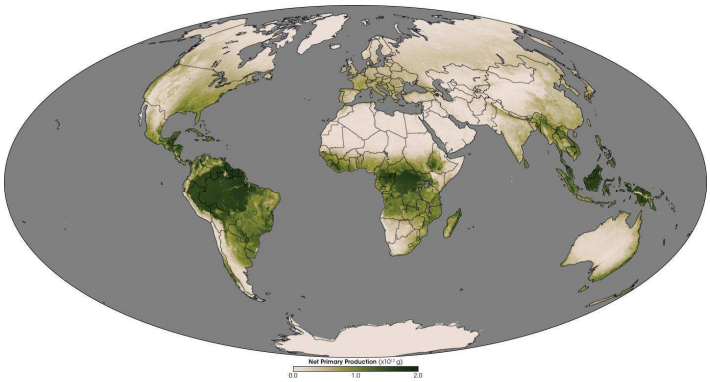
Measuring sustainability

- **Sustainability** implies paying attention to effects on all aspects of the environmental (and some contexts also social & economic) systems.

- **Measuring auditing sustainability:** environmental accounting, full cost accounting (systems), life cycle assessment, dust to dust analysis (products), ecological footprint analysis (systems, products).

Sustainability is a very "holistic" description and very difficult to comprehensively measure or audit.

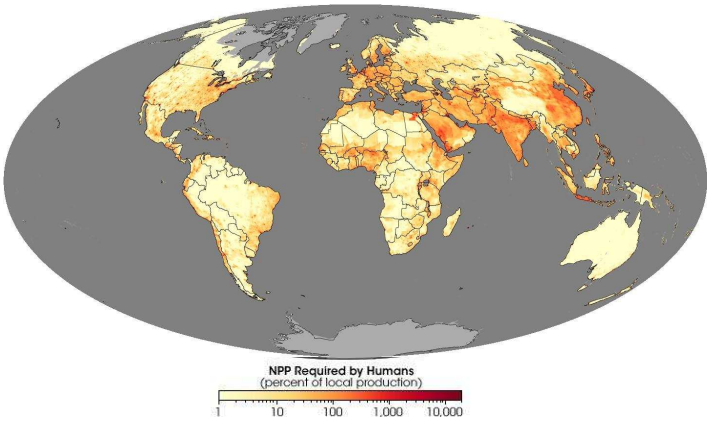
The Green Supply



Net Primary Productivity (NPP) is the amount plant material produced on Earth. It is the primary fuel for Earth's food web and represents all available food and fiber.

56.8 x 10^{12} tons of carbon

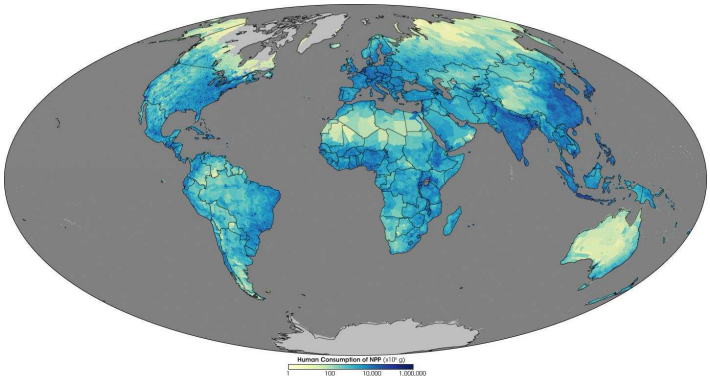
The Human Appetite



1.7 Grains & Vegetables, 1.9 Meat, 0.4 Dairy = 4.0 x 10^{12} tons of carbon for food

0.6 Paper & Fiber, 6.8 Wood & Fuelwood = 7.4 x 10^{12} tons of carbon for commodities

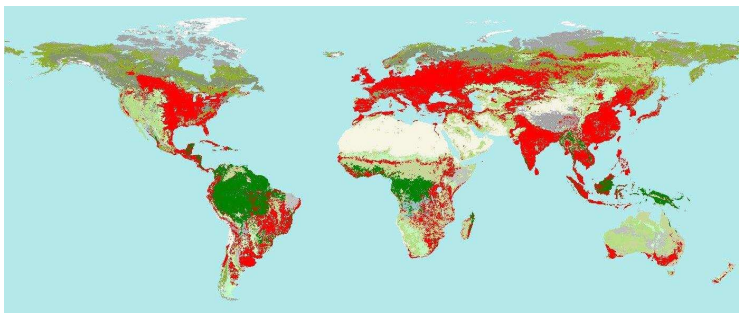
The Human Appetite



Absolute food and fibre consumption (11.4/56.8):

Humans require approximately 20% of Earth's NPP capacity on land

Sustaining the Appetite

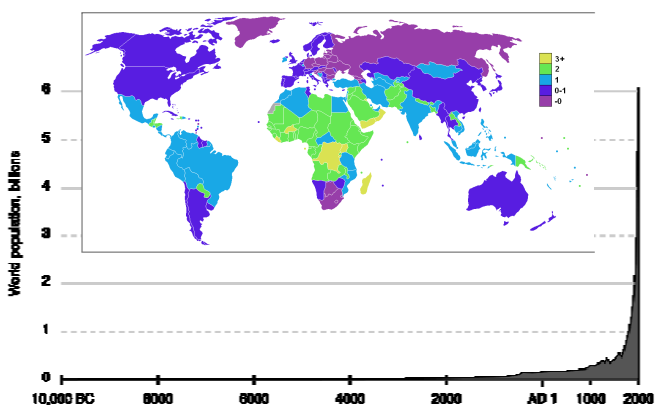


Current landcover

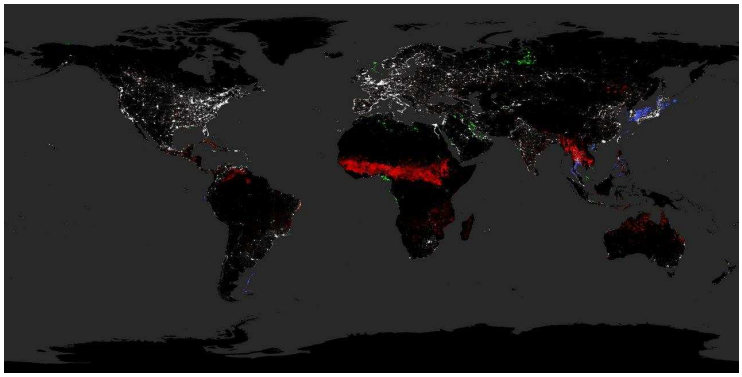
World population: 6.5 Billion

Land area dominated by agriculture: ■ 43%

… and we are not done, yet

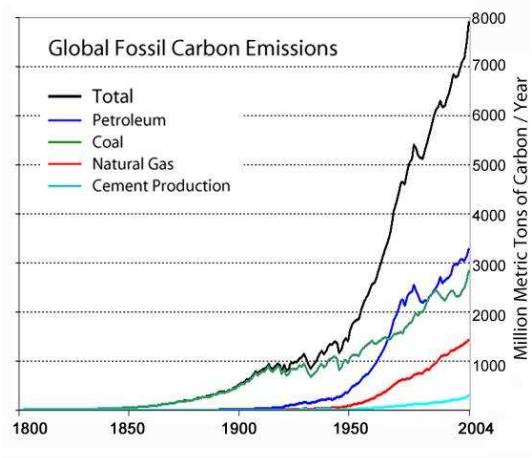


Night Lights (1994-1995)



City Lights: □ Fires: ■ Gas Flares: ■ Fishing Fleets: ■

Carbon emissions



Svante Arrhenius (Nobel price in chemistry 1903)

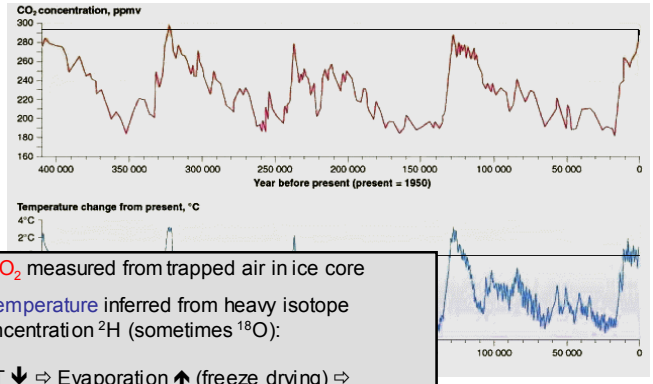
predicted a 3.5 and 5.5°C increase in MAT for a 150, 300 ppm rise in CO_2

THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE
[FIFTH SERIES]
APRIL 1896.
vol 41, pp237-275

XXXI. On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.
By Prof. SVANTE ARRHENIUS

Phil. Mag. (1896) **41**: 237–76

A bigger perspective: half a million years



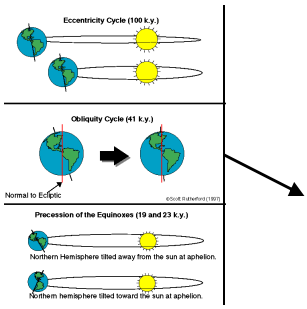
- CO_2 measured from trapped air in ice core
- Temperature inferred from heavy isotope concentration ^2H (sometimes ^{18}O):

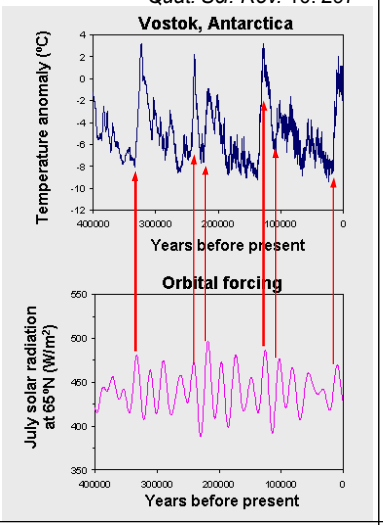
  T ↓ ⇨ Evaporation ↑ (freeze drying) ⇨ heavy isotope concentration ↓ (9ppm ^2H/1°C)

Nature 399: 429-436

Milankovich Cycles & Orbital forcing:

Quat. Sci. Rev. 10: 297



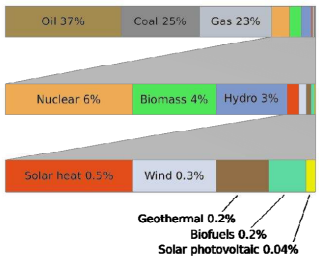


The role of biofuels

- **Sustainability:** US electricity consumption alone would approximately require 40% of the world's biomass.

(The path forward for biofuels and biomaterials Science 311: 484 - 489).

- **World totals:**



Malthus' Theorem

- **Maltus (1766-1834):** "Since human populations increase geometrically and food supplies grow arithmetically, human populations will undergo a cycle of growth and catastrophic decline."
- **1990s "Zeitgeist":** Maltus may be right, but probably not.
- **2000-2004 "Zeitgeist":** Green revolution: "Maltus is wrong".
- **2007 "Zeitgeist":** "Oops! Malthus is probably right - but we don't want to know".

Review Questions

- What are the two definitions of sustainability?
- How is sustainability measured in principle and how is this currently implemented?
- What is the percentage of human use of global biomass production?
- What portion of the landbase is dedicated to sustain human needs for food and fibre?