Human Population

Three stages based on energy acquisition

Progress in reducing suffering

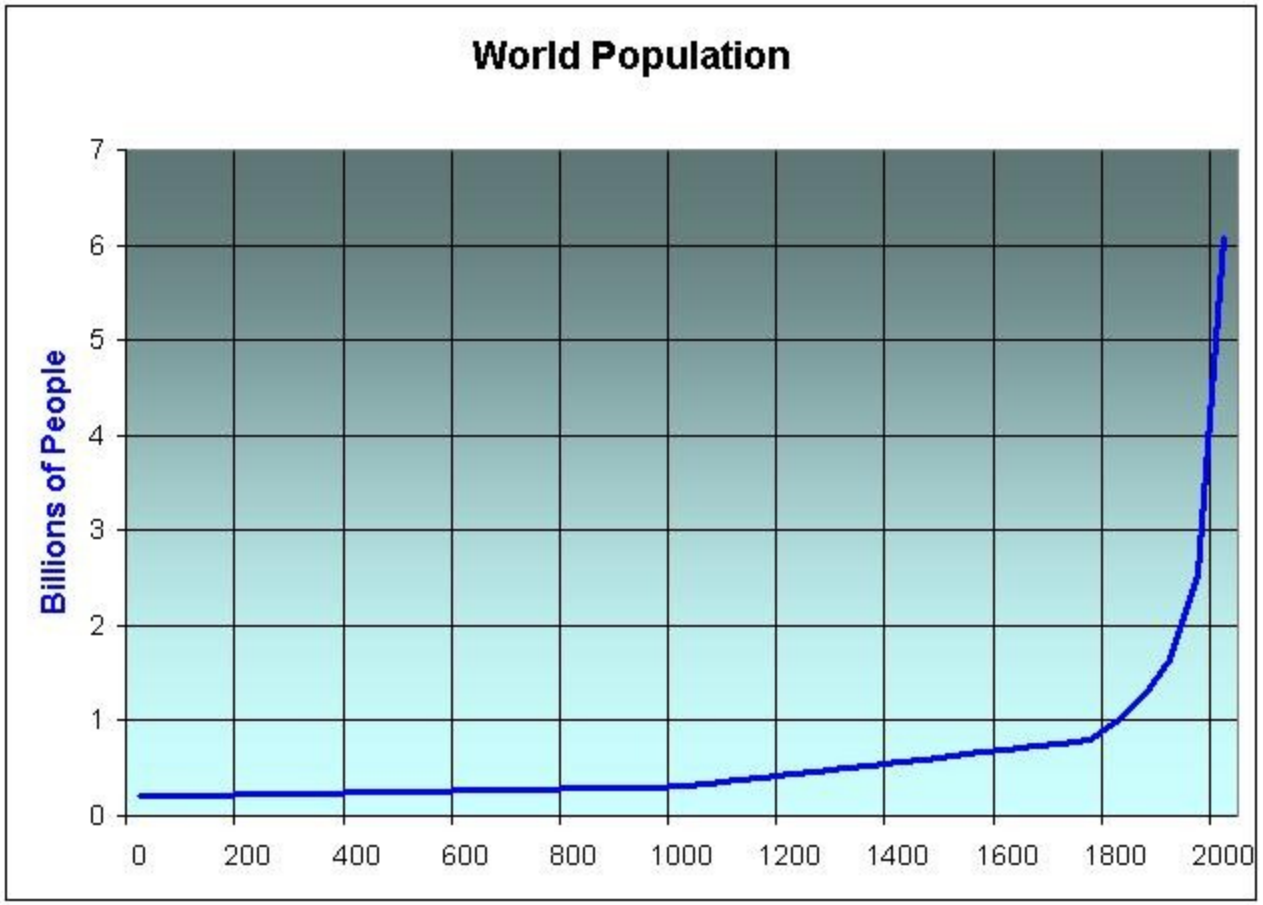
Period of acceleration

Learning Objectives

- There can be no long-term solution to environmental problems unless human population stops growing
- What controls the rate of growth?
- How many people can the Earth sustain?
- The rapid increase in human population occurred with no change in the MAXIMUM lifetime of an individual
- Birth rates have declined faster in countries with a high standard of living than in countries with low standard of living

Human Population

- World 7,679,302,210



Growth rate = Birth rate – Death rate

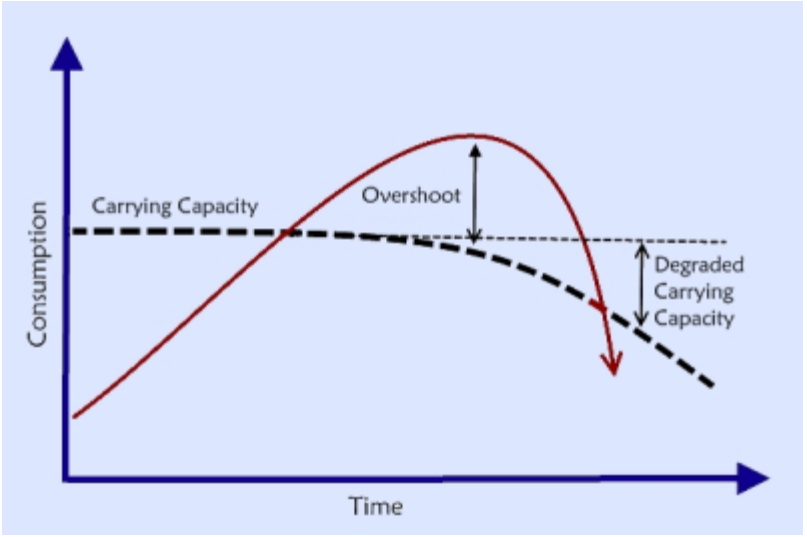
Crude Growth Rate = Crude Birth Rate – Crude Death Rate

Crude = # Per 1000

Zero Population Growth

- Population is stable
- Number of births = number of deaths

- In overshoot, if births go up, then deaths go up (war, famine, plague)



Stages of Civilization:

Hunter Gatherer (>10,000 YA)

Agriculture (10,000YA – present)

Wheat (emmer and einkorn), barley

Sheep and goats

Cattle and pigs

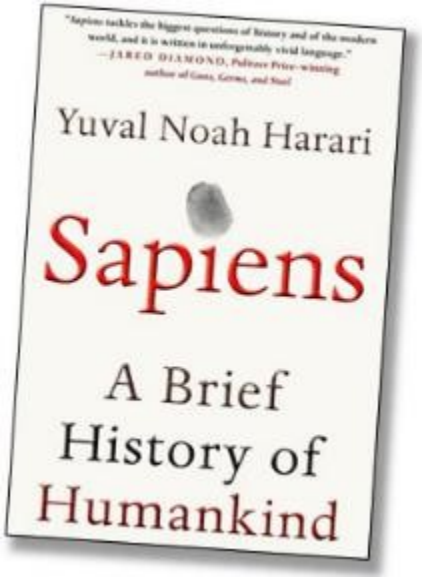
Draught animals (6000YA)

Industrial Revolution (1800 – present) drawdown of stored solar capital to utilize higher energy densities from geologic input

Rapid rise of *Homo sapiens*

[It was] only in the last 100,000 years—with the rise of Homo sapiens—that man jumped to the top of the food chain....Other animals at the top of the pyramid, such as lions and sharks, evolved into the position very gradually, over millions of years. This enabled the ecosystem to develop checks and balances that prevent lions and sharks from wreaking too havoc.

....In contrast, **humankind ascended to the top so quickly that the ecosystem was not given time to adjust**. Moreover, humans themselves failed to adjust.



www.motherjones.com/kevin-drum/2016/02/nice-paragraph-about-why-humans-are-so-damn-paranoid

Stages of civilization and how it affects population

I. Hunter Gatherer – *Home sapiens* emerged 250,000 and until ~10,000 years ago food was based on gathering "sunlight energy" in plants and animals from the ecosystem. Population was low and growth was low

II. Rise of Agriculture – 10,000 years ago until present. Humans domesticated plants and animals for more stable and predictable food supply – gathering "sunlight energy" that they had control over. Population growth increased, and population increased steadily but slowly.

III. Fossil Fuel Age (Industrial Revolution) 1800-present. Use of concentrated "stored solar energy" for plowing, irrigation, fertilizer, transportation, storage, processing, preparation, made food more available. Population growth increased and population exploded. Fewer people needed to engage in farming allowed additional specializations in medicine, technology, industry, etc., etc., etc.

Human Population

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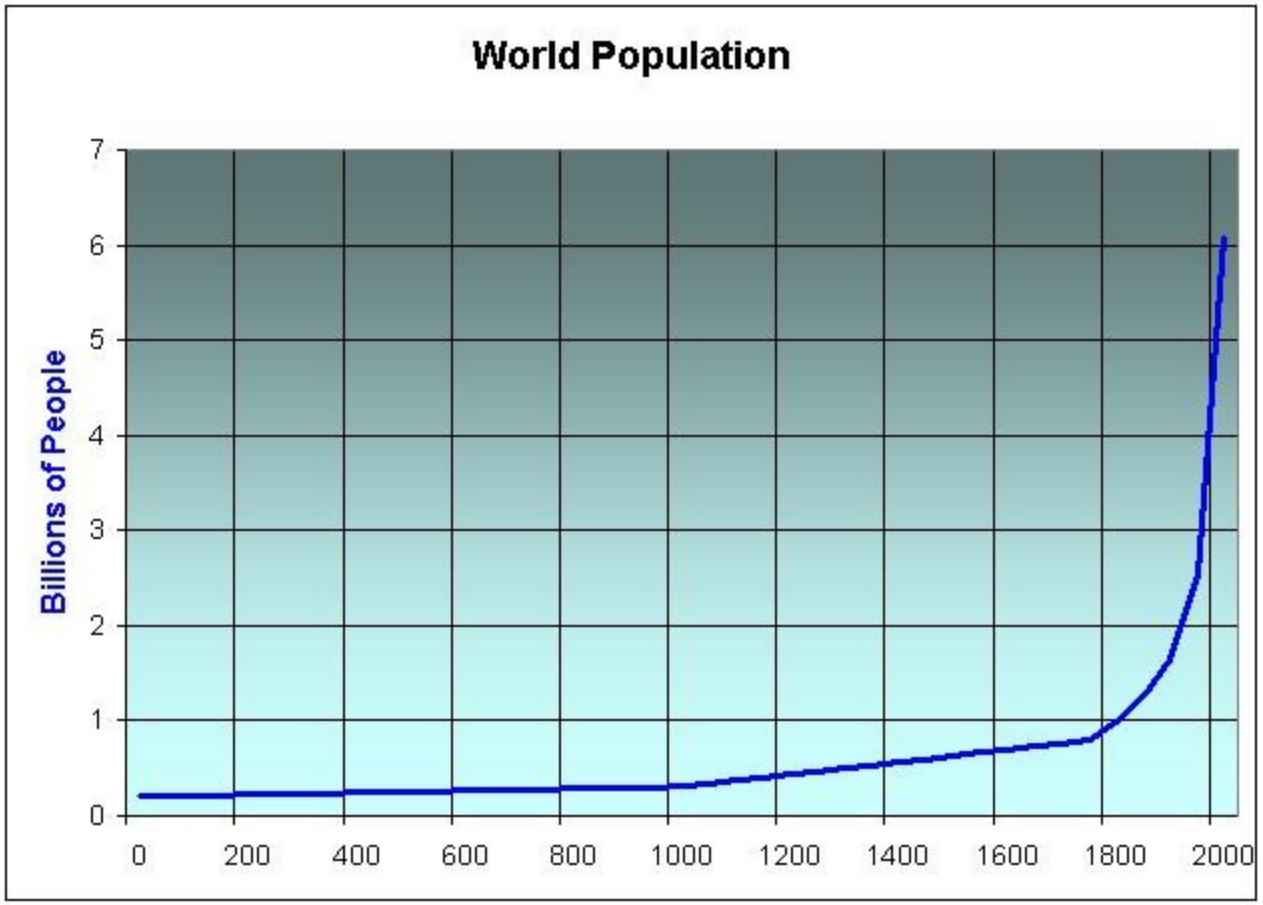
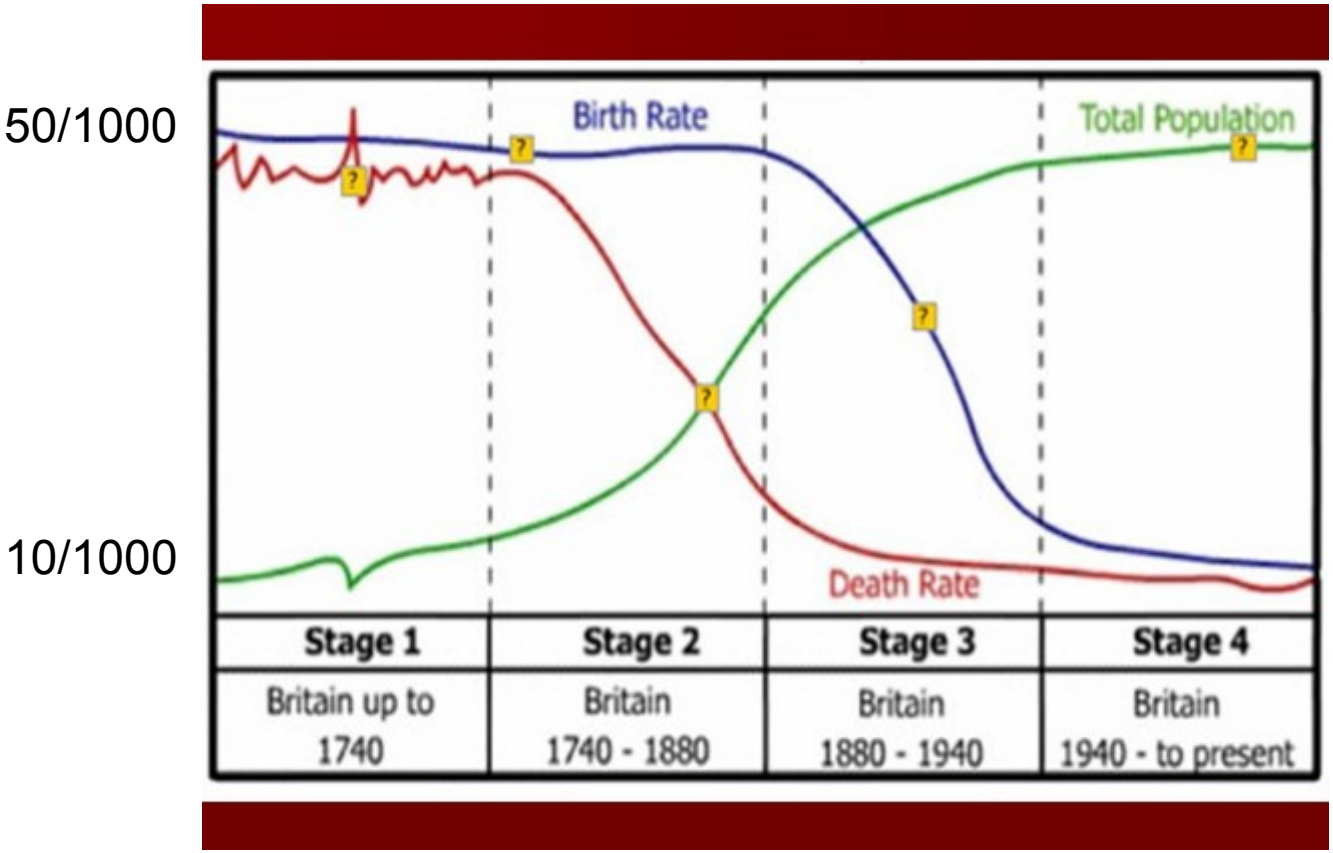
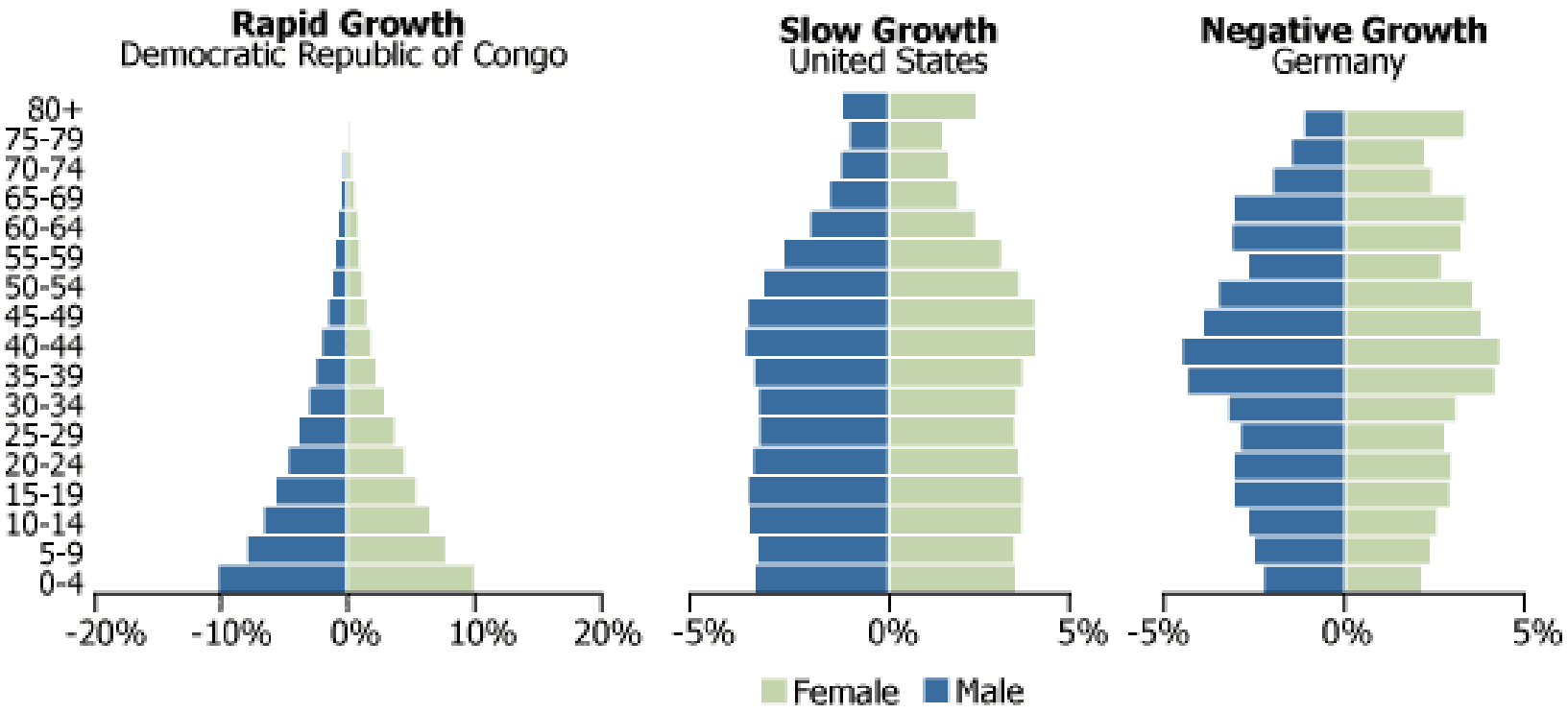


Demographic Transition

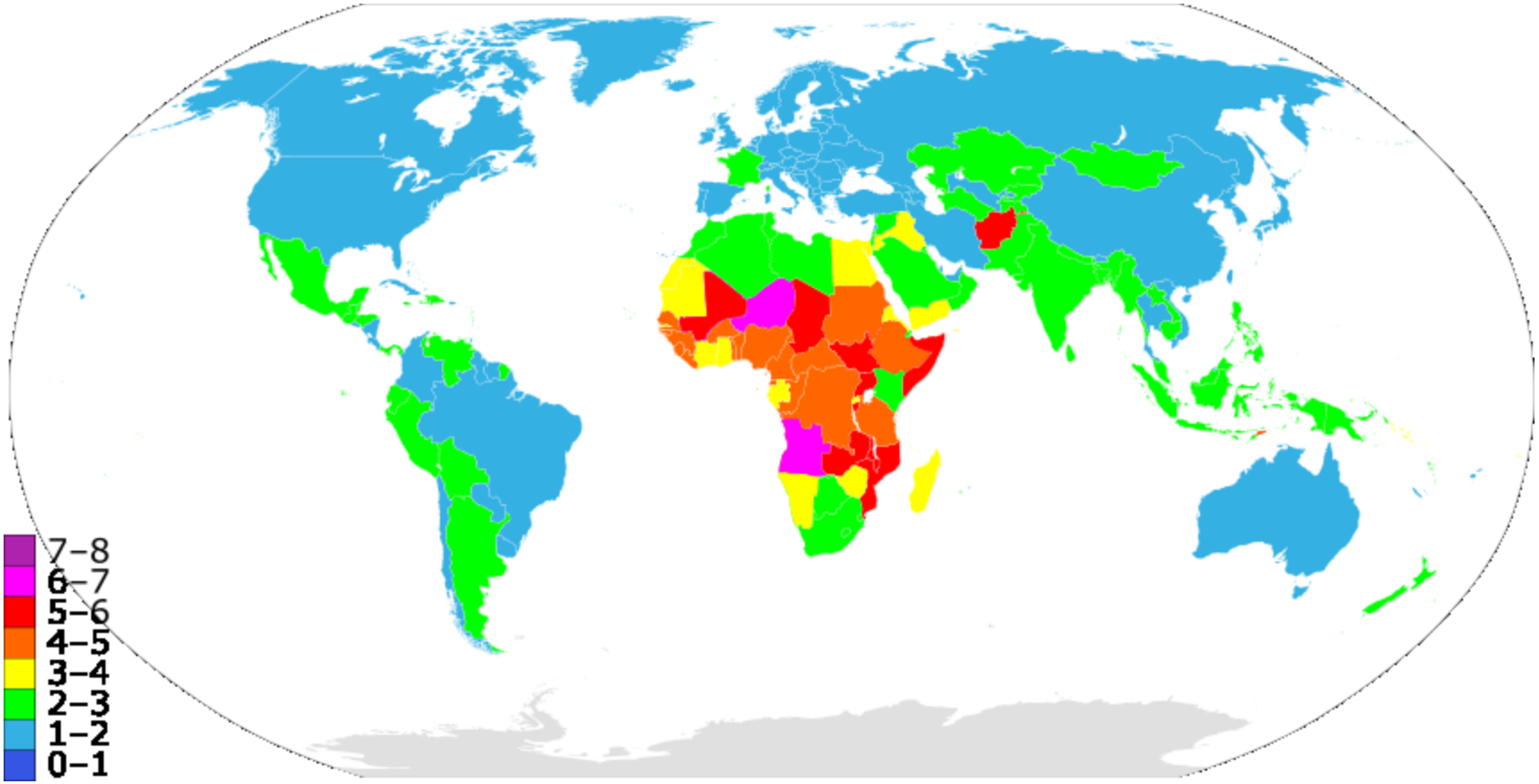


Age structure

- Pyramid, column, inverted pyramid, column with a bulge

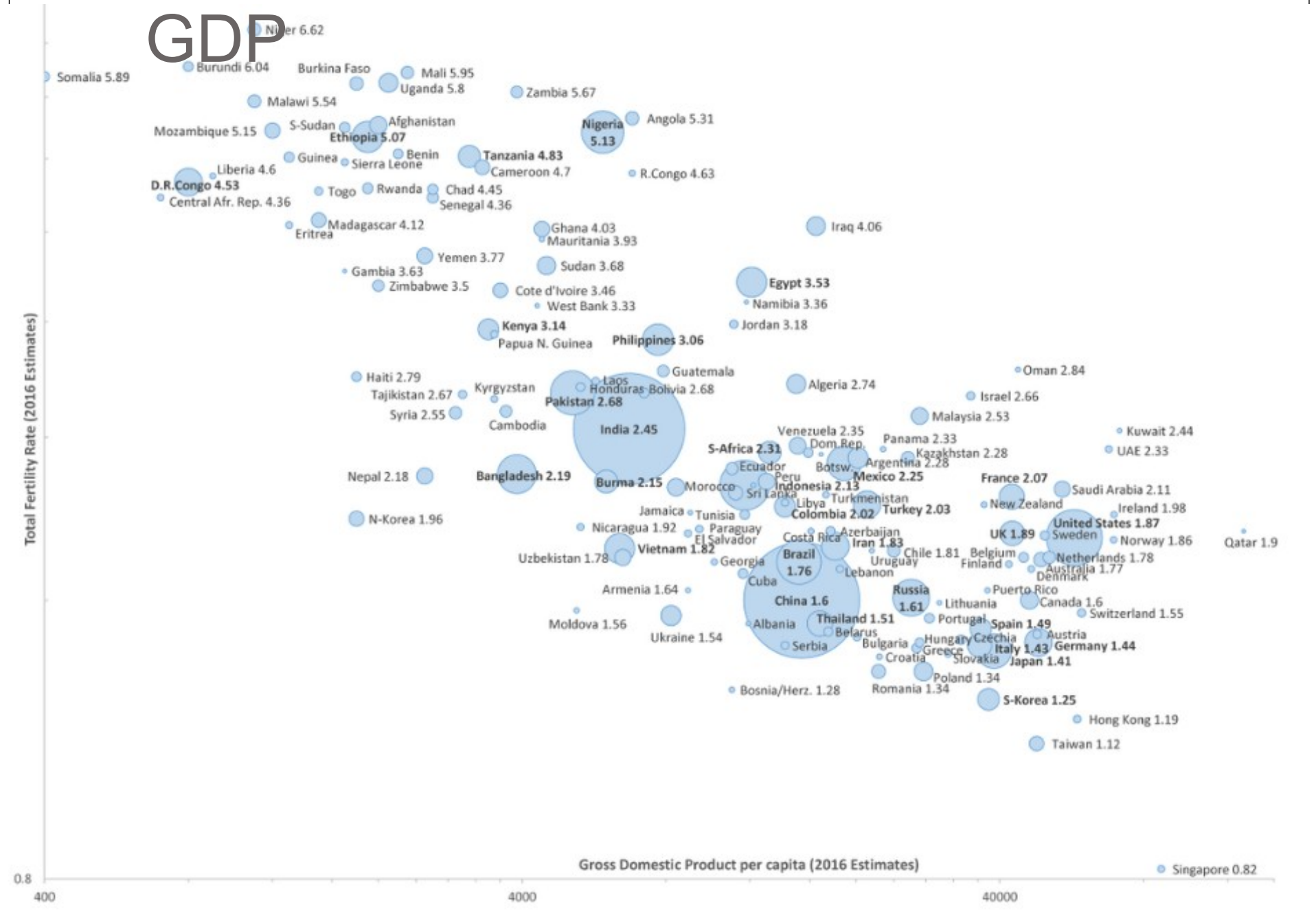


Fertility Rate - average number of children that would be born to a woman over her lifetime



2018 CIA Factbook

Fertility versus GDP

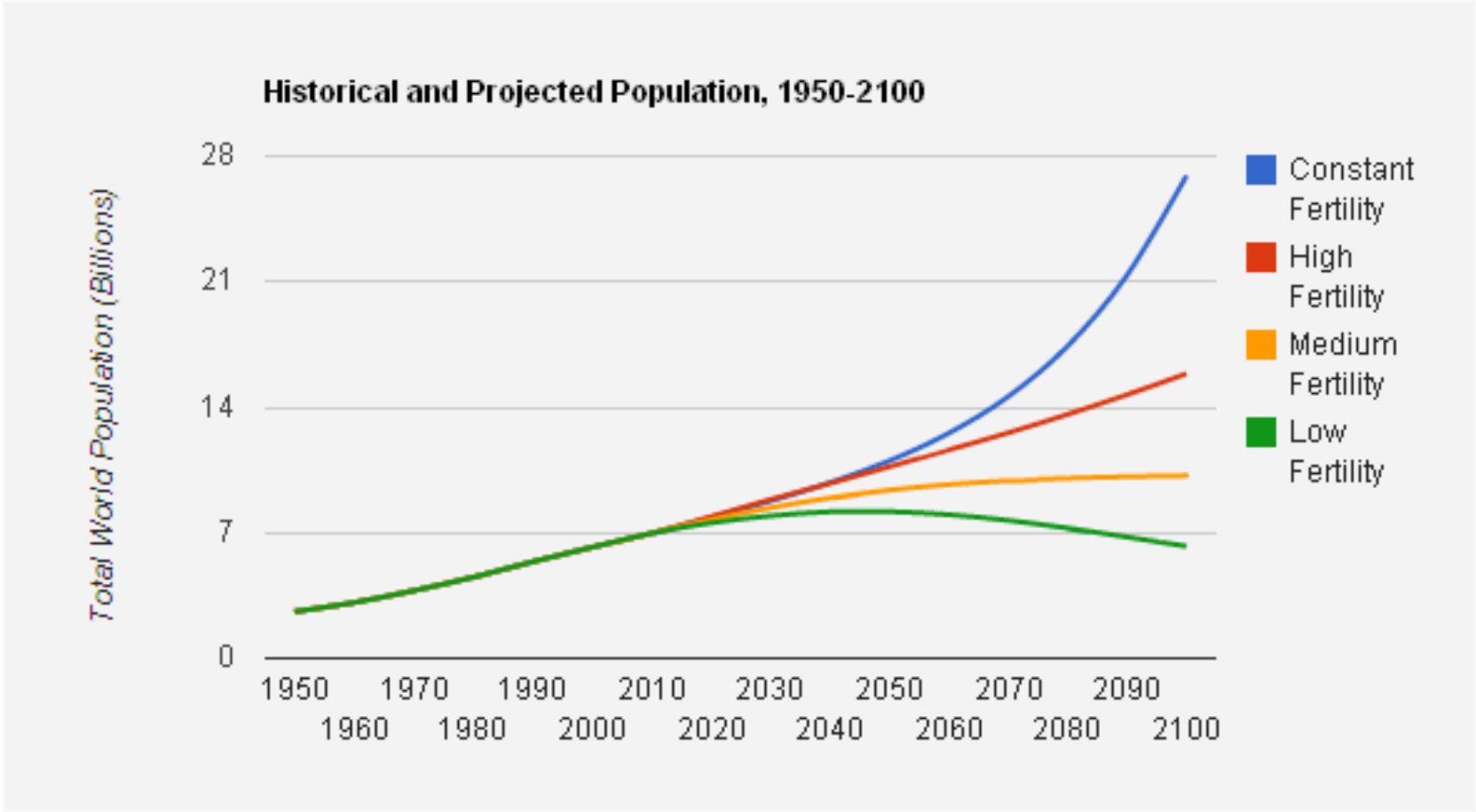


How many people can the Earth support? Limiting factors

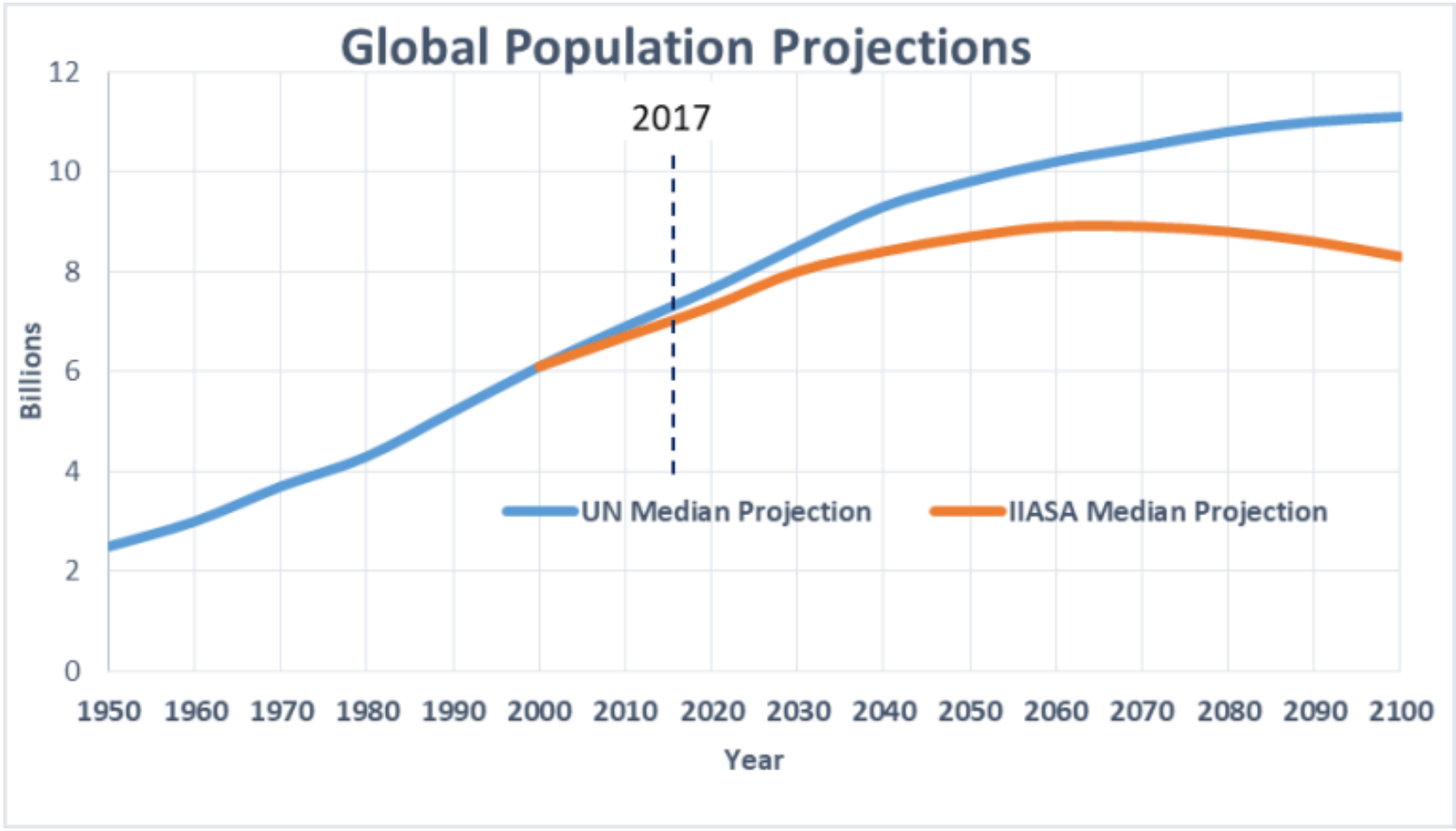
- Food supply
- Land and soil resources – almost all usable agricultural land is being cultivated – each year more soil is lost to erosion than is formed
- Water resources – less than 3% of all water is suitable for drinking and irrigation. Underground reservoirs are being depleted
- Population Density – people per area
- Energy resources and Technology – How much each person uses (mainly energy resources)

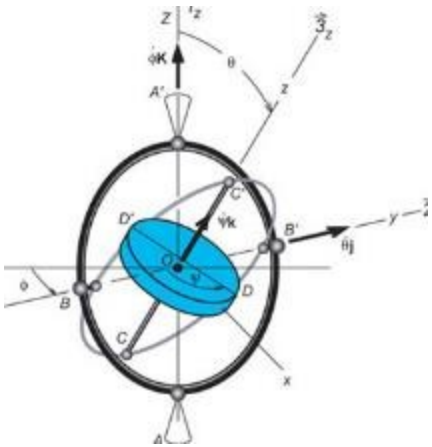
  1 American = 35 Indians = 140 Bangladeshi

United Nations Population projections



World Population projections





Progress

Change

Dynamics

Development

Modification

Process

ɔrmation

Do all these terms have the same implication?

Is the direction always “better”?

Is something lost when something else is gained?

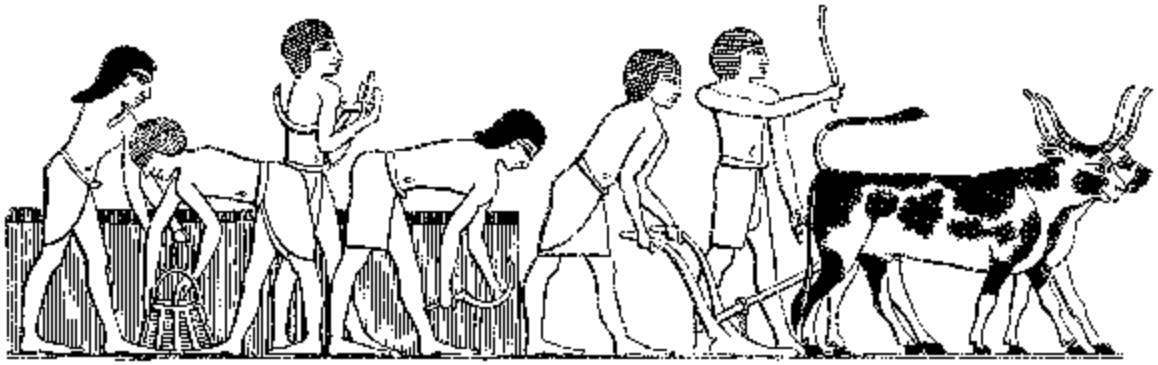
What change leads to destructic ?

Who decides what is a gain or a

Does it depend on who gains ar

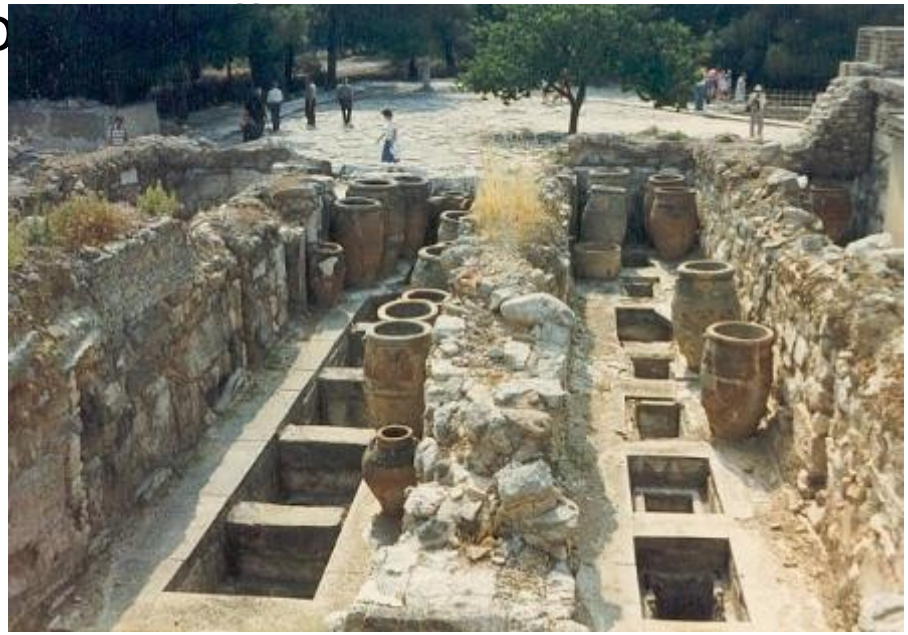
When human societies first evolved as a significant part of the systems of nature, man had to adapt to the food and fuel energy flows available to him, developing the now-familiar patterns of human culture.

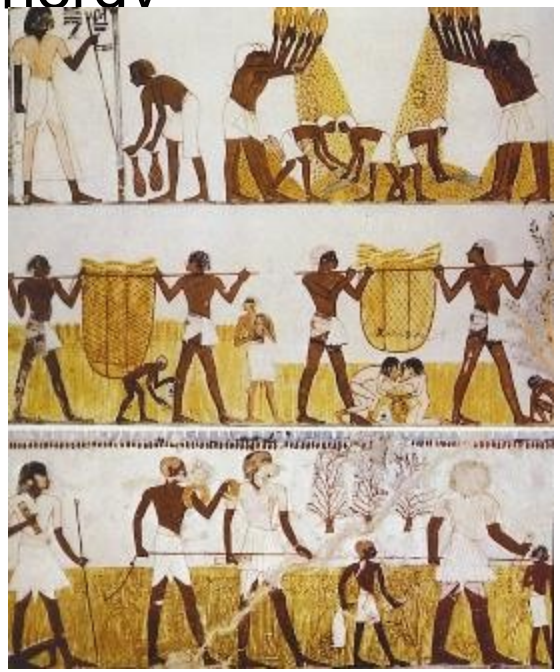
The energy source was sunlight which is spread out so evenly that it is not directly available to man until after some has been concentrated and much has been necessarily lost by the plants and animals.



Societies that were able to survive had to gather food and distribute energies within the social system for their successful continuance, and they developed the group organization necessary for these purposes.

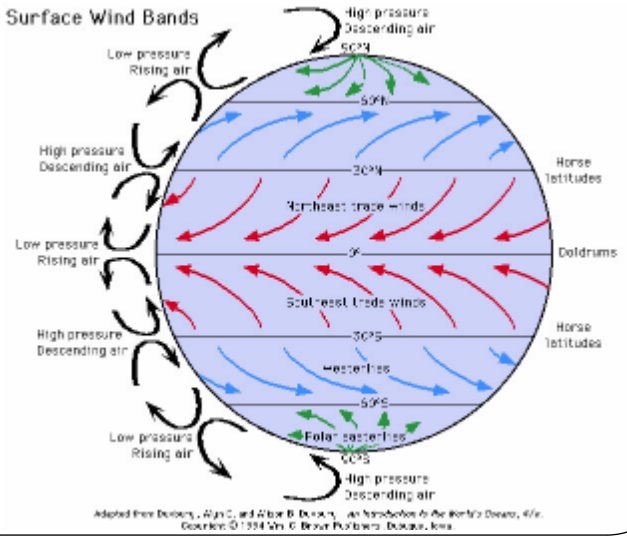
Ethics, folkways, mores, religious teachings, and social psychology guided the individual in his participation in the group and provided means for using energy so

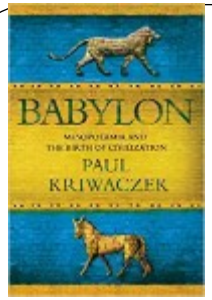


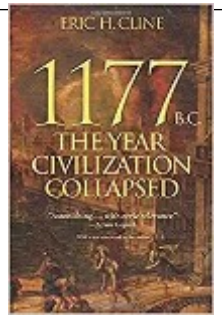


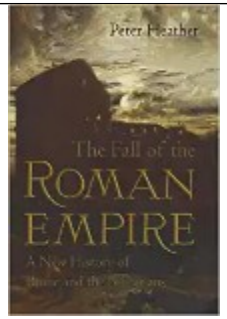
Two main energy flows

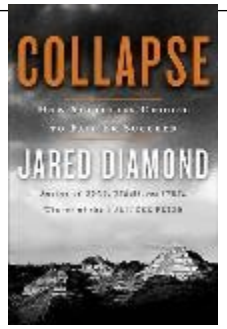
- Solar energy driving photosynthesis
- About one-half of the solar energy is in wavelengths incapable of directly driving photosynthesis and is absorbed as heat.
  - This creates temperature gradients across the globe driving the great wind and water current systems of the earth.
  - This giant heat engine contributes to P-R by bringing raw materials (rain, fertilizer) to sites of production.

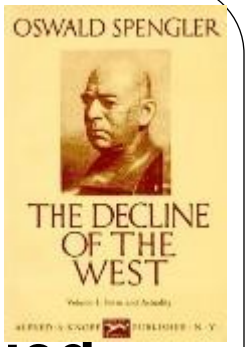






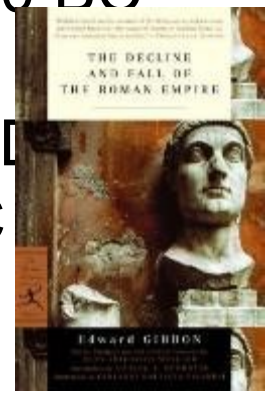


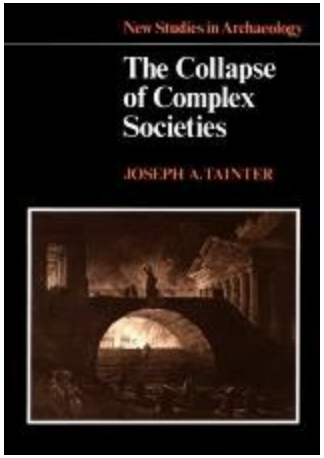




Growth and decay of civilizations has been well studied

Babylonian (Mesopotamian): 3200 – 2200 BC
Egyptian: 2900BC-1680 BC
Mexican (Mayan-Aztec): 160 AD – 960 AD
Classical (Apollinian): 1100 BC – 300 BC
Western: 900 AD – 1800 AD





Typical pattern is deforestation, erosion, flooding, siltation, saltation

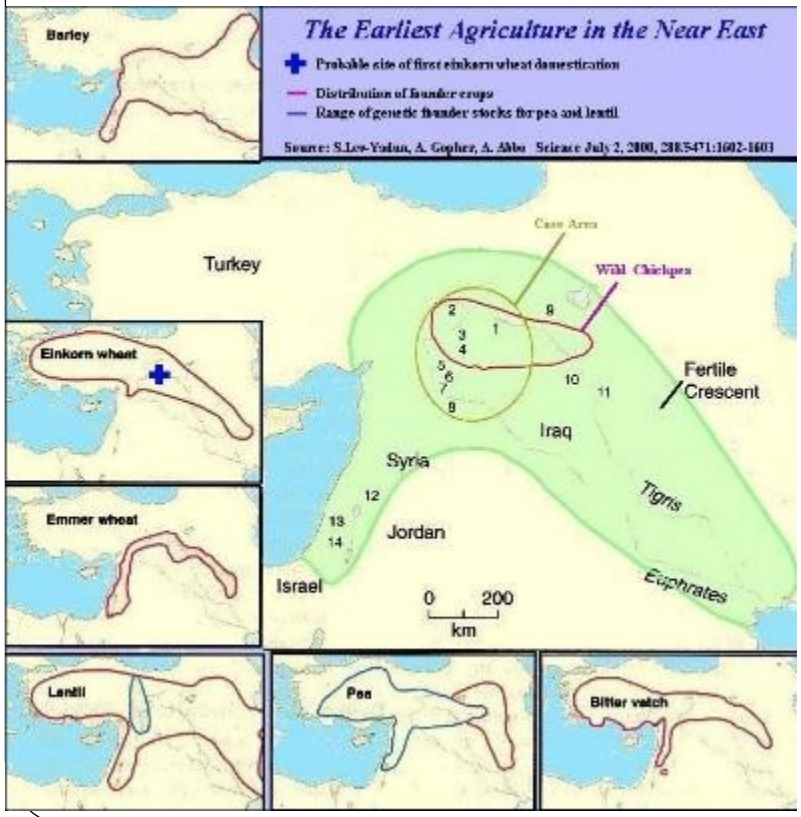
→ soil degradation leads to declining agricultural productivity

All systems show signs of complex growth and **DECAY**

Babylonian (Mesopotamian): 3200 – 2200 BC
Cities, monumental architecture, wide use of metals, writing.

"Within 1000 of emergence of settled communities, villages were abandoned as soil erosion caused by deforestation resulted in badly damaged landscape, declining crop yields and eventually inability to grow enough food" (p. 43).

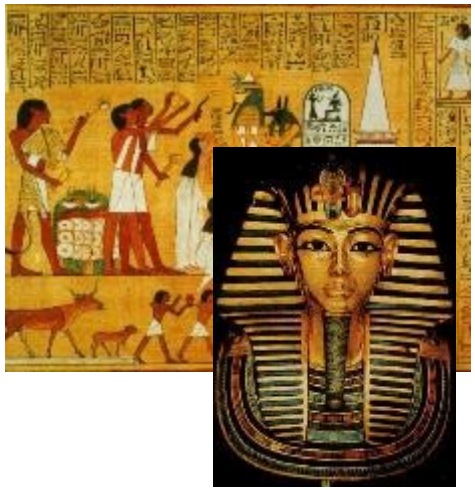
By 1700 BC no wheat could be grown in Southern Mesopotamia,

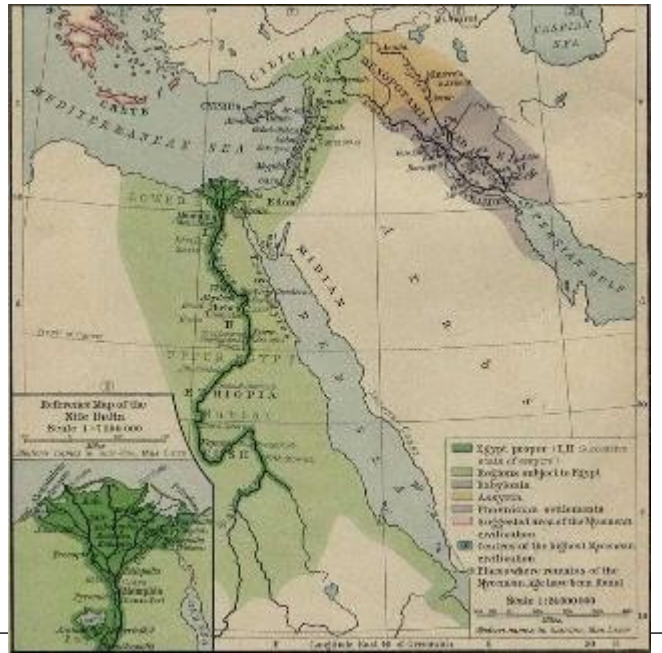


Egyptian: 2900BC-1680 BC

The Nile provided a dependable source of irrigation. Annual flood brought deposits of alluvial silt as natural fertilizer and washed away accumulated salts.

Rulers were given power to control the natural rhythms. Mythically sustained equilibrium boosted by a worldview that affirmed sacred values of nature.

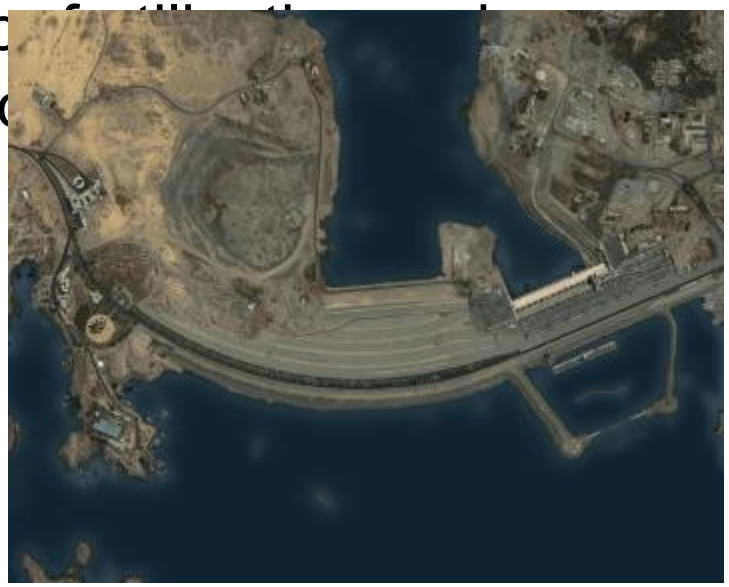




Egypt is the classical model of natural sustainability. It existed autonomously for over 2000 years likely its stability was attributable to the sustainability of its ecological relationships.

Nevertheless, they deforested, overgrazed and destroyed animal habitat.

The balanced approach was continued until the introduction of Western practices fo
irrigation in the 19th century, then c
Aswan Dam in 1970s.

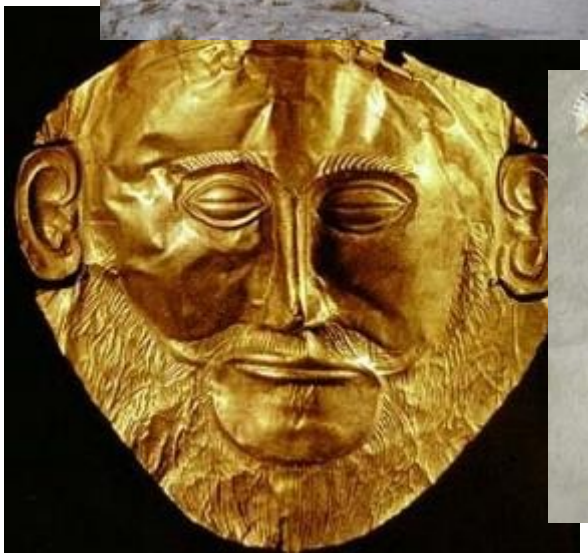


Mexican (Mayan-Aztec): 160 AD – 960 AD

Abundant rainfall, thin soils. Slash and burn agriculture (for maize).
Best soils in lowlands but expanded to slopes eventually utilizing 75% of environment cleared. Agriculture became more intensive and extensive.

Deforestation for fuel, construction, and plaster, affected water cycle.
Extended drought years brought ruin.

Classical (Apollonian): 1100 BC – 300 BC
Soil degradation, deforestation, loss of species, decline of agriculture
The ancients were unable to adapt their economies to the environment in harmonious ways.



Western Europe: 900 AD – 1800 AD

Regrouping after collapse of Roman Empire: fertile land (plow), indented coastline, abundant navigable rivers, abundant iron and other metals, abundant timber.

Nature was seen successively as eschatological, adversarial, collaborative, and recreational.

It was to be conquered and tamed – fairy tales theme of scary wild places

Western Europe: 900 AD – 1800 AD

By 1300 the population had reached 80 million and most of the medieval forest was cleared.

Through agriculture and fire the Europeans had modeled their landscape, especially it plant cover. Reworking a shade tolerant high forest into a sun-fleshed low forest full of shrubs, grasses, forbs.

Royal hunting reserves were being establis

The ecological limits of the agricultural econ
were evident the pressure alleviated throug
famine, and war. Many forests recovered b
economy not until age of exploration and th
harnessing of additional "solar" resources, p
already concentrated in slaves, gold, and goods

Long-term dynamics of socio-ecological systems

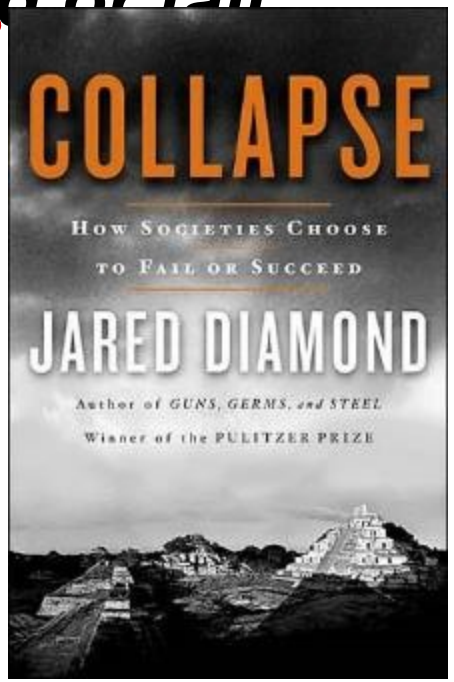
Collapse:

How societies choose to succeed or fail

(Diamond, 2005)

1) Deforestation and habitat destruction
2) Soil problems (erosion, salinization, fertility
3) Water management problems
4) Overhunting
5) Overfishing
6) Introduced species
7) Human population growth
8) Increased per capita impact
9) Human induced climate change
10) Build up of toxic chemicals
11) Energy shortages
12) Full human utilization of earth's photosynthetic capacity

Related to how we use Ecosystem Services

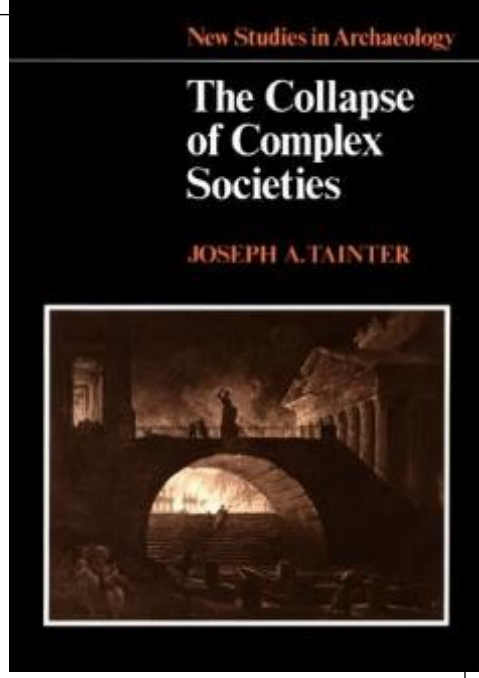


Cycles of civilizations

- “Clearing the past away has allowed the future to grow anew… The aim of wiping out the past has been to allow a superior dispensation to takes its place.”

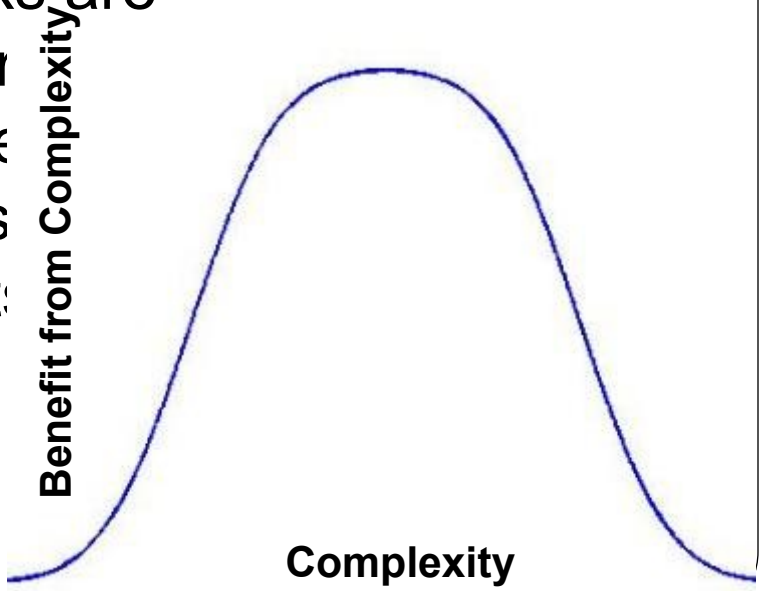
  Kriwaczek, Paul. *Babylon: Mesopotamia and the birth of civilization*. 2010. Thomas Dunne Books.

Collapse of Complex Societies (Tainter 1988)



Complexification is limited as a problem solving strategy.

> "More complex societies are more costly to maintain than simpler ones… as societies increase in complexity, more networks are created among individuals, more hier controls are created to regulate these networks, more information is proces increasing need to support specialist not directly involved in resource production, and the like"
> (Tainter 1988, p. 91).



Similarity between Ecological and Society's stages:
→structural → network → information G&D.

Tainter continues,
"All this complexity is dependent upon energy flow at a scale vastly greater than that characterizing small groups of self-sufficient foragers or agriculturalist. The result is that as a society evolves toward greater complexity, the support cost levied on each individual will also rise, so that the population as a whole must allocate increasing portions of its energy budget to maintain organizational institutions."

We rely on a greater allocation of this energy to maintain the complex structures created.

System grows in complexity,
this provides benefit to the system for achieving its goals

More complex systems require more investment to maintain themselves

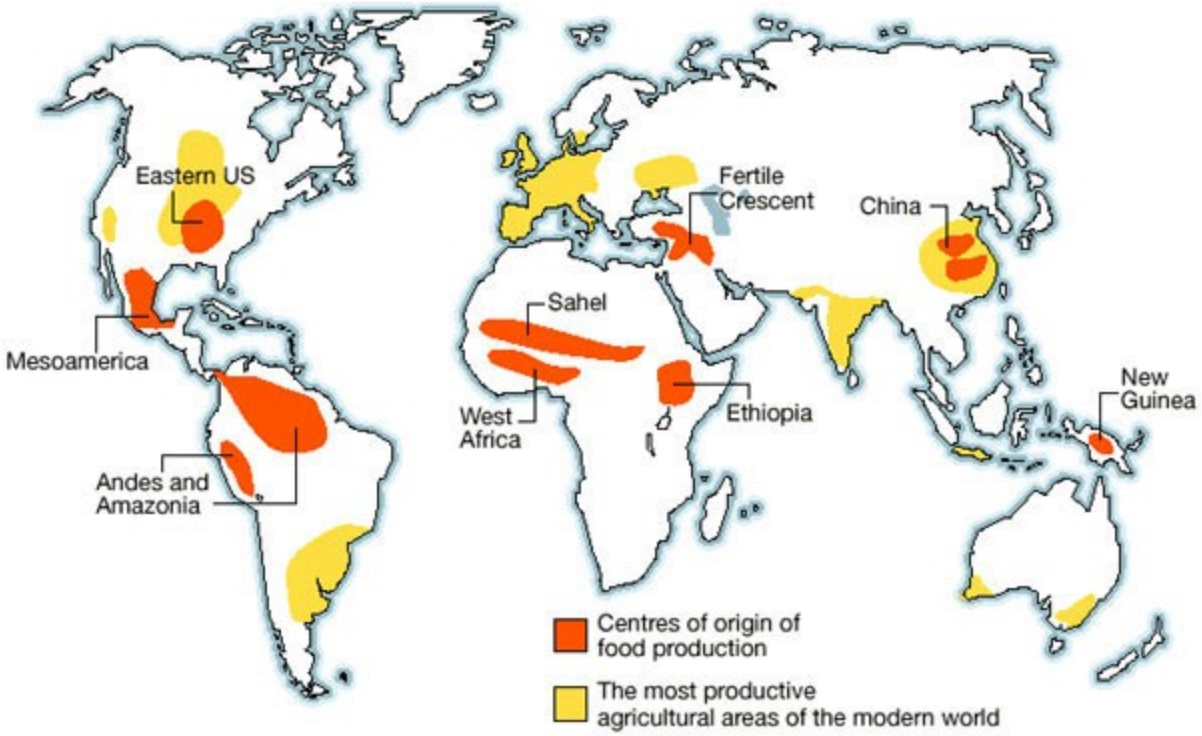
These costs get too high

Adding more complexity has less and less benefit, eventually it becomes detrimental

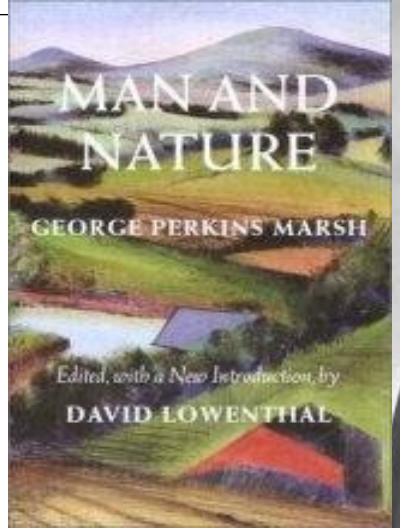
Collapse = decomplexifying is the best alternative

The “appropriate response of the system”, not a

Long term impact of agriculture on agriculture



George Perkins Marsh



- Wrote *Man and Nature* in 1864.
- "A certain measure of transformation of terrestrial surface, of suppression of natural, and stimulation of artificially modified productivity becomes necessary. This measure man has unfortunately exceeded."
- "Before Marsh no one had assessed the cumulative effect of all axes and hoes. For him the conclusion was inescapable. Man depends upon soil, water plants and animals. But in obtaining them he unwittingly destroys the supporting fabric of nature" (p.56)

What ideas helped shape these destructive socio-ecological relations?

Christian worldview adopted in Rome in 313 AD
Biblical attitude of human dominion over the natural
End times and earthly existence temporary
Static nature of nature – God's rationally designed creation
Geocentric model of the universe
Application of providential thinking to economic progress
Belief that economic growth was unlimited and necessary

These ideas all framed the way humans interacted with nature.

Progressive ideology

Increased knowledge and technology generally contribute to an increase in human well-being.

Manifest Destiny – Christian imperative to tame and control the natural world

American Progress by John Gast, circa 1872

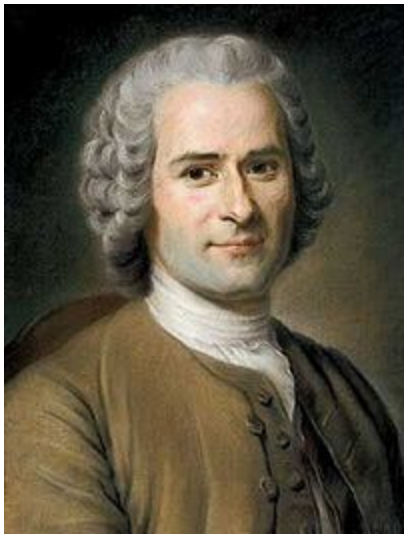
Assumption that insatiable appetites, formerly condemned as a source of social instability and personal unhappiness, could drive the economic machine.

Pre-modern vices were henceforth transformed into the economic virtues that would turn the wheels of modern society

'The Seven Deadly Sins' by Hieronymus

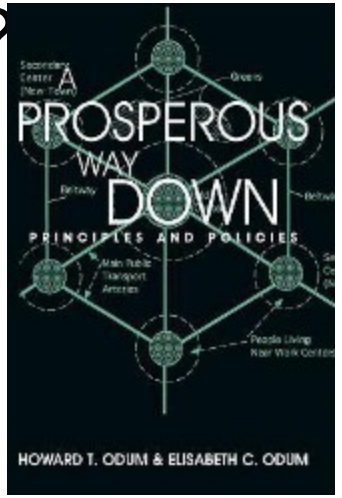
Rousseau was one of the first to attack this idea

Basic human needs: food, shelter, sex. "All other human wants are not essential to happiness, but arise out of man's ability to compare himself to his neighbors and feel himself deprived if he does not have what they have. The wants created by modern consumerism arise from man's vanity" (Fukuyama, p.196).



What are the consequences of this decomplexifying?

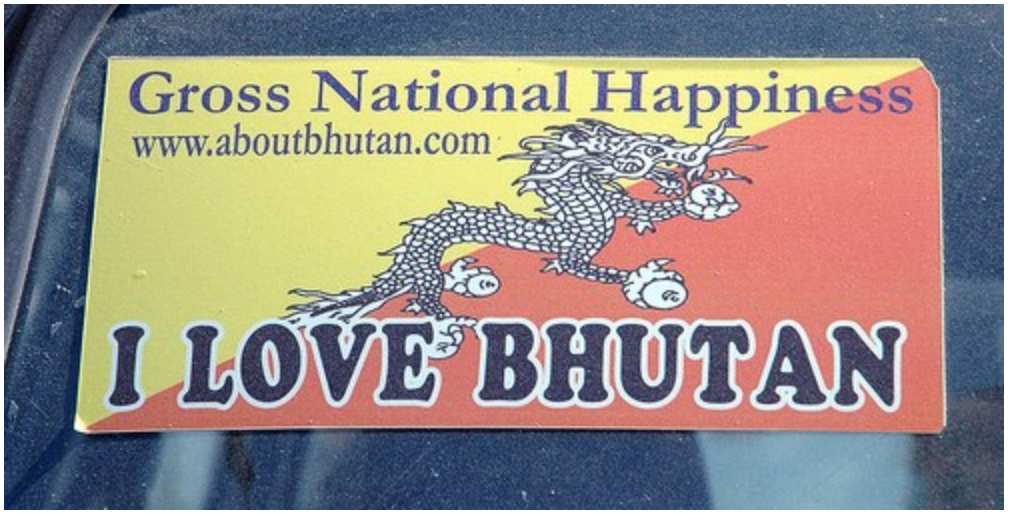
Can we maintain livability and well-being? Prosperity?

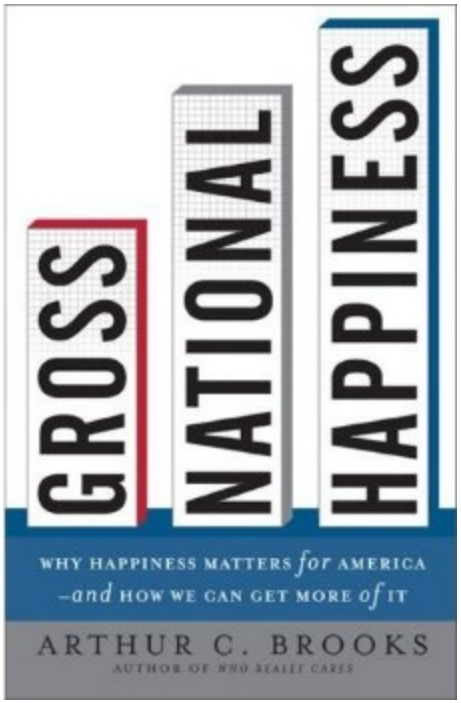


One way is to reprioritize goals away from material growth,

At a national, family, and individual scale;

www.factor10-institute.org





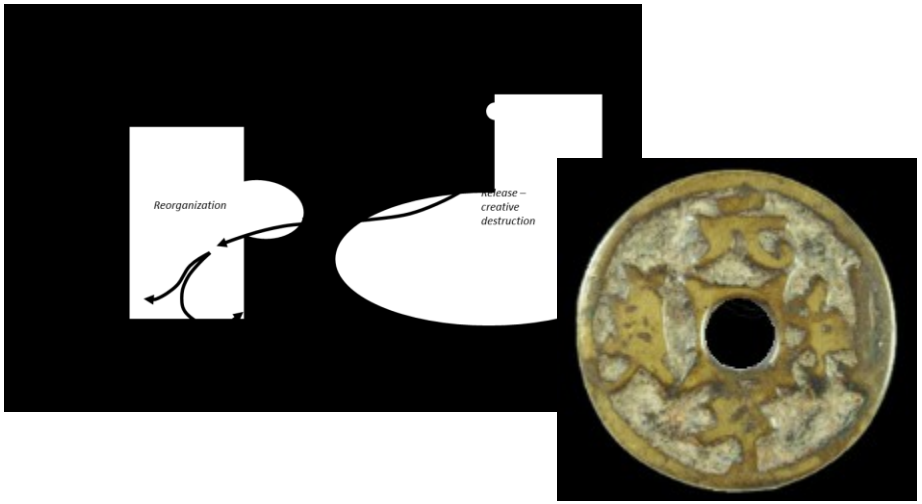
American Dream

Center for a New American Dream

vimeo.com/26573848

I CHING – 1st book in Chinese literature ~1000 BCE

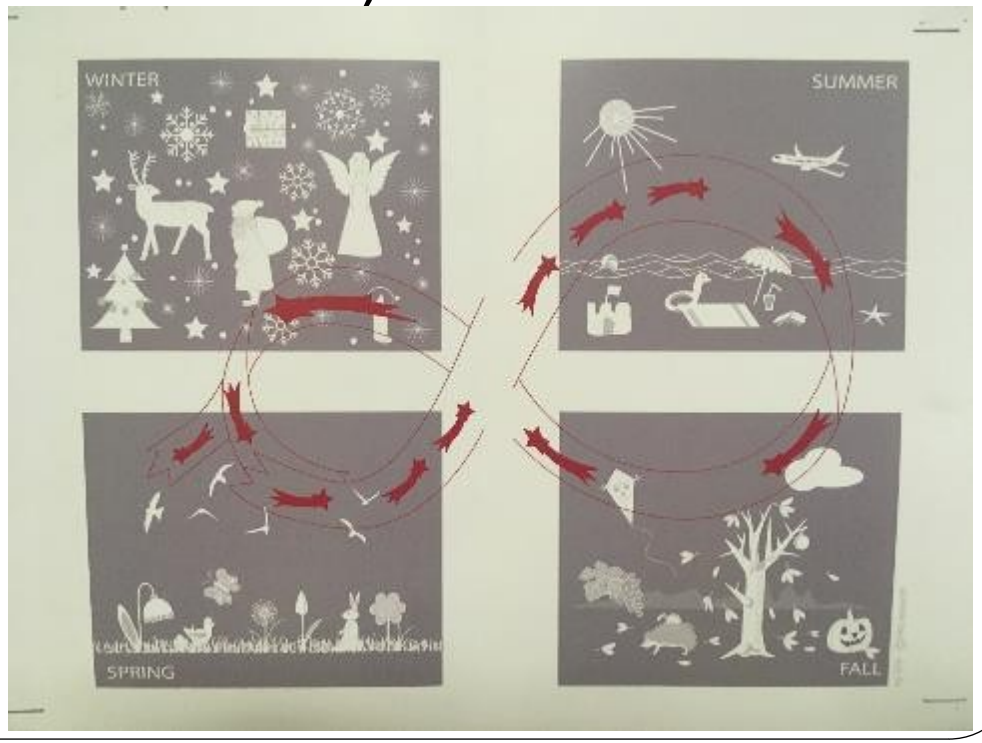
- 元亨利貞 “yuan – heng – li – zhen”; translates as
- To begin – to expand rapidly – to turn to good account – to remain solid
- Each term takes over from the previous… there is no subject



The charm bears the four characters that open the *I Ching*: "Yuan Heng Li Zhen." www.mc.maricopa.edu/~thoqh49081/engagement/History/pictures/i-ching-charm.html

Example of seasons

- Spring – beginning
- Summer – expansion
- Autumn – harvest
- Winter – rectitude (until renewal)



It is not about giving up what we have but getting on a new path (drawn to a new state through reinforcing positive feedbacks).

focusing on quality, culture, social interactions, creativity…

How to build a eco-centric worldvie

Thank you for your Attention!