# Sustainable Food Security beyond 2050 ?

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April 12, 2011

# Main points

A. Hunger gloom and doom
B. Trees recharge water tables, remove $CO_2$ & organically sustainably fertilize the soil
C. Measurement transparency critical, because:
   1. Revenues from mitigation credits can begin to pay the enduring costs of adaptation and this accreditation requires Monitoring, Reporting and Verification (MRV) against a registry validated baseline calculation
   2. Biggest threat is still the obstinate ignorance of our political discourse
D. Therefore, how can GAIA nurture MRV and vice versa?

# 1900

| Number of people | Number of livestock | $Km^2$ forest land cleared | $Km^2$ perennial grassland degraded | Topsoil loss | $CO_2$ e emmited |
|---|---|---|---|---|---|
| 1,650 B | | | | | |

| Annual cerelas production | Food tubers production | Production of food from (fruit) trees | Food from animal sources | Total food availibility | Number of malnurish/ hungry people |
|---|---|---|---|---|---|
| | | | | | |

| $Km^2$ still forested | $Km^2$ perennial grassland | $Km^2$ topsoil intact | CO2 sequestred into landscape | CO 2 sequestred elswhere | CO2 remaining in atmosphere |
|---|---|---|---|---|---|
| 4 B hect | | | | | 290 ppm |

# 1950

| Number of people | Number of livestock | $Km^2$ forest land cleared | $Km^2$ perennial grassland degraded | Topsoil loss | $CO_2$ e emmited |
| --- | --- | --- | --- | --- | --- |
| 2,521 B | 90 mil T | | 9 mil $km^2$ | | |

| Annual cerelas production | Food tubers production | Production of food from (fruit) trees | Food from animal sources | Total food availibility | Number of malnurish/ hungry people |
| --- | --- | --- | --- | --- | --- |
| 1118 mil T (1969) | | | | | |

| $Km^2$ still forested | $Km^2$ perennial grassland | $Km^2$ topsoil intact | CO2 sequestred into landscape | CO 2 sequestred elswhere | CO2 remaining in atmosphere |
| --- | --- | --- | --- | --- | --- |
| 57 mil $km^2$ | | | | | 310 ppm |

# 2000

| Number of people | Number of livestock | $Km^2$ forest land cleared | $Km^2$ perennial grassland degraded | Topsoil loss | $CO_2$ e emmited |
|---|---|---|---|---|---|
| 5,978 B | 218 mil T | 29.0 mil $km^2$ | | | |

| Annual cerelas production | Food tubers production | Production of food from (fruit) trees | Food from animal sources | Total food availibility | Number of malnurish/ hungry people |
|---|---|---|---|---|---|
| 1884 mil T | 93 mil T | 111 mil T | | | 150 mil |

| $Km^2$ still forested | $Km^2$ perennial grassland | $Km^2$ topsoil intact | CO2 sequestred into landscape | CO 2 sequestred elswhere | CO2 remaining in atmosphere |
|---|---|---|---|---|---|
| 38.69 mil $km^2$ | | | | | 370 ppm |

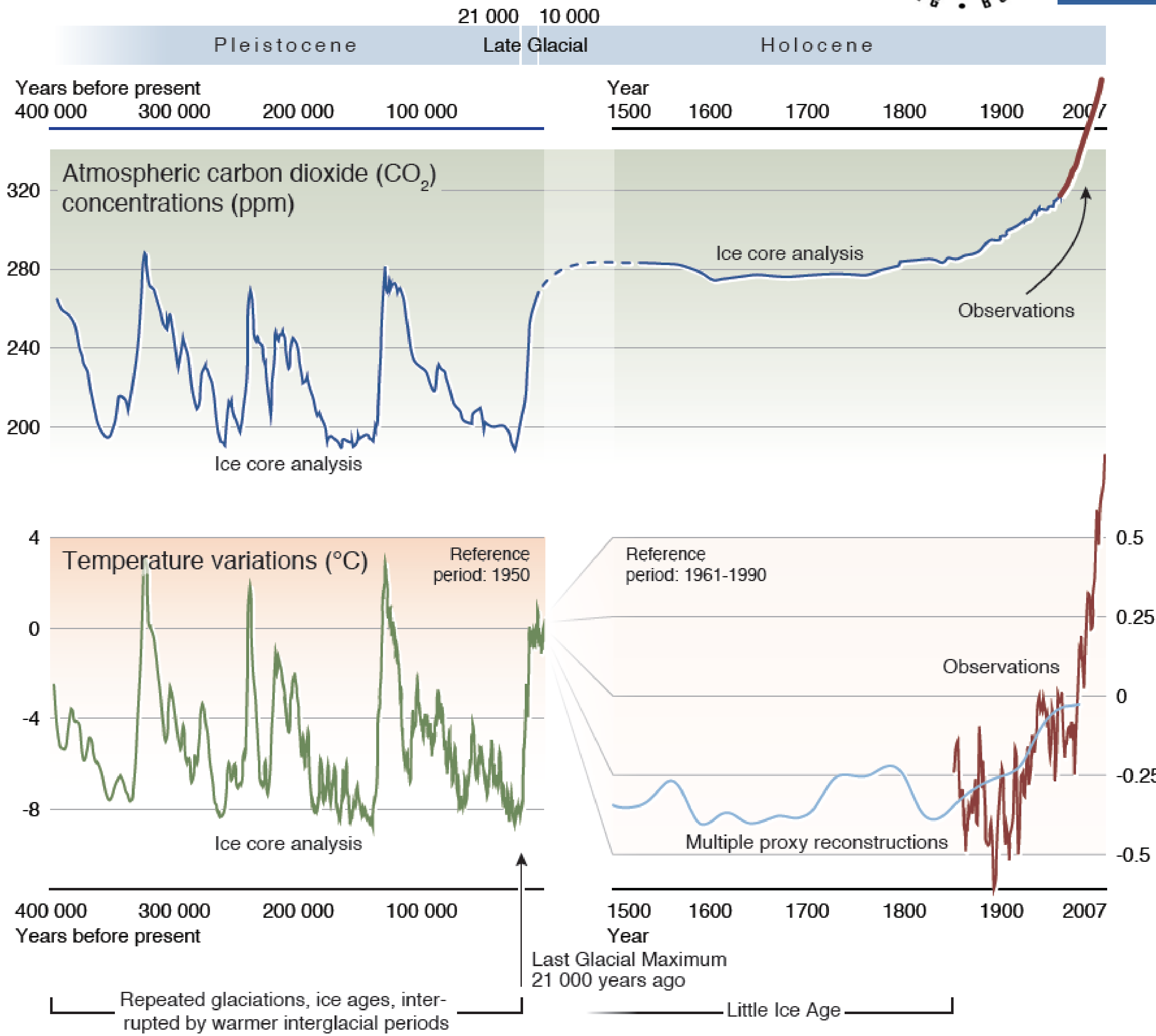
# 2050

| Number of people | Number of livestock | Km² forest land cleared | Km² perennial grassland degraded | Topsoil loss | $CO_2$ e emmited |
|---|---|---|---|---|---|
| 9,150 B | 376 mil T | | | | |

| Annual cerelas production | Food tubers production | Production of food from (fruit) trees | Food from animal sources | Total food availibility | Number of malnurish/ hungry people |
|---|---|---|---|---|---|
| 3012 mil T | | | | | 60 mil |

| Km² still forested | Km² perennial grassland | Km² topsoil intact | CO2 sequestred into landscape | CO 2 sequestred elswhere | CO2 remaining in atmosphere |
|---|---|---|---|---|---|
| | | | | | 550 ppm |

# $CO_2$ and World Temperatures




http://maps.grida.no/go/graphic/historical-trends-in-carbon-dioxide-concentrations-and-temperature-on-a-geological-and-recent-time-scale

# Notes I

- If **per-capita beef** consumption in China raises to that in the US → we will need 343 million tons of grain/year = entire US grain harvest
- World grain consumption has risen each of the last 45 years (except 1974, 1988 & 1995)
- World grain harvest consumed as…
  - 60% food
  - 36% feed for livestock
  - 3% fuel

# Notes II. Since 1980s…

- Global cereal harvests: rising 1.3%/year
- **Production** of world's major cereal crops has **increased**:
  - 37% maiz
  - 20% rice
  - 15% wheat
- Grain **yields per ha**. have grown more slowly than the global population.

**Change in World Grain Yields** (%/ year) (97B3)

| Years - | Total | Rice | Wheat | Corn | Other |
|---|---|---|---|---|---|
| 1950-60 | 2.0 | 1.4 | 1.7 | 2.6 | - - |
| 1960-70 | 2.5 | 2.1 | 2.9 | 2.4 | 2.3 |
| 1970-80 | 1.9 | 1.7 | 2.1 | 2.7 | 0.4 |
| 1980-90 | 2.2 | 2.4 | 2.9 | 1.3 | 1.7 |
| 1990-95 | 0.7* | 1.0 | 0.1 | 1.7 | -0.8 |

* 1.1%/ year if the Soviet Union is excluded.

World Grain harvest (96B1): 1.78 Gt. (1990); 1.69 Gt. (1995).

Source: Bruce Sundquist

# Notes III.

- World population has cut the grain land/person from 0.23 ha in 1950 to 0.10 ha in 2007. Why? Use of chemical fertilizer + the Green Revolution
- 55-70 mil. acres of aditional arable land may be needed to come on line globally
- Worldwide Grain area:
  - 5.9 million $km^2$ in 1950
  - 7.30 million $km^2$ in 1981
  - 6.7 million $km^2$ in 2004

**World Grain land Area/ Capita and Grain land Area** (in millions of $km^2$)

| Year - - - | 1950 | 1960 | 1970 | 1980 | 1990 | 1993 | Units |
|---|---|---|---|---|---|---|---|
| Area/capita | 0.23 | 0.21 | 0.18 | 0.16 | 0.13 | -?? | ha/ capita |
| Area ~ ~ ~ | 5.95 | 6.4 | 6.7 | 7.2 | 6.9 | 6.8 | million $km^2$ |

Source: Bruce Sundquist

# Annual vs Perennial Crops

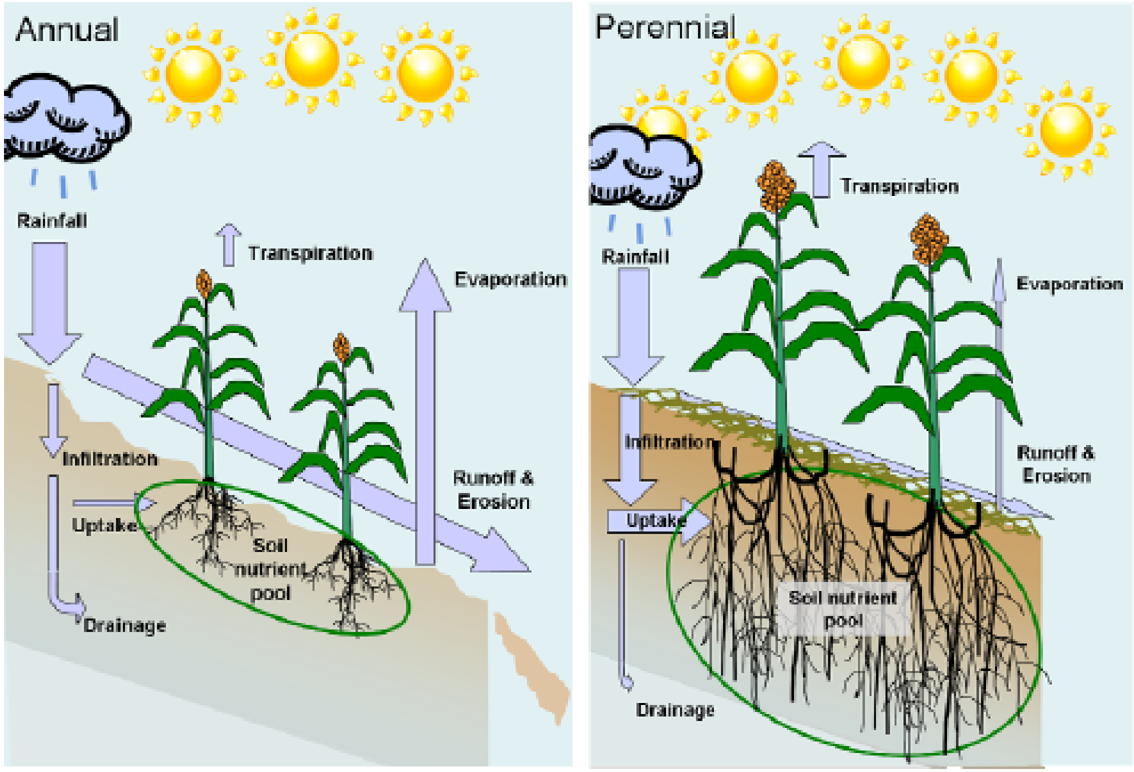



**Fig. S1. Ecosystem functions of annual and perennial crops.** (**Left**) Annual crops have relatively short growing seasons, shallow rooting depths, and lower root densities. This limits their access to nutrients and water, leaves croplands more vulnerable to degradation, and reduces soil carbon inputs and habitat for wildlife. (**Right**) Perennial crops capture, retain, and utilize more precipitation, have access to soil nutrients deeper within the soil, maintain more plant residues at the soil surface, and intercept sunlight for greater lengths of the year (*S1*).

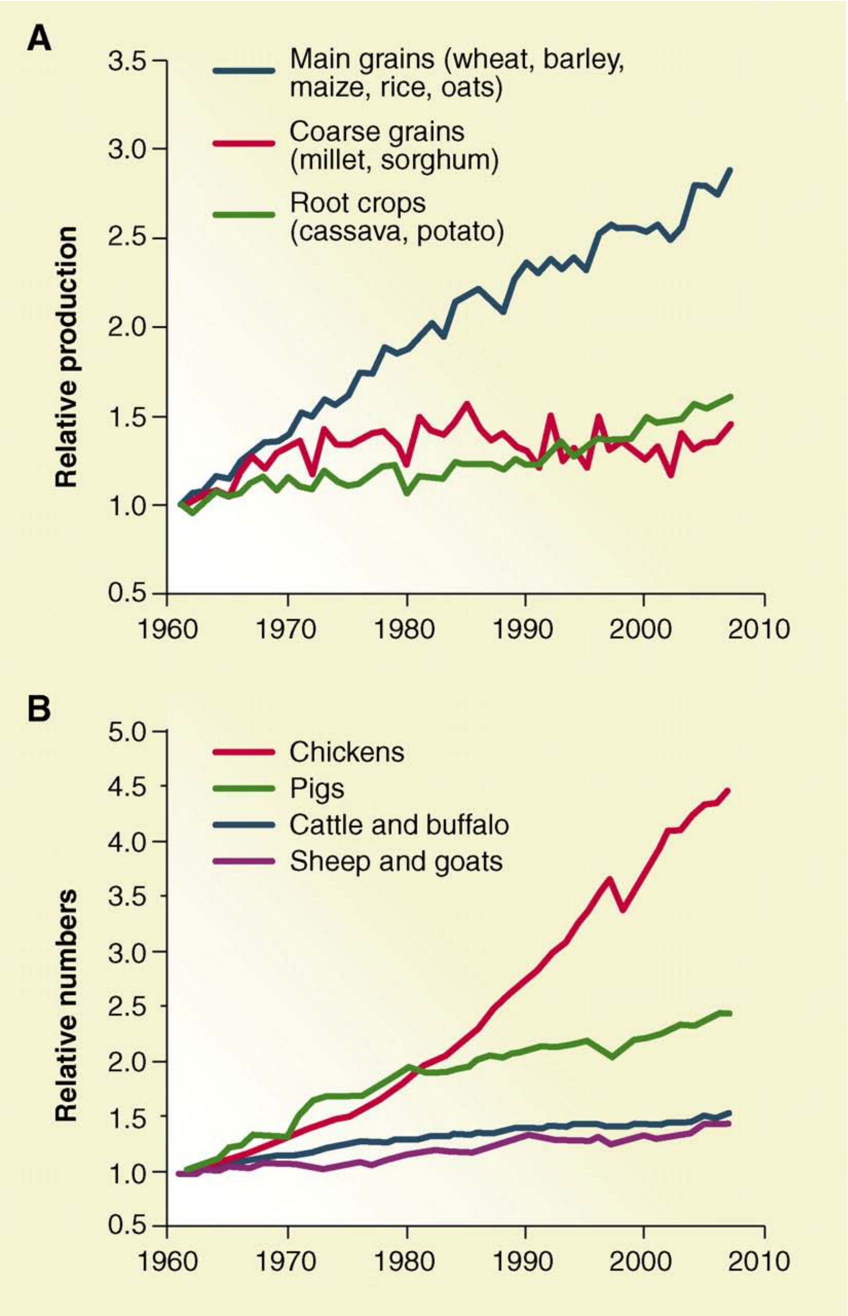
S1. J. D. Glover, C. M. Cox, J. P. Reganold, *Sci. Am.* **297**(August), 82 (2007).

## Annual wheat versus perennial intermediate wheatgrass.


J D Glover et al. Science 2010;328:1638-1639

Published by AAAS

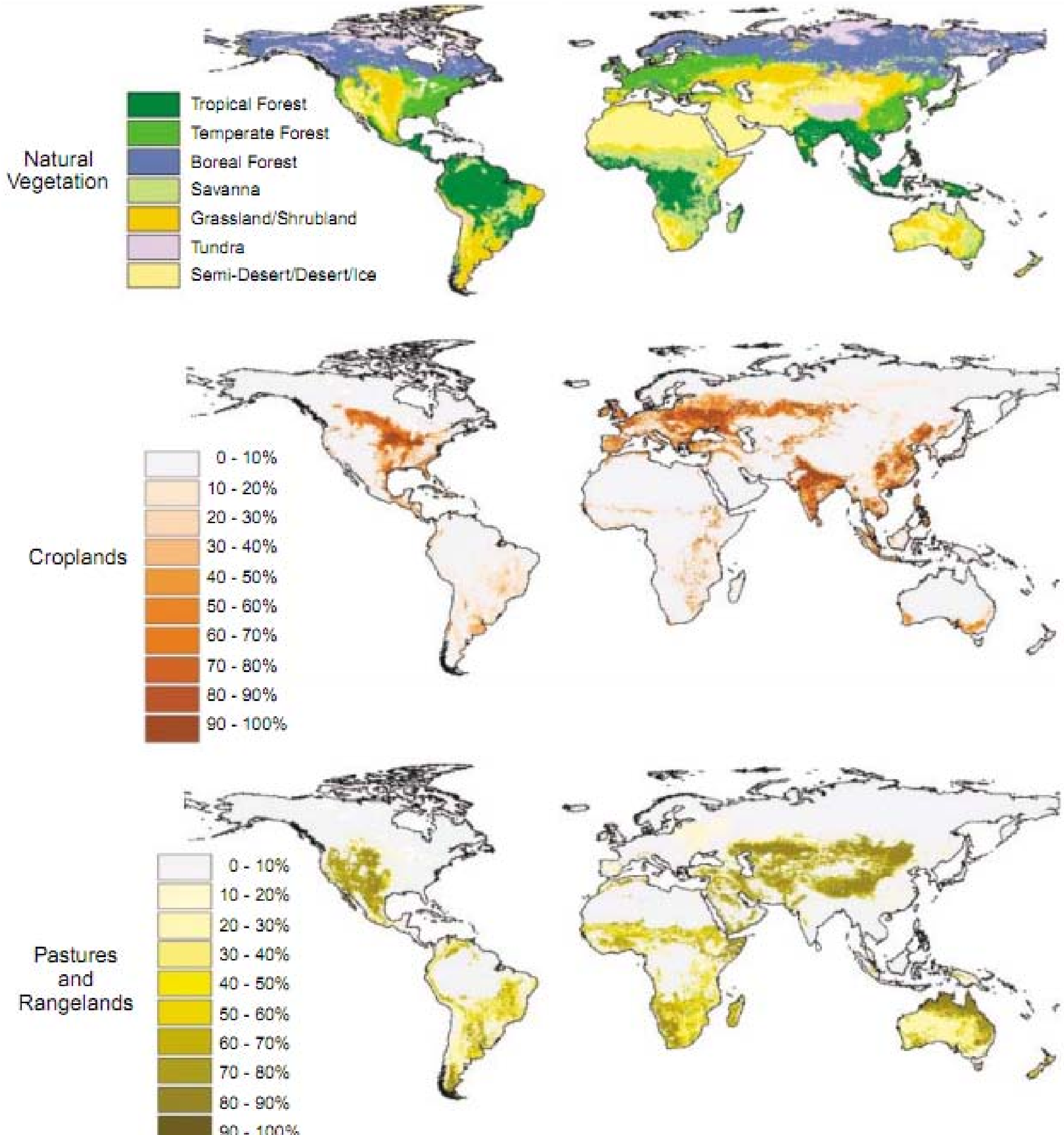
Changes in the relative global production of crops and animals since 1961 (when relative production scaled to 1 in 1961).




Published by AAAS

H C J Godfray et al. Science 2010;327:812-818

# 2005 Forest, Croplands and Pastures




http://landscape.forest.wisc.edu/courses/readings/Foley_etal_2005.pdf

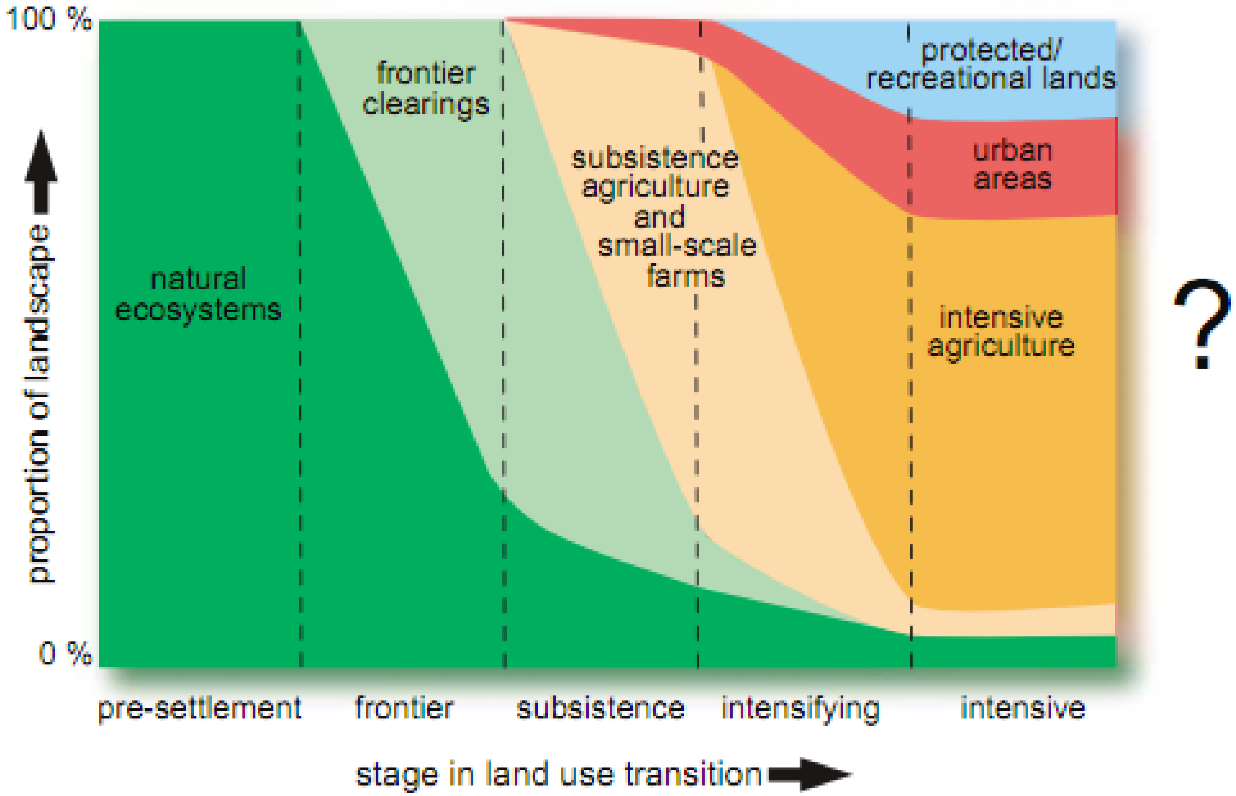
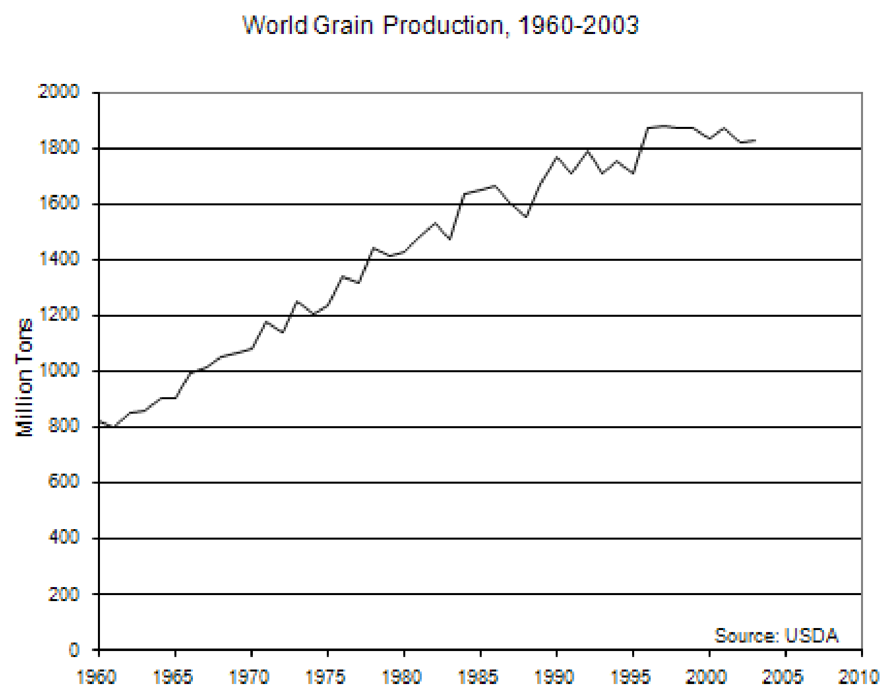
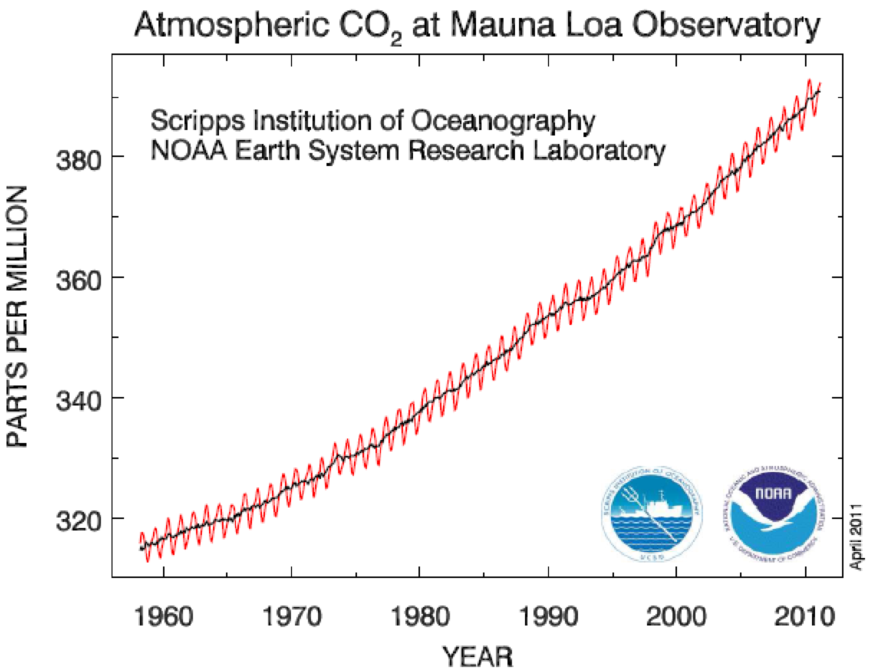



**Fig. 1.** Land-use transitions. Transitions in land-use activities that may be experienced within a given region over time. As with demographic and economic transitions, societies appear also to follow a sequence of different land-use regimes: from presettlement natural vegetation to frontier clearing, then to subsistence agriculture and small-scale farms, and finally to intensive agriculture, urban areas, and protected recreational lands. Different parts of the world are in different transition stages, depending on their history, social and economic conditions, and ecological context. Furthermore, not all parts of the world move linearly through these transitions. Rather, some places remain in one stage for a long period of time, while others move rapidly between stages. [Adapted from (*1*) and (*2*)]

http://landscape.forest.wisc.edu/courses/readings/Foley_etal_2005.pdf



World Grain Production, 1960-2003
Million Tons
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Source: USDA

Atmospheric $CO_2$ at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
April 2011

# Sources:

- UN report 2004 data" (PDF). Retrieved 2010-08-01.
- http://landscape.forest.wisc.edu/courses/readings/Foley_etal_2005.pdf
- Sais libra: http://www.annualreviews.org.proxy3.library.jhu.edu/loi/energyé
- http://www.sciencemag.org/content/328/5986/1638.full?ijkey=jWkVC/8x0TeS2&keytype=ref&siteid=sci%c2%a0#ref-4
- http://www.fao.org/fileadmin/user_upload/esag/docs/Interim_report_AT2050web.pdf
- http://home.windstream.net/bsundquist1/se9.html#A

# Thank you