Food and Water and (Over)Population

ConCERNed workshop on (Over)Population
22nd February 2010
CERN

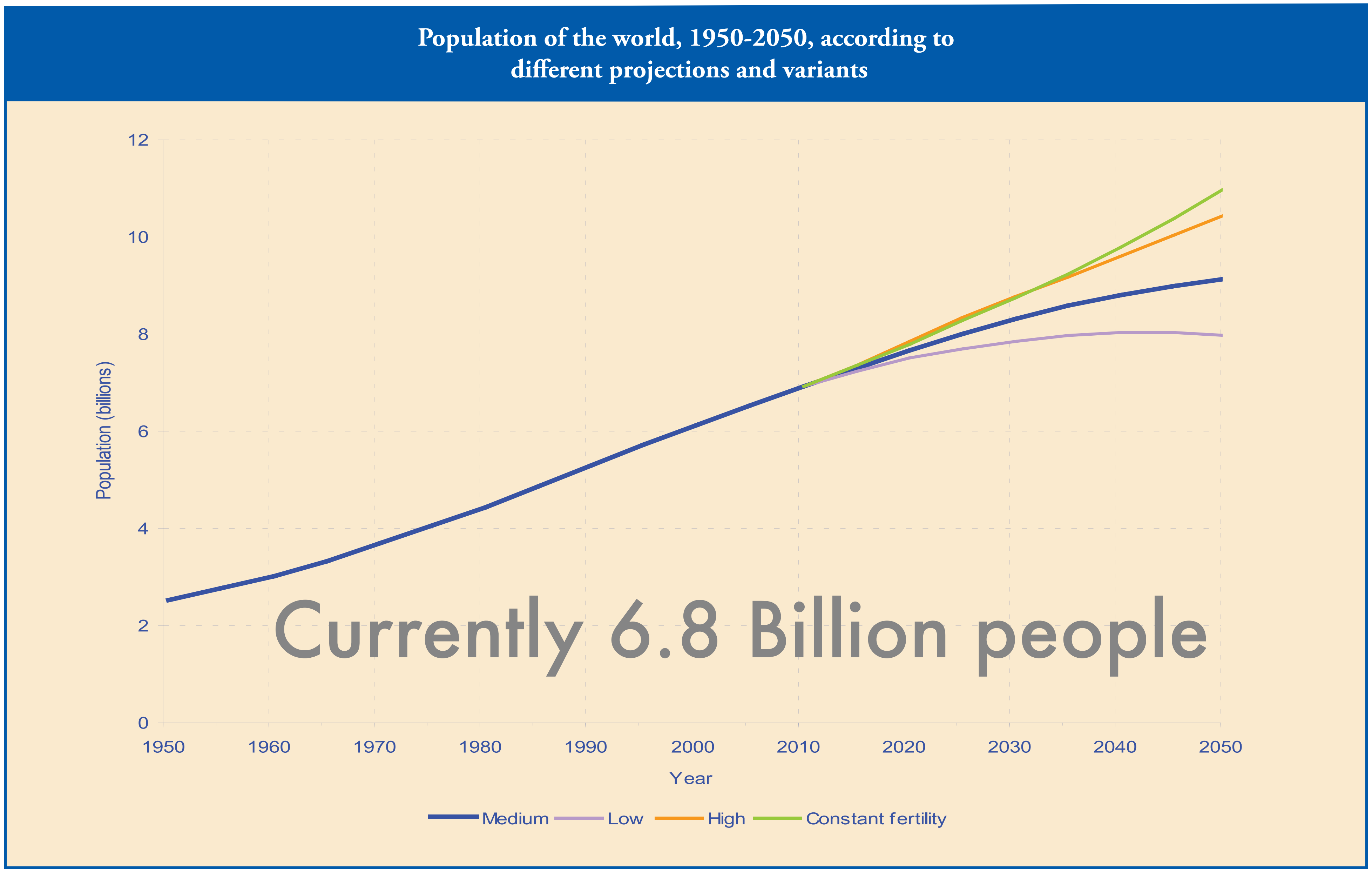
Francesco Spanò
conCERNed for Humanity

Outline

- Status
  - Demand: What we need? Is there enough to feed everyone?
  - Supply: How do we produce it?
- Sustainability of current food production system
- Where to from here? Transition to a post-fossil fuel food production system

How many we are

Population Newsletter - June 2009



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2009). *World Population Prospects: The 2008 Revision.* New York: United Nations.

http://www.un.org/esa/population/publications/popnews/Newsltr_87.pdf

What is nutrition?

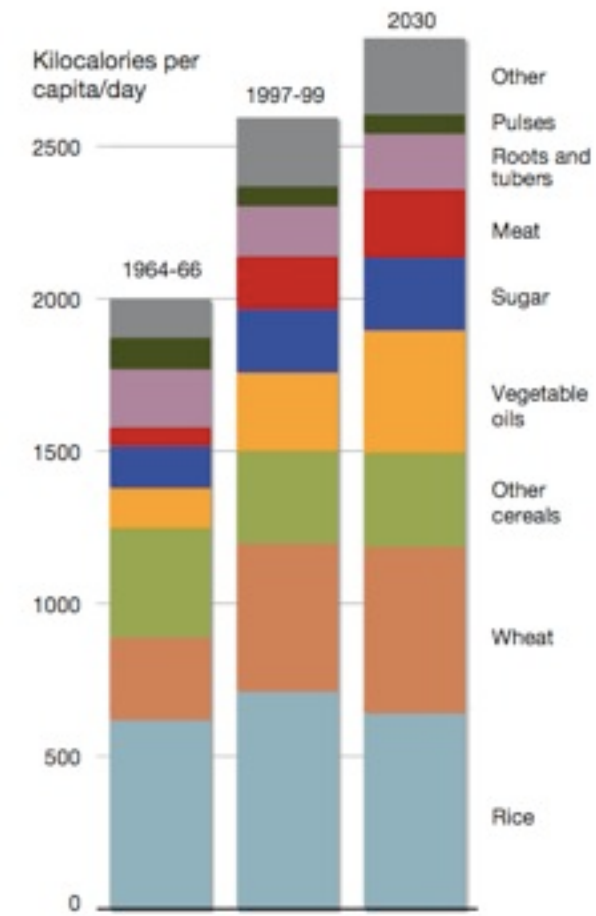
http://www.who.int/nutrition/publications/nutrecomm/en/index.html

- *Nutrition is the intake of food, considered in relation to the body's dietary needs*. Good nutrition – an adequate, well balanced diet combined with regular physical activity – is a cornerstone of good health. Poor nutrition can lead to reduced immunity, increased susceptibility to disease, impaired physical and mental development, and reduced productivity

Food Demand per capita

Other nutrients to be considered

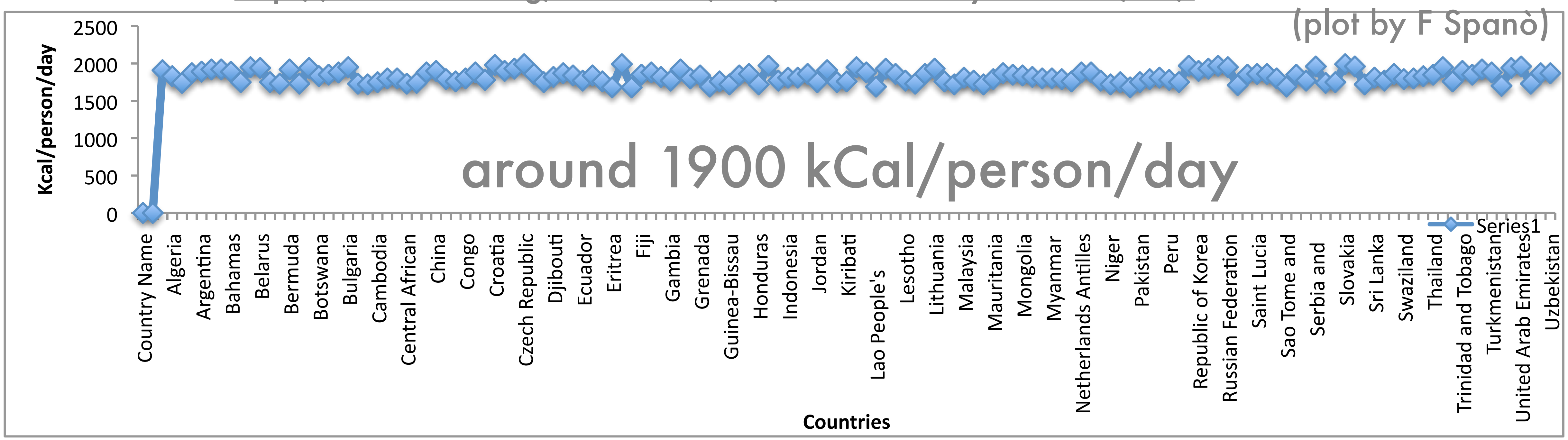
, the dietary proportion of meat has a major influence on global food demand (Keyzer et al., 2005). With meat consumption projected to increase from 37.4 kg/person/year in 2000 to over 52 kg/person/year by 2050 (FAO, 2006), cereal requirements for more intensive meat production may increase substantially to more than 50% of total cereal production (Keyzer et al., 2005)



Calories:Minimum Dietary energy requirement (average) 2004-2006

http://www.fao.org/economic/ess/food-security-statistics/en/

(plot by F Spanò)



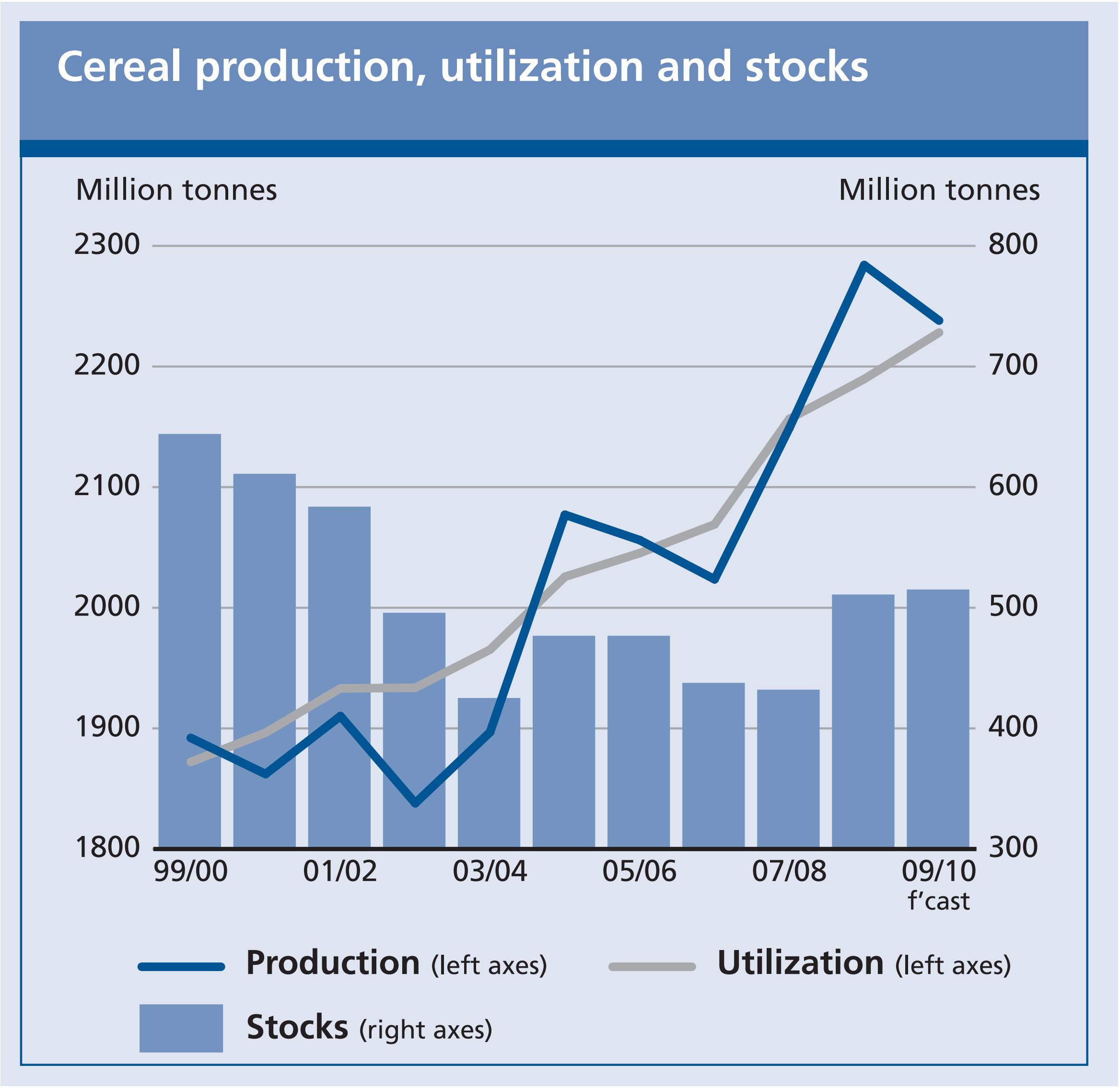
around 1900 kCal/person/day

Food Supply

2284 GKg/year/ 6.8 Gpersons
=335 Kg/person/year=
0.91 Kg/person/day

BUT

Used for Food = 1031GKg/year/
6.8Gper = 151kg/year/person=
0.4 Kg/year/person



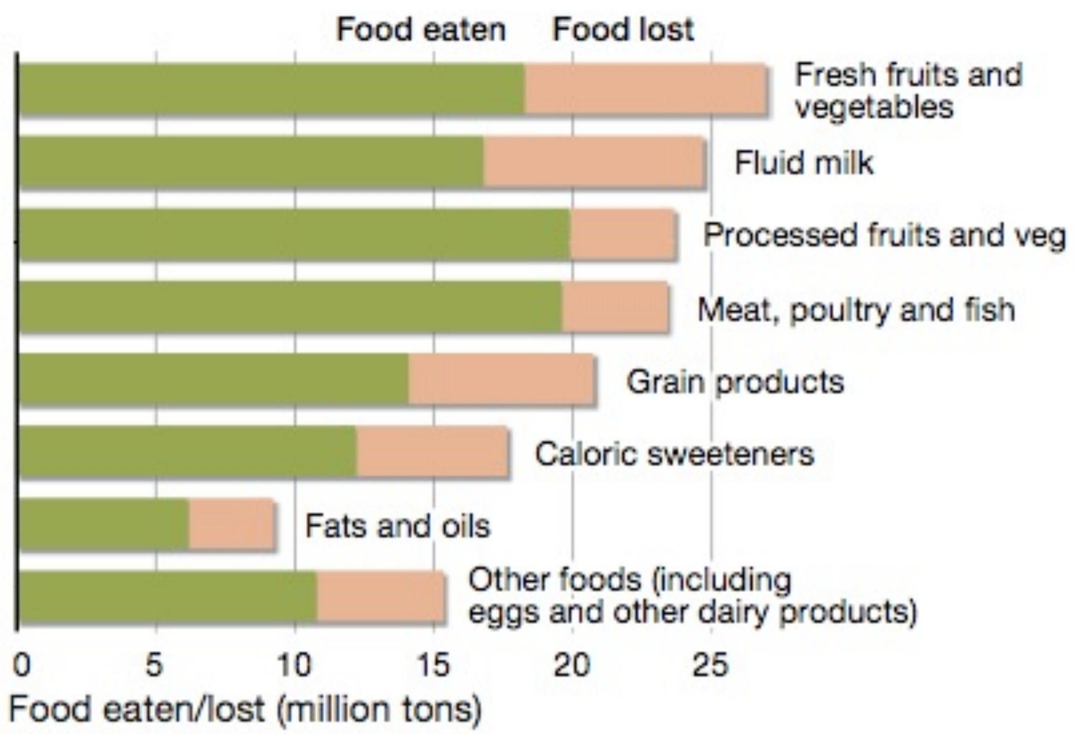


Figure 12: A gross estimate of the global picture of losses, conversion and wastage at different stages of the food supply chain. As a global average, in the late 1990s farmers produced the equivalent of 4,600 kcal/capita/day (Smil, 2000), i.e., before conversion of food to feed. After discounting the losses, conversions and wastage at the various stages, roughly 2,800 kcal are available for supply (mixture of animal and vegetal foods) and, at the end of the chain, 2,000 kcal on average – only 43% of the potential edible crop harvest – are available for consumption. (Source: Lundqvist et al., 2008).

Food from meat

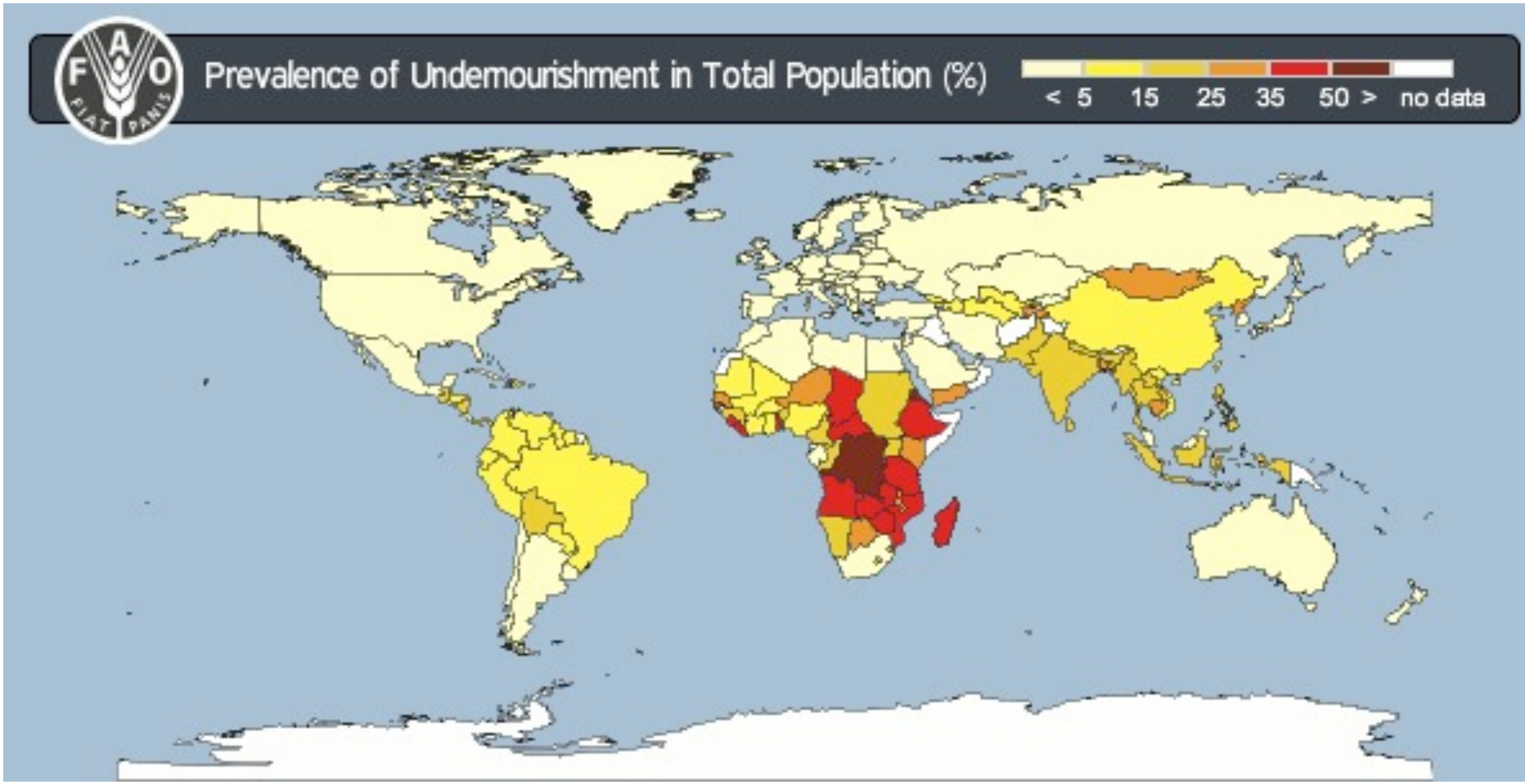
UNEP/GRID

- Meat production increased from 27 kg meat/capita in 1974/1976 to 36 kg meat/capita in 1997/1999 (FAO, 2003), and now accounts for around 8% of the world calorie intake (FAOSTAT, 2009). In many regions, such as in the rangelands of Africa, in the Andes and the mountains of Central Asia, livestock is a primary factor in food security.

- Meat production, however, also has many detrimental effects on the environment, apart from being energy inefficient when animals are fed with food-crops. The area required for production of animal feed is approximately one-third of all arable land. Dietary shifts towards more meat will require a much larger share of cropland for grazing and feed production for the meat industry (FAO, 2006; 2008).

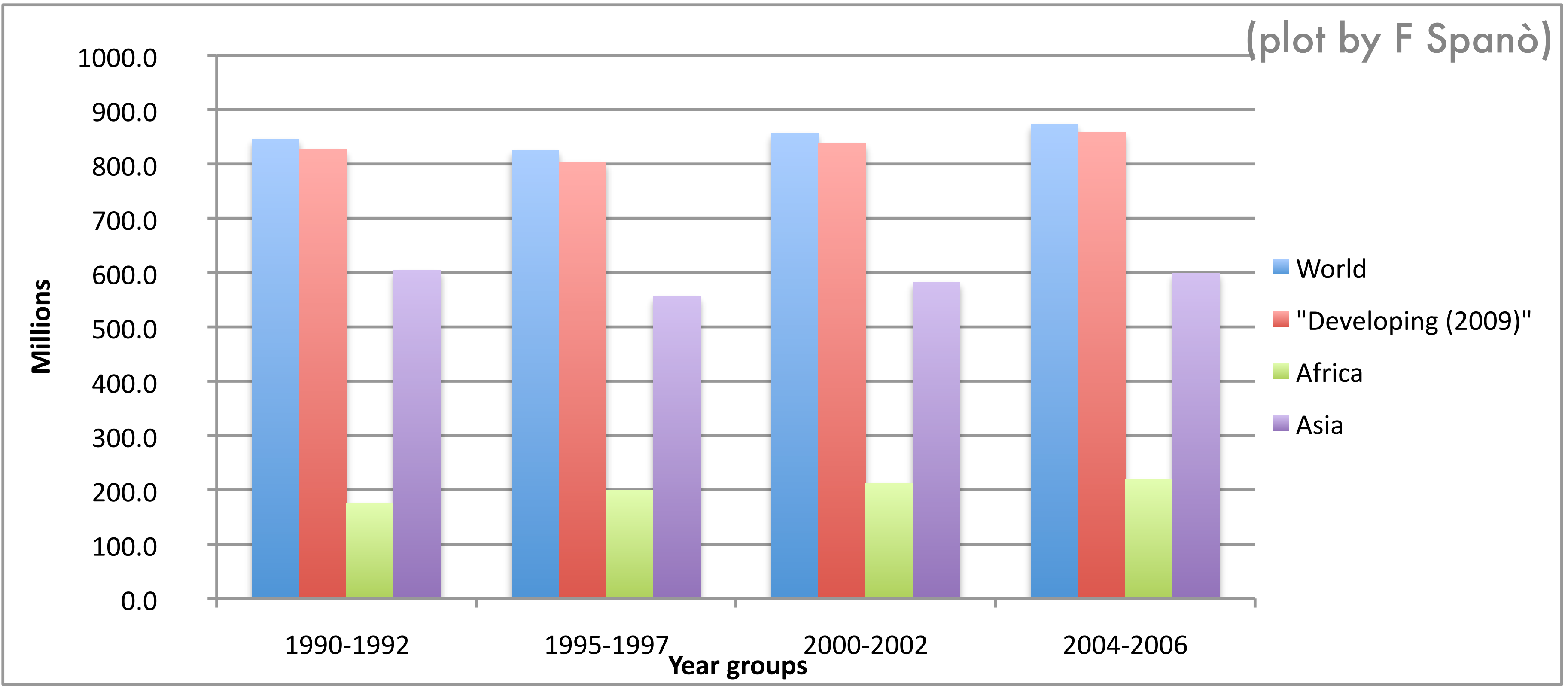
Is it working?: The Hunger Map

http://www.fao.org/economic/ess/food-security-statistics/fao-hunger-map/en/



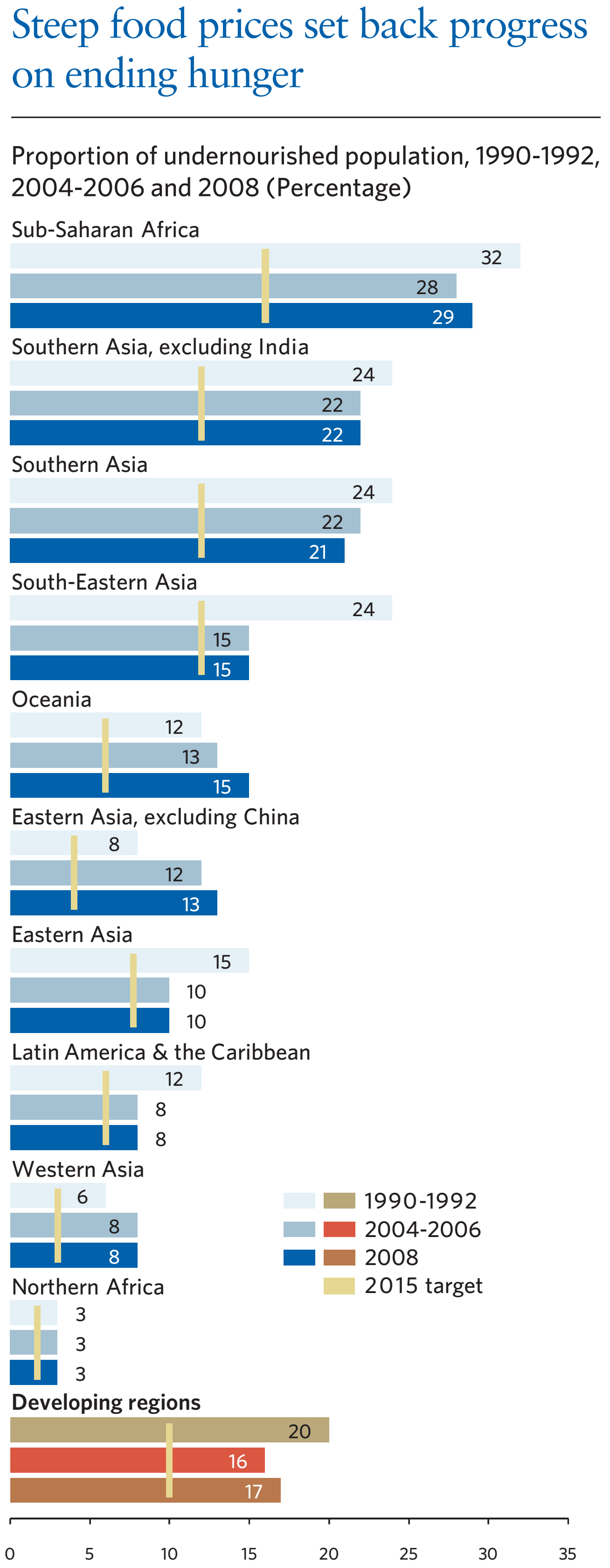
Undernourished People

Millennium Development Report 2009



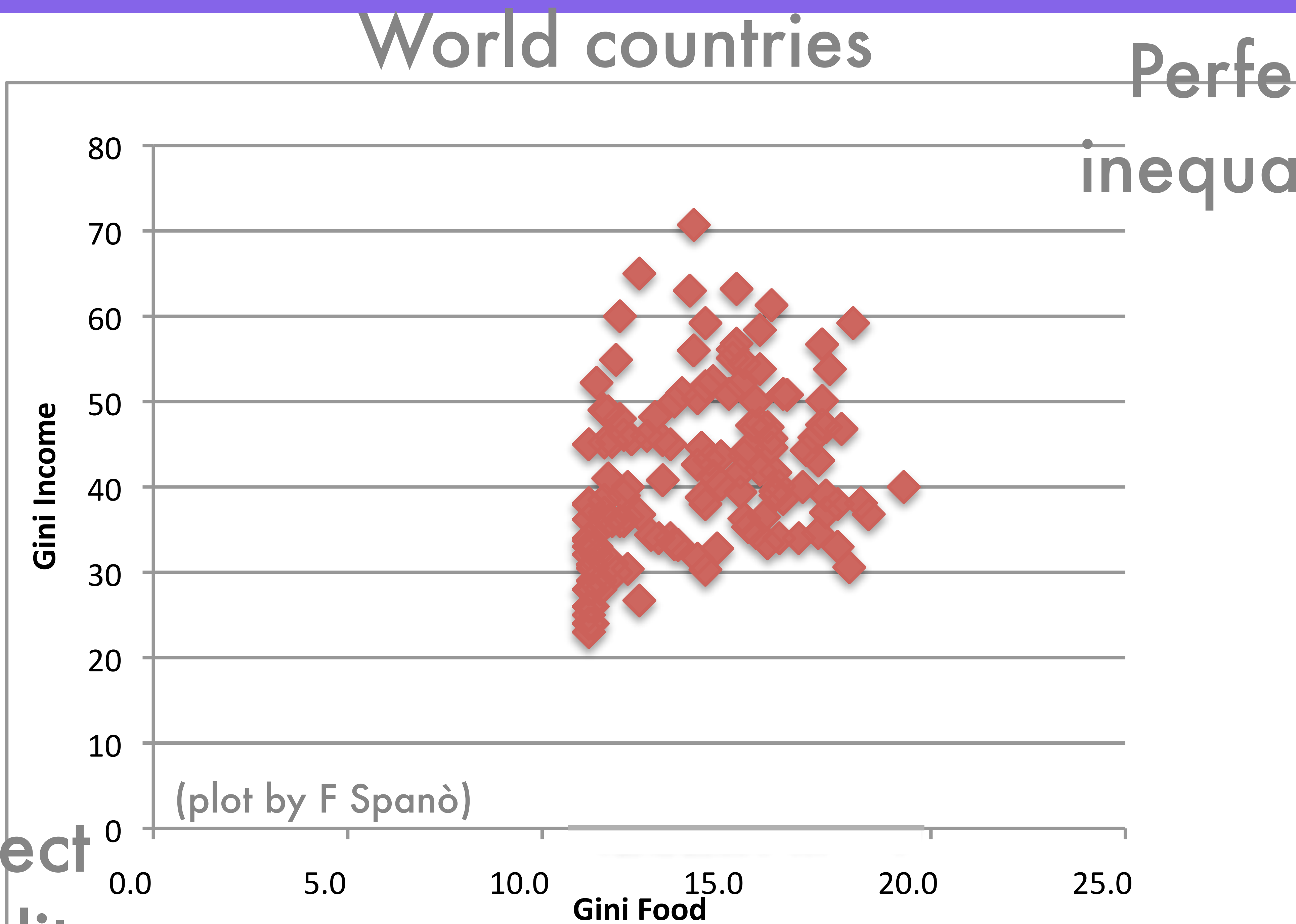
http://www.fao.org/economic/ess/food-security-statistics/en/

Number of undernourished persons



http://mdgs.un.org/unsd/mdg/Resources/Static/Products/Progress2009/MDG_Report_2009_En.pdf

Income inequality and



Perfect inequality

Perfect equality

Inequality of dietary energy consumption distribution

http://www.fao.org/economic/ess/food-security-statistics/en/

Water Demand per capita

http://www.waterencyclopedia.com/St-Ts/Survival-Needs.html

The minimum water requirement for replacement purposes, for an "average" person, has been estimated to be approximately 3 liters (3.2 quarts) per day, given average temperate climate conditions.

- Gleick, P. H. 1996. "Basic Water Requirements for Human Activities: Meeting Basic Needs." Water International. 21:83–92

Drinking, sanitation, and hygiene needs constitute the basic human survival needs for water. These minimum needs total about 50 liters (13.2 gallons) per person per day. In comparison, the average American uses well over ten times that amount. Fifty liters per person per day maintains a person's water balance and provides benefits vital for human health.

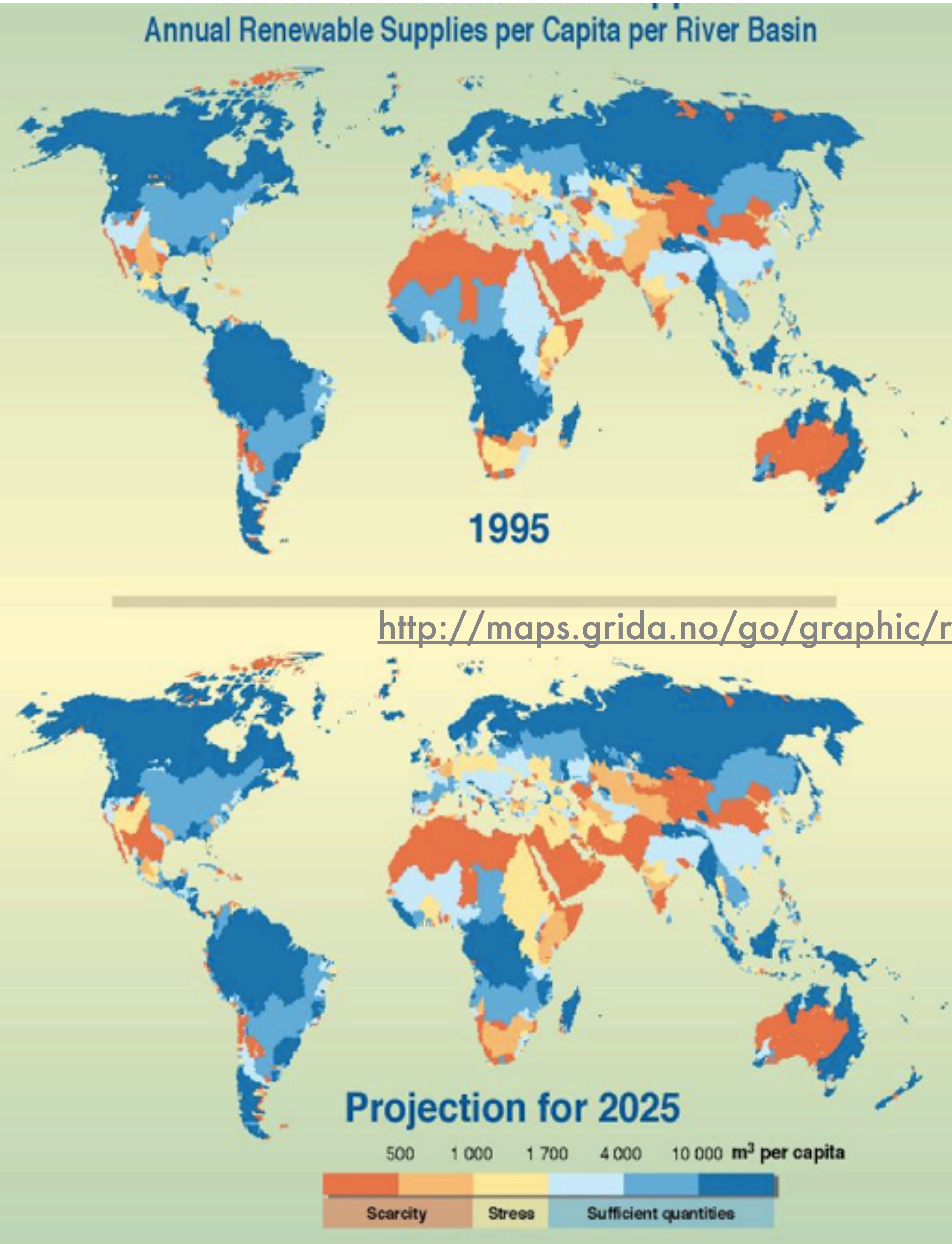
In 2000, it was reported that 55 countries, with a combined population of over 1 billion, average below this basic level.

Read more: Survival Needs - human http://www.waterencyclopedia.com/St-Ts/Survival-Needs.html#ixzz0gHL41P4i

Quantity of water needed to produce 1 kg of:
- wheat: 1 000 L
- rice: 1 400 L
- beef: 13 000 L

(D.Zimmer,and D.Renault, 2003)

Water Supply



North America	m³ per capita per year
1 Yukon	1 249 832
2 Mackenzie	408 243
3 Nelson	15 167
4 Mississippi	8 973
5 St. Lawrence	9 095
South America	
6 Amazon	273 767
7 Paraná	8 025

Europe	m³ per capita per year
25 Danube	2 519
Africa and West Asia	
8 Niger	4 076
9 Lake Chad Basin	7 922
10 Congo	22 752
11 Nile	2 207
12 Zambezi	-
26 Orange	1 050
24 Euphrates and Tigris	2 189

Asia and Australia	m³ per capita per year
13 Volga	4 260
14 Ob	14 937
15 Yenisey	79 083
16 Lena	161 359
17 Kolyma	722 456
18 Amur	4 917
19 Ganges and Brahmaputra	-
20 Yangtze	2 265
21 Murray Darling	-
22 Huang He	361
23 Indus	830

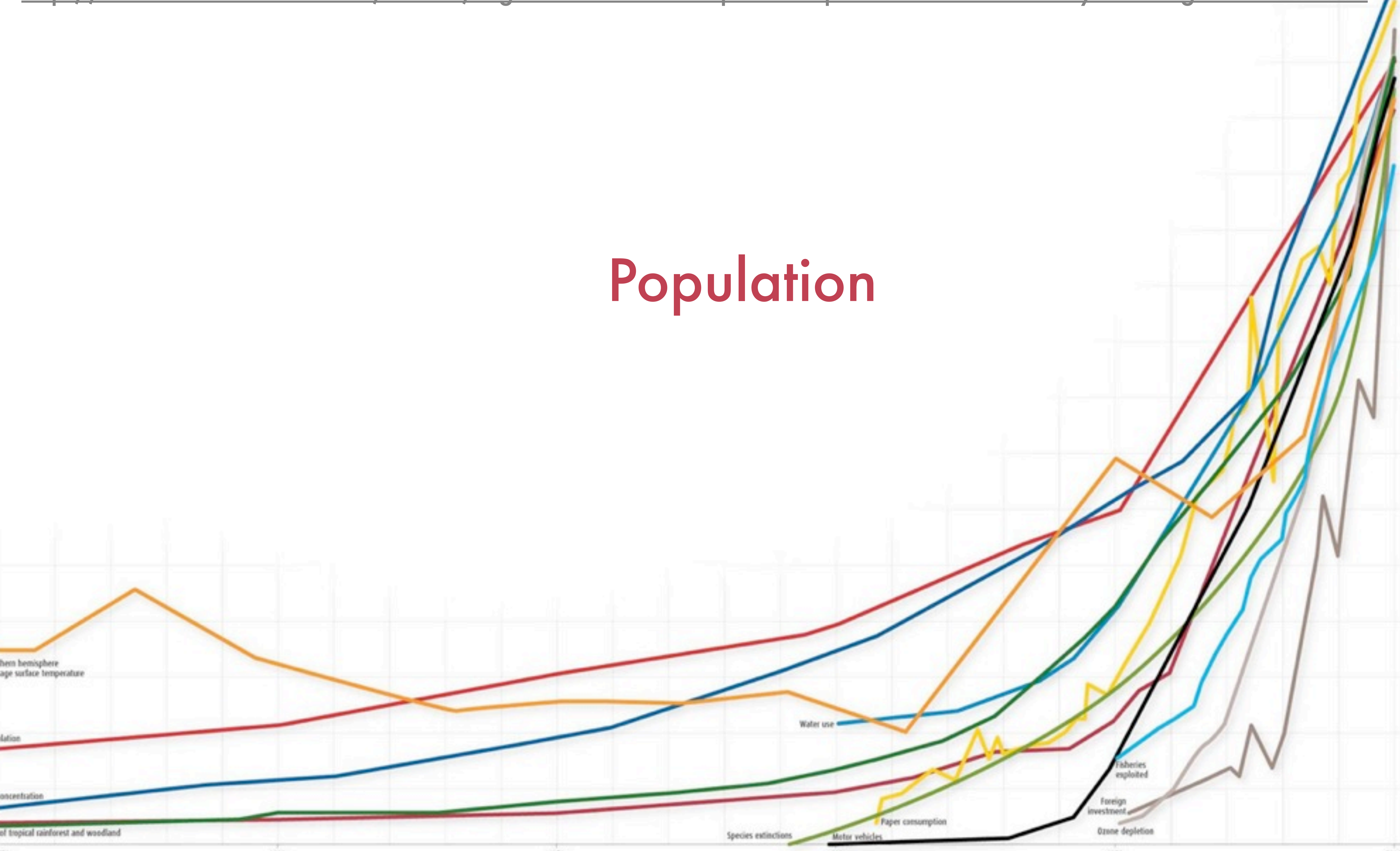
Source: Revenga et al. 2000, from Pilot Analysis of Global Ecosystems: Freshwater Systems.

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

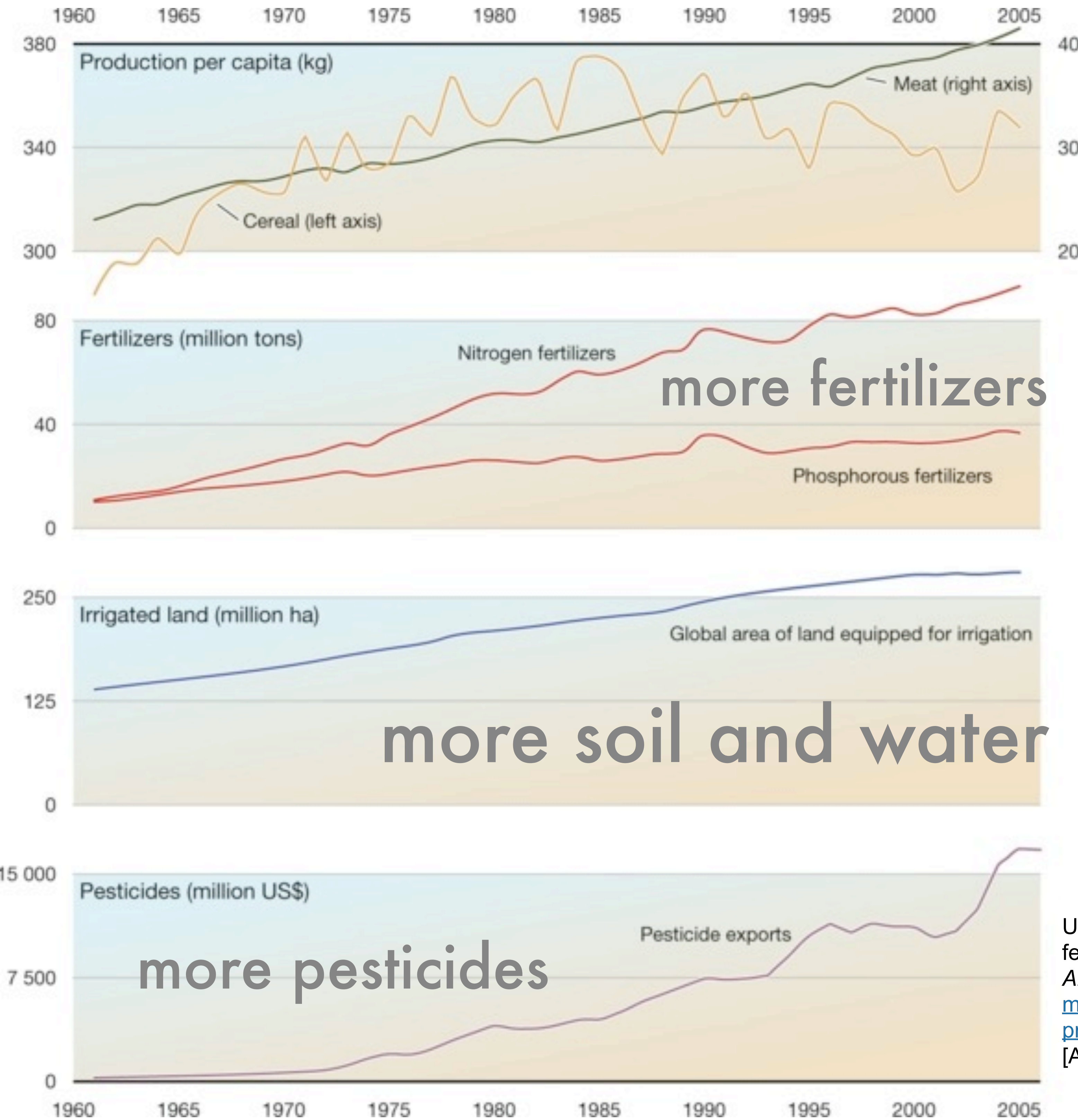
Renewable freshwater supplies, per river basin. Freshwater represents a crucial sort for human development, for nature and for ecosystem services. This graphic compares freshwa supplies in cubic metres per capita, per river basin in 1995 with a projection of freshwater supplies for the same areas in 2025. The graphic shows which areas were experiencing wat stress, which were experiencing water scarcity and which had sufficient quantities of freshwa in 1995, and shows projections for this data for 2025. It also shows the amount of water in cu metres per capita per year that is supplied by 26 major river basins.

The growth system

http://www.newscientist.com/article/mg20026786.000-special-report-how-our-economy-is-killing-the-earth.html



How is food produced?



"***The use of fertilizers accounts for approximately 50% of the yield increase, and greater irrigation for another substantial part (FAO, 2003).*** Current FAO projections in food demand suggest that cereal demand will increase by almost 50% towards 2050 (FAO, 2003; 2006). *This can either be obtained by increasing yields, continued expansion of cropland by conversion of natural habitats, or by optimizing food or feed energy efficiency from production to consumption.*"

UNEP/GRID-Arendal, 'Agricultural trends, production, fertilisers, irrigation and pesticides', *UNEP/GRID-Arendal Maps and Graphics Library*, 2009, <http://maps.grida.no/go/graphic/agricultural-trends-production-fertilisers-irrigation-and-pesticides> [Accessed 20 February 2010]

Resources and Sustainability

- Food
- Water

Energy

TopSoil Biodiversity WaterCycle

Climate

Carrying capacity

What is the impact of all of this?

Resources: Energy

- Current agriculture is an energy sink

The Food and Farming Transition: Toward a Post-Carbon Food System, Post Carbon Institute prepared in cooperation with The Soil Association (UK). Available online at www.postcarbon.org/food.

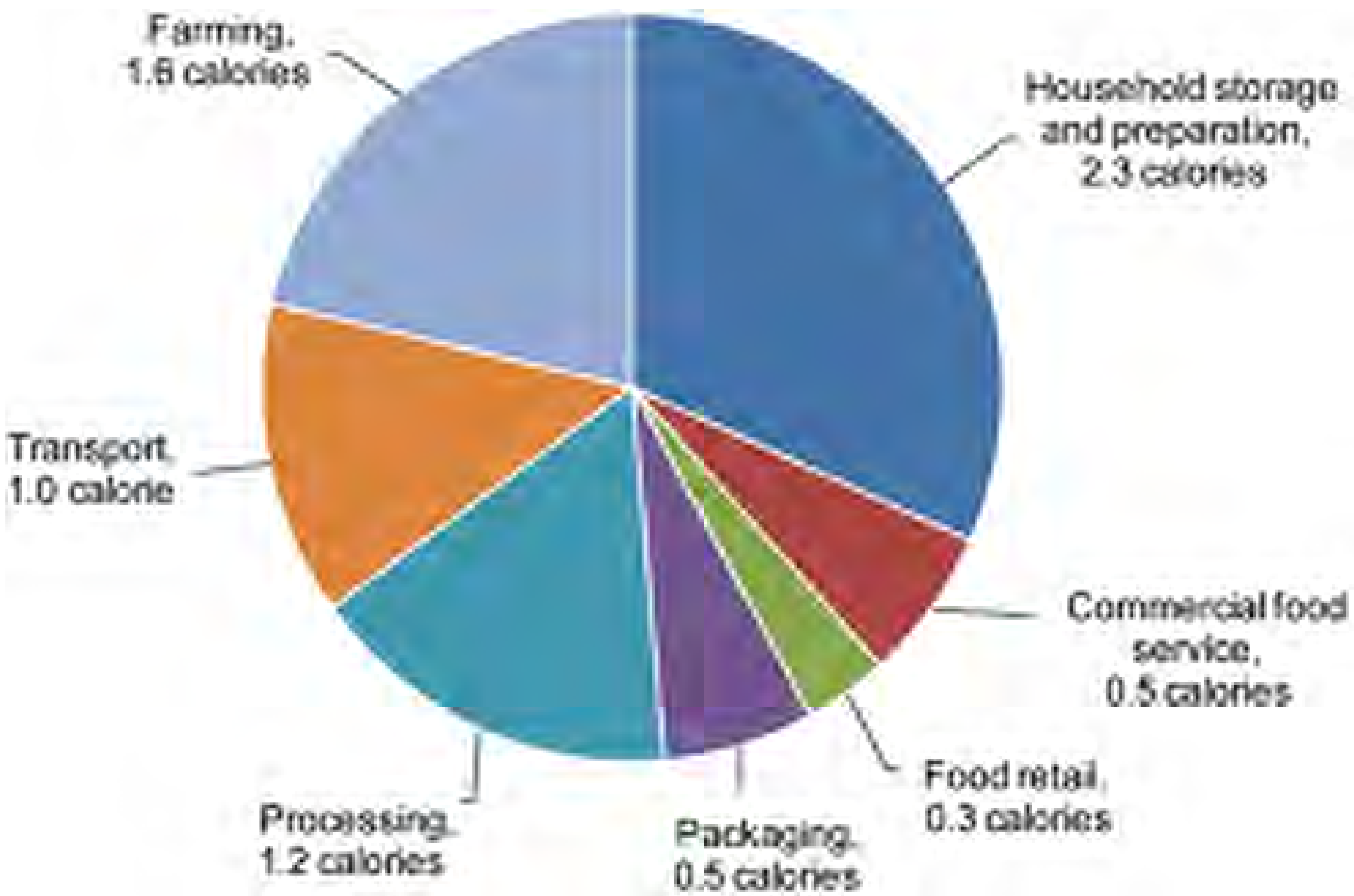
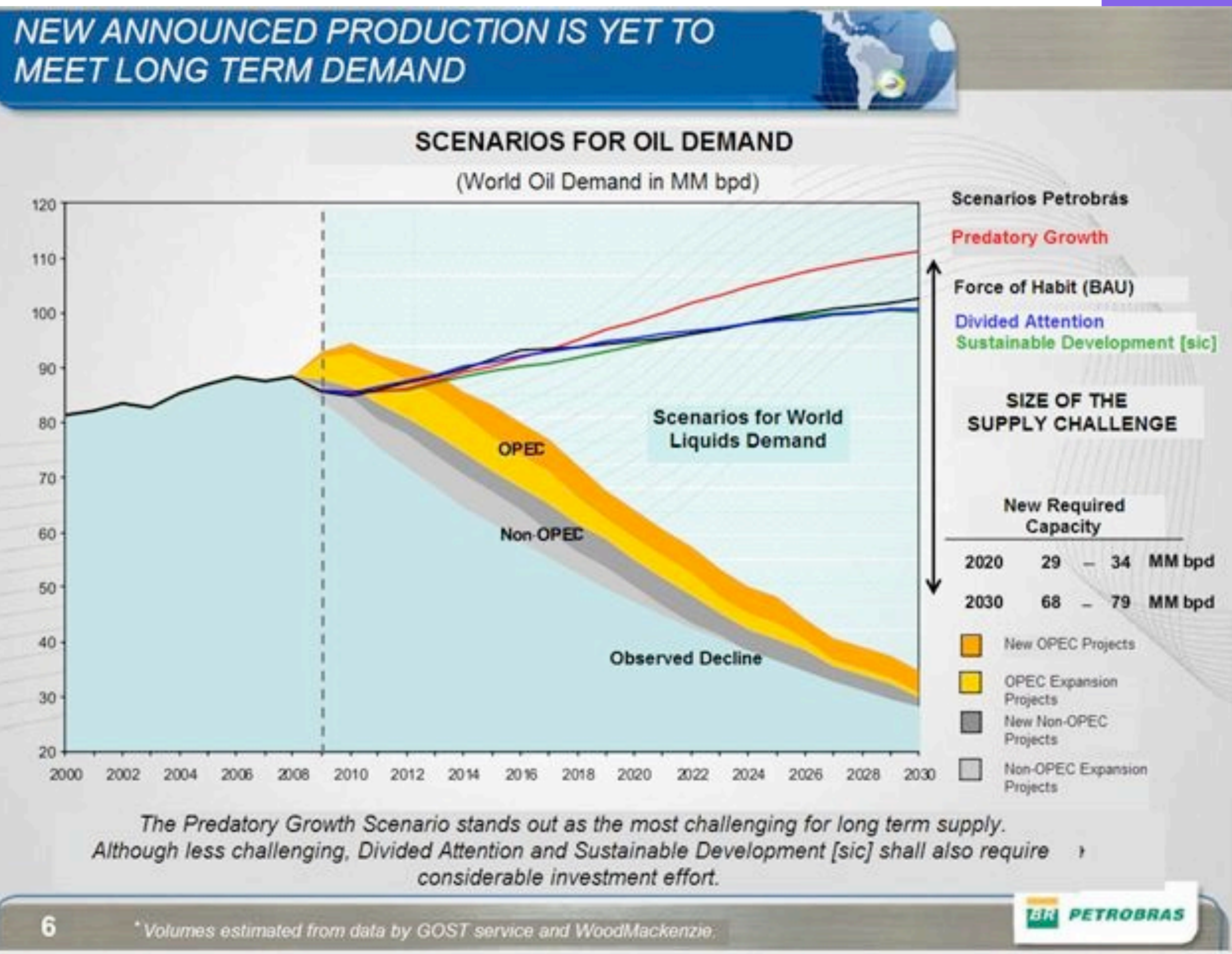


Figure 1. Energy expended in producing and delivering one food calorie. Approximately 7.3 calories are used by the U.S. food system to deliver each calorie of food energy. Farming accounts for less than 20% of this expenditure, but still consumes more energy than it delivers.[1]

The use of fertilizers accounts for approximately 50% of the yield increase, and greater irrigation for another substantial part (FAO, 2003).

1 Adapted from: M.C. Heller and G.A. Keoleian, "Life Cycle-Based Sustainability Indicators for Assessment of the U.S. Food System," University of Michigan (2000).

Enter Peak Oil



Fertilizers are soil amendments applied to promote plant growth; the main nutrients present in fertilizer are nitrogen, phosphorus, and potassium

To give the reader an idea of the energy intensiveness of modern agriculture, production of one kilogram of nitrogen for fertilizer requires the energy equivalent of from 1.4 to 1.8 liters of diesel fuel.

from "Eating fossil fuels" by D Pfeiffer

http://www.fromthewilderness.com/free/ww3/100303_eating_oil.html

http://www.heatingoil.com/blog/petrobras-ceo-peak-oil-production-is-now205/

Resources: Soil

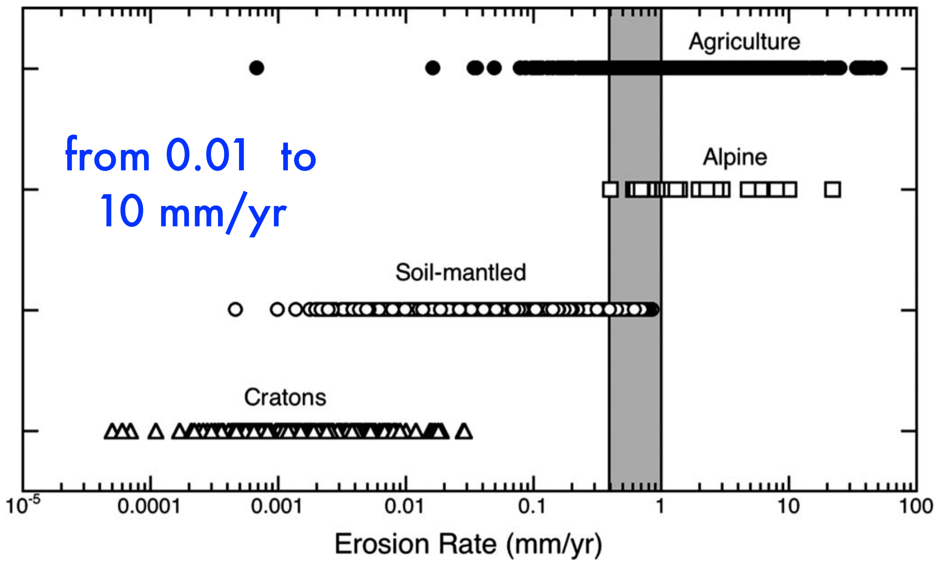
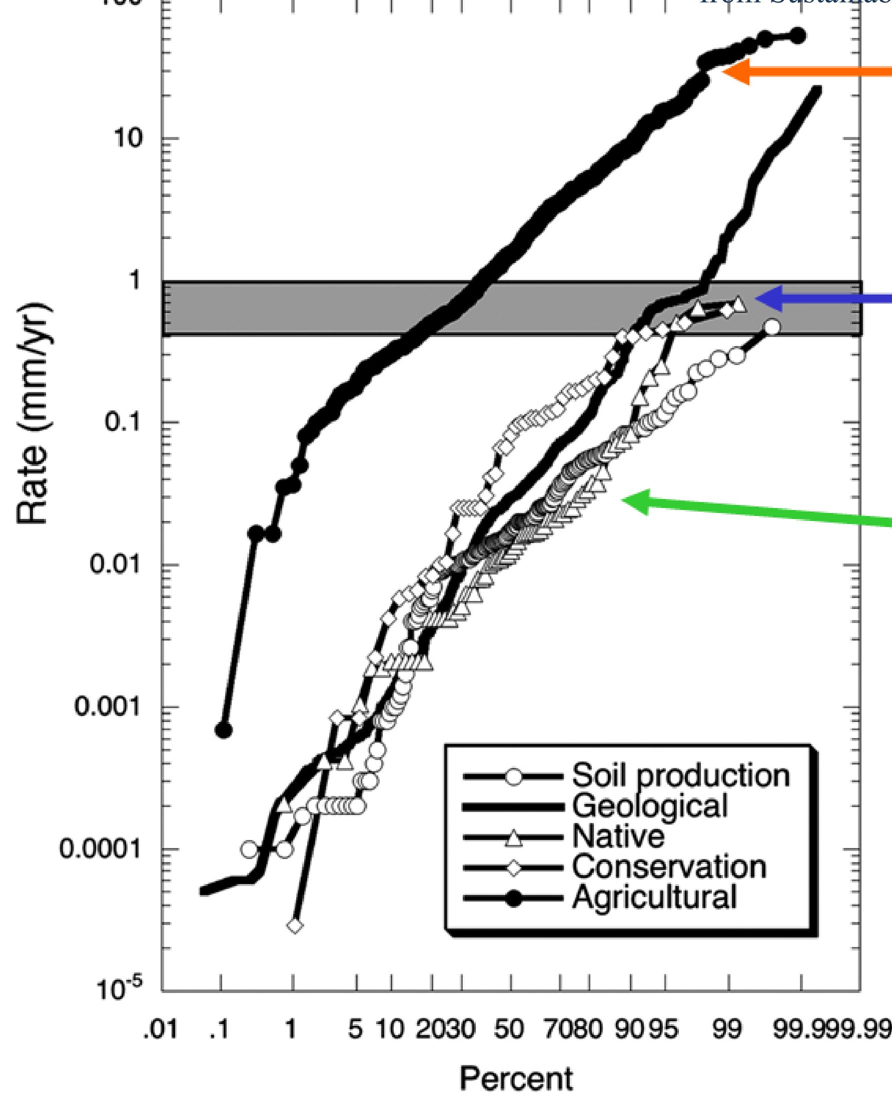


Fig. 1. Comparison of rates of soil erosion from agricultural fields under conventional agriculture (*n* = 448) and geologic erosion rates from low-gradient continental cratons (*n* = 218), soil-mantled landscapes (*n* = 663), and alpine terrain (*n* = 44) (sources are listed in SI). Soil erosion rates reported in various units were converted to equivalent lowering rates assuming a soil bulk density of 1,200 kg/m^3. Shaded area represents range of the USDA. *T* values (0.4–1.0 mm/yr) were used to define tolerable soil loss.

geological erosion rate = rate at which soil in a particular environment would erode under native vegetation, which they maintained would match the rate of soil production.

from Sustainable Agriculture Whitepaper



Conventional agriculture has extremely high rates of soil erosion.

Some agricultural methods approach levels seen in native vegetation.

Our sustainable goal is to have soil erosion be less than soil production.

- Improved soil and water conservation: Organic production methods increase soil carbon (organic matter), water infiltration rates and water holding capacity, making more water available to plants per inch of rainfall received. Soils with less organic matter allow more surface runoff (removing topsoil and nutrients with the water), permit higher surface evaporation, and retain much less water within the soil structure (Fig. 9).[22]

from

Soil erosion and agricultural sustainability
David R. Montgomery* PNAS **August 14, 2007** vol. 104 no. 33 **13268–13272**

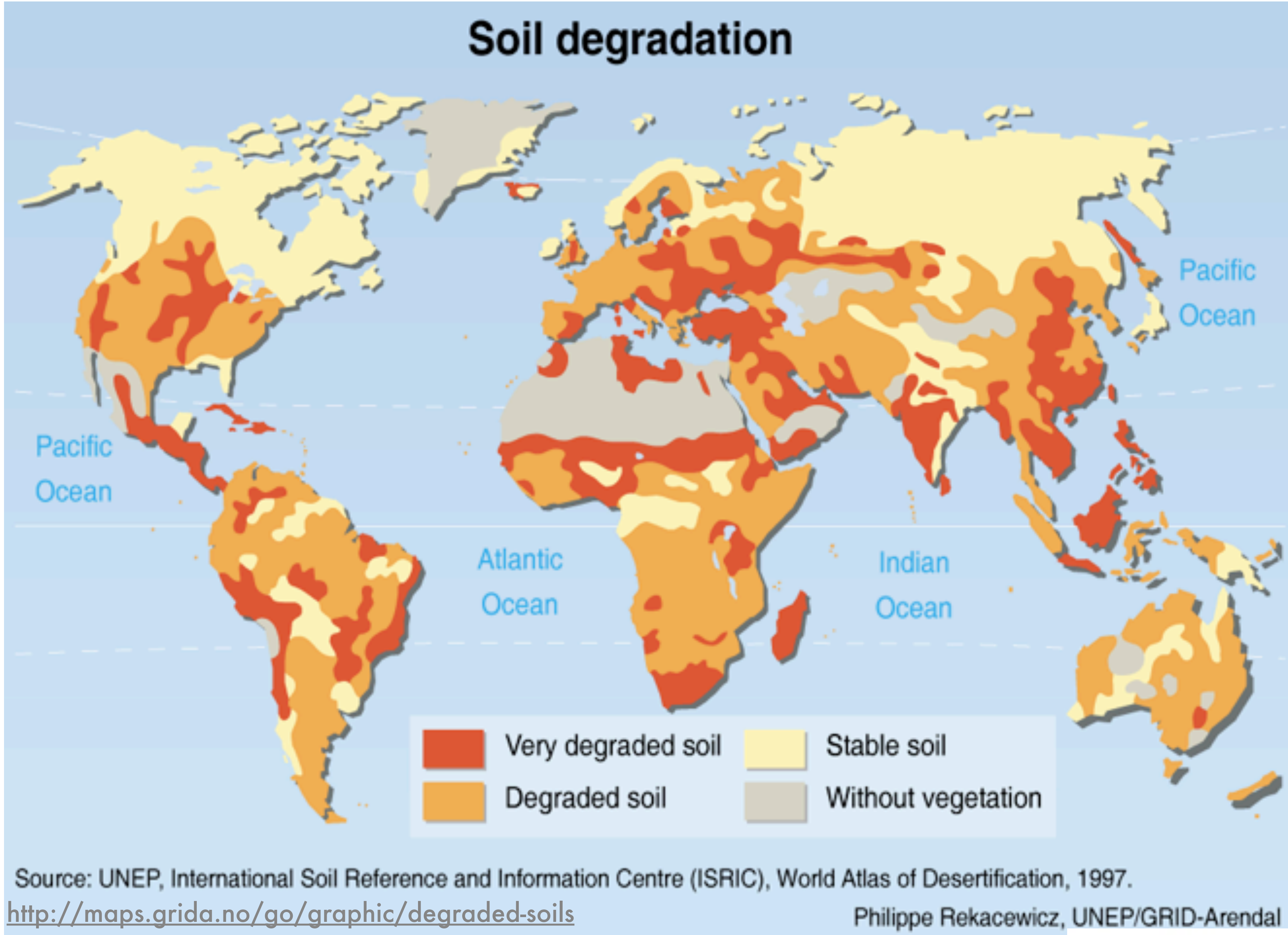
Fig. 9. Probability plots of rates of soil erosion from agricultural fields under conventional (tillage) and conservation agriculture (e.g., terracing and no-till methods), with erosion rates f areas and plots under native vegetation, rates of soil production, and geologic rates of eros (Graphic modified from Montgomery D. 2007)

The method employed for the GLASOD survey is set out in full in Oldeman et al. (1990). In summary, a set of mapping units, relatively homogeneous in their physical characteristics, was established. For each mapping unit, national experts were asked to estimate:

- Type of degradation: water erosion, wind erosion, chemical deterioration, physical deterioration, and subdivisions of these.
- Degree of degradation: light, moderate, strong, extreme.
- Relative extent of degradation, as percentage of the mapping unit affected.
- Causative factors of degradation: deforestation, overgrazing, agricultural activities (improper agricultural management), overexploitation of vegetation (cutting for fuelwood, etc.), industrial activities (pollution).

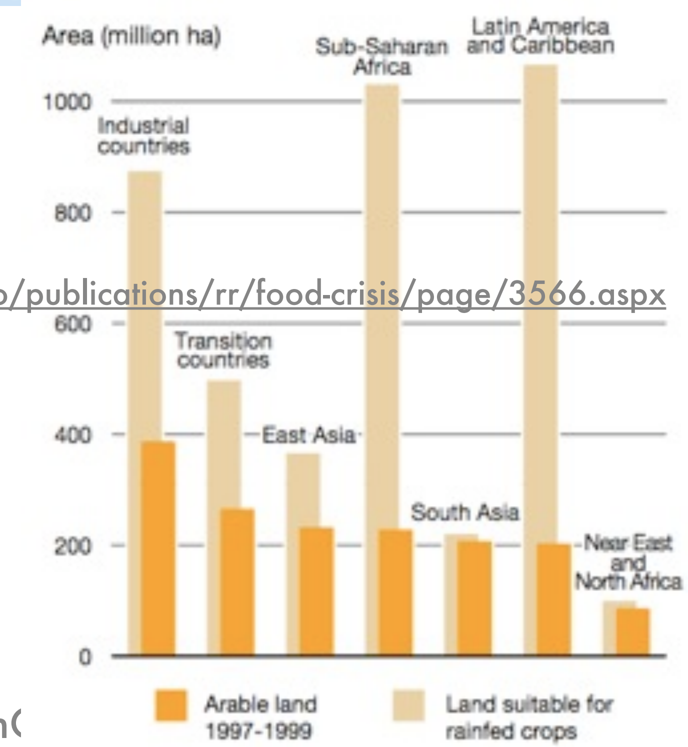
The full set of definitions may be found in Oldeman *et al.* (1990). For present purposes, it is important to note the degrees of degradation, defined in terms of reductions in land productivity. In abbreviated form, these definitions are as follows:

- Light: somewhat reduced agricultural suitability.
- Moderate: greatly reduced agricultural productivity.
- Strong: biotic functions largely destroyed; non-reclaimable at farm level.
- Extreme: biotic functions fully destroyed, non-reclaimable



http://maps.grida.no/go/graphic/degraded-soils

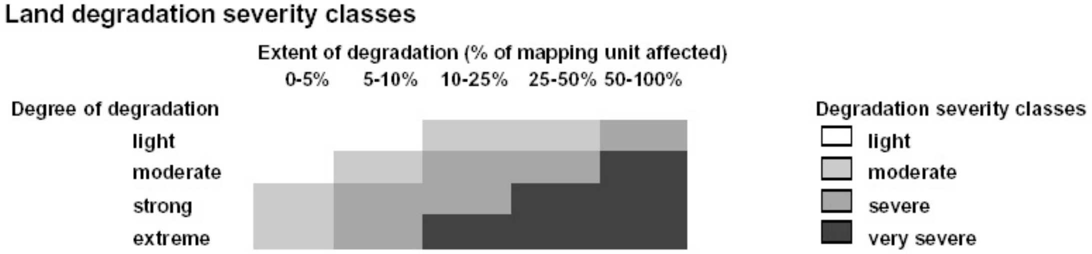
Degraded soils. Soil degradation is a key global environmental indicator. Very degraded soils are found especially in semi-arid areas (Sub-Saharan Africa, Chile), areas with high population pressure (China, Mexico, India) and regions undergoing deforestation (Indonesia). Degraded soils reduce the possibilities for agriculture, increases the expansion of drylands/desert and hightens the risk for erosion. This map presents the state of global soil degradation, from the GLASOD study in 1997.



http://www.grida.no/publications/rr/food-crisis/page/3566.aspx

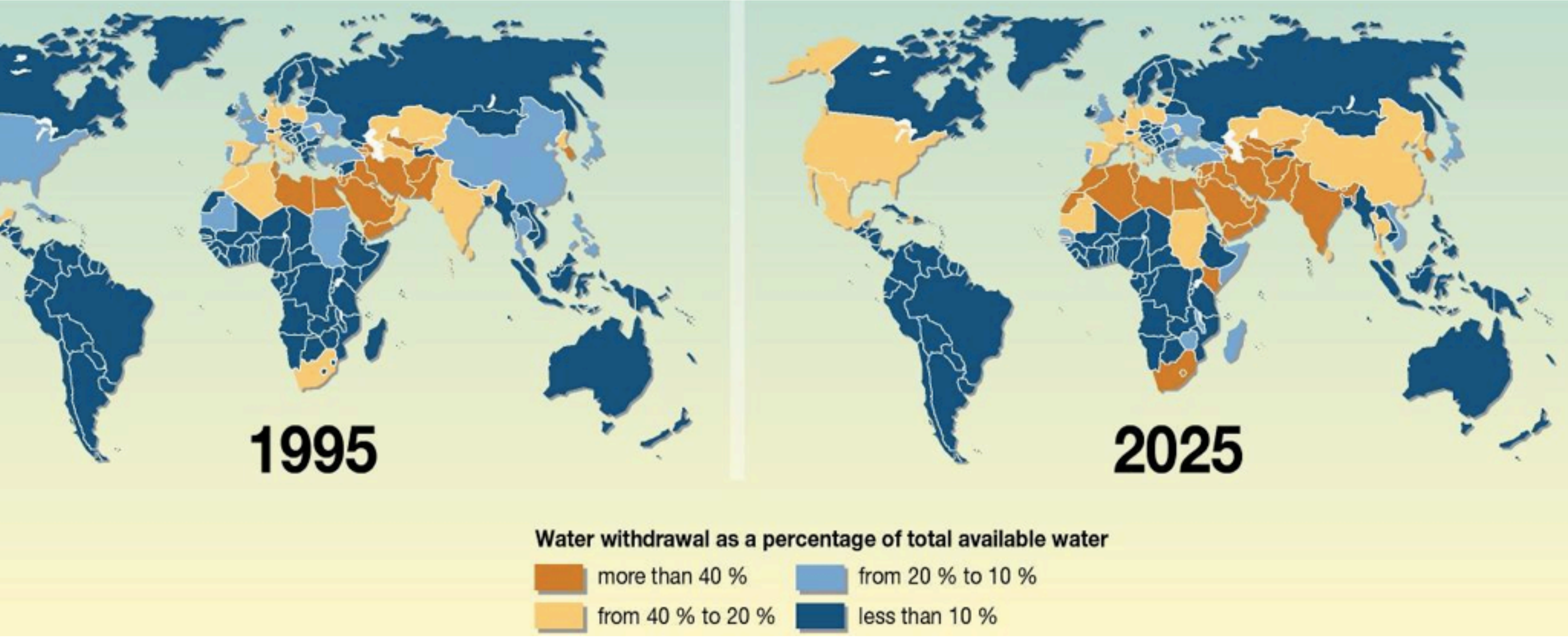
ftp://ftp.fao.org/agl/agll/docs/landdegradationassessment.doc

FIGURE 13
Land degradation severity classes



Resources: Water

http://maps.grida.no/go/graphic/increased-global-water-stress



Increased global water stress. According to Population Action International, based upon the UN Medium Population Projections of 1998, more than 2.8 billion people in 48 countries will face water stress, or scarcity conditions by 2025. Of these countries, 40 are in West Asia, North Africa or sub-Saharan Africa. Over the next two decades, population increases and growing demands are projected to push all the West Asian countries into water scarcity conditions. By 2050, the number of countries facing water stress or scarcity could rise to 54, with a combined population of four billion people - about 40% of the projected global population of 9.4 billion (Gardner-Outlaw and Engleman, 1997; UNFPA, 1997). - Many African countries, with a population of nearly 200 million people, are facing serious water shortages. By the year 2025, it is estimated that nearly 230 million Africans will be facing water scarcity, and 460 million will live in water-stressed countries (Falkenmark, 1989). - Today, 31 countries, accounting for less than 8% of the world's population, face chronic freshwater shortages. Among the countries likely to run short of water in the next 25 years are Ethiopia, India, Kenya, Nigeria and Peru. Parts of other large countries (e.g. China) already face chronic water problems (Hinrichsen et al., 1998; Tibbetts, 2000). - Bahrain, Kuwait, Saudi Arabia and the United Arab Emirates have resorted to the desalinization of seawater from the Gulf. Bahrain has virtually no freshwater (Riviere, 1989), while three-quarters of Saudi Arabia's freshwater comes from fossil groundwater, which is reportedly being depleted at an average rate of 5.2 km3 per year (Postel, 1997).

Resources: BioDiversity

The loss of correlations,
the mono-culture violence

- Monoculture, no rotation
- Loss of biodiversity

Resources: humanity

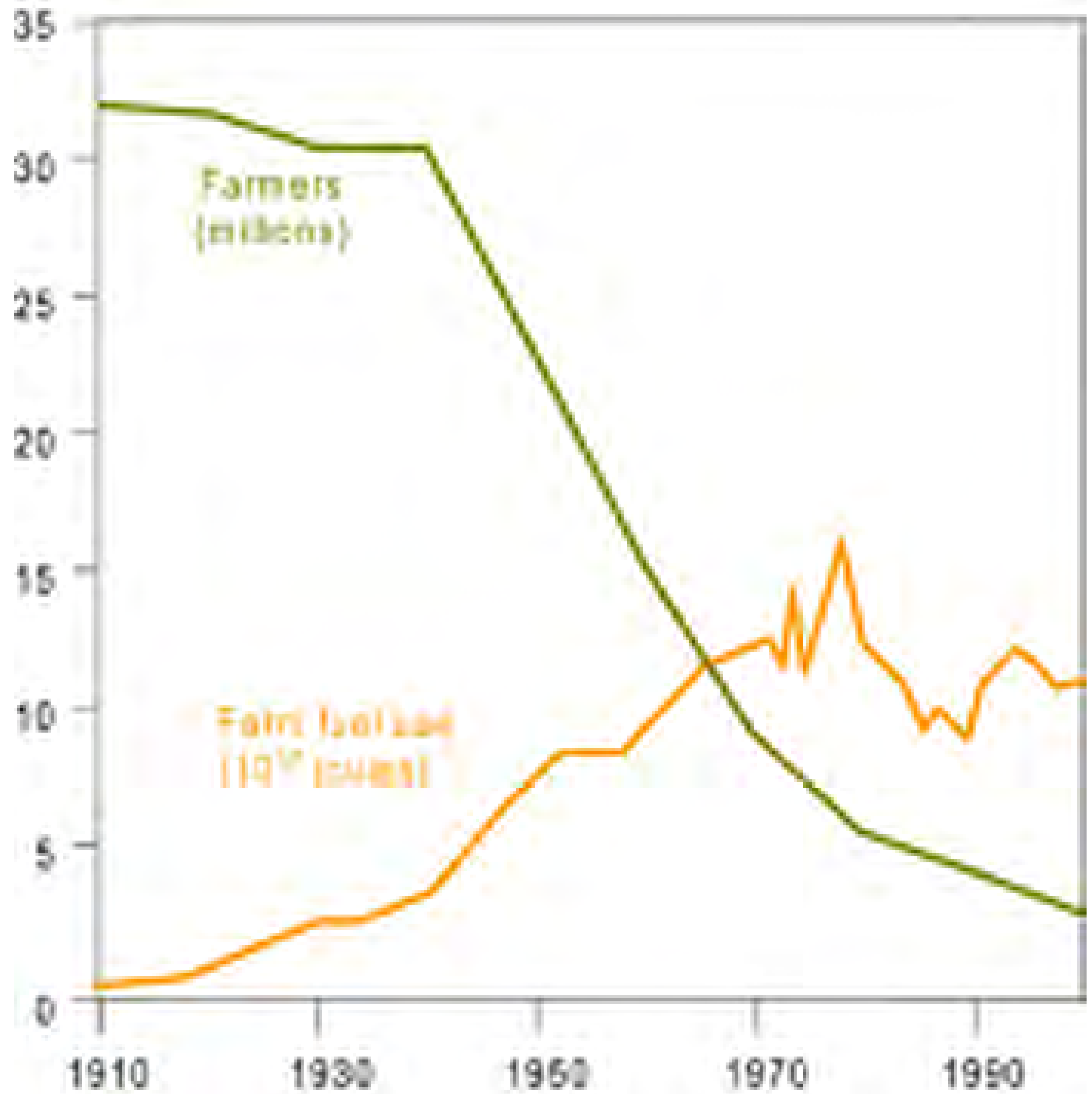


Figure 2. U.S. farm population and direct fuel consumption, 1910-2000. Direct farm fuel consumption includes only fuels consumed on farms. At least as much fuel is used to manufacture farm inputs, such as nitrogen fertilizers, pesticides, and plastics. Both direct and indirect fuel consumption peaked in 1979.[2,3]

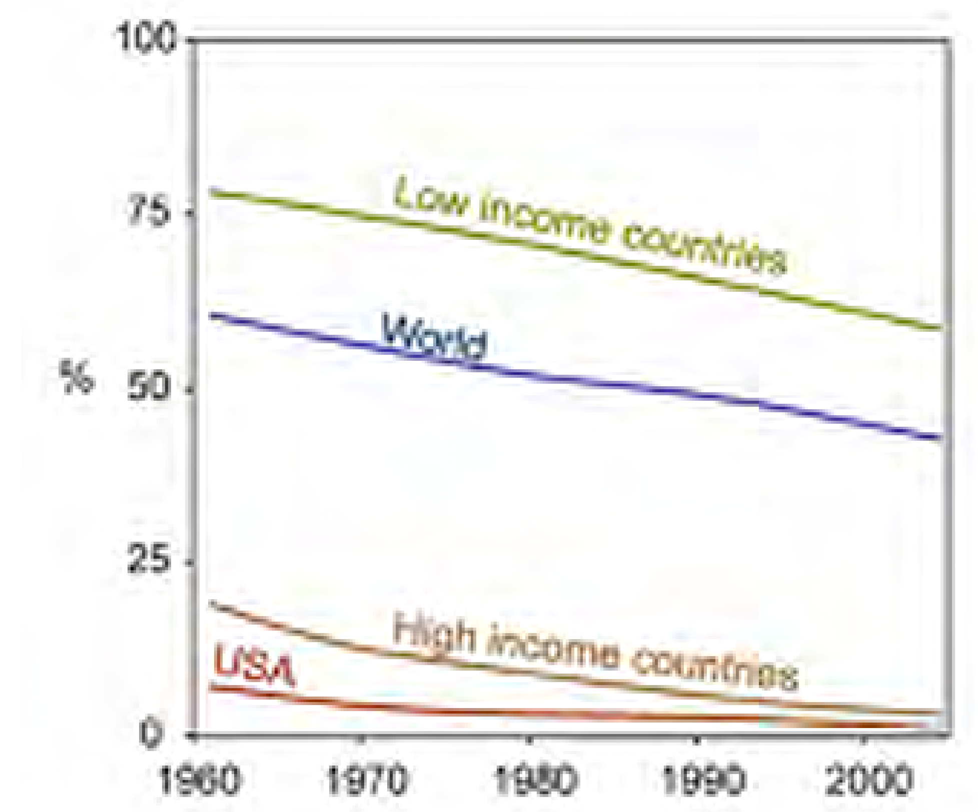
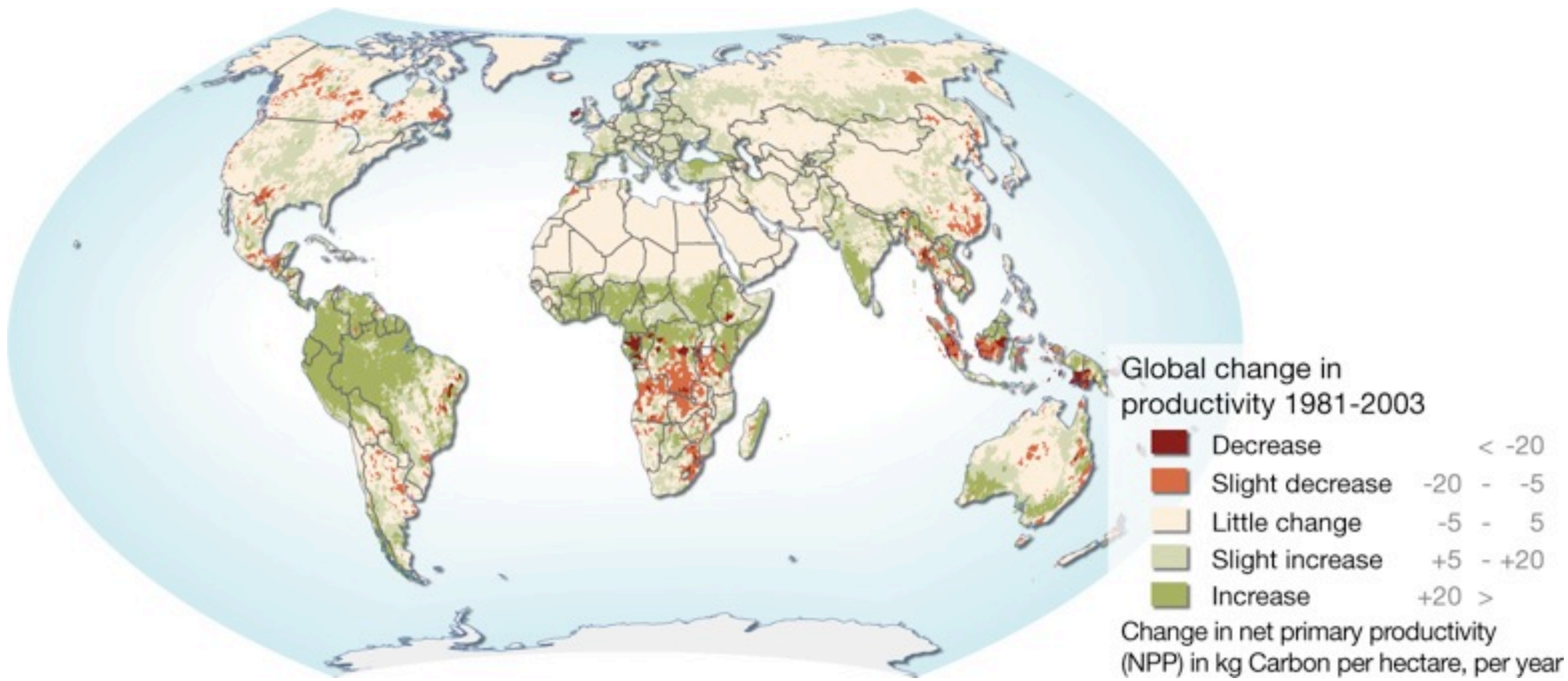


Figure 10. Proportion of population engaged in agriculture, 1961-200

The Food and Farming Transition: Toward a Post-Carbon Food System, Post Carbon Institute prepared in cooperation with The Soil Association (UK). Available online at www.postcarbon.org/food.

Is BAU viable/Sustainable?



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UNEP/GRID-Arendal, 'Trends in productivity 1981-2003 (greening and land degradation)', *UNEP/GRID-Arendal Maps and Graphics Library*, 2009, <http://maps.grida.no/go/graphic/trends-in-productivity-1981-2003-greening-and-land-degradation> [Accessed 20 February 2010]

Need to facto in population growth

The Population Challenge: Key to Global Survival

the Population institute 2007

By comparing several relevant figures, a sense of urgency and priority becomes apparent. Table 3 shows several developing countries—all among the world's 40 most populous. The fourth and fifth most populous nations, Indonesia and Brazil, respectively, have similar rates for total fertility, population increase, and unmet need for family planning. However, Indonesia has less than half the gross domestic product (GDP) of Brazil, and is close to utilizing all of its arable land. Brazil has a much lower population density and cultivates a much smaller percentage of potential agricultural land.

Egypt and Ethiopia are similar in many respects—including population, density and percentage of cultivated land; however, Egypt has exponentially more irrigated land and four times the GDP as Ethiopia, greatly reducing risks of drought. Ethiopia has much higher fertility and triple the unmet need for family planning, as well.

Bangladesh has reasonable numbers for several categories, yet its astound- ing population density puts it at significant risk; natural disasters frequently place the country in the headlines.

Uganda, which utilizes its available land relatively well, has very little irrigated land, exposing its vulnerability to drought. In addition, while Uganda has a relatively favorable GDP for the region, it has relatively high population density and very high unmet need.

Table 3
Populous Countries, Agriculture, Income and Population Factors

Country	Population (in millions)[a]	World Rank	Arable Land (%)[b]	Land Cultivation of Permanent Crops (%)[b]	Irrigated Land (sq. km.)[b]	GDP per capita ($US)[b]	Population Density (per sq. km.)[c]	Rate of Natural Increase[a]	TFR[a]	Unmet Need (%)[d]
Indonesia	231.6	4	11	7	45,000	3,900	117	1.4	2.4	9
Brazil	189.3	5	6.9	0.89	29,200	8,800	22	1.4	2.3	7
Bangladesh	149.0	7	55.4	3.08	47,250	2,300	1,045	1.9	3.0	11
Nigeria	144.4	9	33	3.14	2,820	1,500	142	2.5	5.9	17
Philippines	88.7	12	19	16.7	15,500	5,000	277	2.1	3.4	17
Egypt	73.4	15	2.9	0.5	34,220	4,200	74	2.1	3.1	10
Ethiopia	77.1	16	10	0.65	2,900	1,000	70	2.5	5.4	34
Tanzania	38.7	33	4.2	1.16	1,840	800	41	2.6	5.4	22
Kenya	36.9	34	8.0	.97	1,030	1,200	59	2.8	4.9	25
Uganda	28.5	39	21.6	8.9	90	1,900	120	3.1	6.7	35

Sources: [a]: Population Reference Bureau; [b]: Central Intelligence Agency World Factbook; [c]: United Nations; [d]: Guttmacher Institute (for married women aged 15-49)

http://www.populationinstitute.org/external/files/reports/21st_centry.pdf

Where to from here?

Our current predicament
UNSUSTAINABLE

fossil dependent, mechanized

energy sink and globalized

industrial, externalized, individualistic

soil consuming, water stressing, nature invasive and polluting

The best way to make our food system more resilient is clear: decentralize and relocalize it.

The Food and Farming Transition: Toward a Post-Carbon Food System, Post Carbon Institute prepared in cooperation with The Soil Association (UK). Available online at www.postcarbon.org/food.

Transition to a different model

Example of Sustainable farming

http://postcarbon.webvanta.com/new-site-files/Reports/FarmlandLP-SustainableAgWhitepaper.pdf

Sustainable Agriculture Whitepaper

by

Jason Bradford, Ph.D.
and Craig Wichner May 2009

Operations and Structure	Conventional Farm	Sustainable Farm
Fertility	Buy tons of compost or inorganic NPK products	Use nitrogen fixing cover crops, compost animal bedding, and recycle local organic waste
Seeds	Buy commercially developed and patented seeds	Select open pollinated seeds and save those that perform best, buy from regional seed developers when necessary
Energy	Buy liquid fuels and electricity for equipment to perform tasks	Whenever possible let biological processes do necessary work, seek local renewable energy options otherwise
Managing biodiversity	Buy chemicals to combat unwanted organisms	Focus on the health of the soil and the appropriate soil biology to grow healthy crops. Know weed and pest biology well enough to keep them in check through smart management of the whole farm. Create habitat along field edges.
Landscape diversity	Low, usually specializing in one class of food, e.g., grains, dairy, vegetables	High, usually adapting production to the landscape and rotating crops as needed.
Distribution	National to global via commodity markets	Local to regional via fair trade and direct to consumer channels

Table 1. Conventional farms depend largely on external inputs, harm the environment, have low diversity, and don't contribute directly to regional food security. By contrast sustainable farms internalize costs, benefit the environment, encourage diversity, and participate in local food systems.

A societal project: example

Similar lists for Government Institutions, Business.

T

A new culture

Check out

http://www.transitiontowns.org/

Individual and Family

The food and agriculture transition ultimately comes down to choices made at the market and meals consumed at the dinner table. Therefore actions by individuals are just as important to the success of the transition as anything that can be done by farmers, governments, or food businesses. Anyone can undertake the following steps immediately.

1. **Assess food vulnerabilities and opportunities.** Take an honest look at typical monthly food purchases and give careful thought to their implications. How much food comes from within 100 miles? How much is packaged and processed? How many meals are meat-centered? Where is food bought? How would the family cope with a doubling or tripling of food and fuel prices?

2. **Make a plan.** Create an ideal food scenario for the family, including diet, shopping habits, and gardening goals. Identify concrete actions and a timeline to move toward this scenario. Post these at home in a prominent location.

3. **Garden.** Even families without access to land can grow sprouts in a jar or a few food plants in a window box. Join a community garden. Learn from, and teach, other gardeners.

4. **Develop relations with local producers.** Even families with large gardens probably can't grow all of their own food. Use local farmers' markets or CSAs to access locally-grown food and reduce dependence on the global food system.

The Food and Farming Transition: Toward a Post-Carbon Food System, Post Carbon Institute prepared in cooperation with The Soil Association (UK). Available online at www.postcarbon.org/food.

Time to act

http://transitiontowns.org/uploads/TransitionResources/OilCartoonHereford.jpg