Population growth and energy

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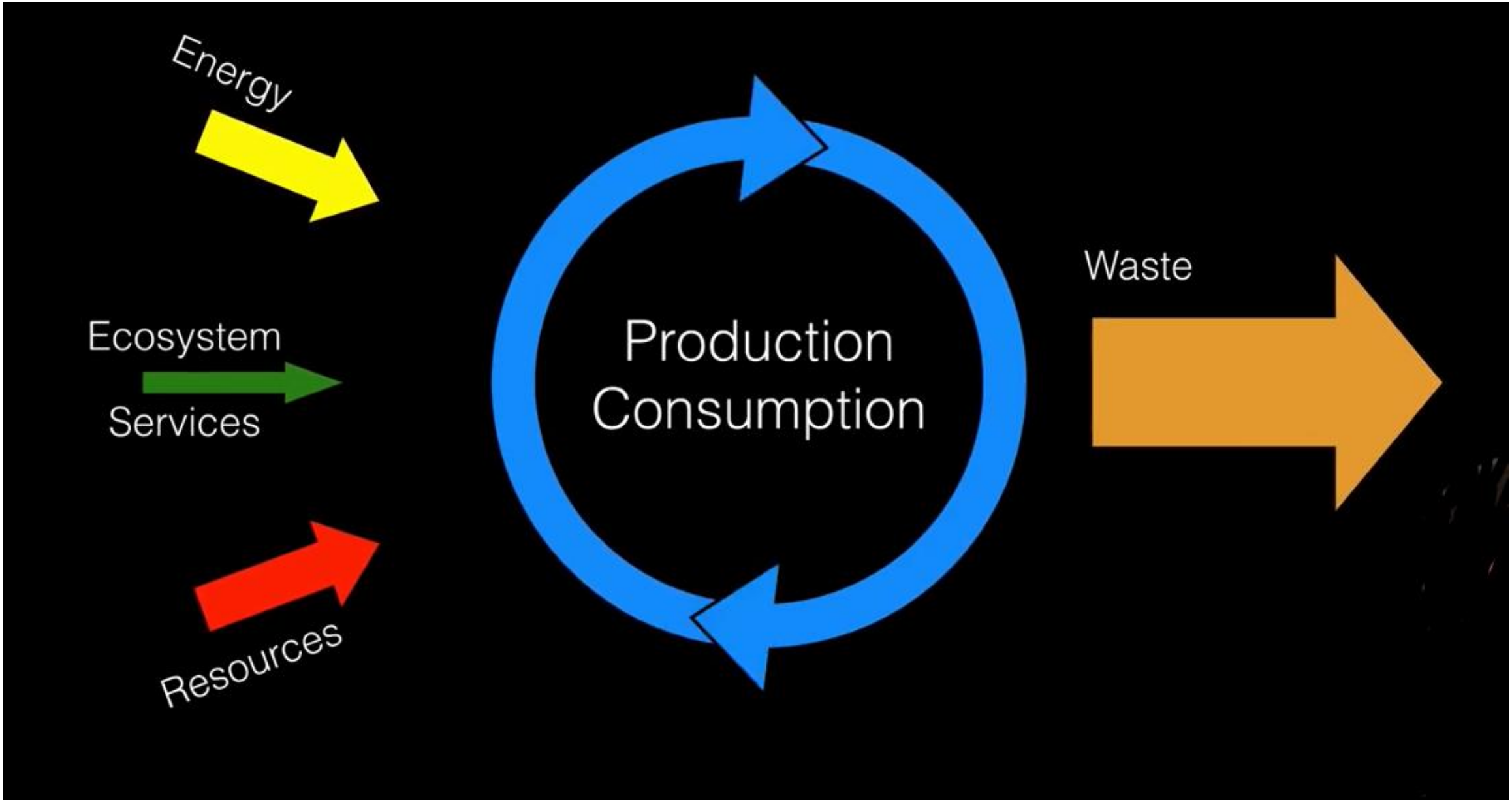

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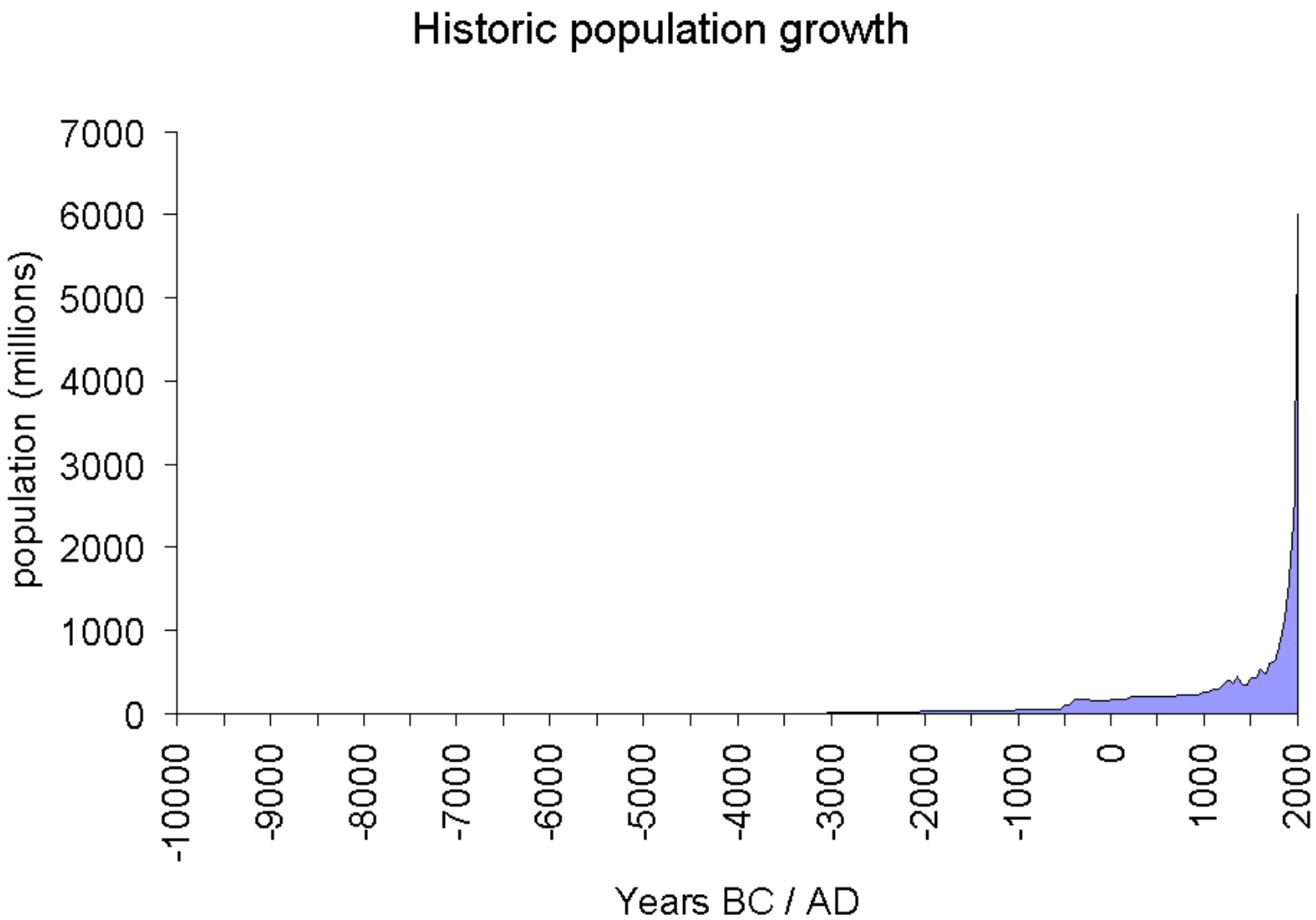

Source: US Census Bureau via Wiki

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Population growth

- Driven by fecundity (reproductive rate) – how many offspring individual may have in his lifetime.
- A population doesn´t grow to its full potential (indefinitelly).
- Limits of population growth – conditions for life and reproduction.
  - Food, temperature, space...
- Limiting factors – density (in)dependent - plateau
- Carrying capacity – number of inhabitants that ecosystem can sustain with available sources.

Population growth

- Limits of growth supressed by „infinite“ amount of energy from fossil fuels. – mechanisation of agriculture + medical advances + savage systems + living in formerly unhabitable places.

Development of the society – maximalisation of energy flows

- „In every instance considered, natural selection will so operate as to increase the total mass of the organic system, to increase the rate of circulation of matter through the system, and to increase the total energy flux through the system so long as there is present and unutilized residue of matter and available energy (Alfred Lotka, 1922).

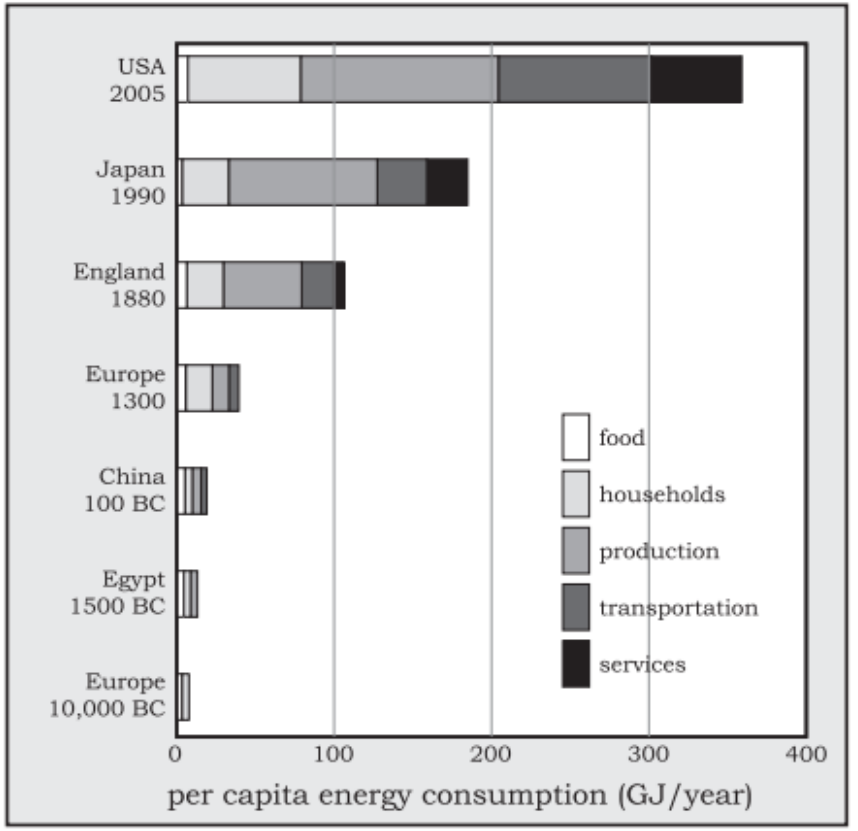

Fig. 35.2. Typical per capita energy consumption rates during the past 12,000 years.

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The first energy era (hunters and gatherers)

- Human metabolism + fire.
- Muscles to secure food, shelter, aquiring material.
- Useful work of healthy adult: 50 – 90W.
- Energy returns in foraging – barely positive to as much as 40x .
- First usage of draft animals to cultivate the field (the very beginning of the agriculture)
- Sustainable (= able to be maintained at a certain level) economy = damages were reparable.

= If the ecosystem was harmed too much and stopped providing the resources, people moved to another place.

The first energy transition

- Early, preindustrial agriculture (beginning between 9000 BC and 6000 BC, lasting app. 16th century)
- Domestication of draft animals + fire to produce metals = increase of energy usage.
- Animals: 200 – 500W.
- Fire to produce bricks and containers and to smelt metals.
- Charcoaling to convert wood to charcoal to iron (inefficient process).
- Nearly complete deforestation of some parts of Mediterranean (Spain, Cyprus, Syria – iron) and the Near East (Iran, Afghanistan – copper).
- Considerable impact of people on the environment. Development is prevented by the limits of the environment.
- Still no spare resources for education, science, tech development.

First prime movers

- Muscles replaced by waterwheels and windmills to grain milling, oil pressing, wood sawing etc.
- Late 11th century England – more than 5600 water mills, 1/350 people.
- Higher performance of draft animals (better harnessing, shoeing etc.)
- Production of metals limited by the limits of environment.
- Early 18th century – typical English furnace produced app. 300 tons of pig iron/year. 8kg of charcoal per 1kg of iron, 5kg of wood per 1kg of charcoal = annual demand 12 000 tons of wood. All natural forests gone.
- 1 mill tons of iron requires ¼ of the British Isles under coppiced wood.
- = in 1200 London surrounding is deforested, by 1500 metal ores shipped to Ireland, Scotland, Wales for smelting, then the the industry moves to U.S.

Industrial age

- Substitution of animate energy by engines and energies of fossil fuels (still in process in dome areas – Africa)
- By 1900 several European countries energized by coal.
- Previously the lack of energy prevents the population from (also economic) expansion. No spare resources for education, science, technological development. It was changed by the fossil fuels.
- Watt´s steam machines 20kW. Industrialization, transportation, rise of well being. An inexpensive and reliable supply of heat and electricity.
- But environmental consequences (serious changes of interactions in the ecosystem)
- = fossil fuels provided a critical amount of energy for the humankind to develop. They (for uncertain period of time) removes the limits of (economic and population) expansion.

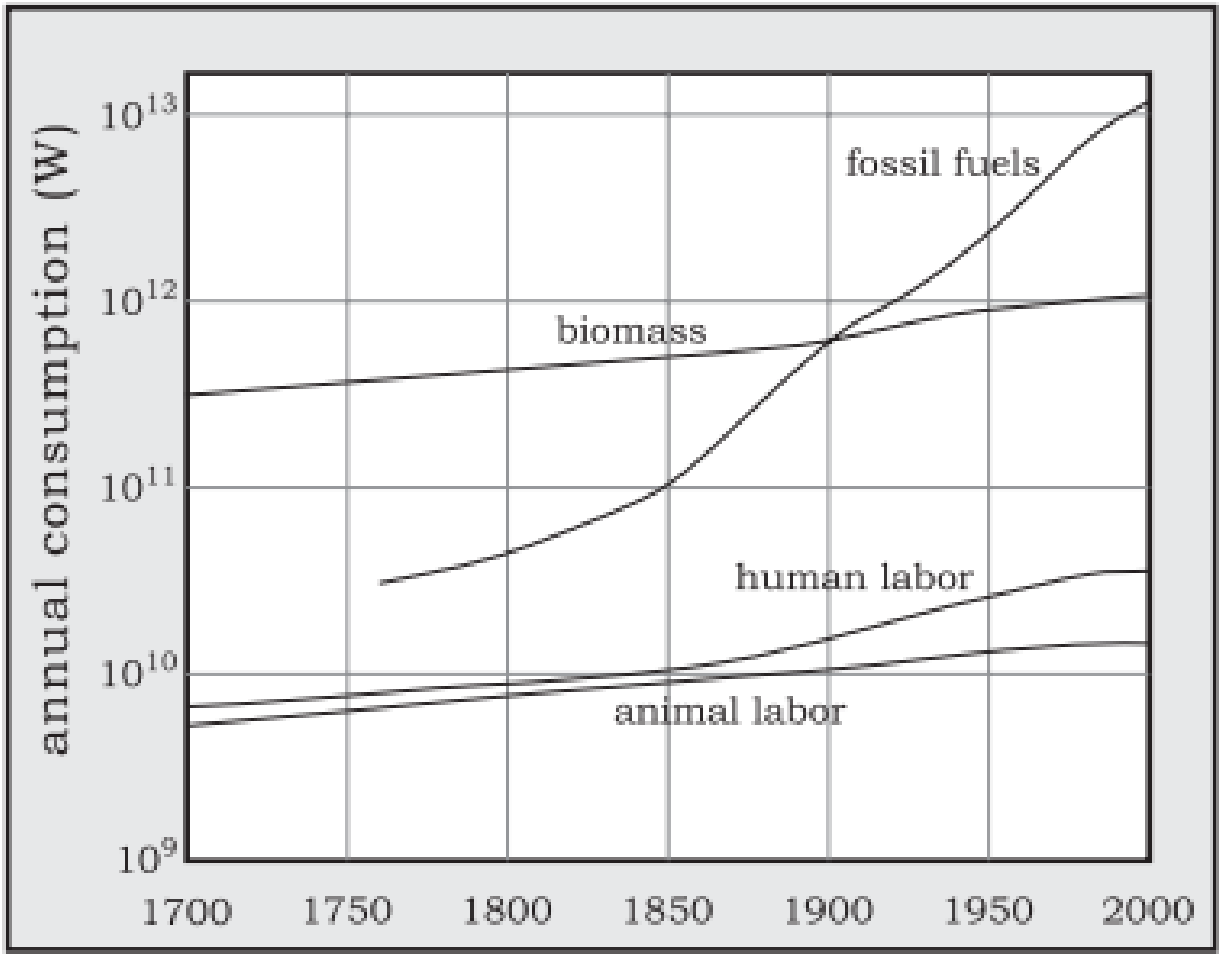
Latest energy transition

- Started by the first electricity plants in 1880s
- Electricifaciton and inovation
- An inexpensive and relable supply of electricity transformed every aspect of everyday activities – light, time-saving gadgets, energizing transport, boosting industrial production.
- By 1950 oil and gas approx. 35 % of the world´s primary energy supply and by 2000 their combined share over 60 %. With coal fossil fuels provides 90 % of all commercial primary energy supply.

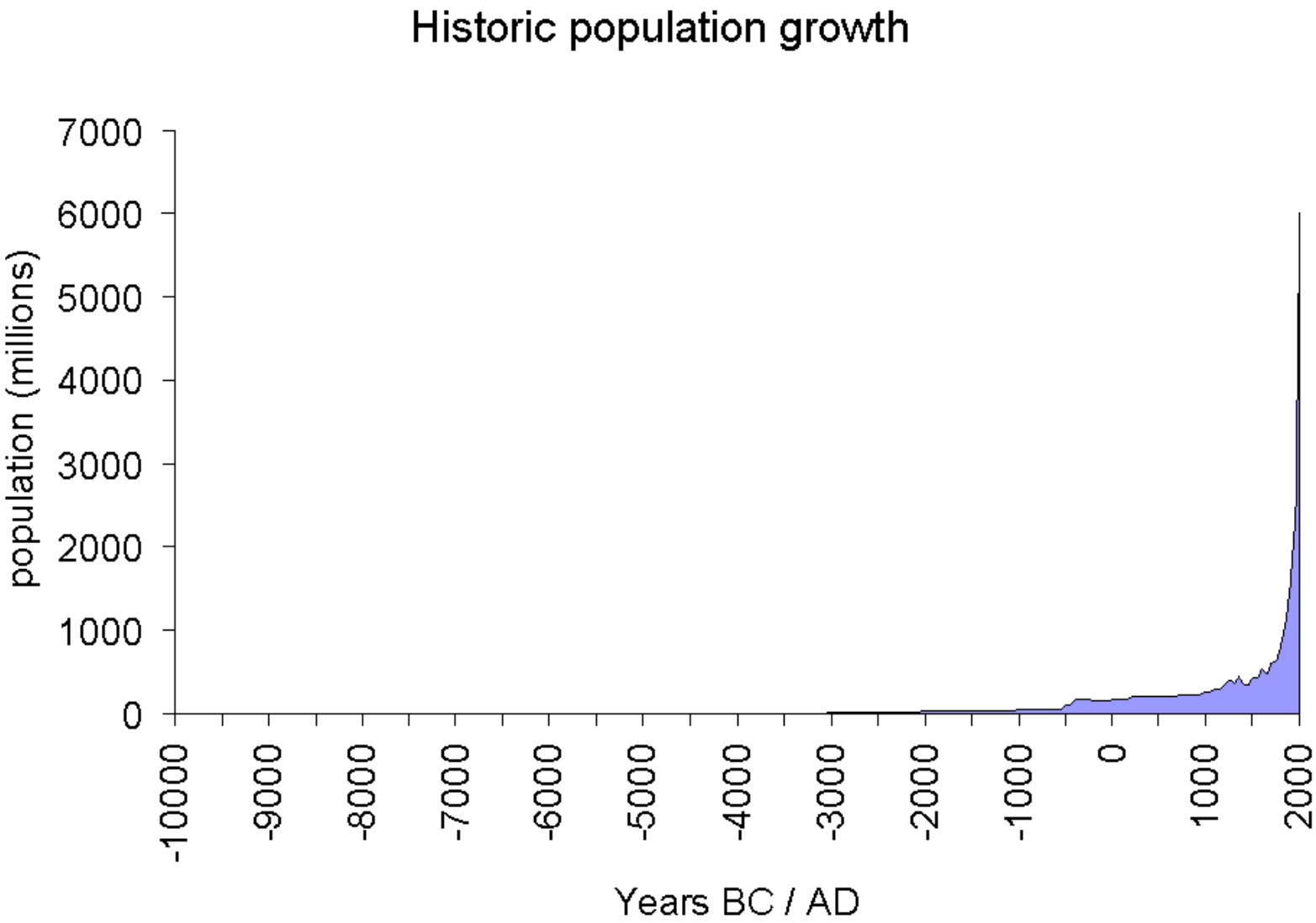
= fossil fuels drive up farm productivity and hence reducing (drasticaly) agricultural population by mechanizing industrial production and letting the labor force move into the service sector.

- But their impact on the environment is tremendous.

Development in energy consumption



Global consumption of primary energy, 1750–2000.



Source: US Census Bureau via Wiki

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The math of population growth

- Exponential growth - growth that increases at a consistent rate.
- xt=x0(1+r)t
- The rule of 70 – to find the doubling time divide the percentage number into 70 = approximate number of years needed to double.

Thomas Malthus (1766-1834)

- An Essay on the Principle of Population.
  - Food is necessary for people to survive
  - Children will continue to be born
  - The power of population growth is indefinitely greater than the power of the Earth to produce subsistence.
- Malthusian trap (population growth instead of high standard of living).

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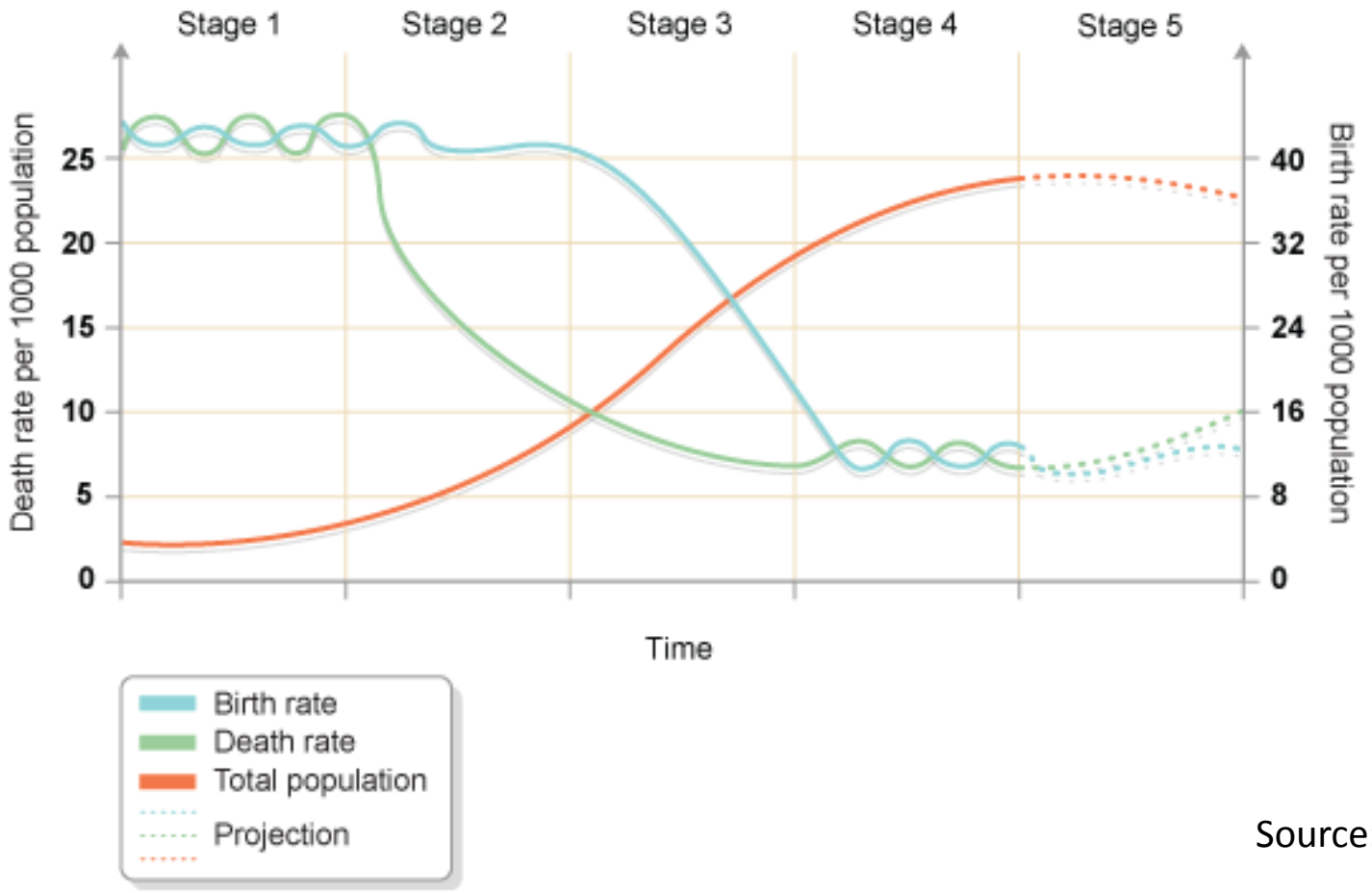
- Technological development.
- Relationship between afluence and population growth (demographic transition theory).

Demographic transition model



Source: W. Thompson

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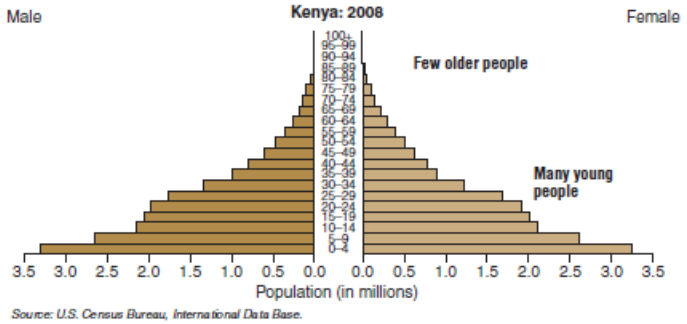
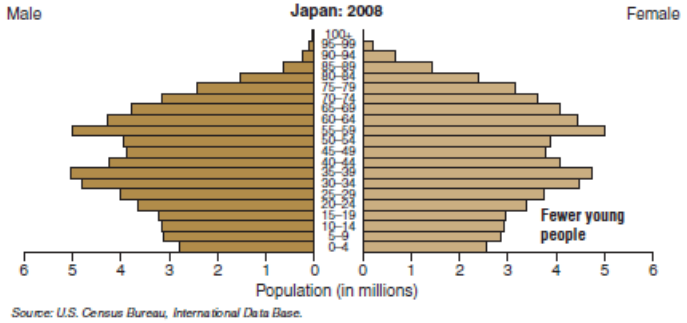
Age structure



Source: U.S. Census Bureau, International Data Base.



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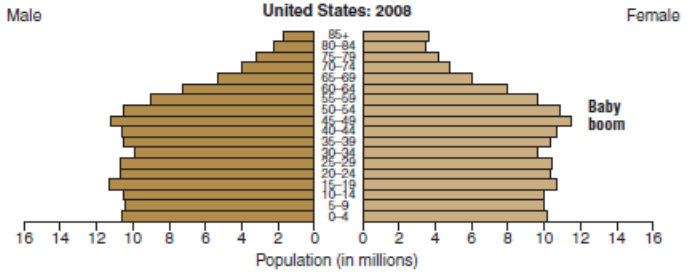

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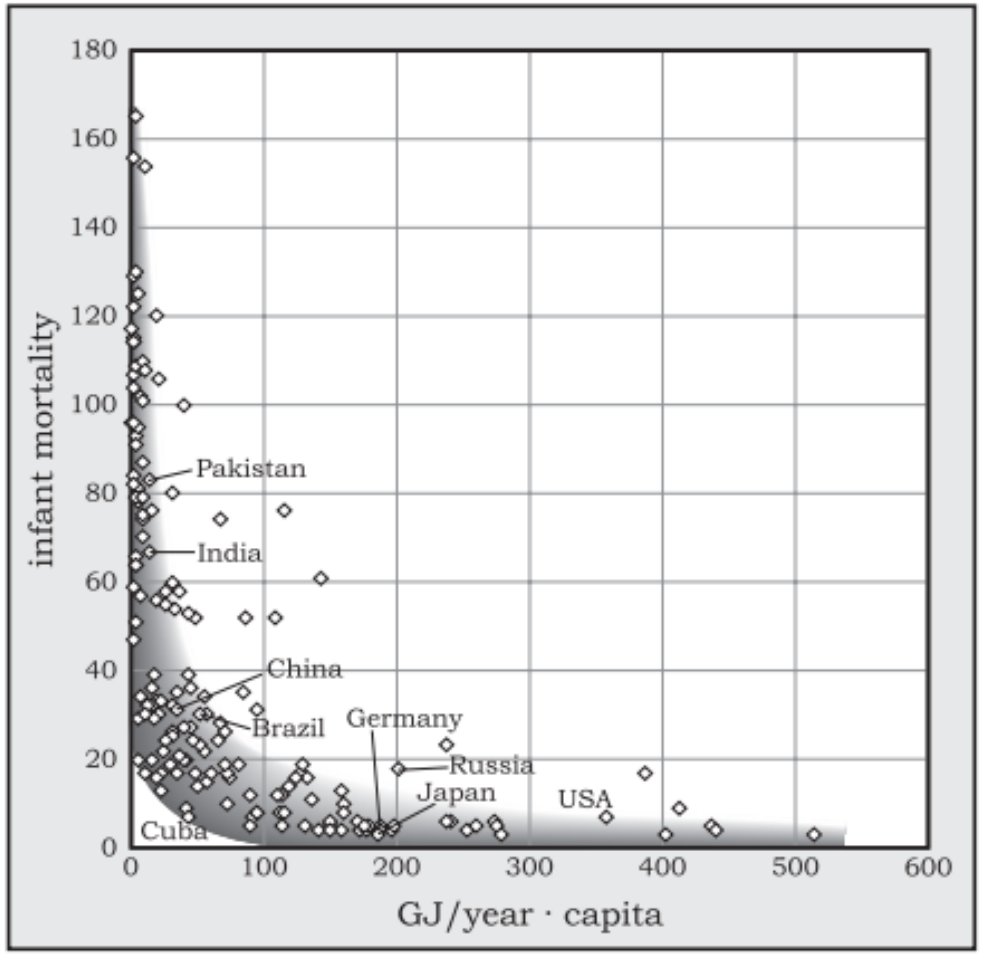
Technological development



Per capita energy use and infant mortality.

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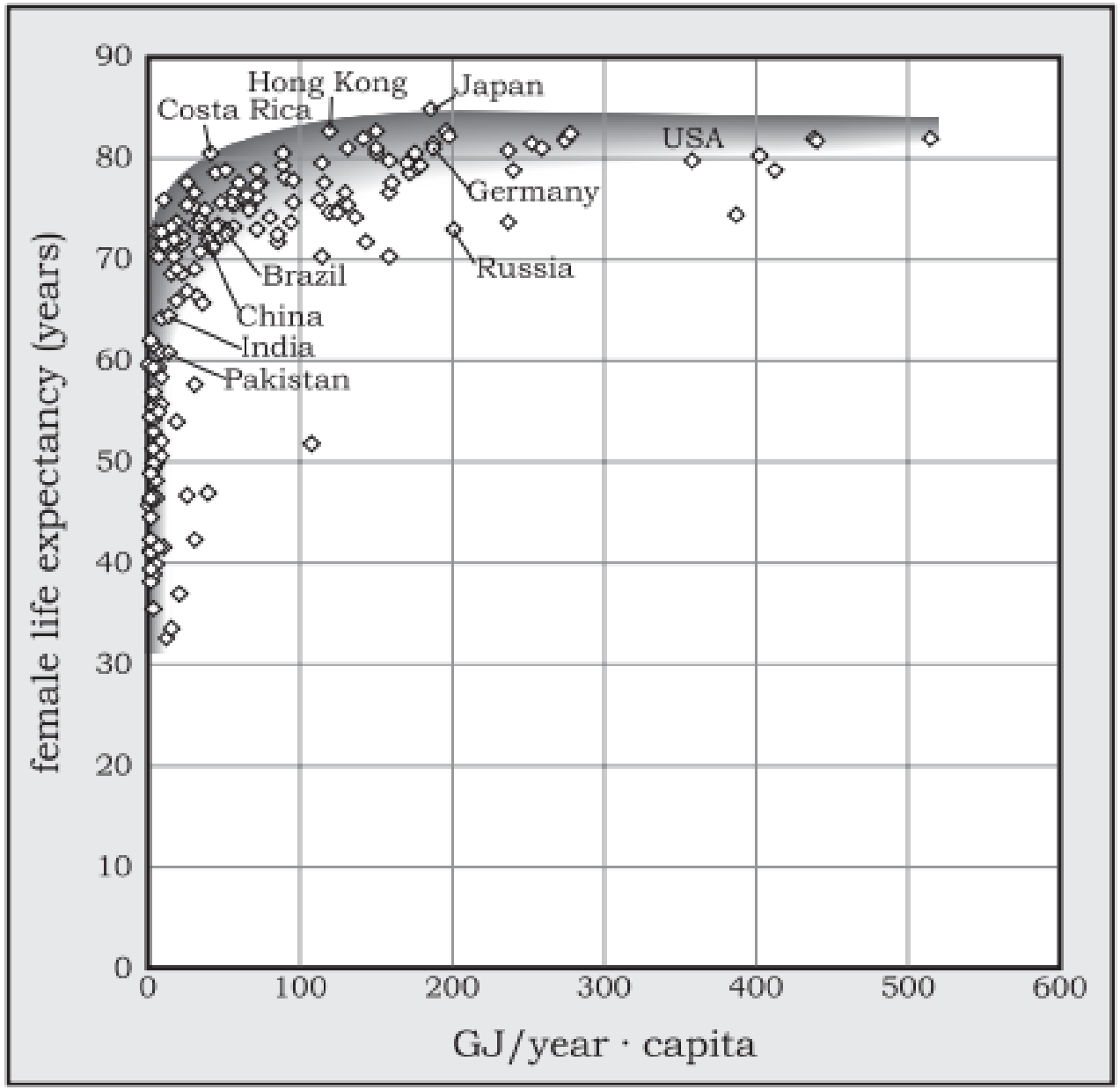

Per capita energy use and female life expectancy at birth.

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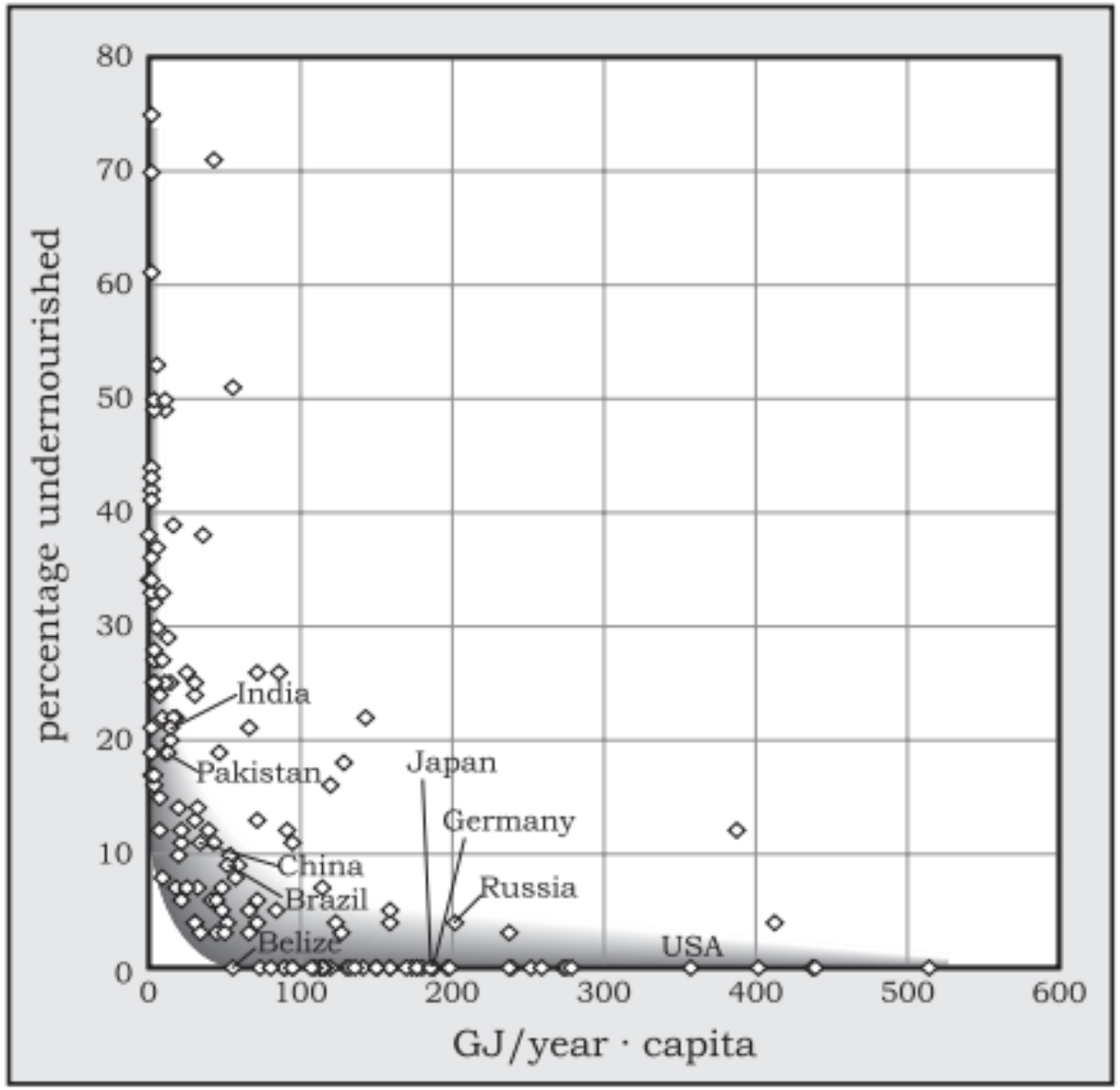

Per capita energy use and malnutrition.

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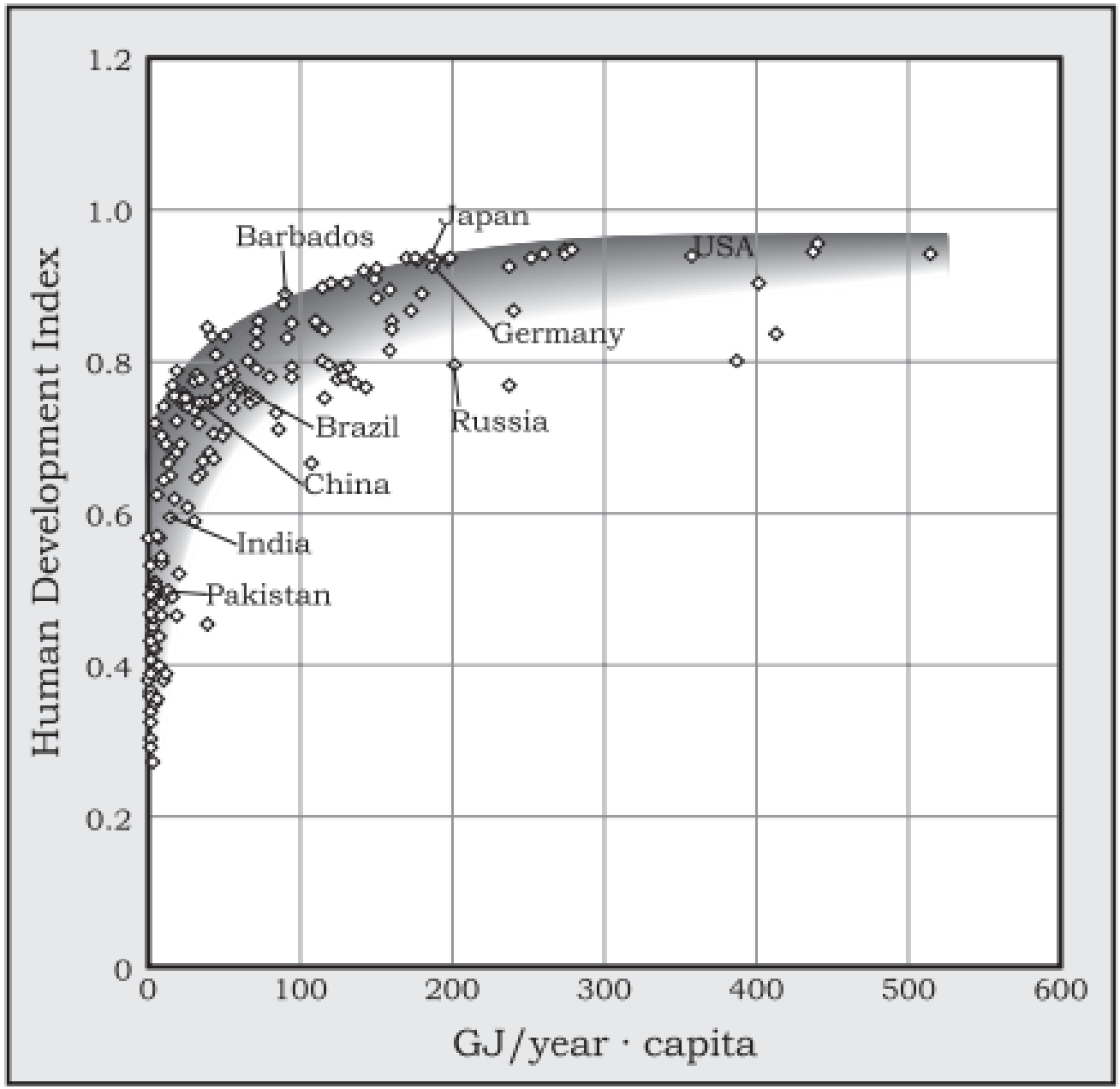

Per capita energy use and HDI.

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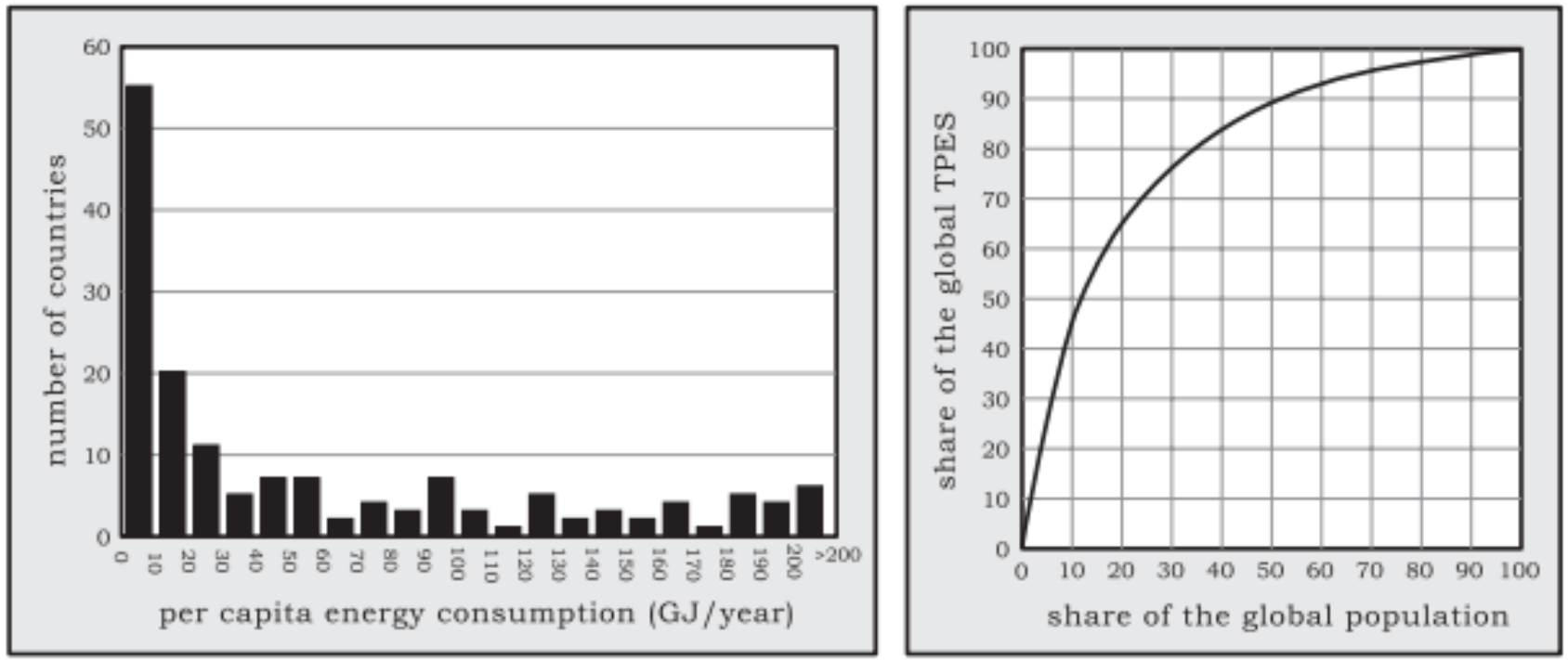
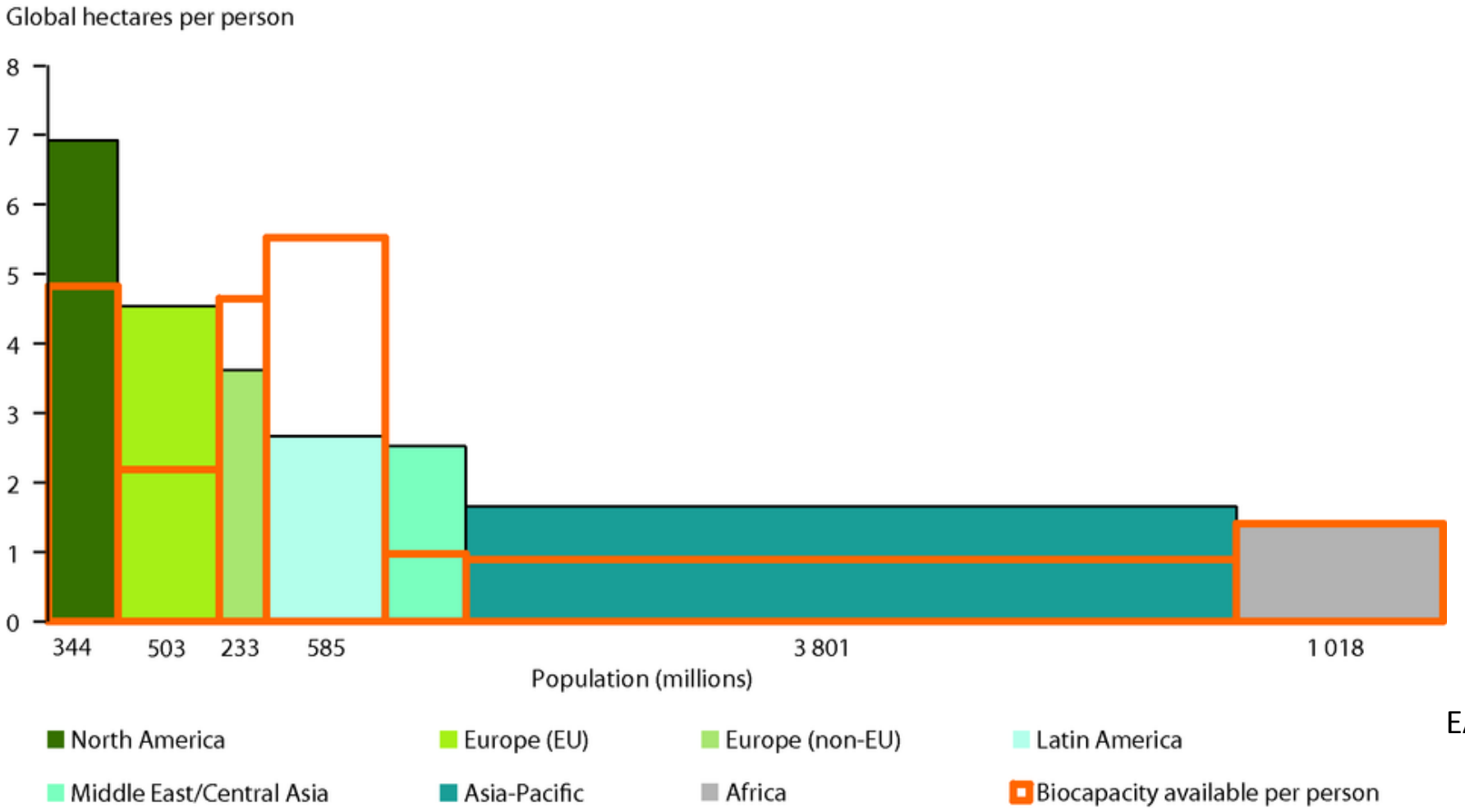


Pronounced inequities of global energy consumption.

Ecological footprint



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Do we need to limit the population growth?

- Cornucopians (boomsters, vs. Malthus and followers = doomsters)
- Reformists: Work within existing structures to make society more “green”
- Revolutionaries: Sustainability is not possible without radical change
- Environmental determinists: Ecological limits will impose changes on society whether we like it or not

- The Voluntary Human Extinction Movement