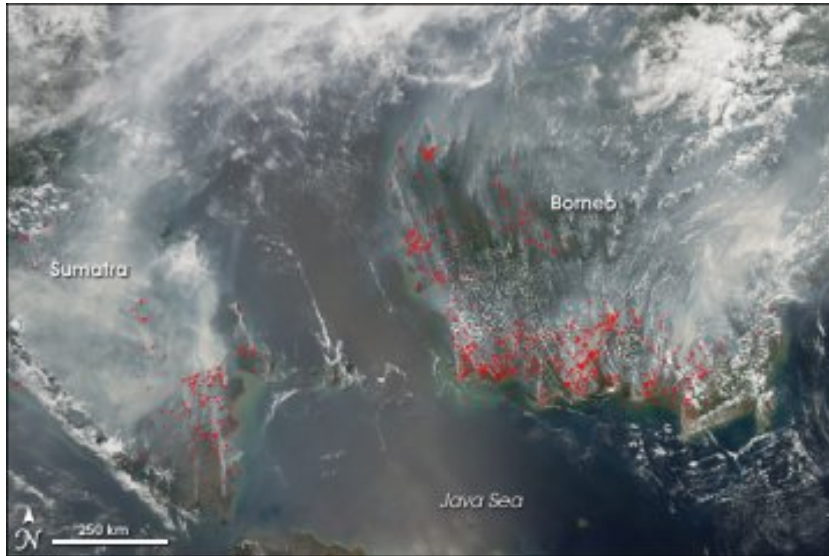
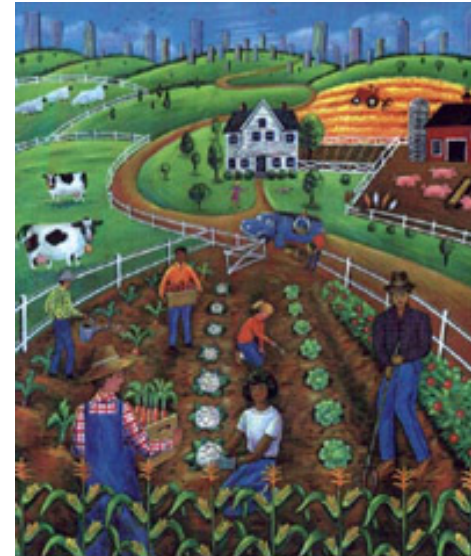


Speth: *Bridge at the Edge of the World*



Fires clearing areas for logging in Indonesia



Eight major global problems exceeding the limits of sustainable usage:

- Climate disruption from Warming – feedback loops;
- Losing forests, especially tropical forests rich in species and carbon;
- Loss of arable land, topsoil – fifty million acres yr lost to sprawl and degradation;
- Overuse of accessible freshwater; loss of half of wetlands high in biodiversity and ecosystem services (healthy watersheds filtering runoff that flows into rivers);
- Destruction of marine fisheries – 75% fished to capacity or over-capacity now;
- Increases in toxic pollutants: pesticides, fertilizers, medicines entering waters;
- Excess nitrogen fixing from fertilizer and resulting dead zones in waters;
- Loss of biodiversity from forests, wetlands, 20% of freshwater fish species gone;

Speth: *Bridge at the Edge of the World*



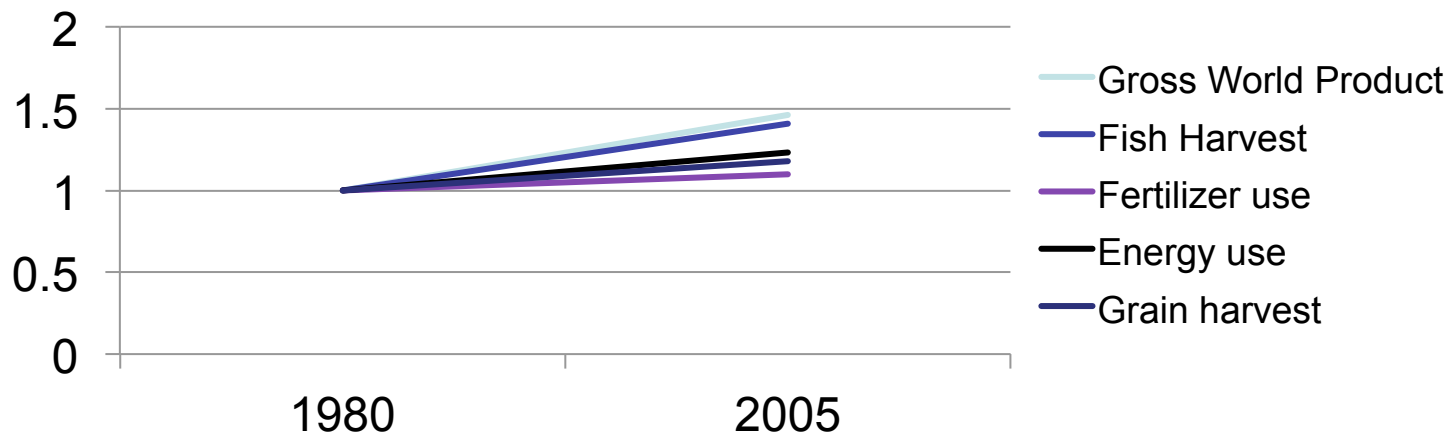
Five major response strategies:

- Fortress World – protect our nation, ignore others;
- Market world – rely on free market to develop more efficient technology to decouple GDP growth from increased natural resource use (throughput);
- Policy reform world – free market with environmental law to stop externalities, market failures, and protect public goods;
- New sustainability world: policy reform and legal regulation, but also changes in demand, conceptions of happiness, move away from consumption-focus – which is driven by advertising in his view.
- Social green world: social justice, empowering the poor, decentralization;

Speth ch.2: Economic Growth depends on Rising Throughput

Speth cites J.R. McNeil's evidence that economic growth has not 'decoupled' from increasing extraction of natural resources and use of ecosystem services (e.g. pollution sinks):

- McNeil's data shows that from 1890 to 1990, the use of natural resources (e.g. energy sources and fish) generally increased at a higher over % than world GDP, which went up 14 fold.
- That means that this economic growth was very dependent on natural resource usage; that usage increased more intensively.
- From 1980 to 2005 we see a GWP (all nations' GDPs combined) increasing faster than various measures of natural resource usage and pollution (throughput). So economic growth is becoming more efficient, *decoupling from throughput to an extent*.
- But this decoupling is not happening fast enough. Natural resource usage is still going up over time, towards hard limits.



The "Green Growth" program is an effort in southeast Asian nations to argue that they can continue exponential growth while reducing environmental impacts.



Efficiency effect in energy = one aspect of decoupling

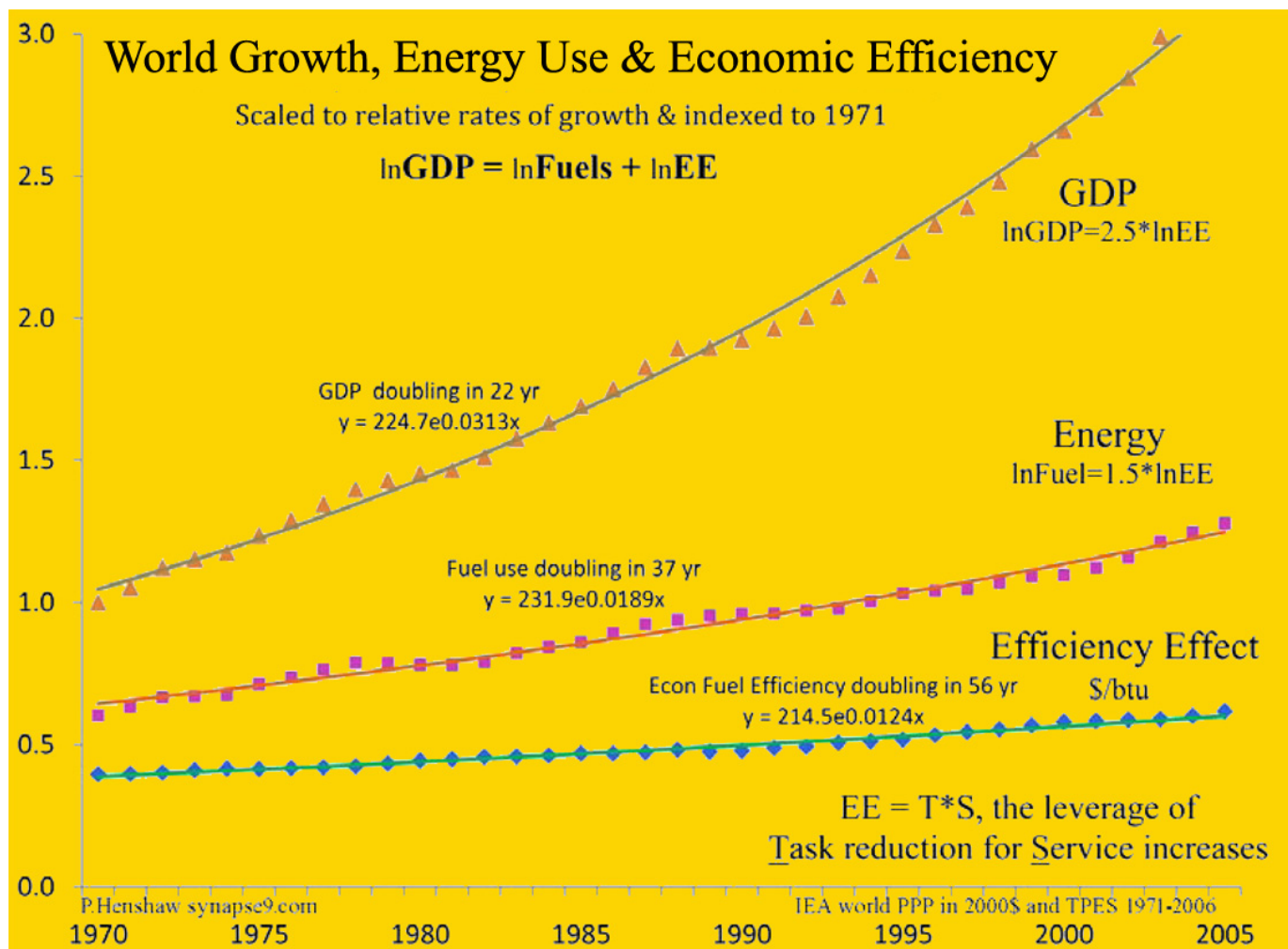
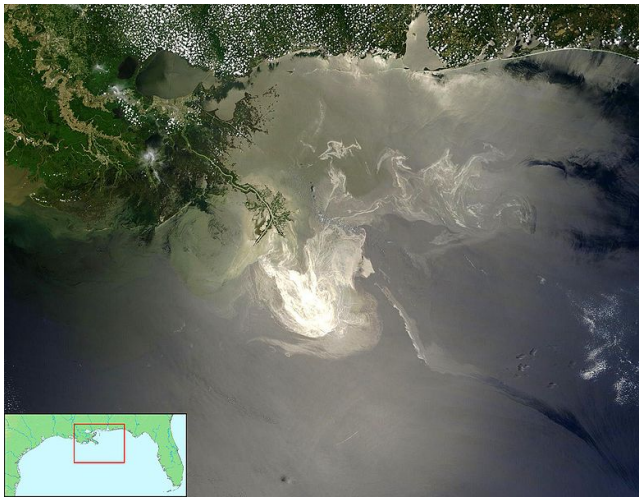


Fig. 1- IEA world data 1971-2006: Economic product (GDP in 2000\$), Energy use (TPES in btu's) & Economic Energy Efficiency (\$/btu), each scaled to their relative growth rates and indexed to 1971 value; The "efficiency effect" is implicitly the result of improving 'know-how' in using energy to create what people will buy.

Speth: Root Causes of Unsustainable Economic Growth

1. Market failures due to *rent-seeking* (getting subsidies, buying assets at sub-market value, monopolies)
2. Market failures due to *externalizing* environmental costs, such as pollution, onto others.
3. GDP figures don't include environmental asset losses as a debit, or deduct for inequality, crime, other social harms; they don't reflect preserved wilderness or biodiversity as an asset;
4. Corporate structure focuses managers on immediate growth in stock value;
5. **The big one:** *future generations* do not participate in the market (yet); so their interests are not reflected in short-term profit-seeking (p.61). How can their demands and needs be reflected?
6. **Discounting:** This is related to discounting of future goods and costs – their utility-value declines the farther they are in the future according to standard economic models (and human psychology).
7. **Globalization:** (a) corporations are multinational, more powerful than many small nations; (b) and national governments compete with one another for businesses, which lowers incentives for tough environmental standards or treaties that will limit various kinds of pollution;
8. Speth also lists cultural factors: poor environmental education, esp. in developing world; political systems in which corporate lobbies have too much influence; people rely on regulation to fix the problems rather than considering their own consumption patterns.



← Deepwater
Horizon oil spill.

A clear-cut in
Russia →



A sample microeconomic case of pricing in environmental “externalities”

Take a single product you buy, say a plastic bottle of pickled herring fish.

- Suppose it costs \$6 in the store (and goes nicely on bread for a snack)

What’s environmental impact is left out of this cost?

1. Suppose we add 40 cents for the cost of the CO₂ released from the boat that caught the herring and the truck that drove it from the packing plant to your local supermarket (that’s the potential cost of the warming attributable to the portion of CO₂ from transportation attributable to this one bottle).
2. Suppose we add in another 10 cents for the CO₂ released by the power used in the packing plant to process and package this one bottle of fish. (We could calculate this cost instead as the cost of sequestering the carbon if that were required).
3. Suppose we add in another 10 cents for the cost of recycling the plastic bottle, or of the marine life lost due to the plastic pollution building up in the oceans.
4. Suppose we add in another 30 cents for the cost of lost future productivity from the herring stock that is being depleted at above its carrying capacity (the opportunity cost to this portion of the global commons).
5. Suppose we add in 5 cents for the depletion of metals and other minerals from non-renewable stocks mined for use in the factory equipment and vehicles involved in bringing you this product.
6. Finally, suppose we add in 5 cents more to cover the costs of running the administration of these regulations added to the free market system to compensate for environmental impact.
7. Now your bottle of pickled herring costs \$7.00 instead, roughly a 15% increase.

Speth: Markets, Demand, and Law/Regulation

Ways of Making Controlling Market Dynamics to Move towards Sustainability:

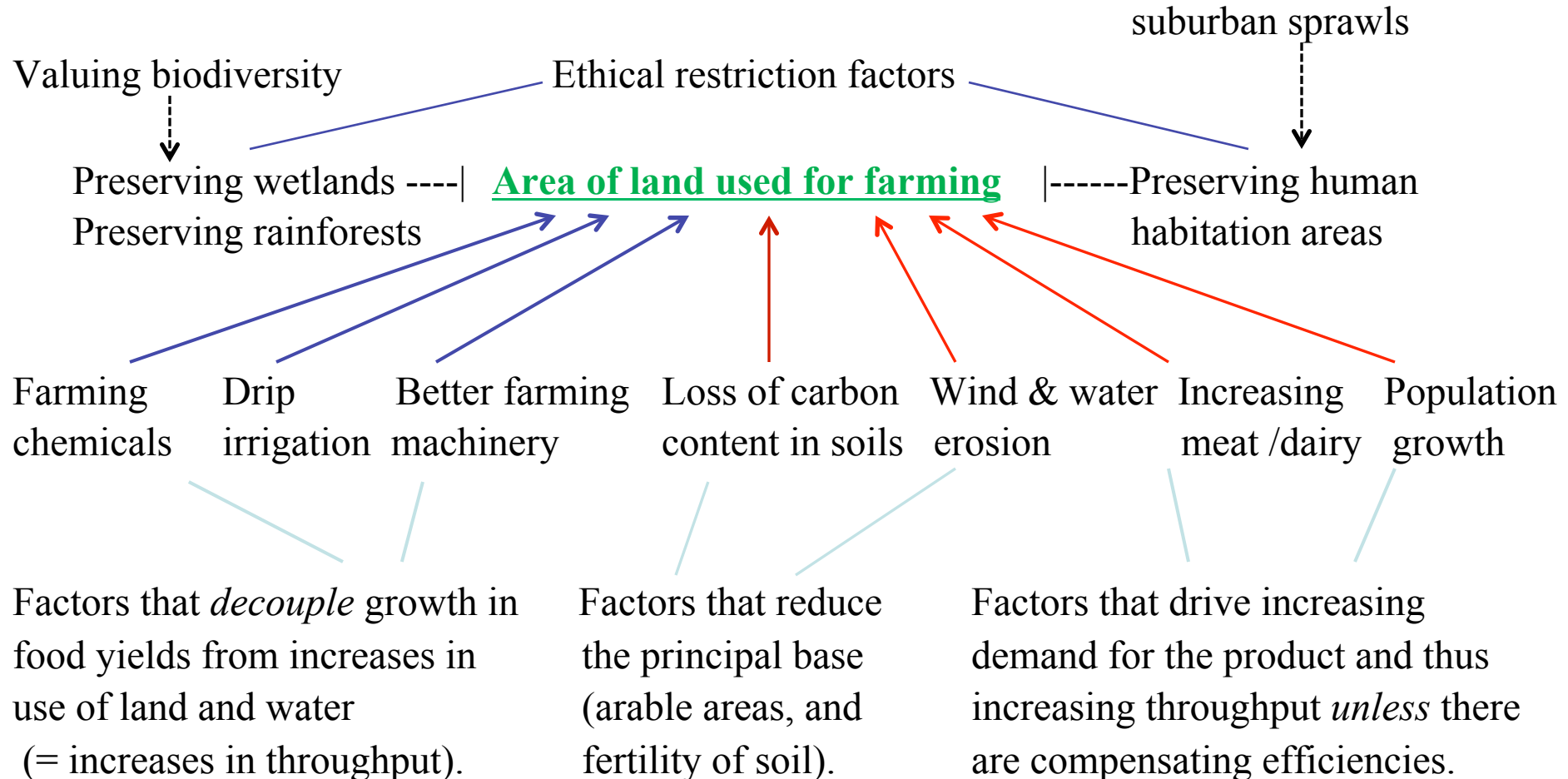
- Cap max amounts of certain pollutants, gov. sells tradeable rights to unit-pollution.
- Cap usage of certain environmental goods at max levels and trade usage rights.
- Get rid of perverse subsidies that lower costs of environmentally harmful products
- Put surtax on products and services that harm public environmental goods.
- Ban certain kinds of harmful products / productive processes outright (e.g. clearcut).
- Set aside protected lands with very limited or no for-profit use (e.g. national parks).
- Increase consumer demand for organic goods, environmentally friendly products.
- Change corporate culture to favor more environmentally friendly processes.



Liquid = market forces; they conform to the shape of glass (= demand + regulation).

Decoupling & 'I=PAT:' factors driving increases and decreases in use of land resources for food

Let's focus on the issue of land resources for farming to see how we might reach, or try to avoid reaching, the limits of sustainable yield:

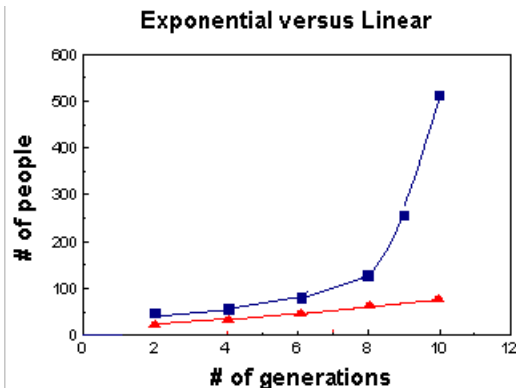


Which set of factors are larger? This determines growth in environmental impact or footprint.

Martenson's *Crash Course*: key points in initial chapters

Chapters on our prospects, predicament, and economic challenges:

- We are reaching a point of declining oil; what will replace it? [maybe shale gas?].
- Economic growth, energy use, and environmental resources are totally intertwined.
- A good life requires meaningful relationships, activities, careers in which we can develop our talents, in a stable environment and politically secure society; it does not require maximum consumer products (p.11-12), “prosperity” includes easier access to conveniences and plentiful and varied job opportunities;
- For any trend on which people’s well-being depends, the central question is: is this sustainable? (p.17). [*Pyramid schemes* are the paradigm of non-sustainable trends]
- With exponential growth, doubling comes sooner over time – *speeding up* effect.
- The increases in energy usage are impressive; China doubling energy use in 9 years (that doesn’t mean that raw materials use doubled, but they are related).
- His central prediction is that eventually, total energy use will have to decline (p.38).



Start	2 pennies	addition	total	% increase
Week 2	2 +	2	4	100%
Week 3	4 +	2	6	50%
Week 4	6 +	2	8	33.3%

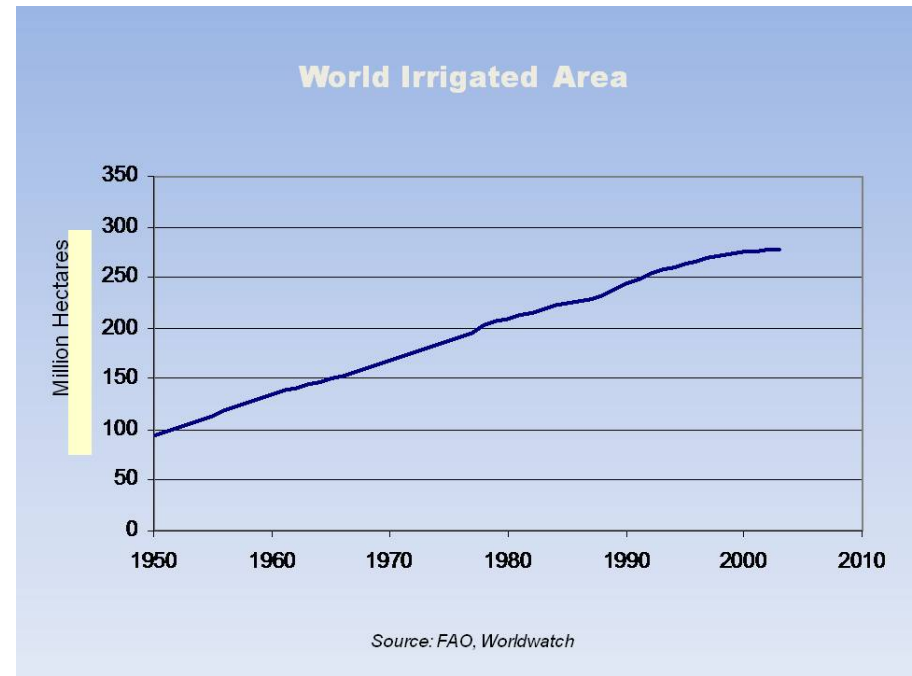
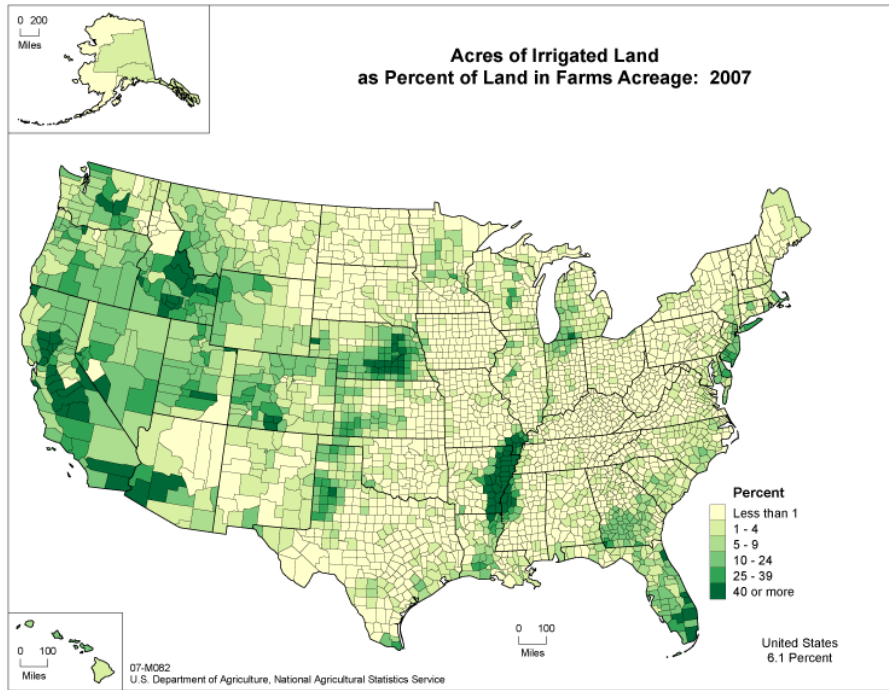
Stuart Pimm: *Scientist Audits the Earth* Ch.2

- Human consumption of plants: 1 billion for 6 billion people: 1.2 billion now
- Plant use via livestock (mostly meat): 2 billion tons: 2.4 billion now
- Fish – an apparently small number (23 million, but see ch.7)
- Plant growth used for products and fuel: 2 billion tons: 2.2 billion now
- Plant growth wasted from production process: 25 billion: 26 billion now?
- Plant growth foregone by cities, roads, parking lots: 3 billion 3.2 billion now?

Total human usage of plant growth on land: 35 billion

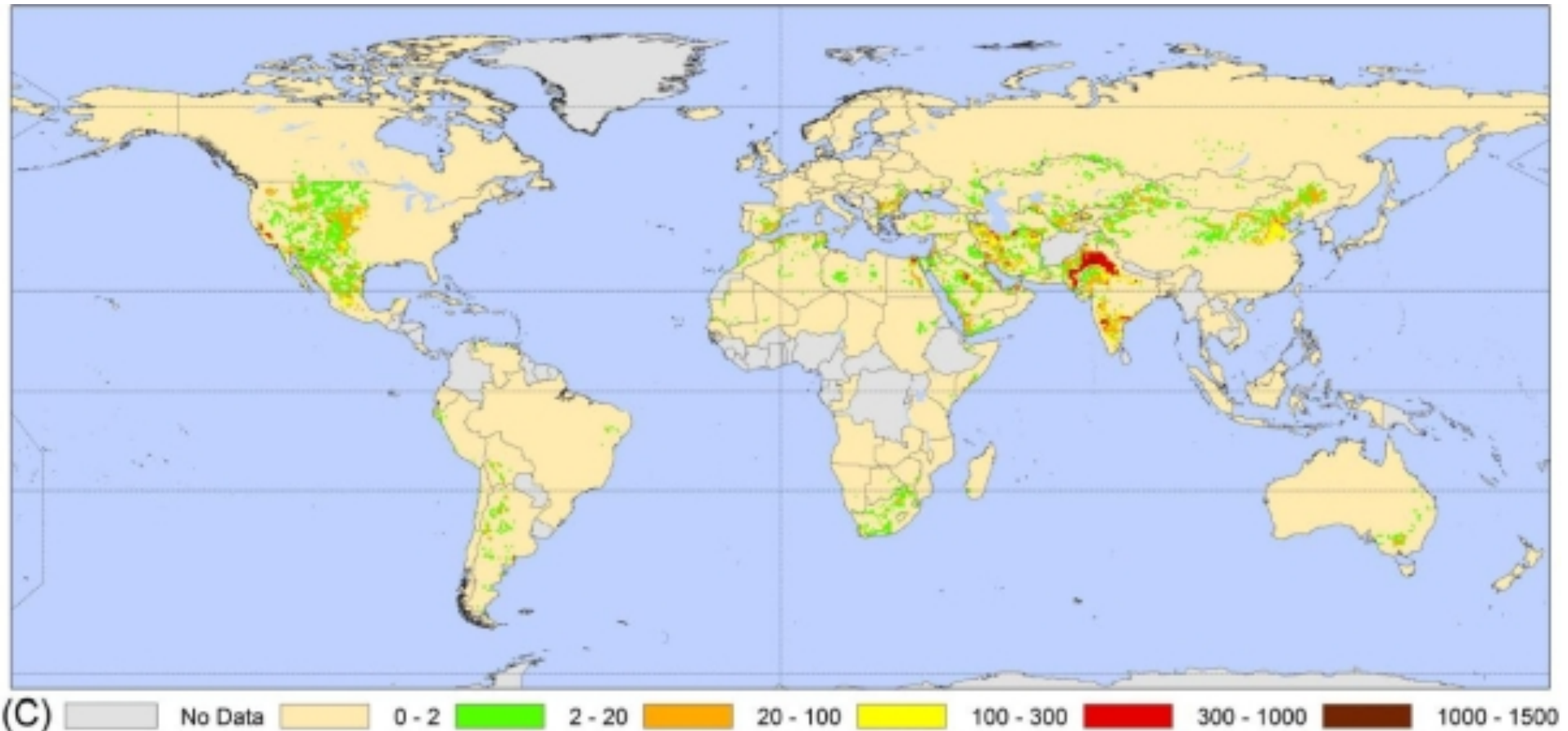
Total production on land: 115 billion globally

Lester Brown on falling water tables and shrinking harvests



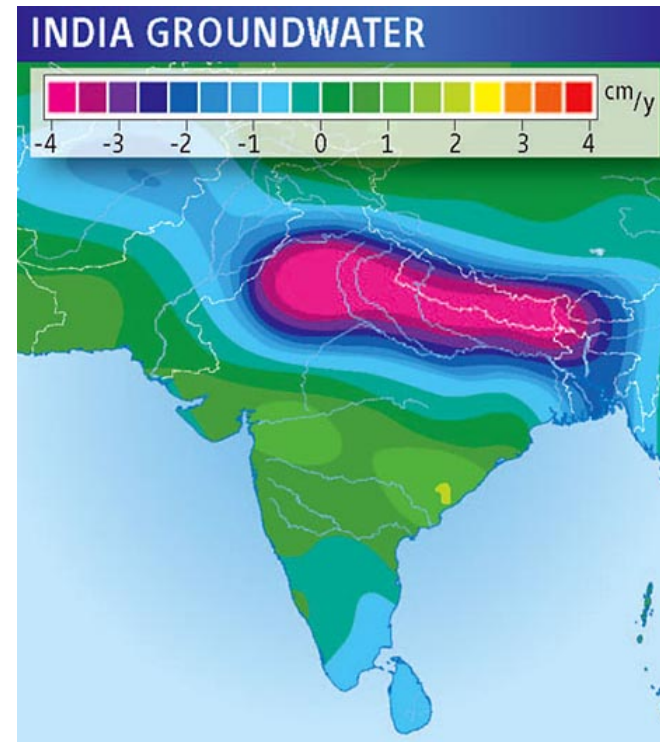
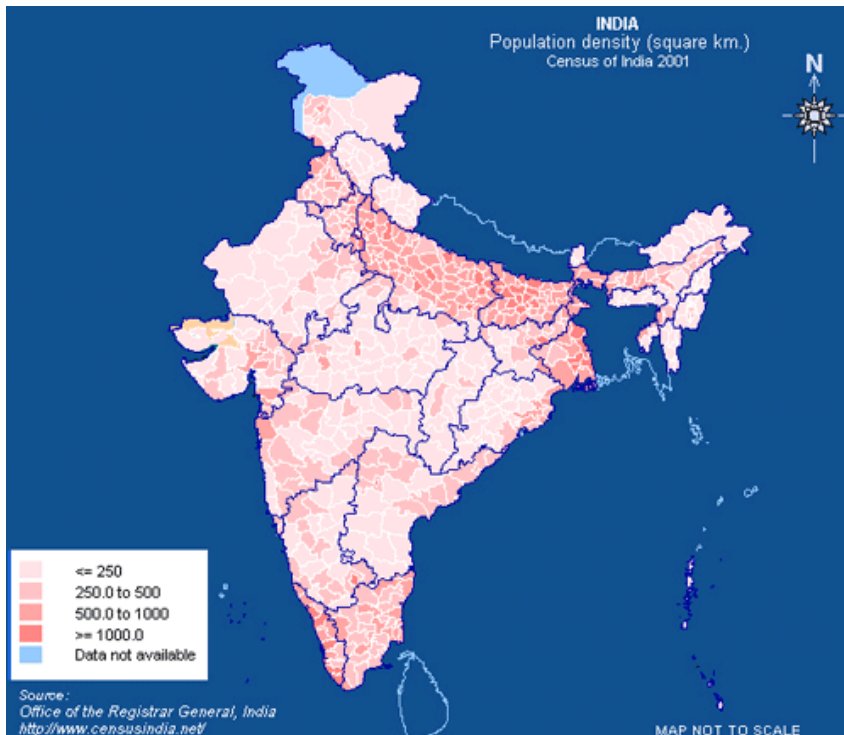
1. Saudi fossil aquifer depleted; Yemen burning through its fossil aquifer, which is mostly gone.
2. 70% of freshwater used by humans is used for irrigation – part of the grain explosion since 1950.
3. Like grain, water demand has tripled in the last 50 years [compare Dodds' figures]
4. World water deficit (excess of withdrawals over refills) increases each year.
5. US problems: Ogallala fossil aquifer; CA has lost 17% of its irrigated land since the high point; Texas has lost 28% .
6. Problems in India and China are even more severe. Beijing is drilling 1000 feet down now for water, 5x increase in just 20 years.
7. The increase in world irrigated land area is about to stop and turn downward.

Worldwide groundwater depletion rates



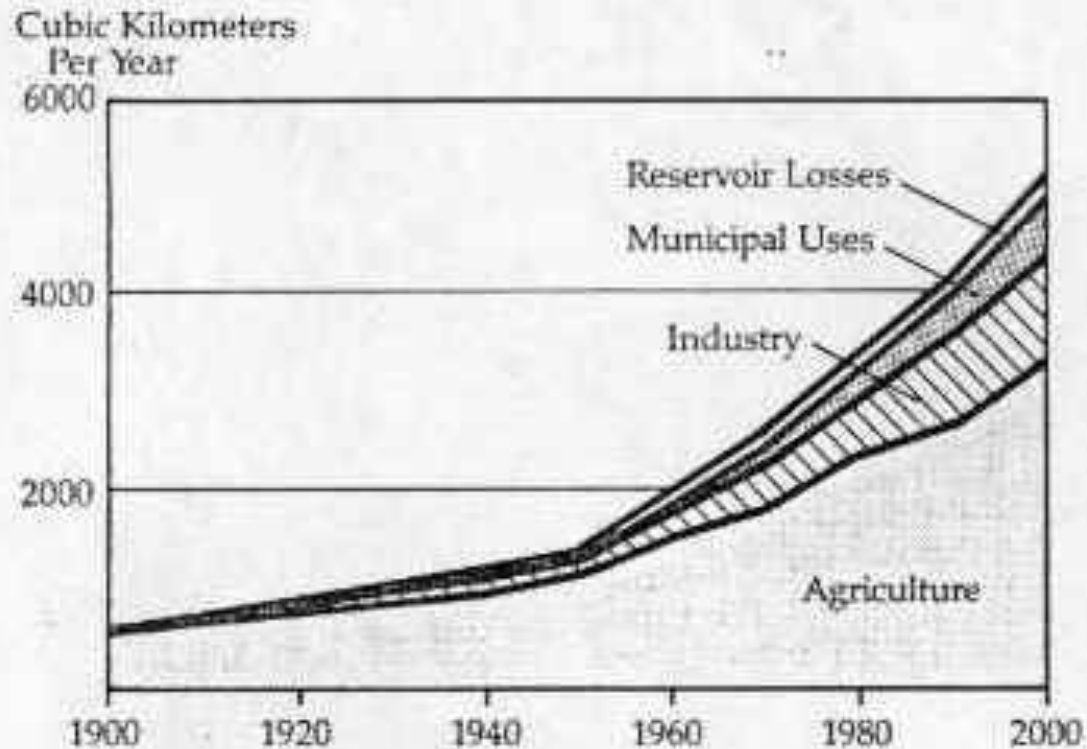
Lester Brown on water problems, continued

1. Available freshwater falling in Syria and Iraq due to Turkey damming Euphrates and Tigris rivers
2. Grain production falling throughout all nations in the Middle East except Lebanon (p.28).
3. Afghanistan, another conflict region, has lost 50% of groundwater sources in last decade.
4. Water levels falling a meter a year under major cities in Pakistan, reservoirs filling with silt.
5. Mexico faces dropping aquifer levels under the Sonora wheat growing area.
6. Cities outcompeting farmers for water supplies around the world.
7. What happens if “food bubbles” driven by unsustainable rates of water use burst at once in several parts of the world while population continues to grow?



Freshwater usage breakdown

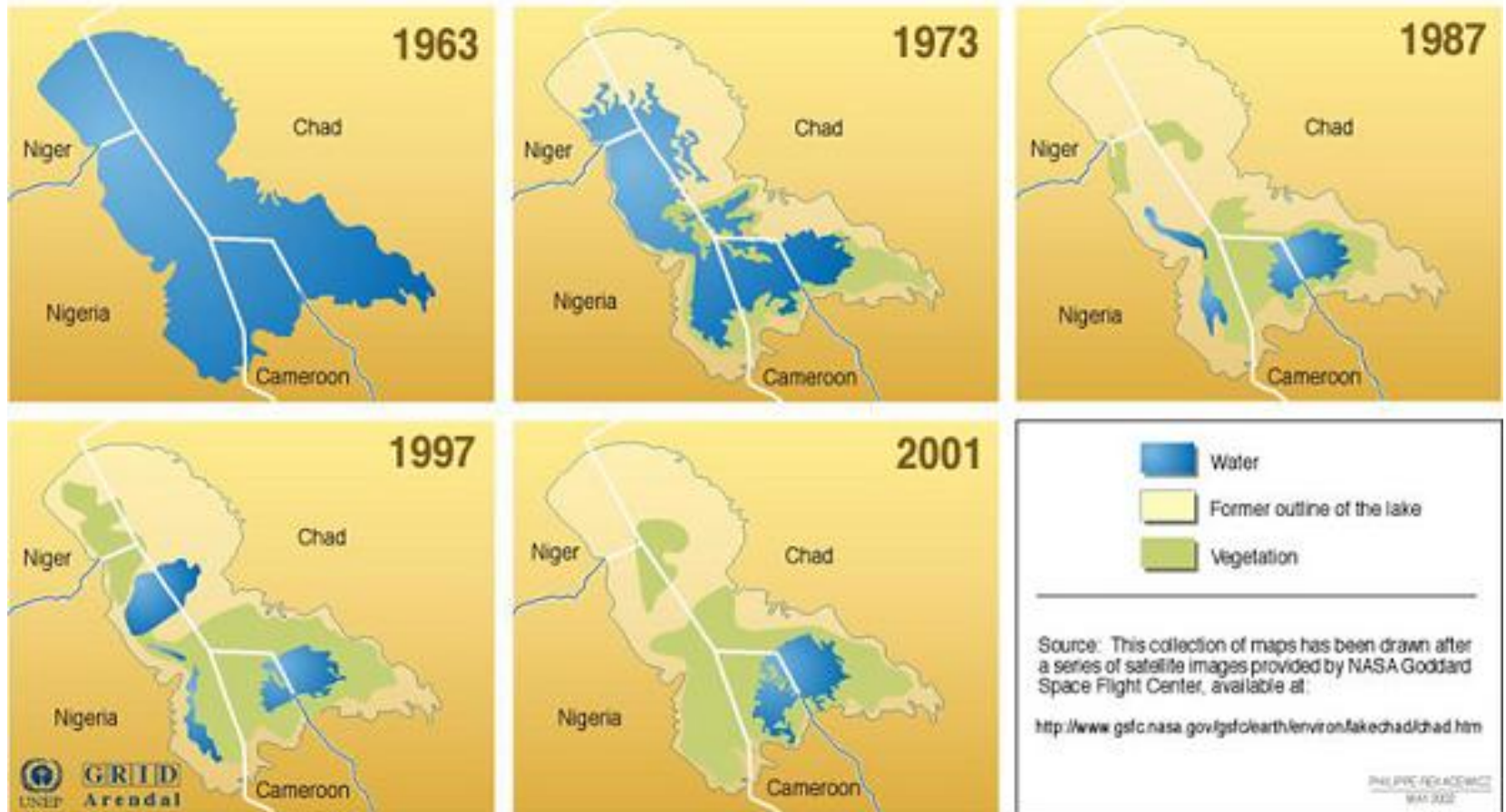
(note heavy use by industry and agriculture via irrigation)



Notice that agricultural water usage (most of which is for irrigation and animal waste flushing) climbed from about 1000 CK per year in 1950 to almost 5000 CK per year in 2000 due to the Green/Grain Revolution intensification. Industry usage has grown too, but most of the increase is due to agriculture.

Lake Chad on the southwest Sahara border

The Disappearance of Lake Chad in Africa



Shrinking of the Aral Sea in Kazakhstan



July - September, 1989

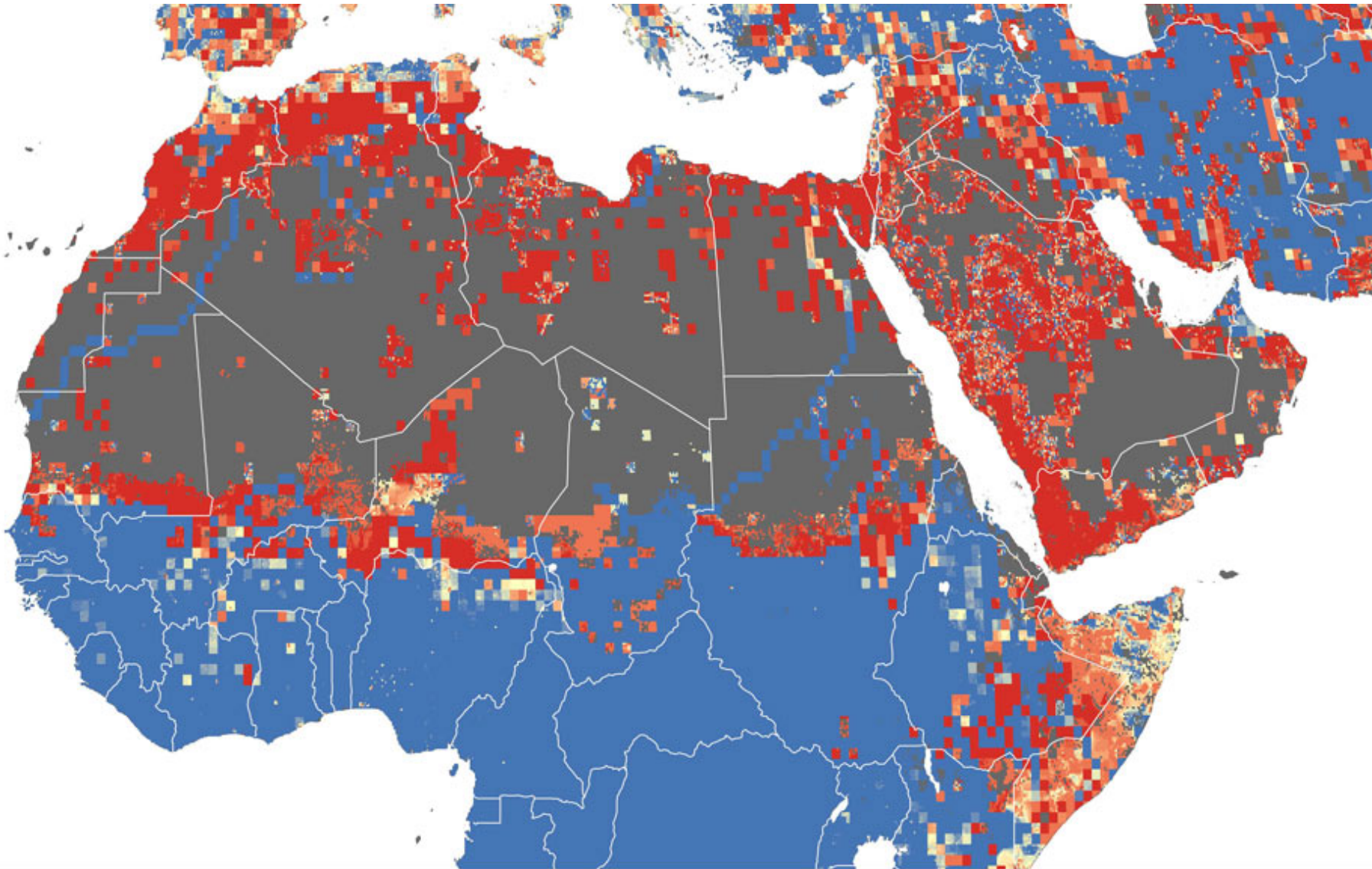


October 5, 2008



Shows original location of Aral Sea in central Asia

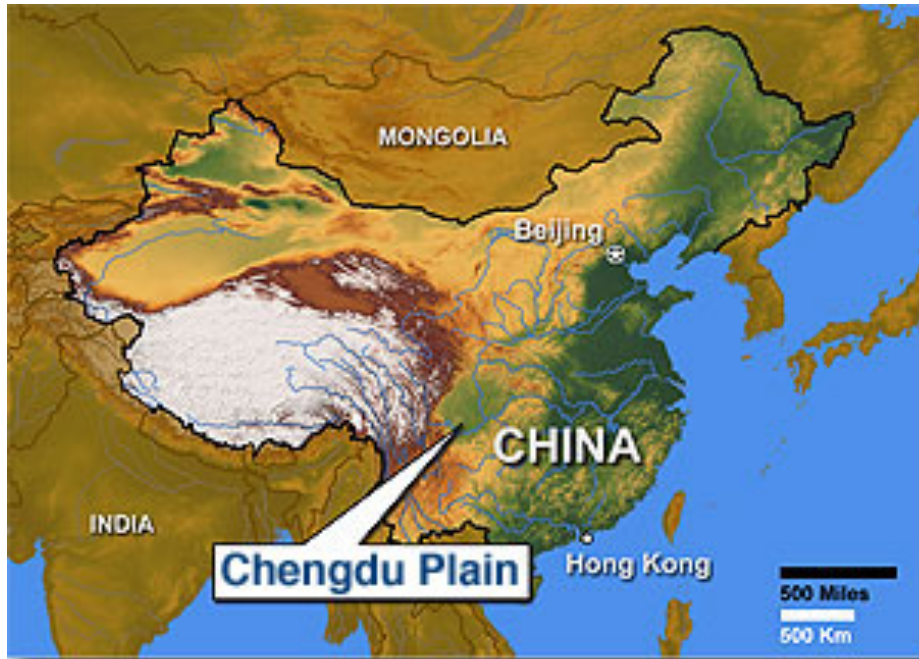
Water stress in north Africa & Middle East



Water Stress Index 2011

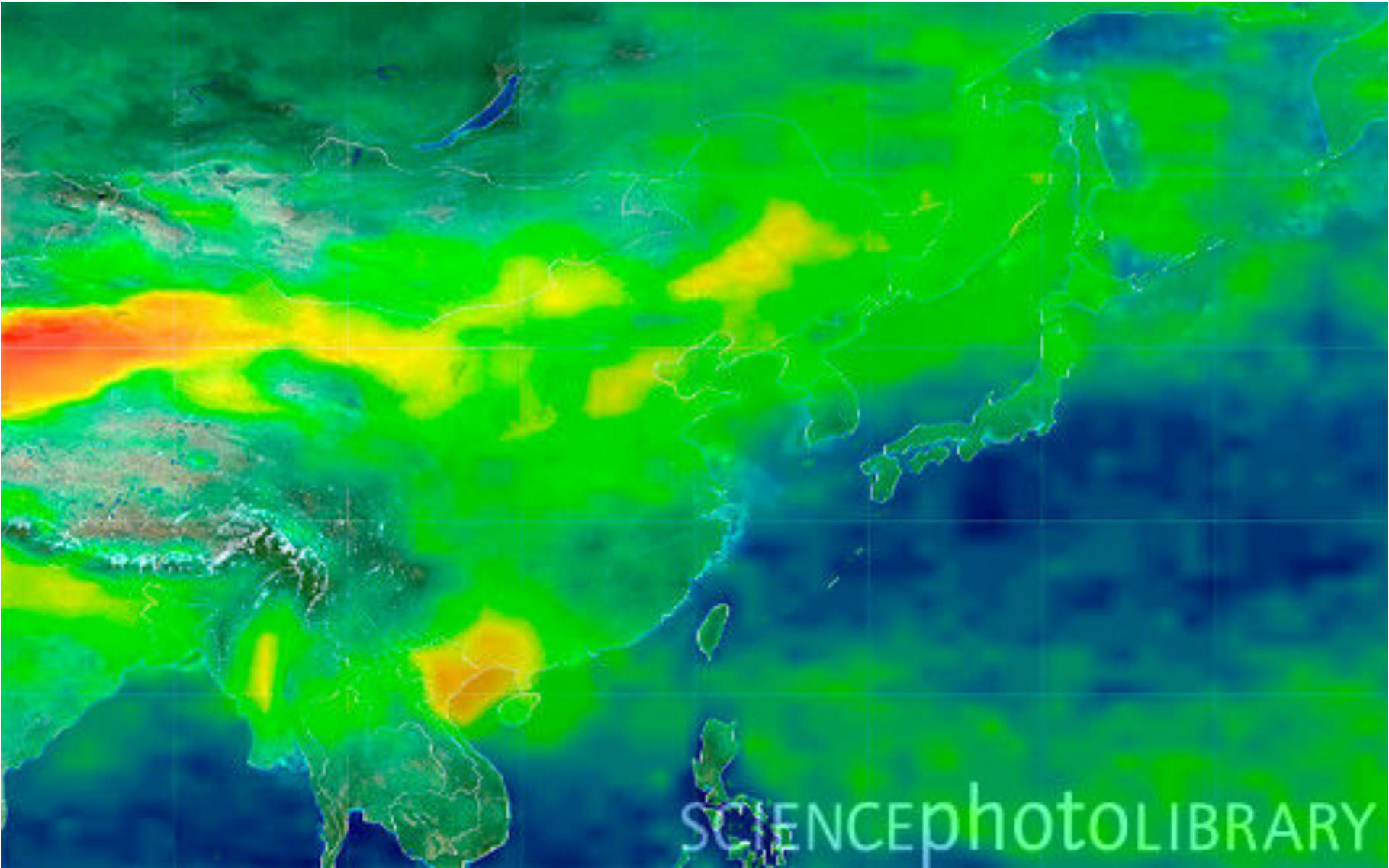
Low Medium High Extreme No data

Lester Brown on Eroding Soils and Expanding Deserts



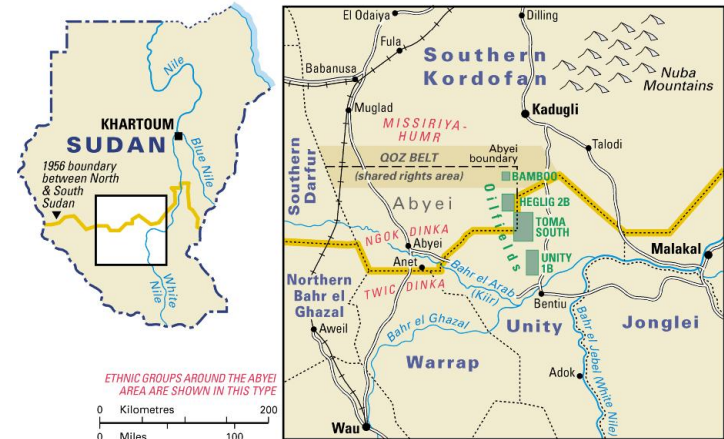
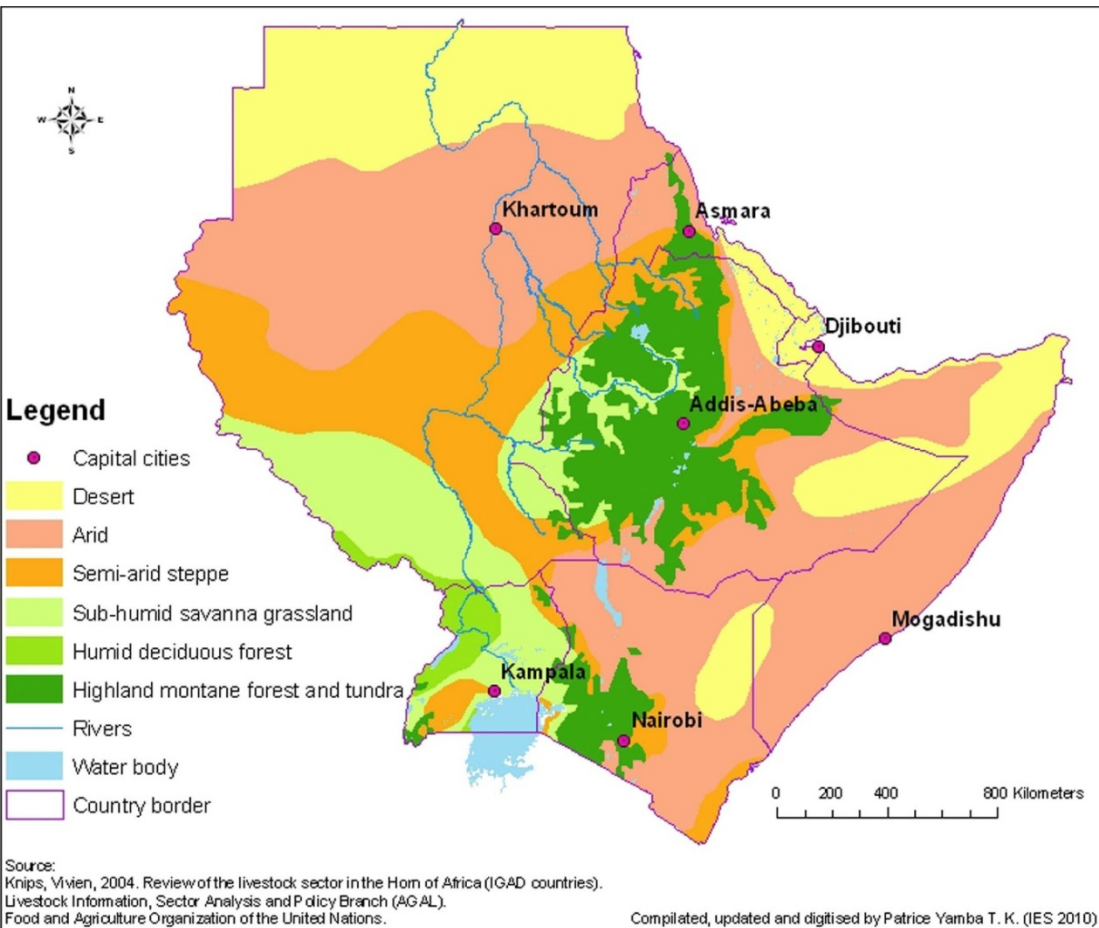
1. Dust bowl in north-west China as deserts expand; 23 days of dust storms hit Korea in 1970s, up to 100 days from 2000 – 2010.
2. 2500 billion tons of carbon in world's soils vs 760 billion tons in atmosphere now.
3. Almost a third of the world's cropland is losing topsoil at an excessive rate. 25% of earth's land area now affected by desertification (UN report 2010).
4. Compare US great plains dustbowl of 1930s; Soviet "virgin lands" project in 1950s, Kazakhstan
5. Dust bowl forming in Sahal region across Africa between Sahara desert and Congo tropical forests.
6. Much of the problem is due to overgrazing, too many cows, sheep, goats for these lands to sustain. China has 291 million sheep and goats vs 9 million in US, and roughly equal herd of cattle.
7. 24% of India's land area slowly turning into desert; 40% of Indian children undernourished.
8. Africa: up from 300 million livestock in 1950 to 862 livestock in 2009; tracks population growth.

Satellite images of dust storms over China and Mongolia



Land Problems in the Horn of Africa

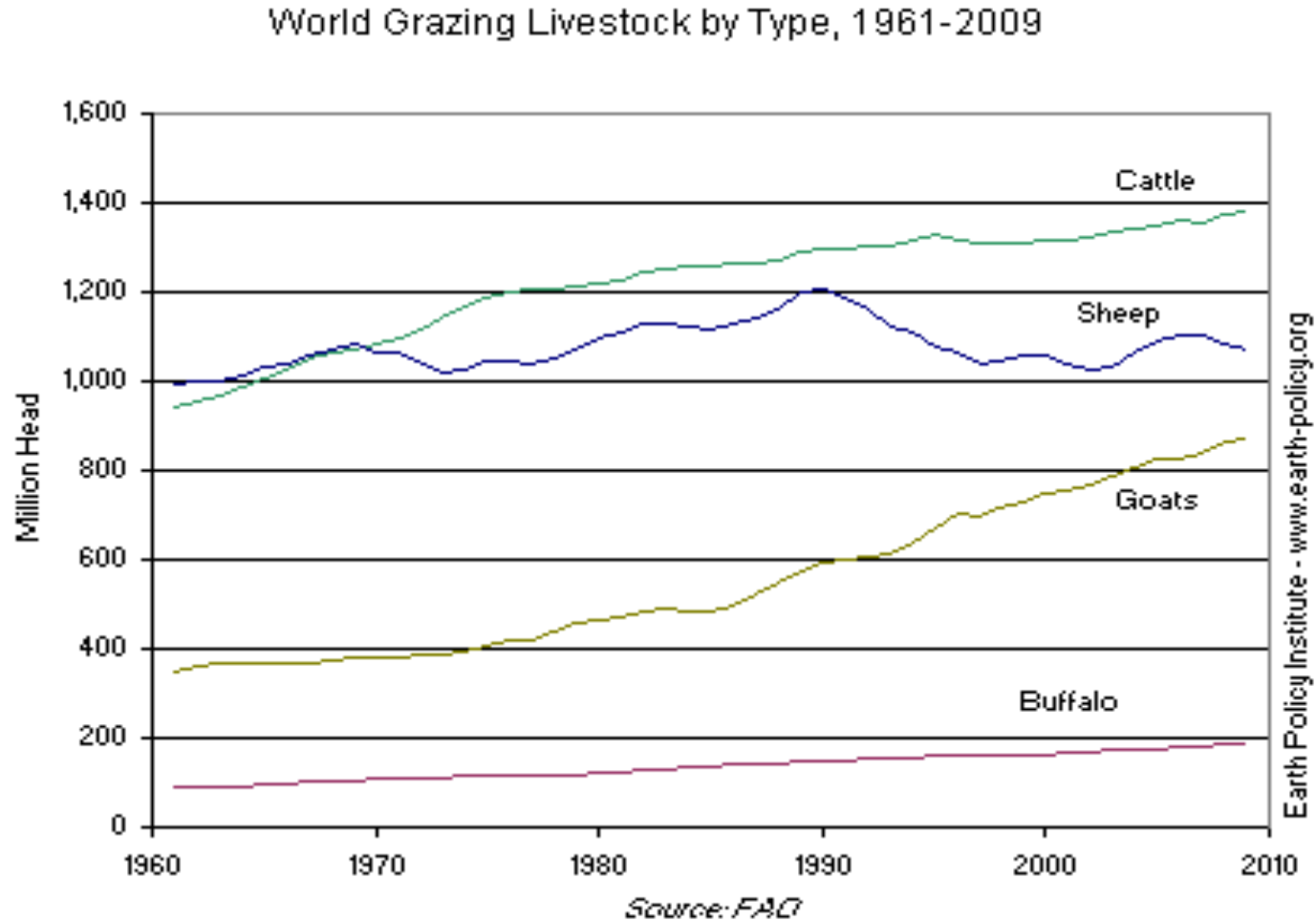
1. First large map on bottom left shows how dry Somali, northern Sudan, and northeast Kenya are compared to wetter parts of Ethiopia and Uganda / central-west Kenya.
2. Conflict has raged over control of southern and western Sudan. Somalia is a failed state, one of the worst places in the world to live. Over a million refugees have fled to camps in Kenya, Ethiopia.
3. South Sudan has now seceded, but its border remains under attack, threat of invasion from north.



Another view of the troubled eastern Sahel region



World Grazing Livestock increase over time



Total livestock up from roughly 2500 million in 1950 to 3600 million in 2010

-- See http://www.earth-policy.org/data_highlights/2011/highlights14

Recent foreign land acquisitions for food



A: Other deals (area unknown)

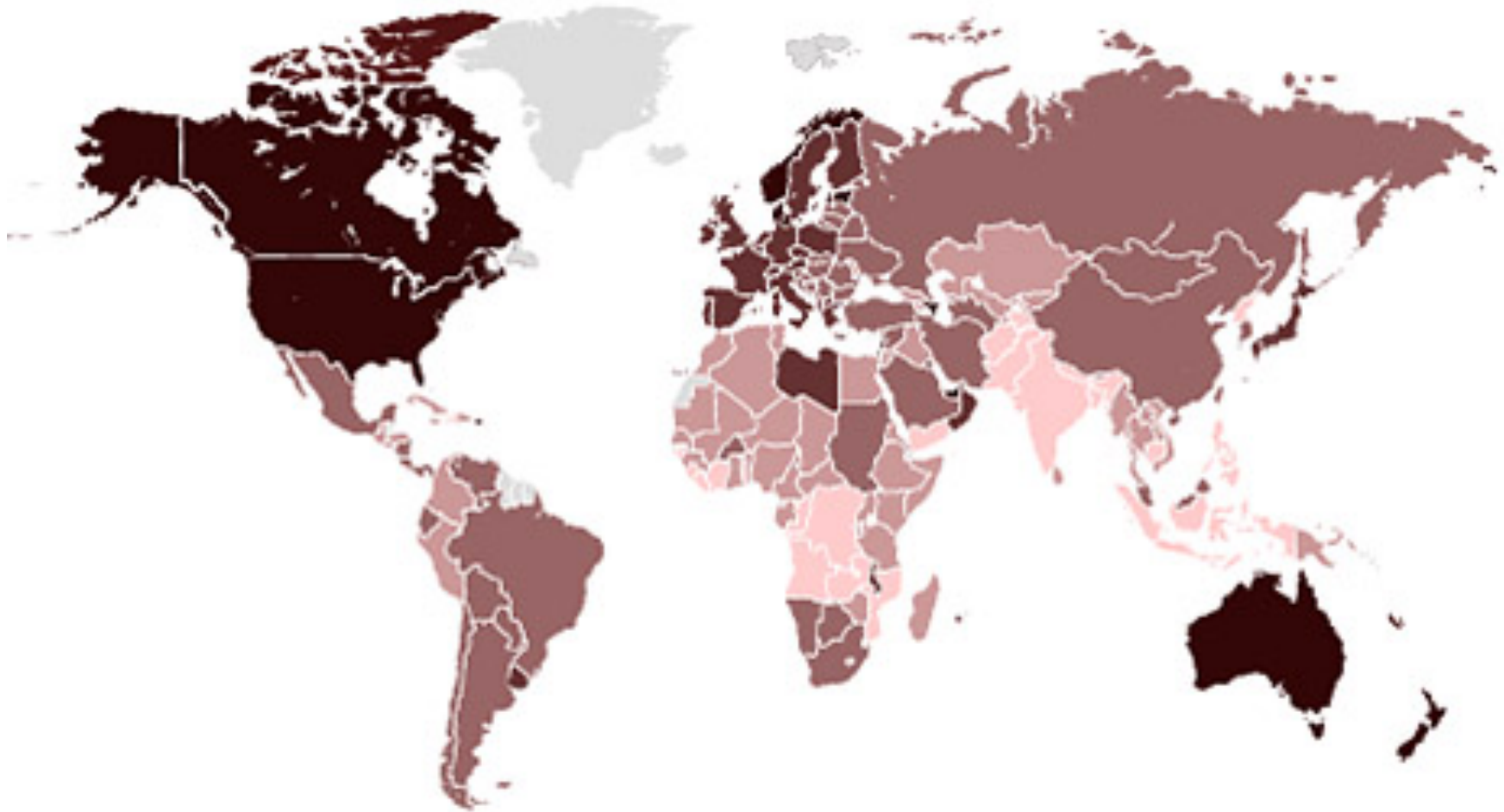
Target	Investor	Deal type/value
Cambodia	Kuwait	Land for rice
China	United States (Goldman Sachs)	\$450m-500m, poultry and pigs
Ethiopia	India	\$4bn
	UK (Sun Biofuels)	Jatropha
	Saudi investors	\$100m
Malawi	Djibouti	unknown
Mozambique	UK (Sun Biofuels)	Jatropha
Sudan	Egypt	Wheat (2m tonnes pa)
	Kuwait	"Giant" strategic partnership
	Qatar	Joint holding firm
Turkey	Bahrain (Agricapital)	\$500m (may rise to \$3bn-6bn)

B: Failed deals

Target	Investor	Size of deal
Mozambique	China	\$800m
Philippines	China	1.24m ha
Indonesia	Saudi Arabia (Saudi Binladin Group)	0.50m ha
Madagascar	South Korea (Daewoo)	1.30m ha

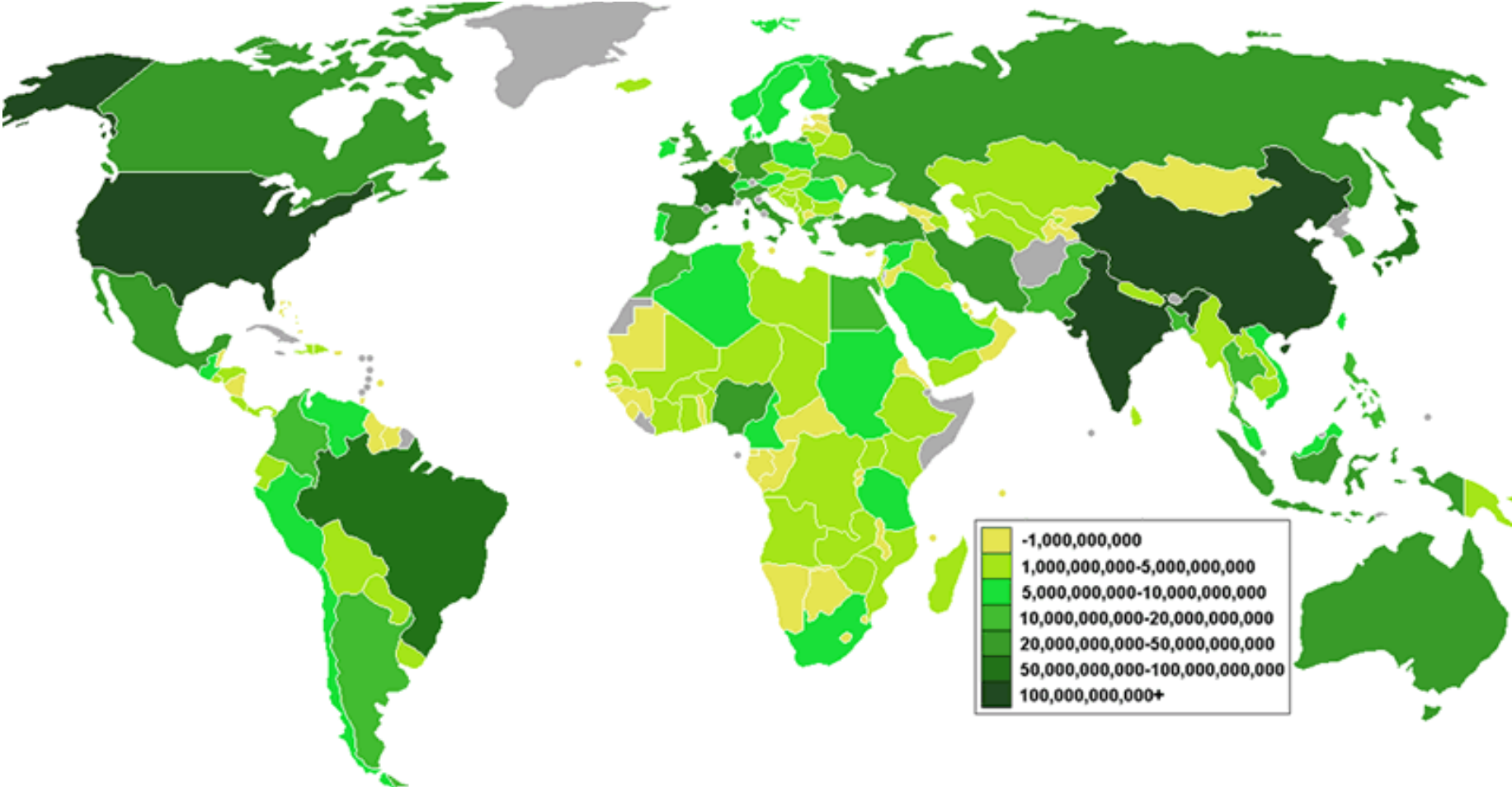
Environmental Impact of Different Nations

ECOLOGICAL FOOTPRINT BY COUNTRY

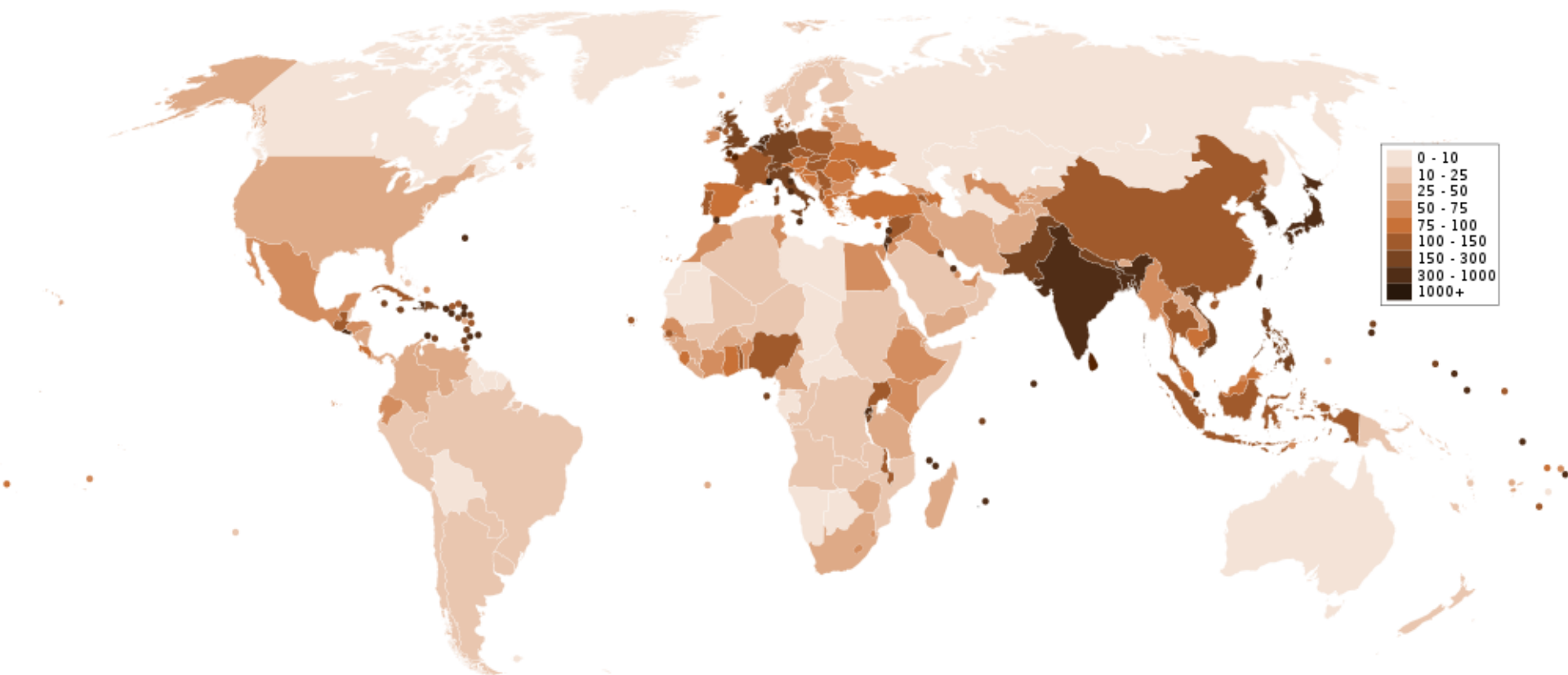


SOURCE: WWF

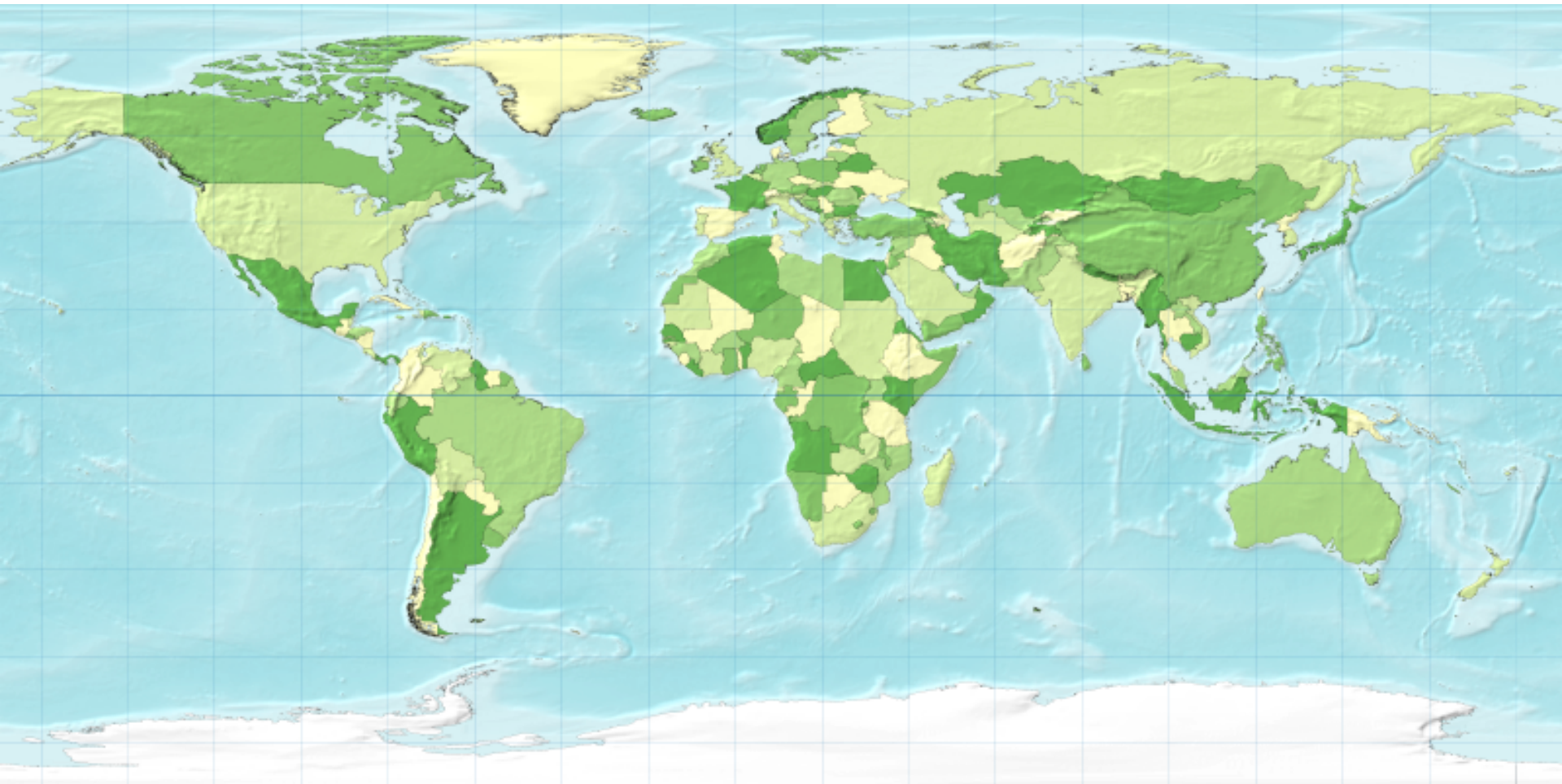
Nations by Agricultural Output



Nations by Population Density



A Peters Projection of the World

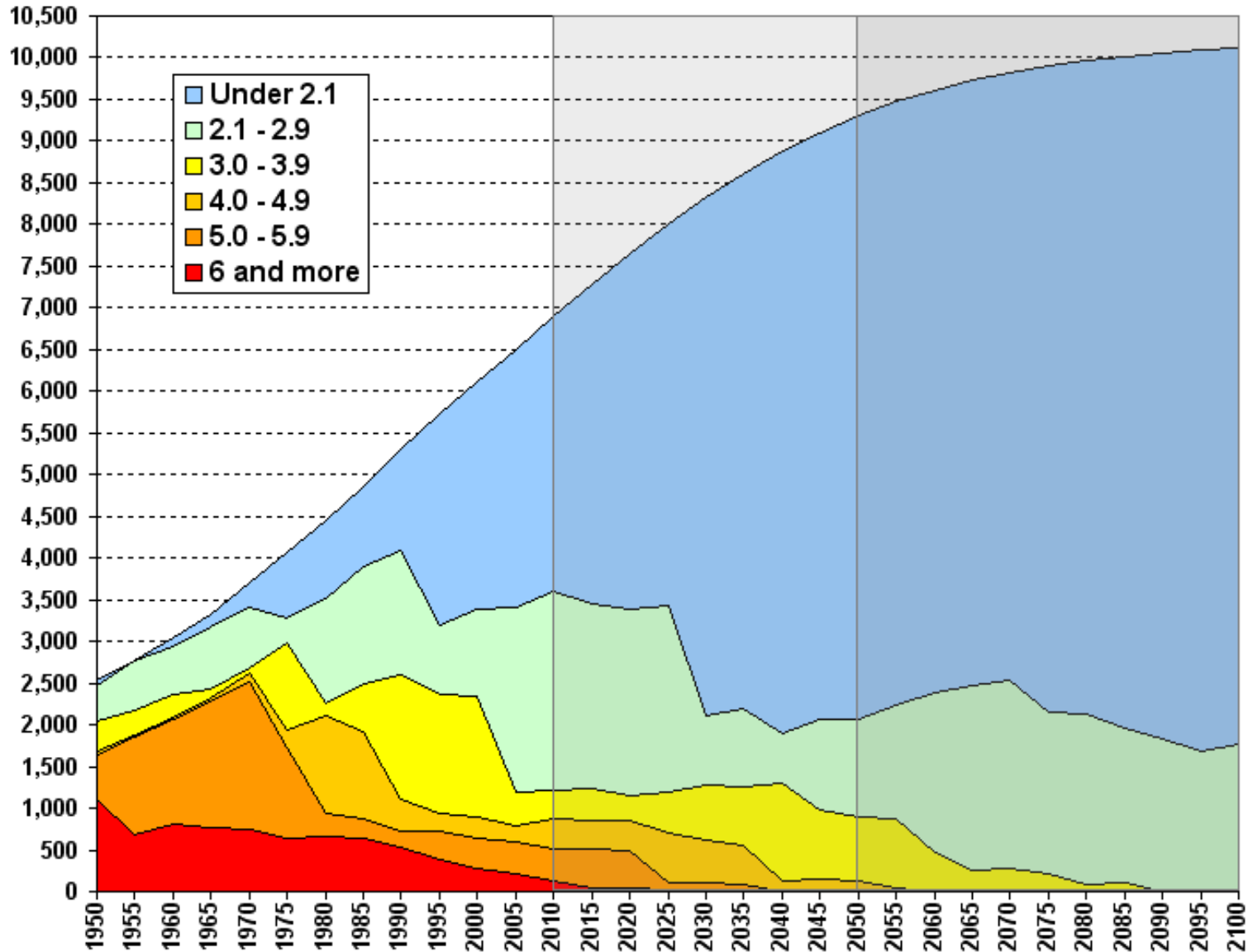


Walter Dodds: *Humanity's Footprint* Updated Charts

- Population
- World Economy
- World Water Usage
- Energy Usage
- Fertilizer Usage
- Other Toxins
- Arable Land per capita
- World Grain Yields

World Population projected increases

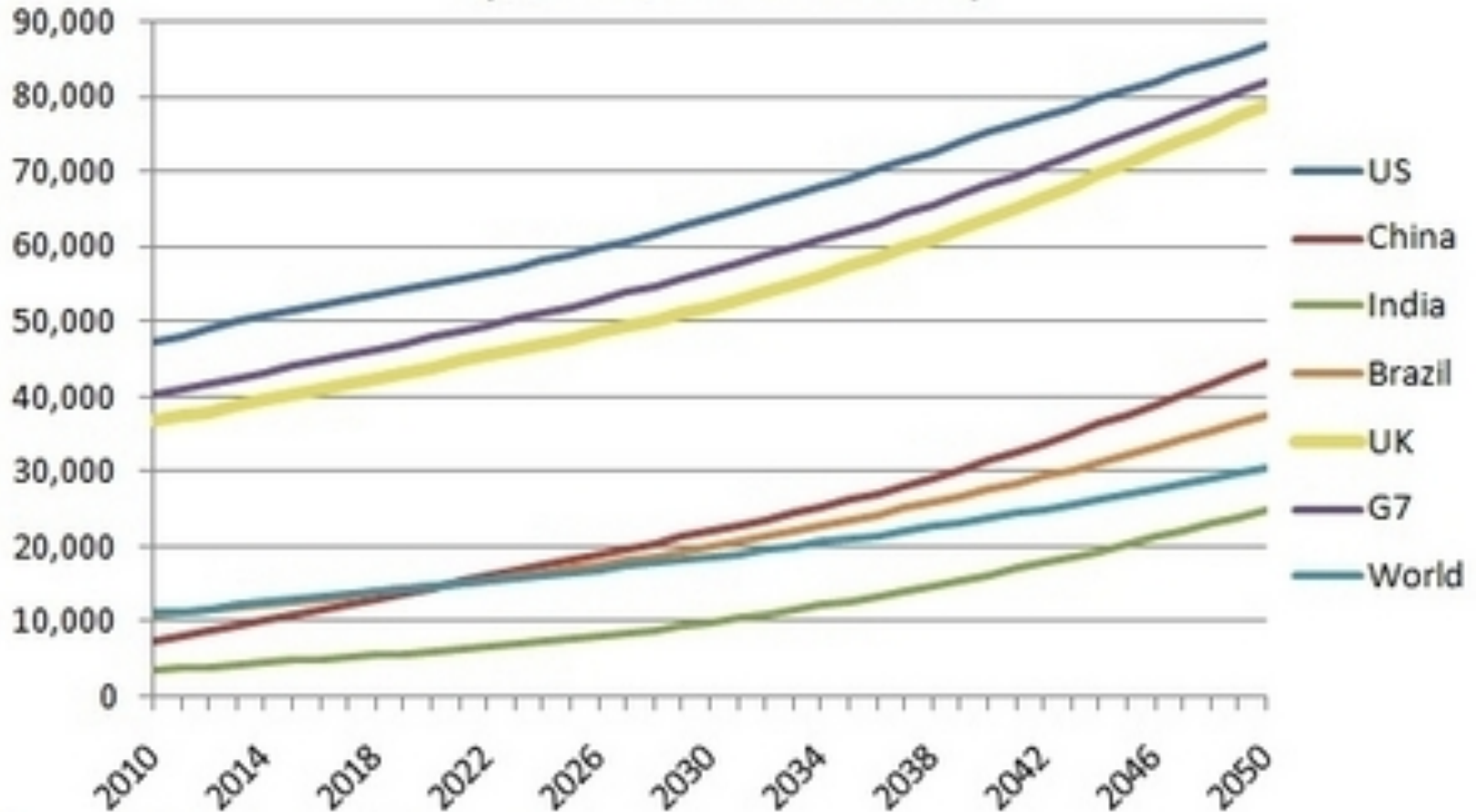
(UN 2010 update)



World Economic Growth

Can the global economy double again in real terms? A 2011 projection.

GDP per capita
(\$, PPP, 2009 Prices)

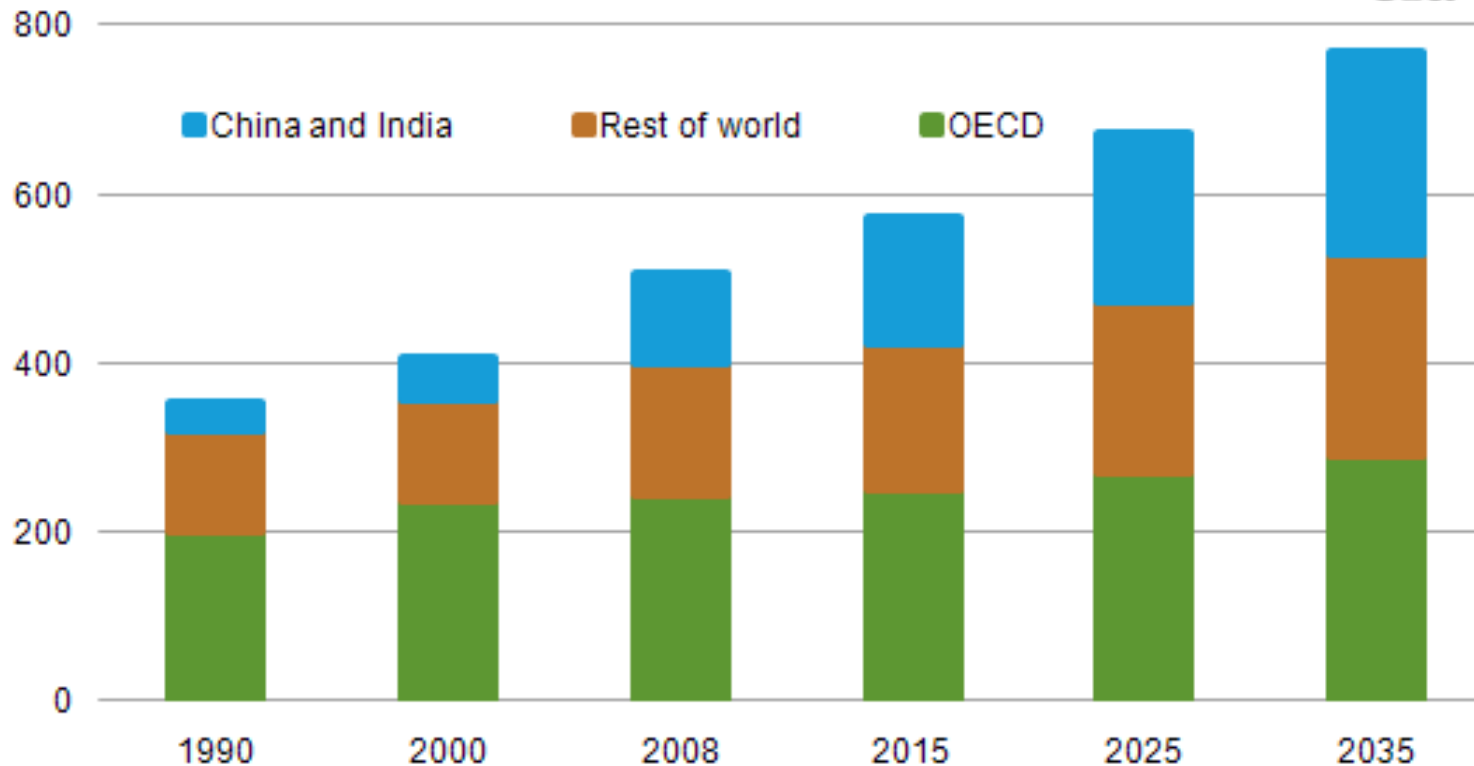


Sources: PwC projections, US Census Bureau

World Energy Usage

A 2011 projection by the US Energy Information Administration

Global Energy Consumption
quadrillion Btu



Notice that global energy usage is projected to increase by over 50% from 2008 to 2035. If most of this comes from fossil fuels it means a huge expansion in greenhouse gas emissions.

The Developing World overtakes in Energy Usage and Greenhouse Gases

World Energy Consumption (1965-2009)
% of worldwide energy consumption

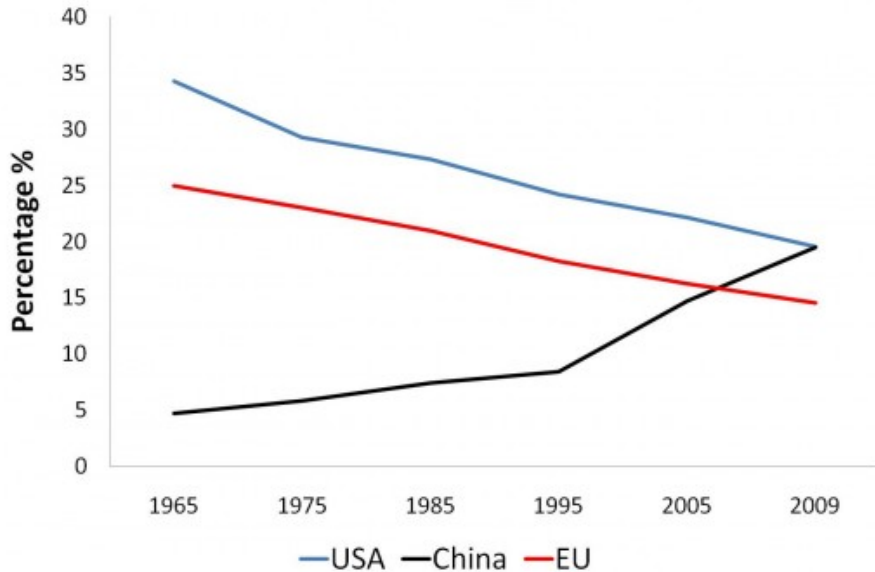
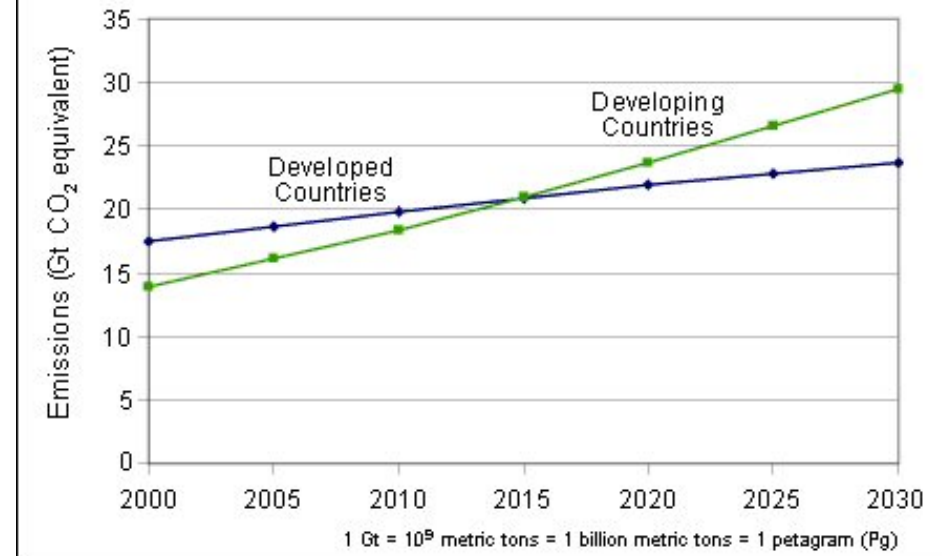


Figure 3: Total Greenhouse Gas Emissions by Region

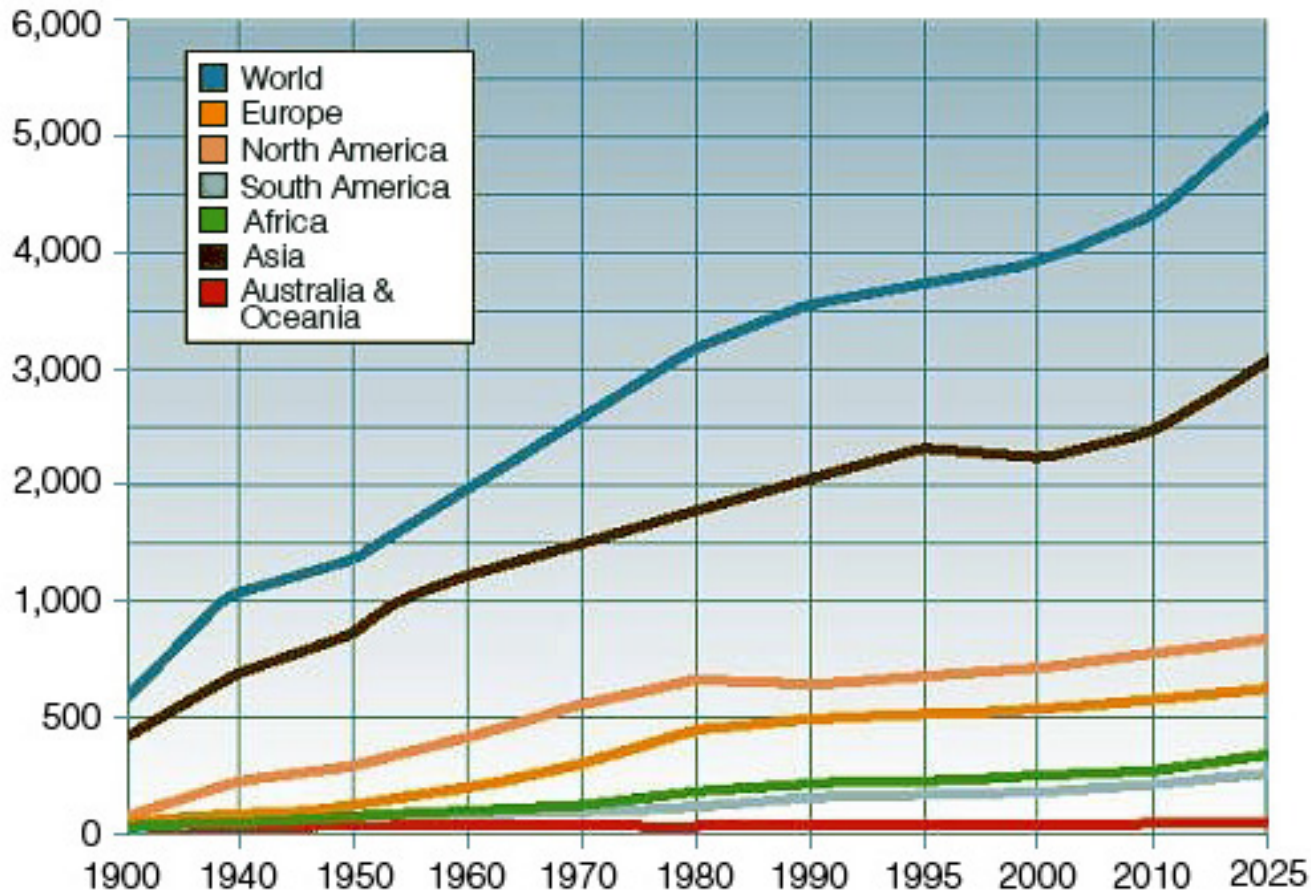


World Water Consumption

2009 projection

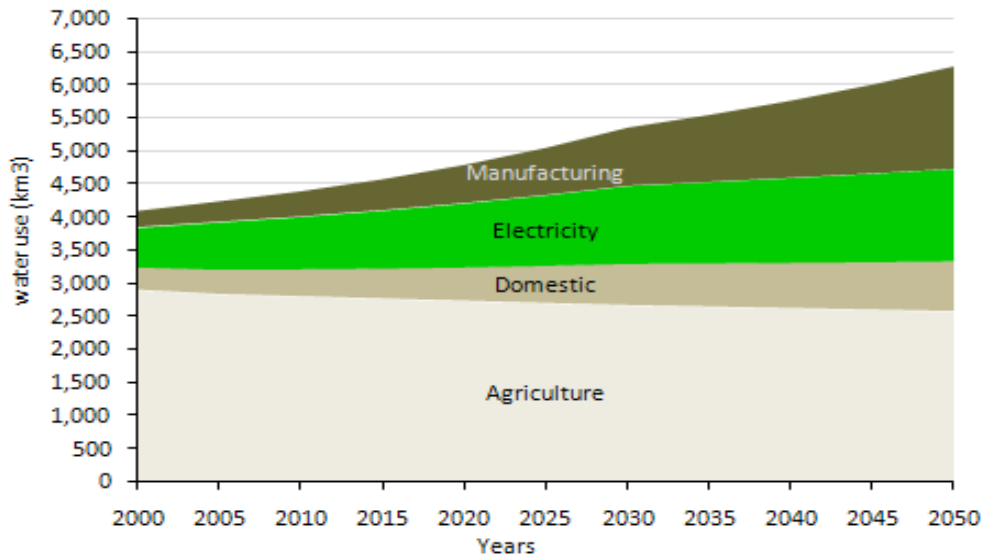
Global Water Consumption 1900 - 2025

(by region, in billions m³ per year)



A projected increase of 15% from 2010 to 2025. But consider the proposal on FAO-Water chart for recycling city wastewater for use in farm irrigation and industry.

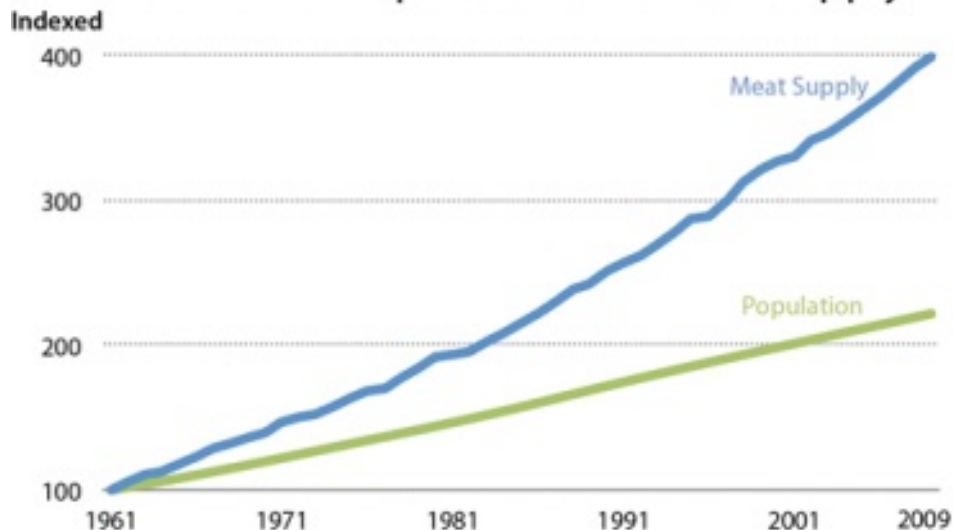
World Water & Meat – a longer projection



This projection suggests not too much increase in per person water use by mid-century: if we have risen from 7 to 9 billion people, but water use goes up about 31%, that is only a slight *per capita* rise.

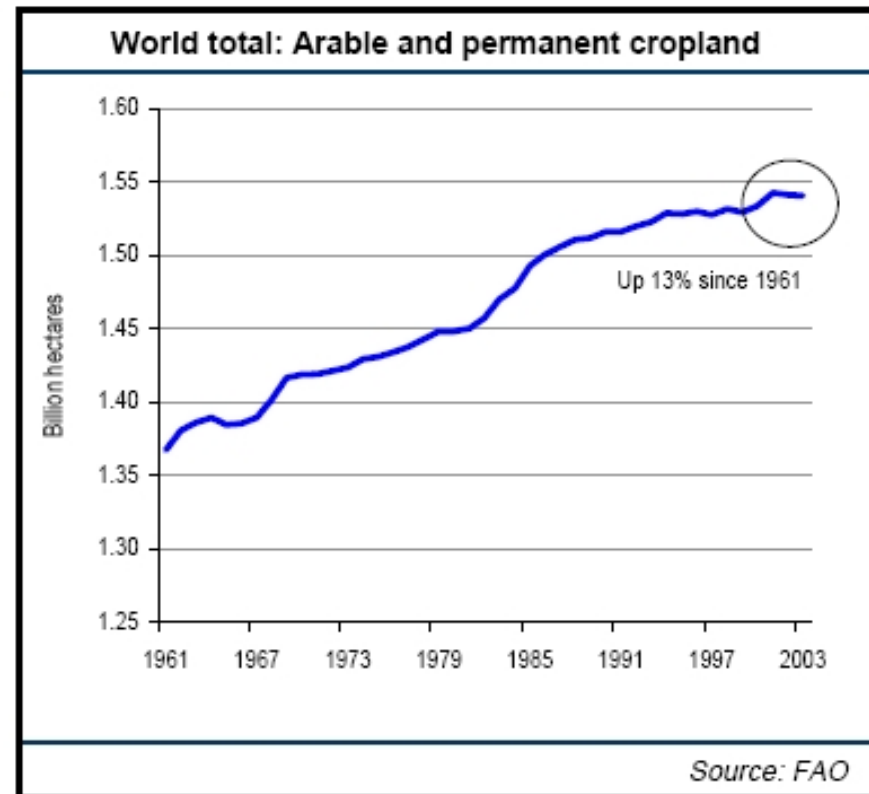
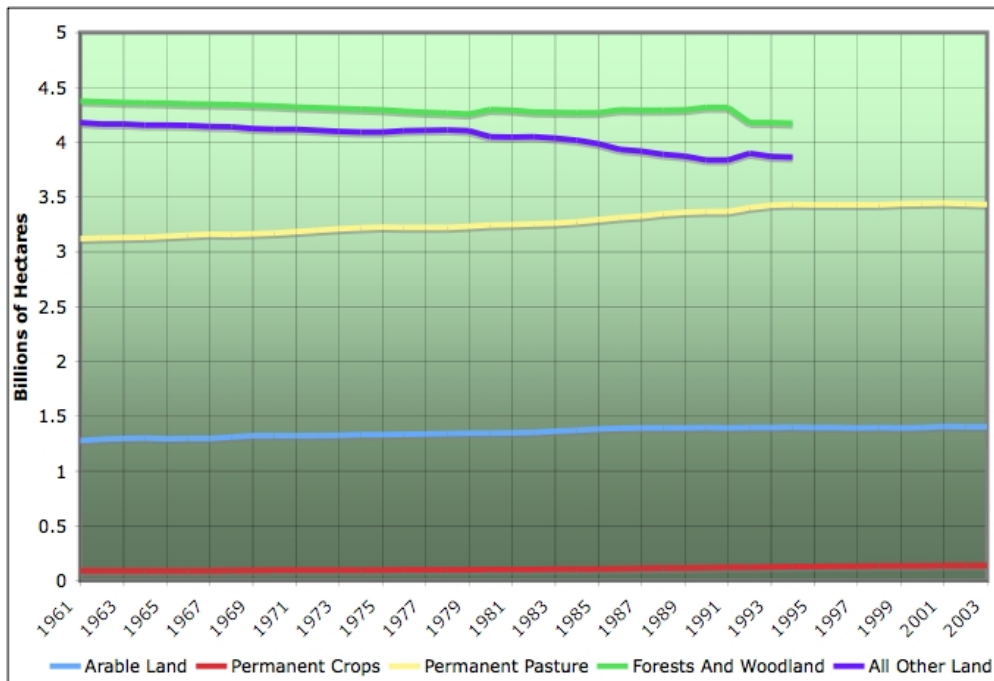
The *per capita* rise in water use might be higher, though, if meat use expands a lot, or if more grazing animals have to be fed on grain crops rather than by grazing on grasslands (as these are lost to erosion).

Growth of Population and Meat Supply



Note how fast meat supply rose in the last two decades according to the FAO: about a 40% rise (the blue line), well above the rise in population for the same 20 years – which shows that per capita meat-eating is increasing on average.

World Arable Land changes over time – older graph vs 2005 FAO data

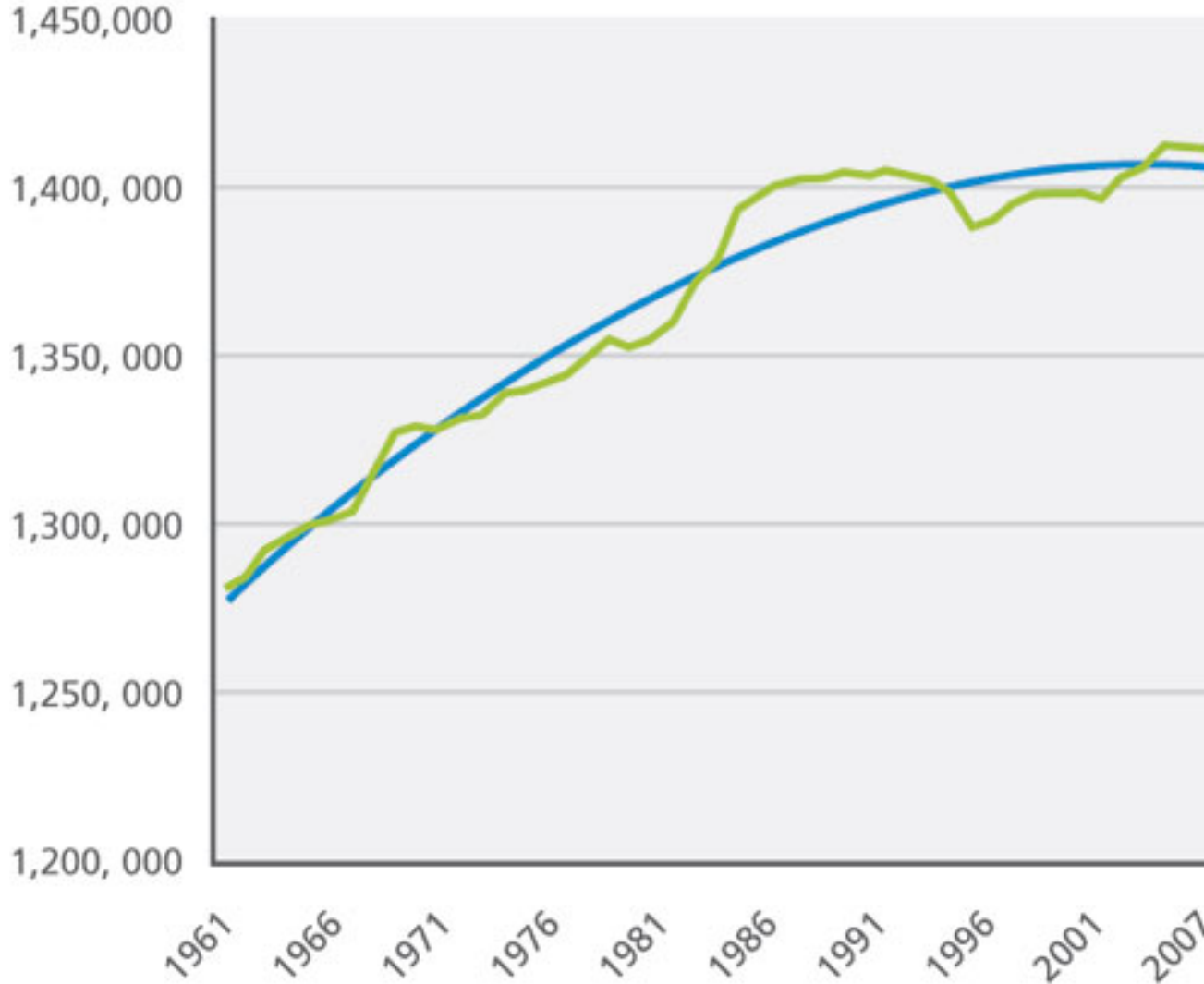


Source: FAO

World Total Farmable Land

from Land Commodities Asset Management webpage

Total arable land (1,000 Ha)



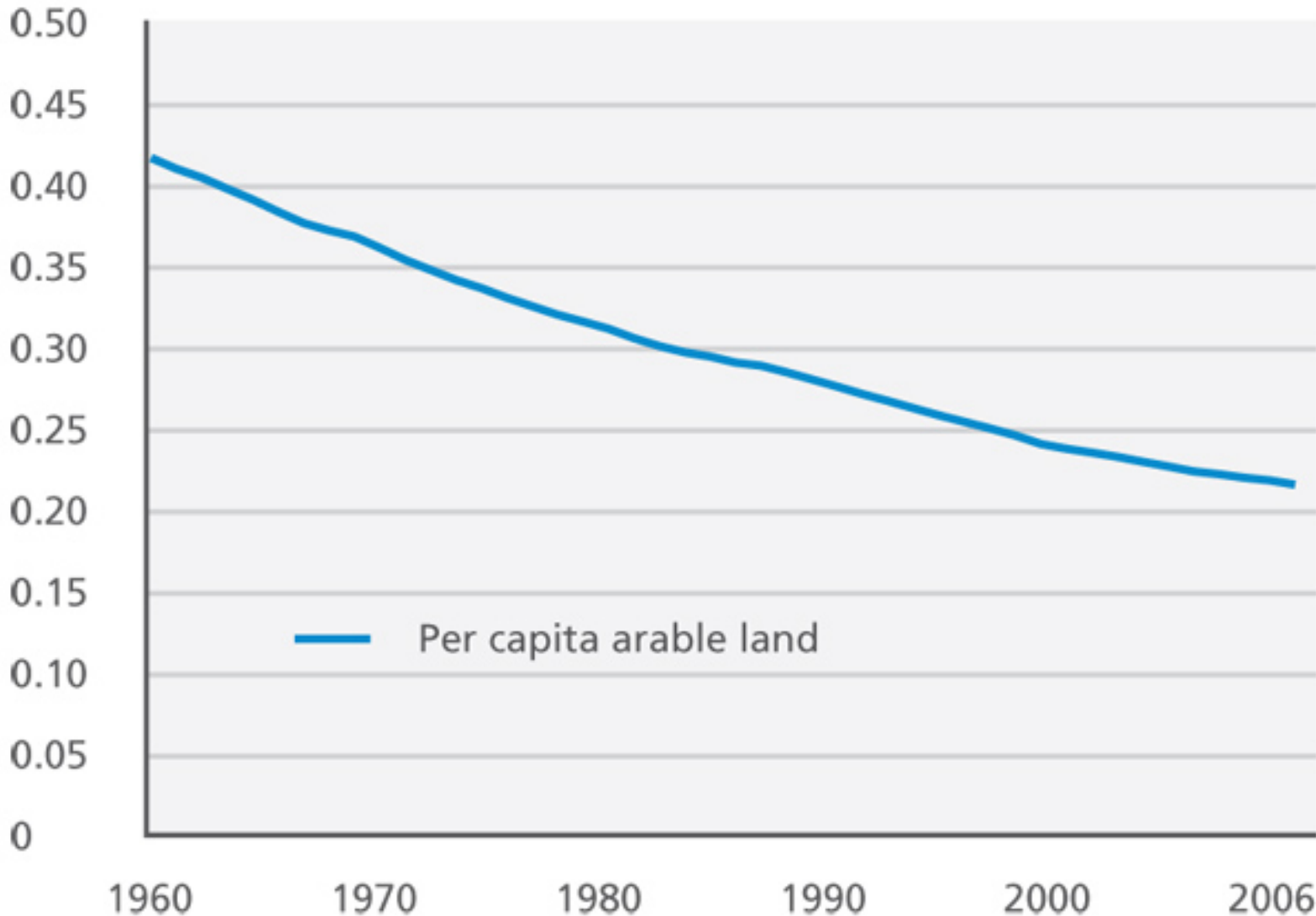
We see total farmable land leveling off around 1.4 billion hectares.

This is about **11.7%** of the 11.9 billion hectares of ice-free land available.

Arable Land per Person

from Land Commodities Asset Management webpage

Arable land per capita (Ha)

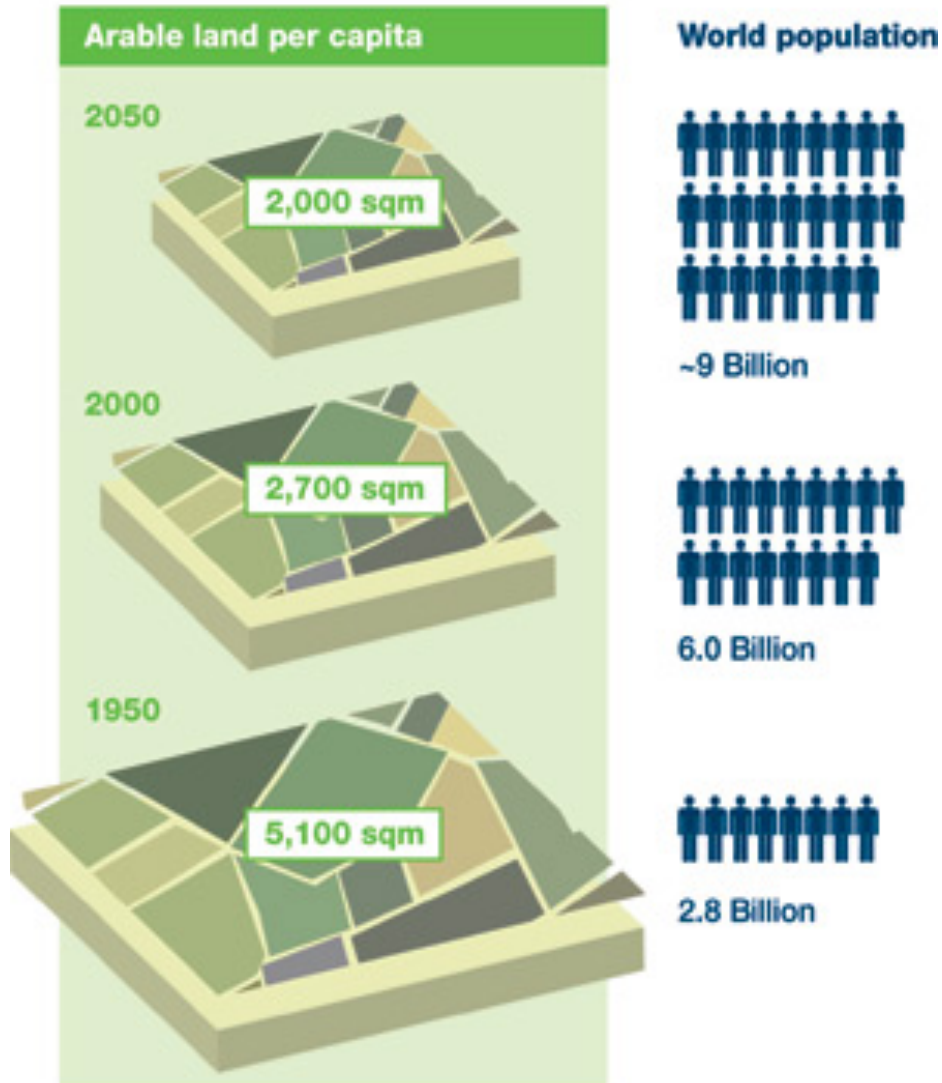


The increase in arable land is not fast enough to keep pace with population growth.

But increases in efficiency have tripled yield while the farmland per person was cut in half.

Another view

Globally arable land per capita is shrinking



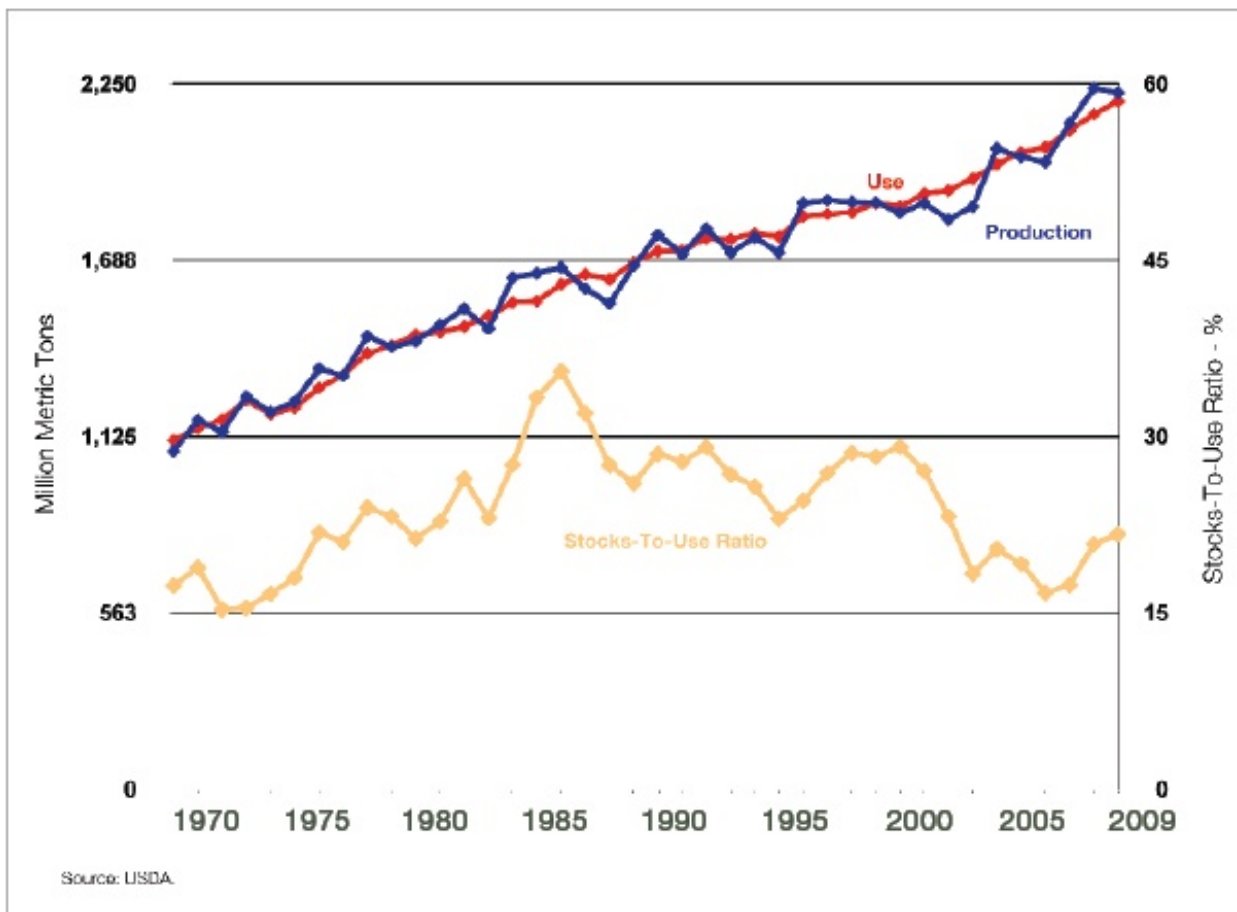
Projection from the Seedquest.com webpage.

Note that this implies a growth to 18 trillion square miles total in 2050.

World Grain Production to 2009

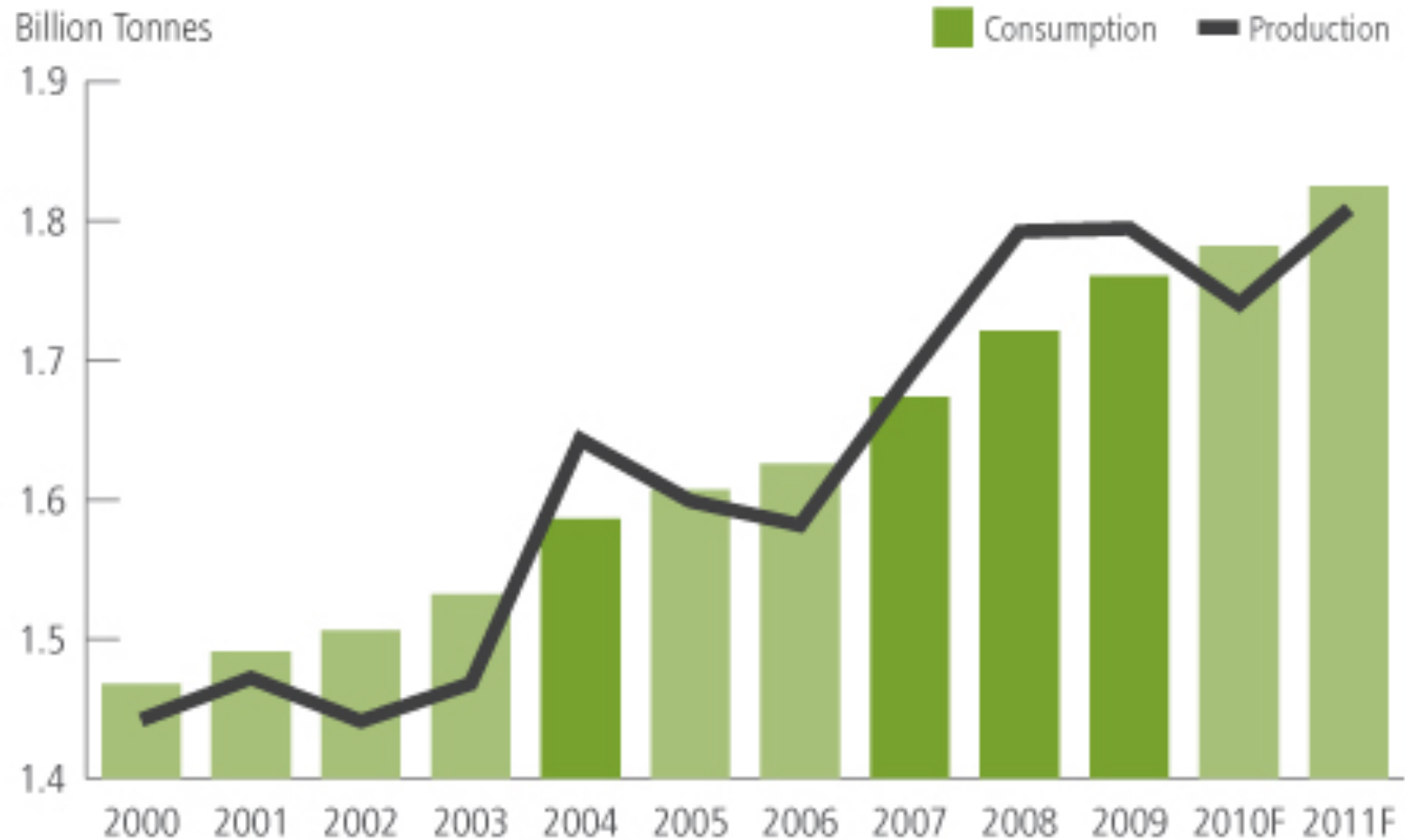
(slightly higher estimates than others)

World Grain Production and Use, 1970 - 2009



Grain production has generally kept pace with increased use since 1970; however, grain use has exceeded production in two out of every three years since 2000, resulting in a declining stocks-to-use ratio. "Stocks-To-Use Ratio" is a measure of grain available to even out sudden changes in supply and demand.

World Grain Production to 2011



Based on crop year data. For example, 2011F refers to the 2011/12 crop year.
Light bars reflect years when consumption exceeded production.

Source: USDA

World Grain Inventory margins fall: declining stocks-to-use ratios

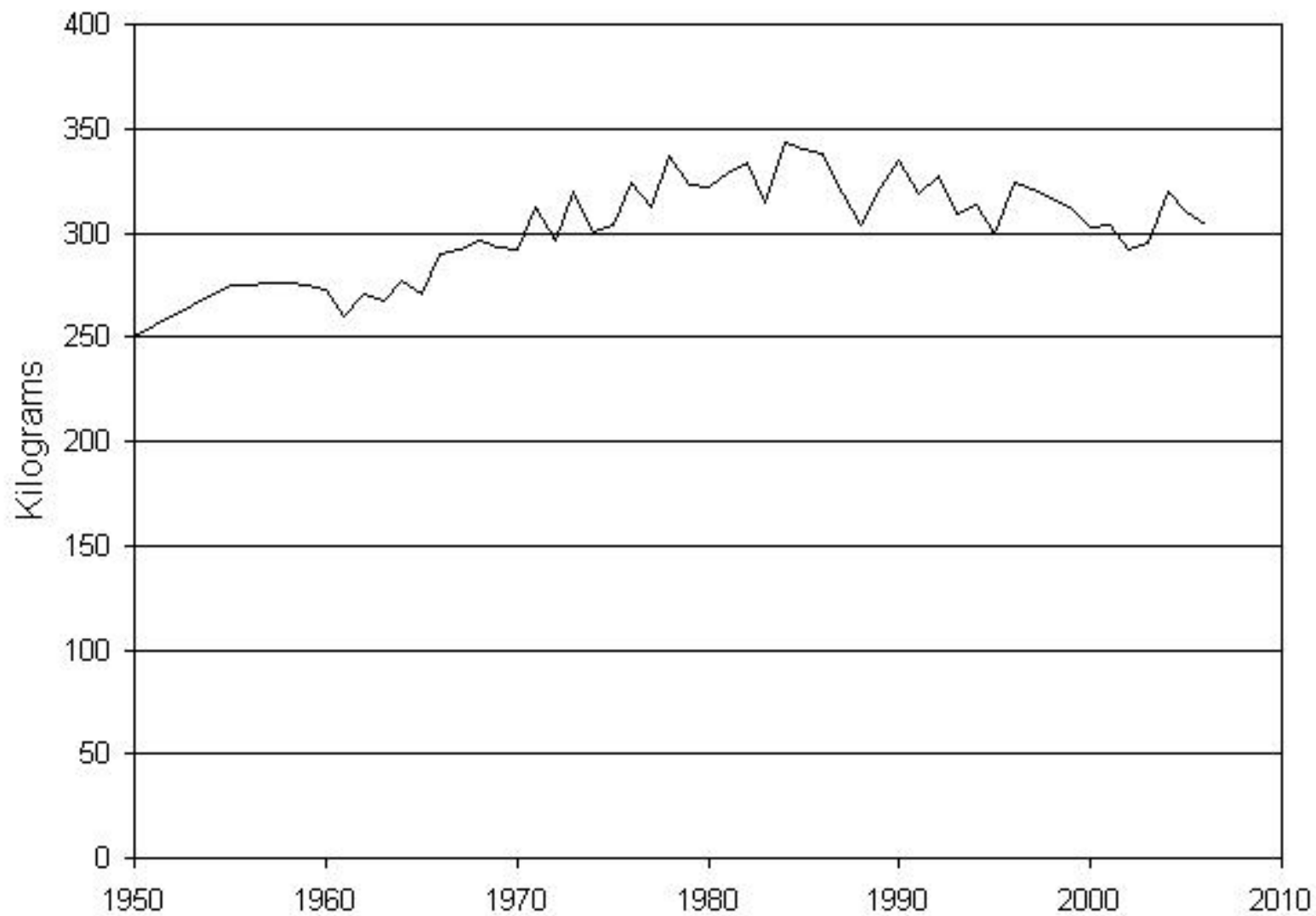


Based on crop year data. For example, 11F refers to the 2011/12 crop year.

Assumes demand growth of 2 percent. Previous 10-year growth in production/consumption averaged approximately 2 percent annually.

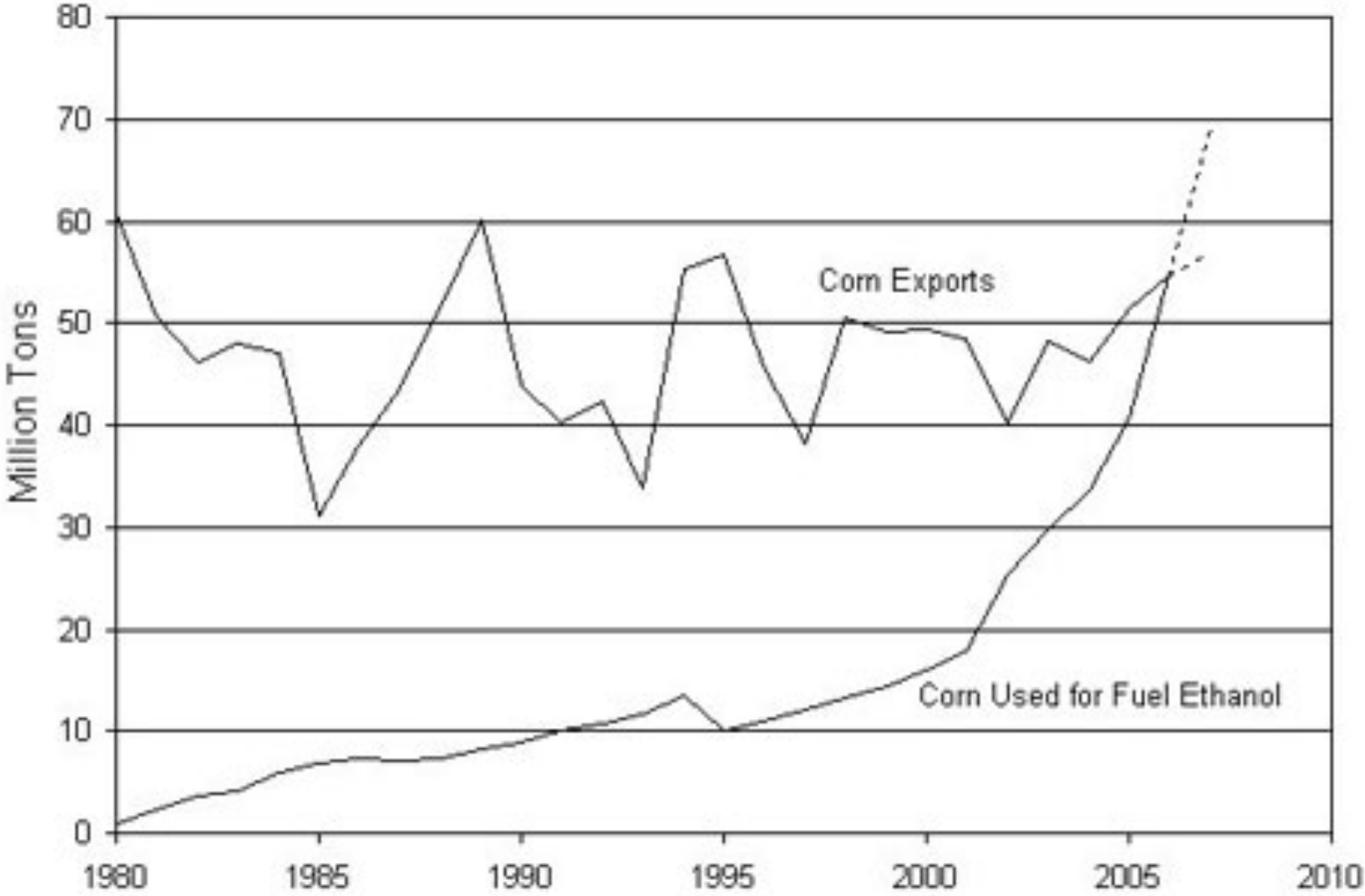
Source: USDA, PotashCorp

World Grain Production Per Person, 1950-2006



Source: USDA, United Nations

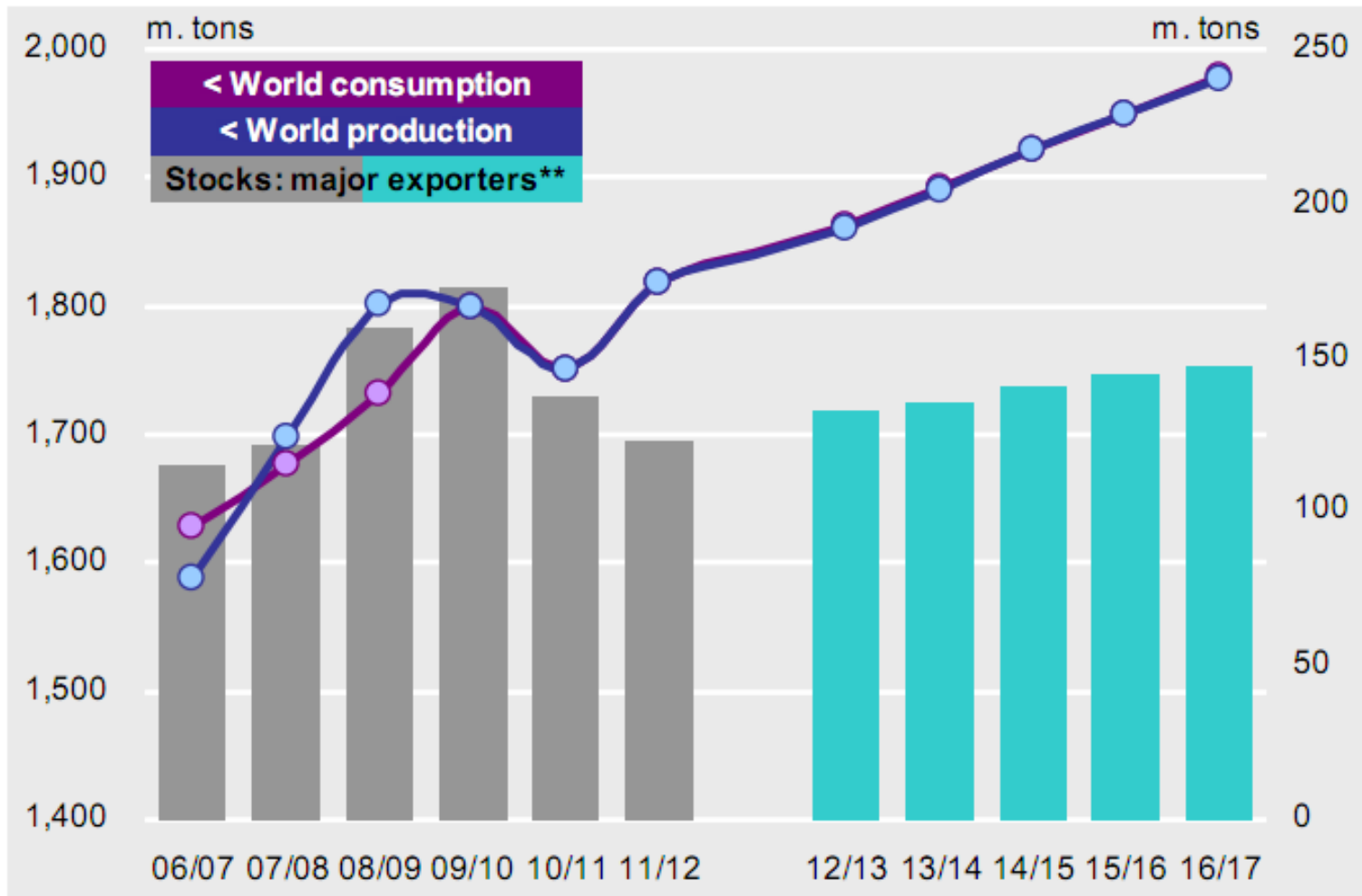
Increasing diversion of corn to ethanol



Source: USDA

World Grain projections to 2017

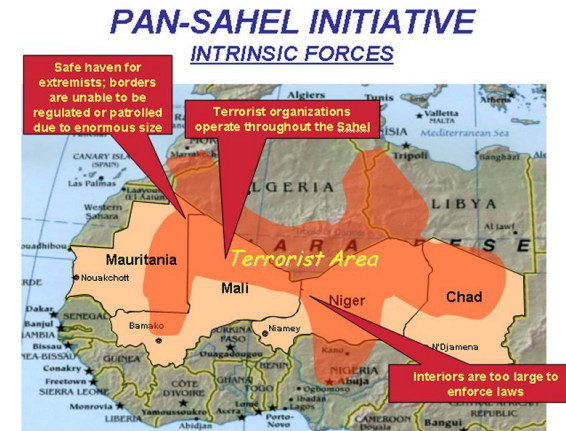
TOTAL GRAINS*: WORLD SUPPLY AND DEMAND



Sample Global Problems with Institutional Roots

This limits the global order's power to address several serious problems that could only be solved with cooperation among many nations:

- Security threats in lawless zones; proliferation of powerful weapons; and even regional instability in areas where non-state actors (including various terrorist movements) are gaining power.
- Inability to respond to mass humanitarian atrocities, failing or collapsed states, or civil wars whenever the permanent members of the Security Council are not united – e.g. Syria now.
- Often a single nation, or small group of nations, will take the initiative – leading to lack of multilateral legitimacy and potentially also other nations “free riding” on those that shoulder the burden.
- Market instabilities that threaten wild swings in the prices of staple products (and thus foods), in energy sources, in banking services and harbor the potential for market failures to cascade globally.
- The threat of illnesses spreading to pandemic proportions in a short time, with fast travel and cargo transports around the world.
- Chronic, endemic poverty in several nations that are ‘behind the curve’ of industrial development, basic infrastructure, and stable political institutions – very unevenly spread benefits of growth.
- Environmental problems: topsoil loss, overfishing, climate change, deforestation in tropical regions, and excessive freshwater needs.



The Sahel region of Africa where terrorist movements and weapons traffickers and spreading along with deteriorating fragile ecosystems.



There are 2.1 million child workers in Philippines. This photo was taken in Mandaluyong city, east of Manila, where children look for scrap metal.