Wind Crest Learners

Population and affluence

Climate Conversations

June 10 – July 8, 2021

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Slides to be posted

http://portfolio.du.edu/OurClimate

Scroll down to bottom of the right-hand column.
You will find the slides posted there under
Climate Conversations for each class.

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Ask questions of me at JFOrmes@gmail.com

Population

Hominids first appeared in the Neogene Period, about 3.5 M years ago.

Identifiable cultures started about 11,000 years ago.

Affluence

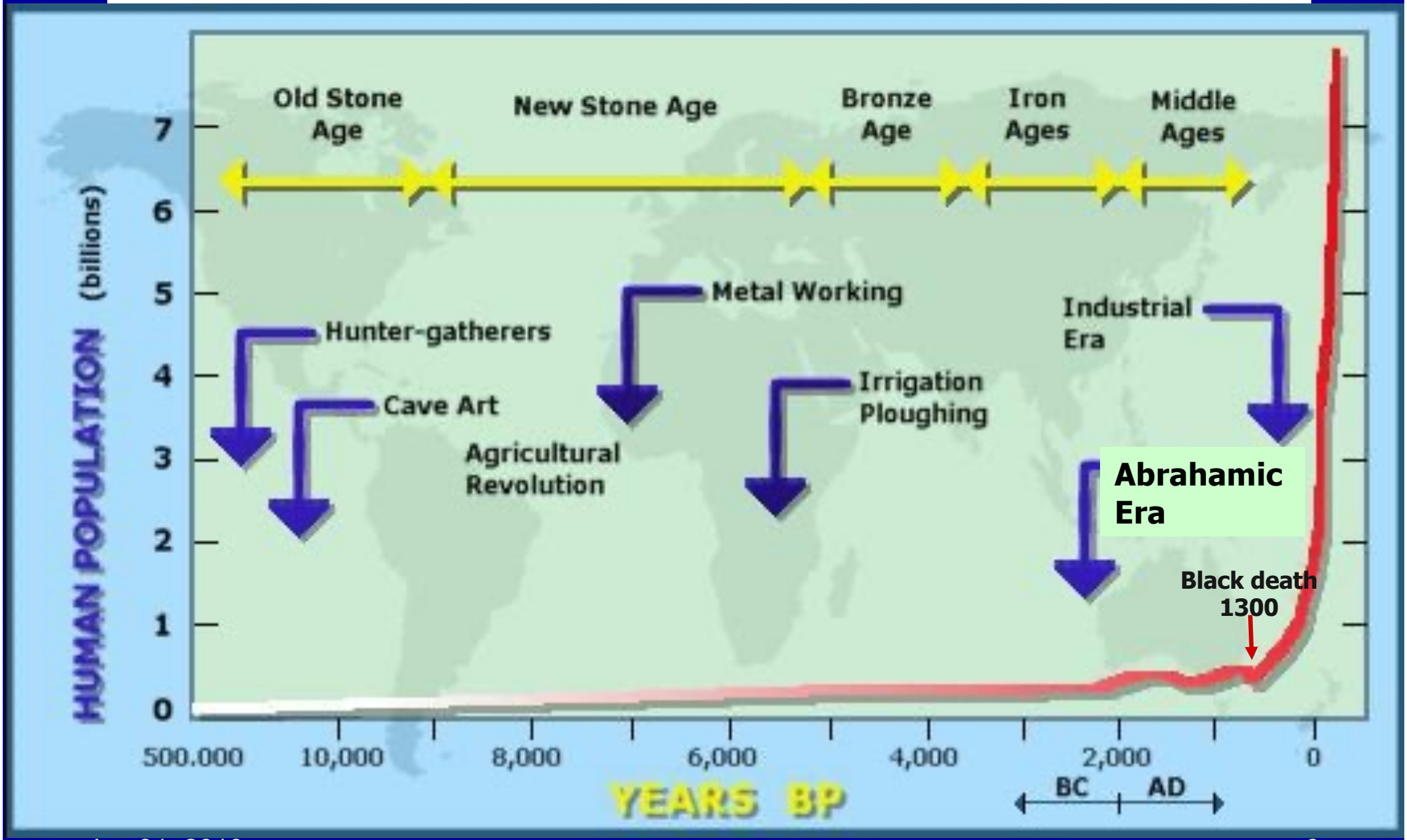
- Per capita consumption of goods and services
- Represented by GDP per capita
- Equivalently energy consumption per capita

The good life! Cars, travel, restaurant food, fresh fruit from far, far away, ….

What we're going to discuss today

- Population history and projections
  - Why 11 billion (or close to it) is baked in
- Affluence
- Global Carrying Capacity

World Population Growth Through History

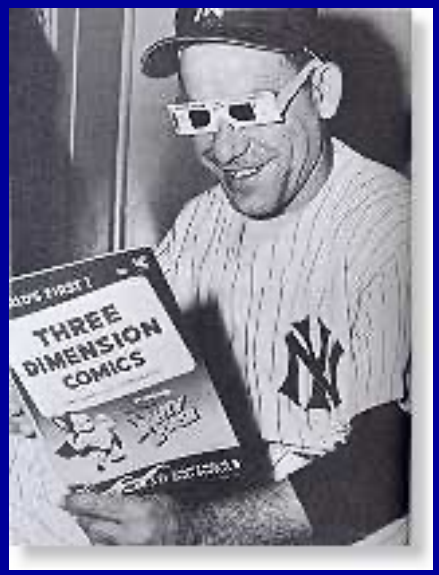


- “It’s hard to make predictions, especially about the future.”

Lawrence Peter "Yogi" Berra

How long will it take for my investment to double?
Use Rule of 70

$$\frac{70}{\text{Annual interest rate}} = \text{\# years for investment to double}$$



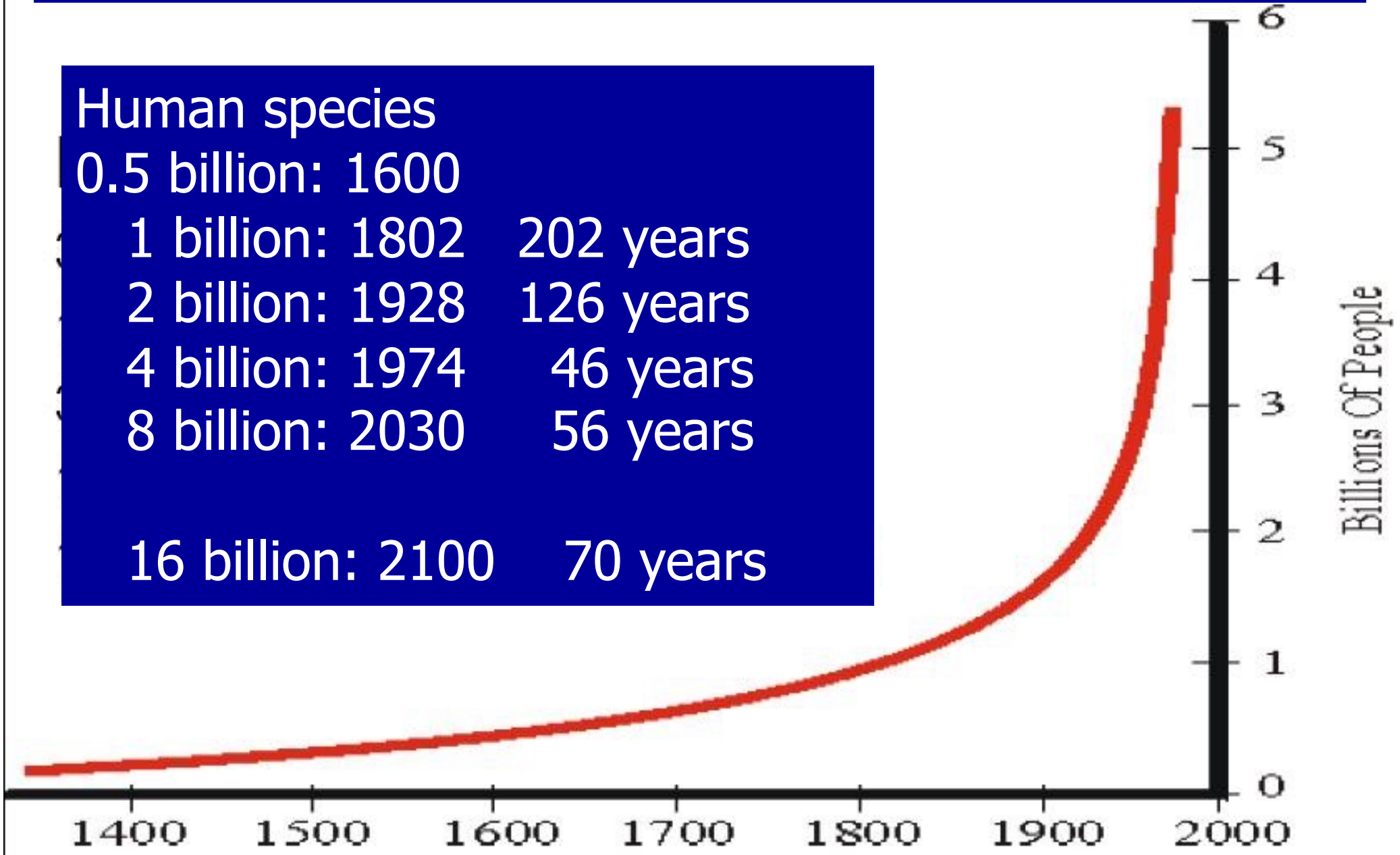
Works for population growth, too.

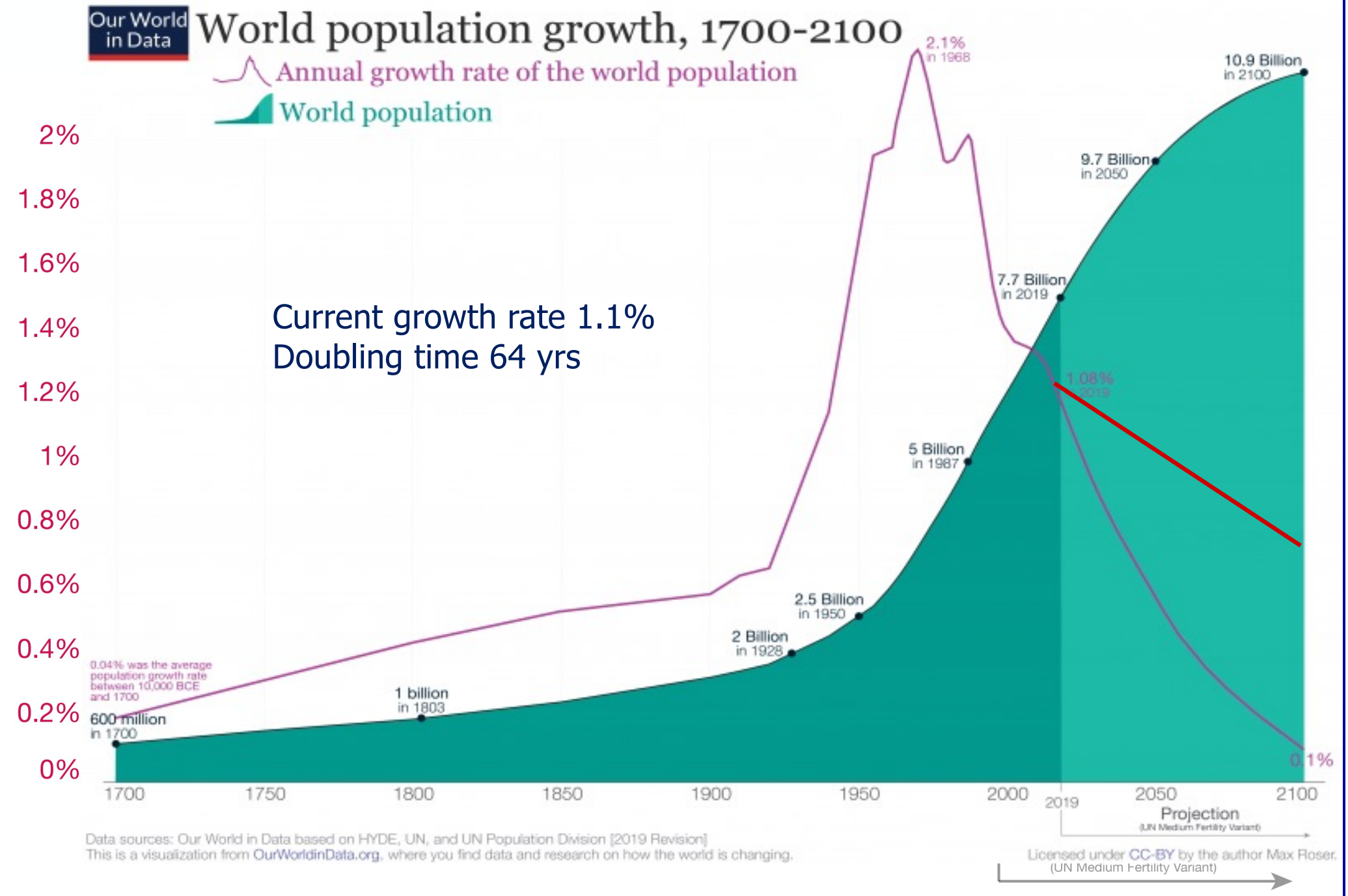
$$\frac{70}{\text{1\% Annual growth rate}} = \text{70 years for population to double}$$

20th Century growth rate was "super exponential" until inflection point circa 1980

Human species

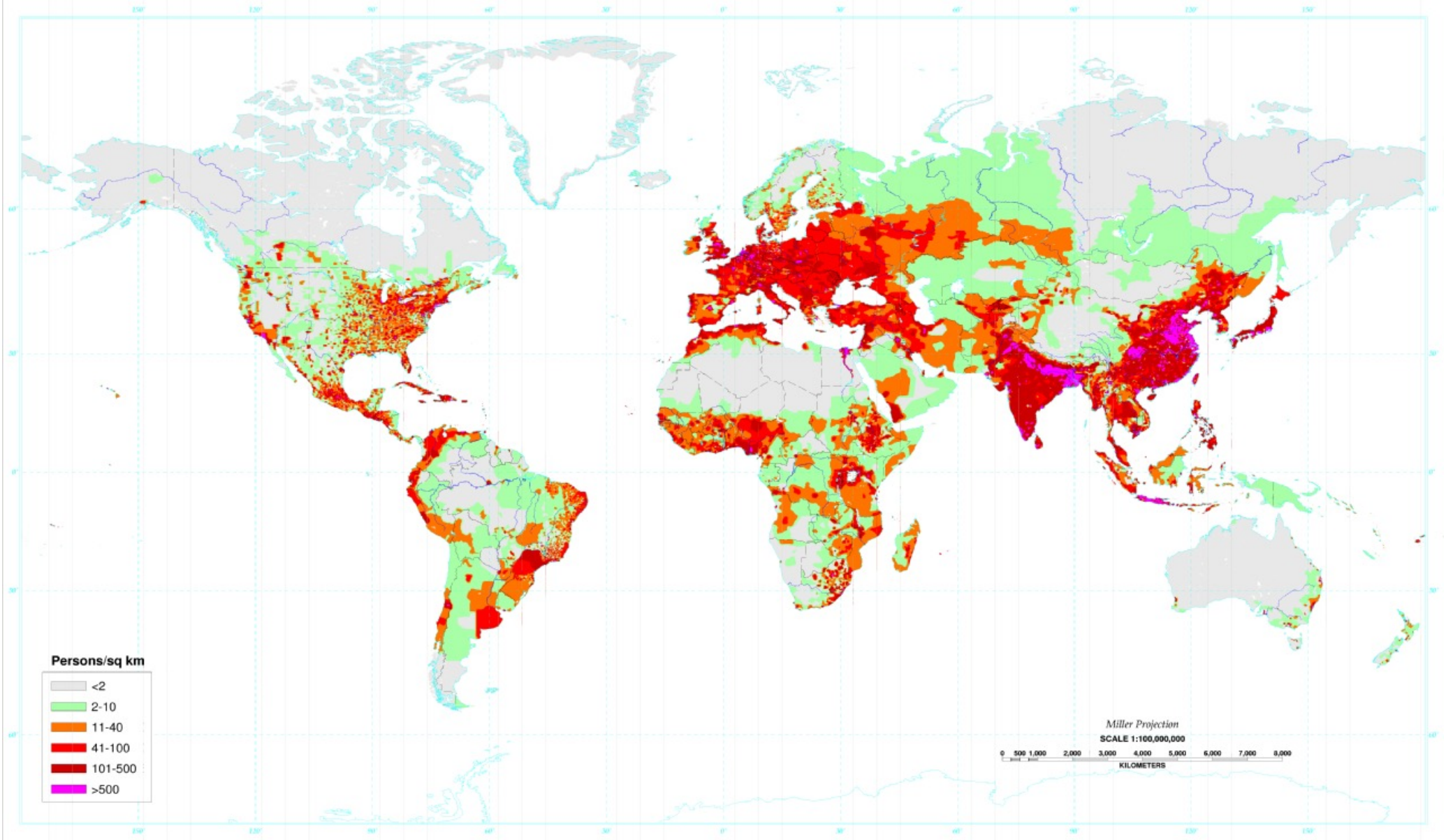
0.5 billion:	1600	
1 billion:	1802	202 years
2 billion:	1928	126 years
4 billion:	1974	46 years
8 billion:	2030	56 years
16 billion:	2100	70 years



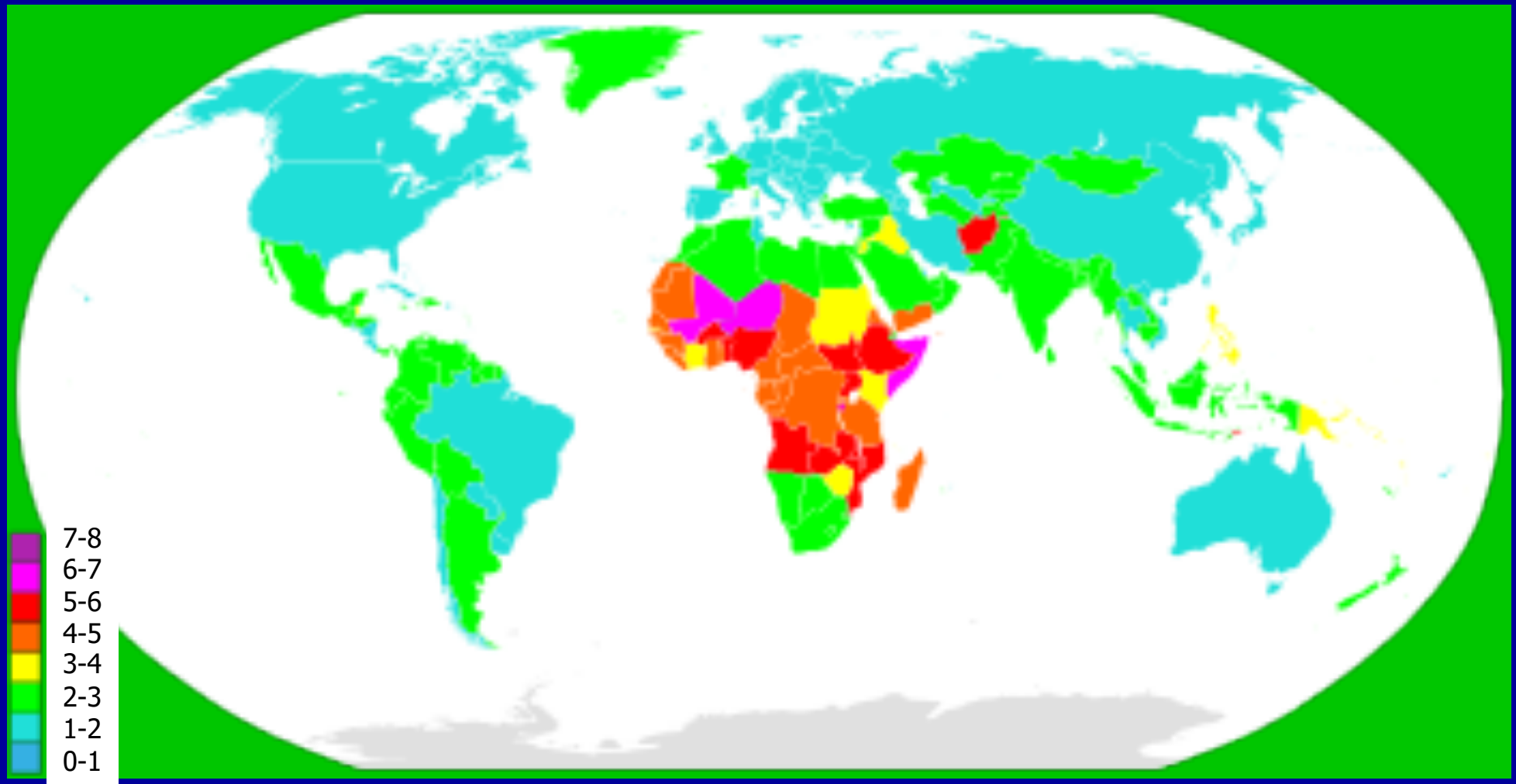


Data sources: Up to 2015 OurWorldInData series based on UN and HYDE. Projections for 2015 to 2100: UN Population Division (2015) – Medium Variant.
The data visualization is taken from OurWorldinData.org. There you find the raw data and more visualizations on this topic.

Population density



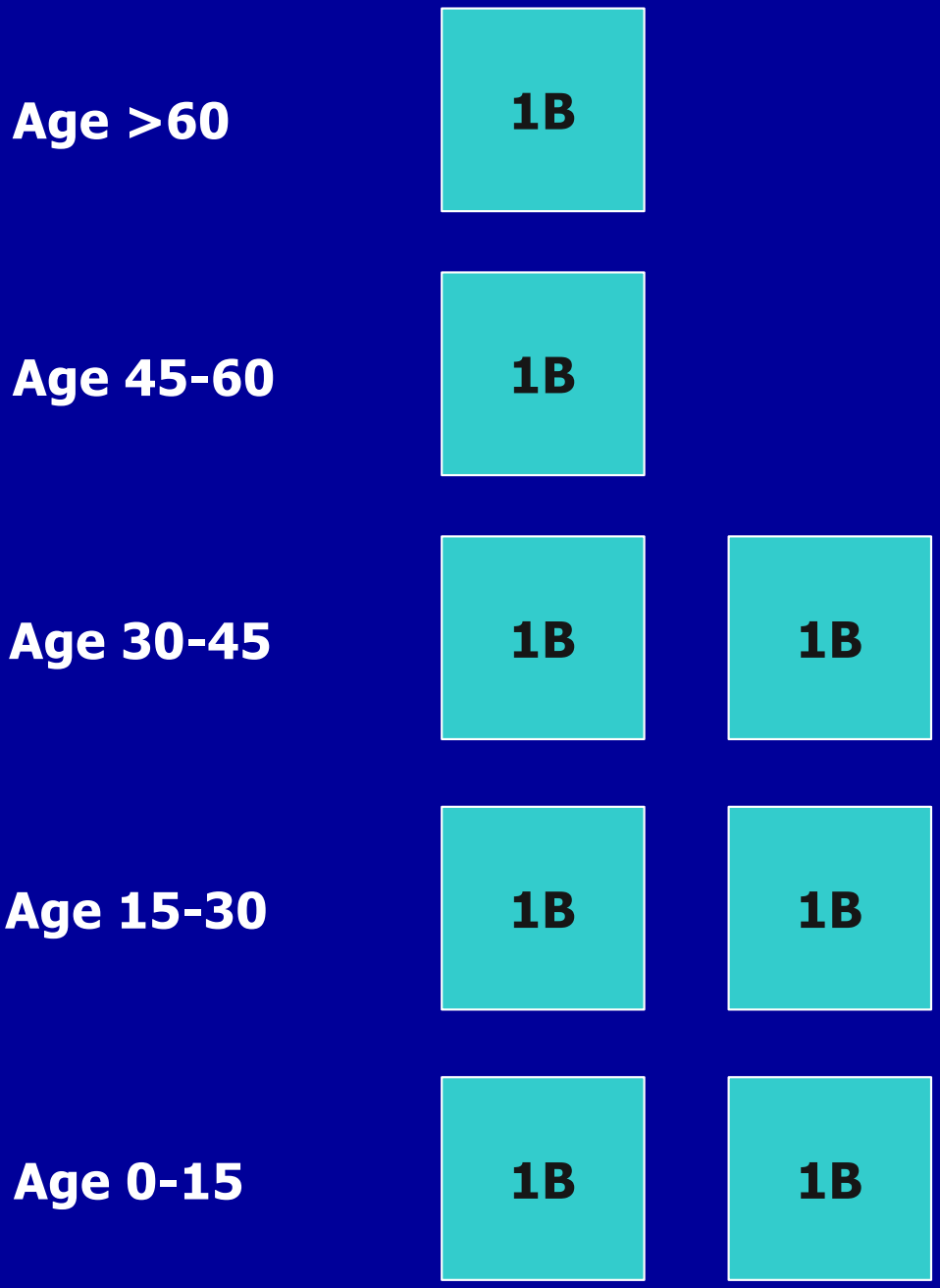
Population growth rate



Scale: children per mother

20th century growth was superexponential

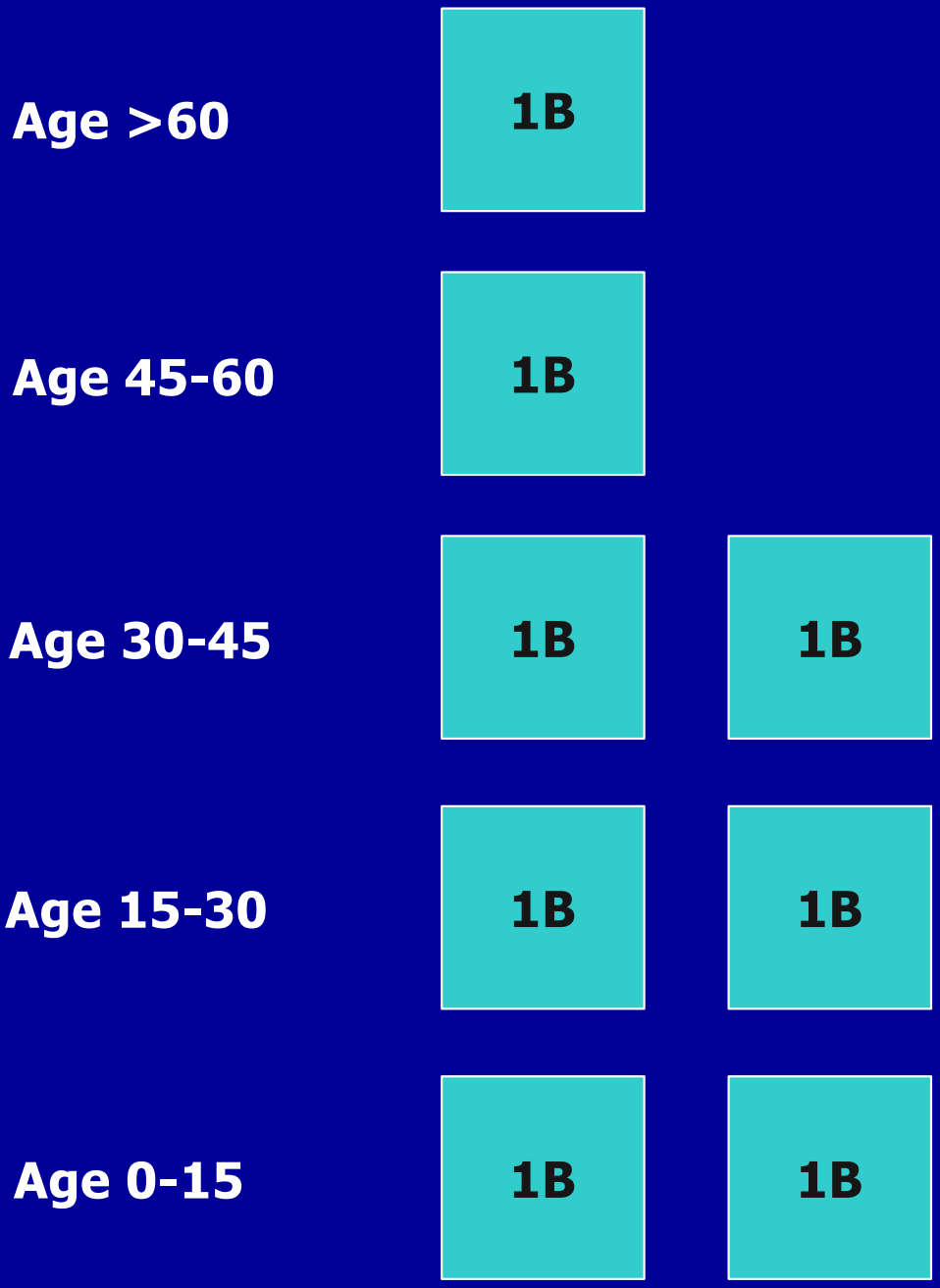
Consequences:
There were lots of young people and fewer old people.
And it will take a generation to stabilize even at no increase in growth rate.



Approximate age distribution now

Approximately 8 B souls; each box represents 1 B people

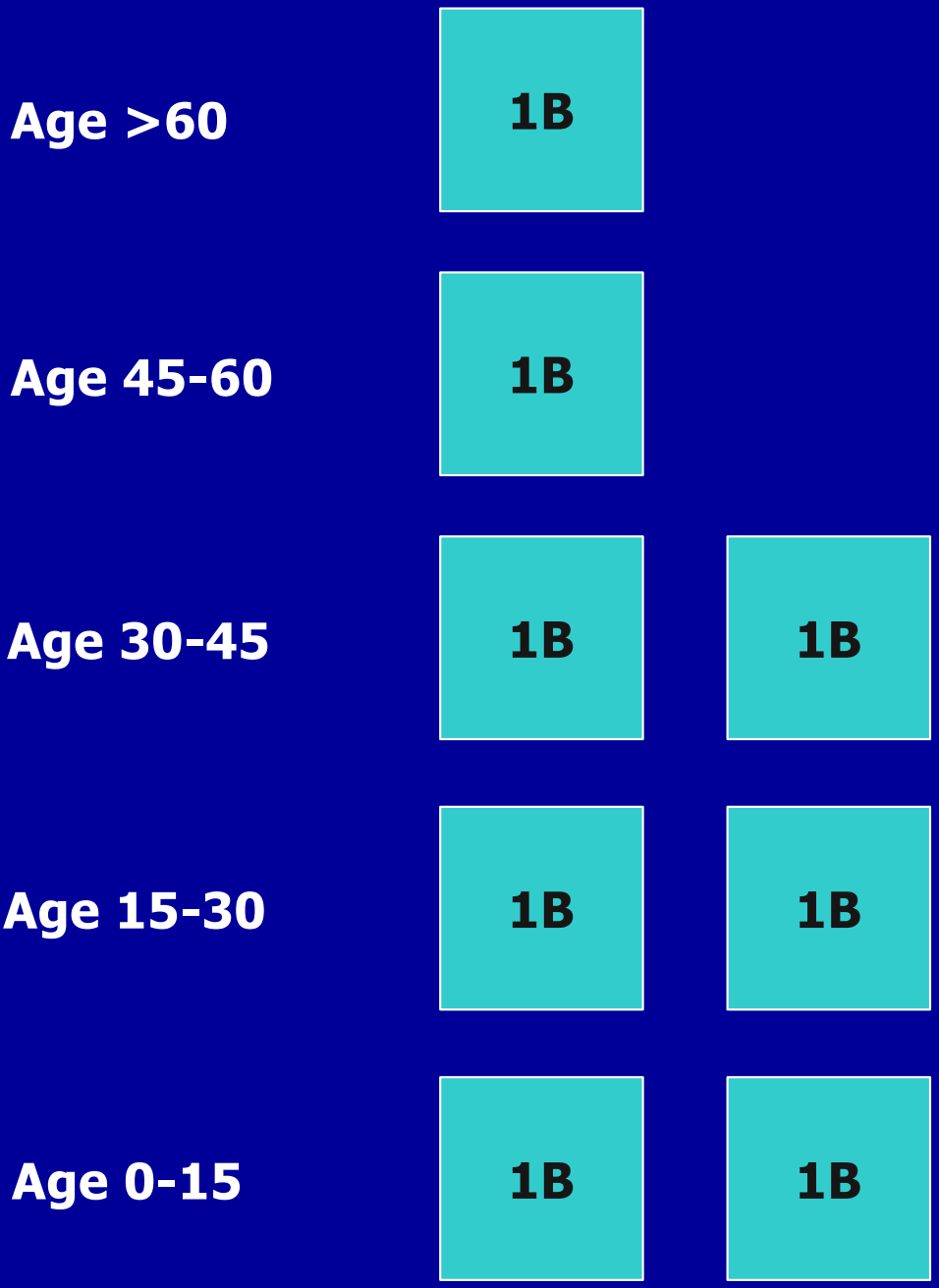
Credit for this demonstration goes to Hans Rosling, a Prof. of International Health at Karolinska Institute of Sweden.



Approximate age distribution now

Approximately 8 B souls; each box represents 1 B people

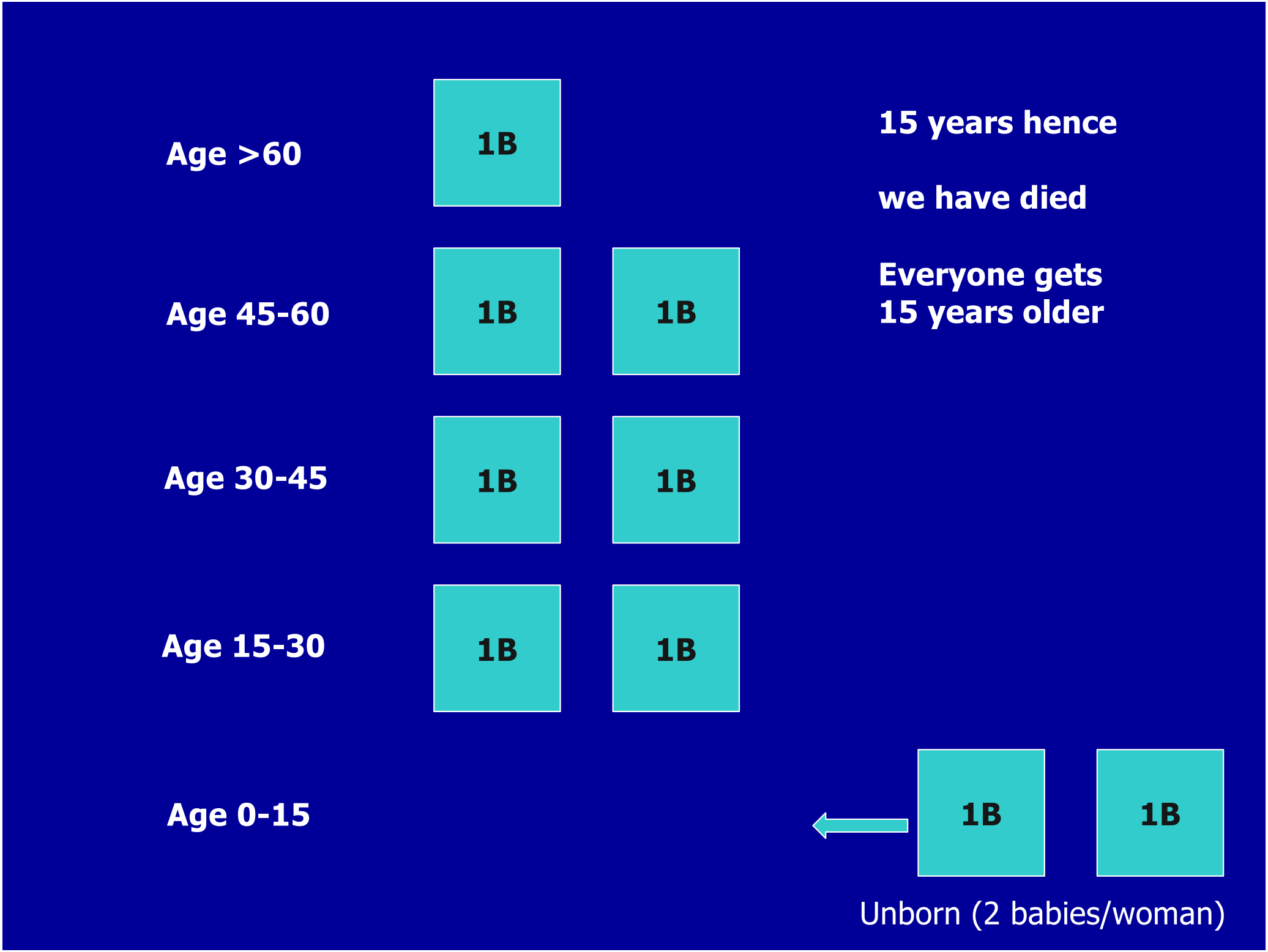
Lots of young people to take care of us older folks.

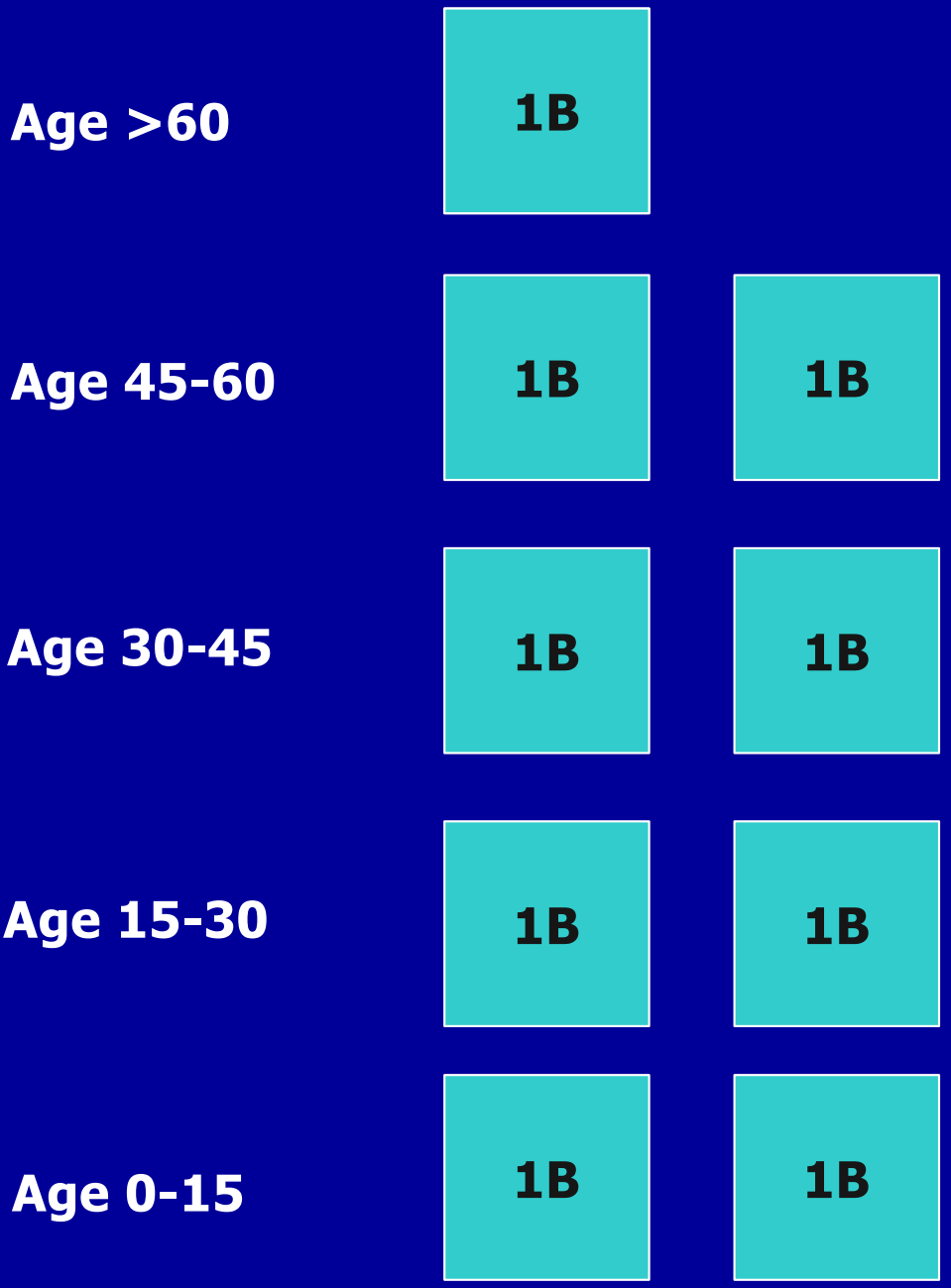


15 years hence

we die

Credit for this demonstration goes to Hans Rosling, a Prof. of International Health at Karolinska Institute of Sweden.


Age >60
1B
15 years hence
we have died
Age 45-60
1B
1B
Everyone gets
15 years older
Age 30-45
1B
1B
Age 15-30
1B
1B
Age 0-15
1B
1B
Unborn (2 babies/woman)



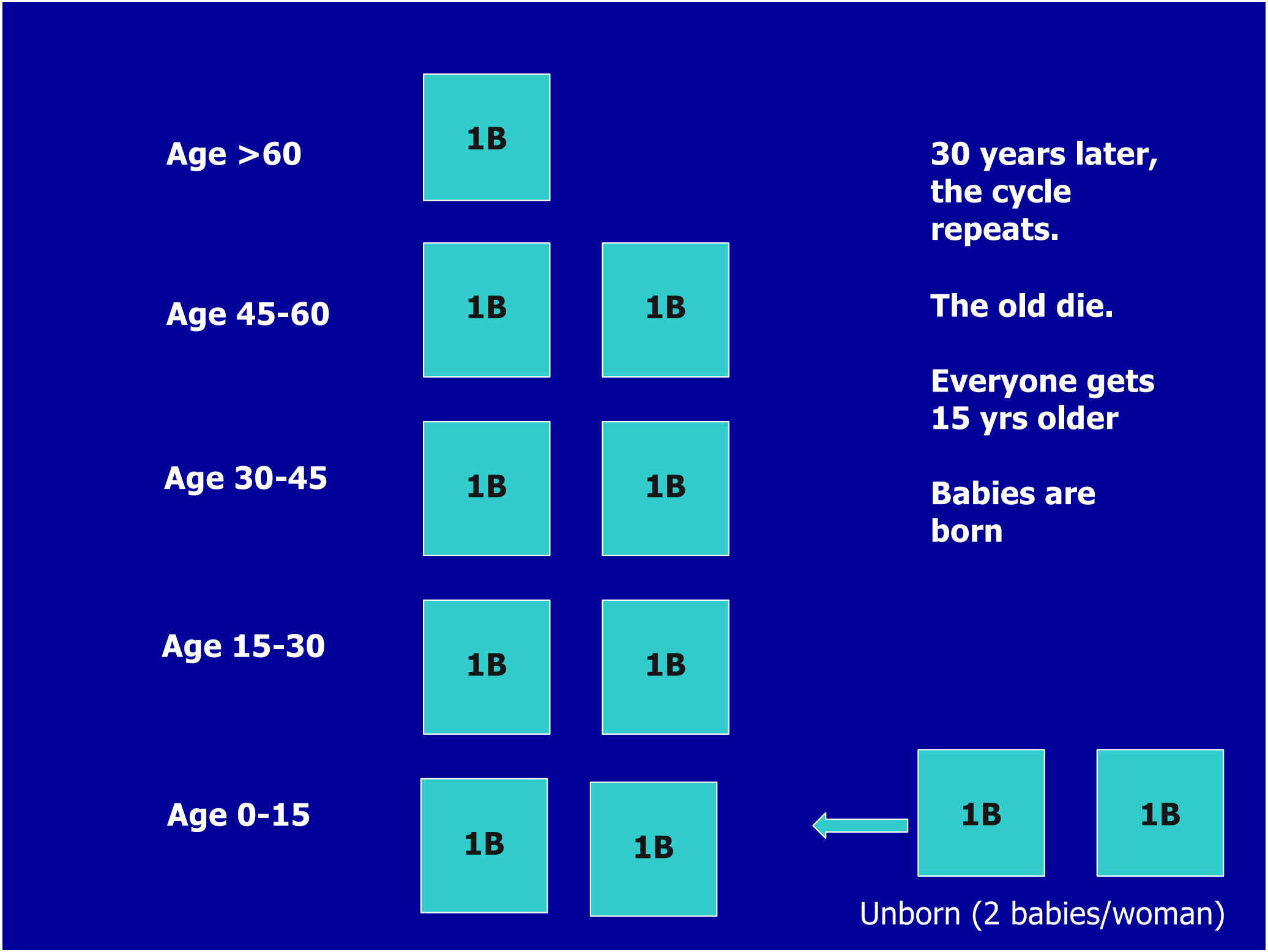
15 years hence

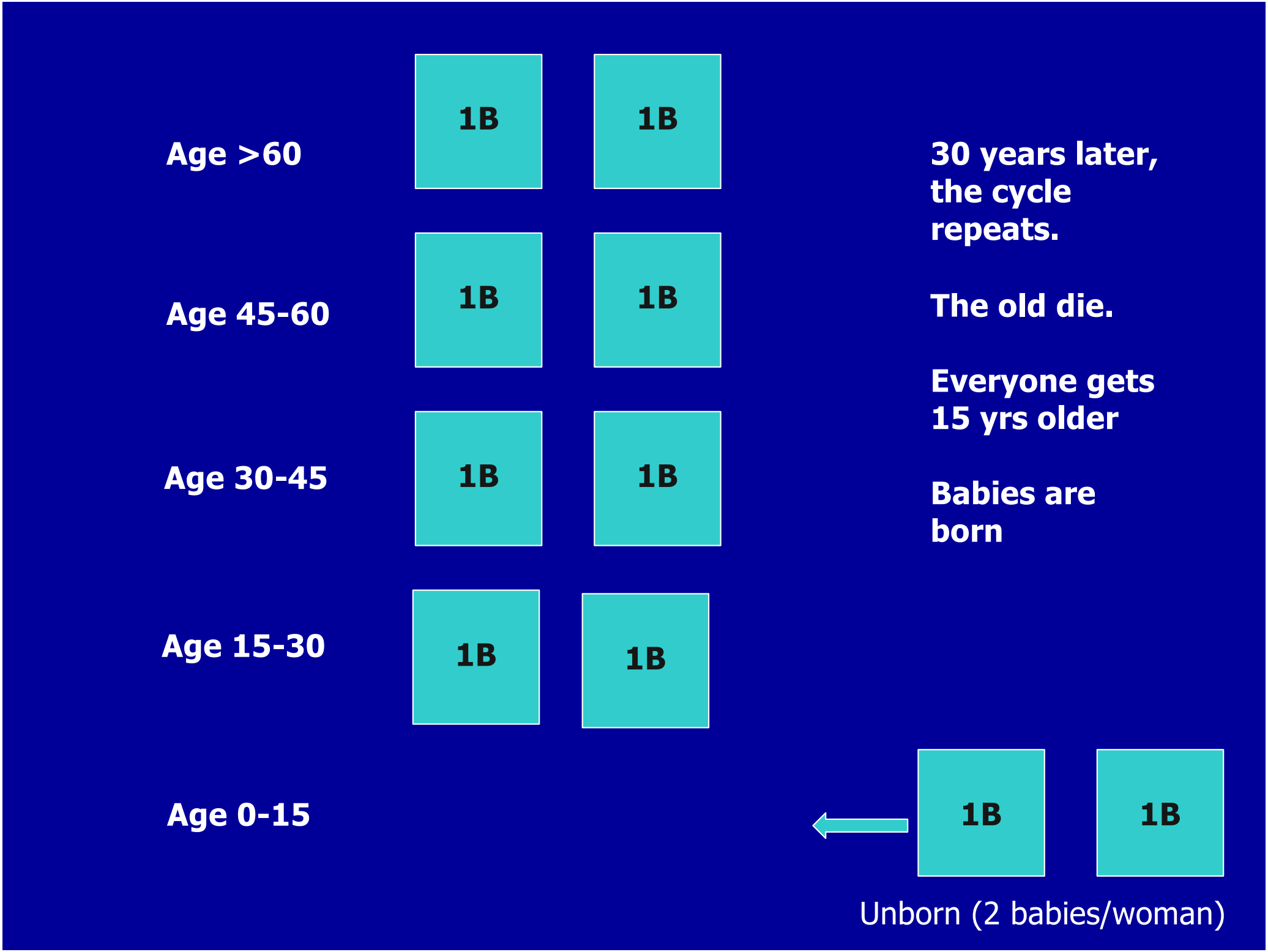
we have died

Everyone gets 15 years older

And 2B babies have been born

9 Billion


Age >60
1B
Age 45-60
1B
1B
Age 30-45
1B
1B
Age 15-30
1B
1B
Age 0-15
1B
1B
30 years later, the cycle repeats.
The old die.
Everyone gets 15 yrs older
Babies are born
1B
1B
Unborn (2 babies/woman)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Unborn (2 babies/woman)
30 years later, the cycle repeats.
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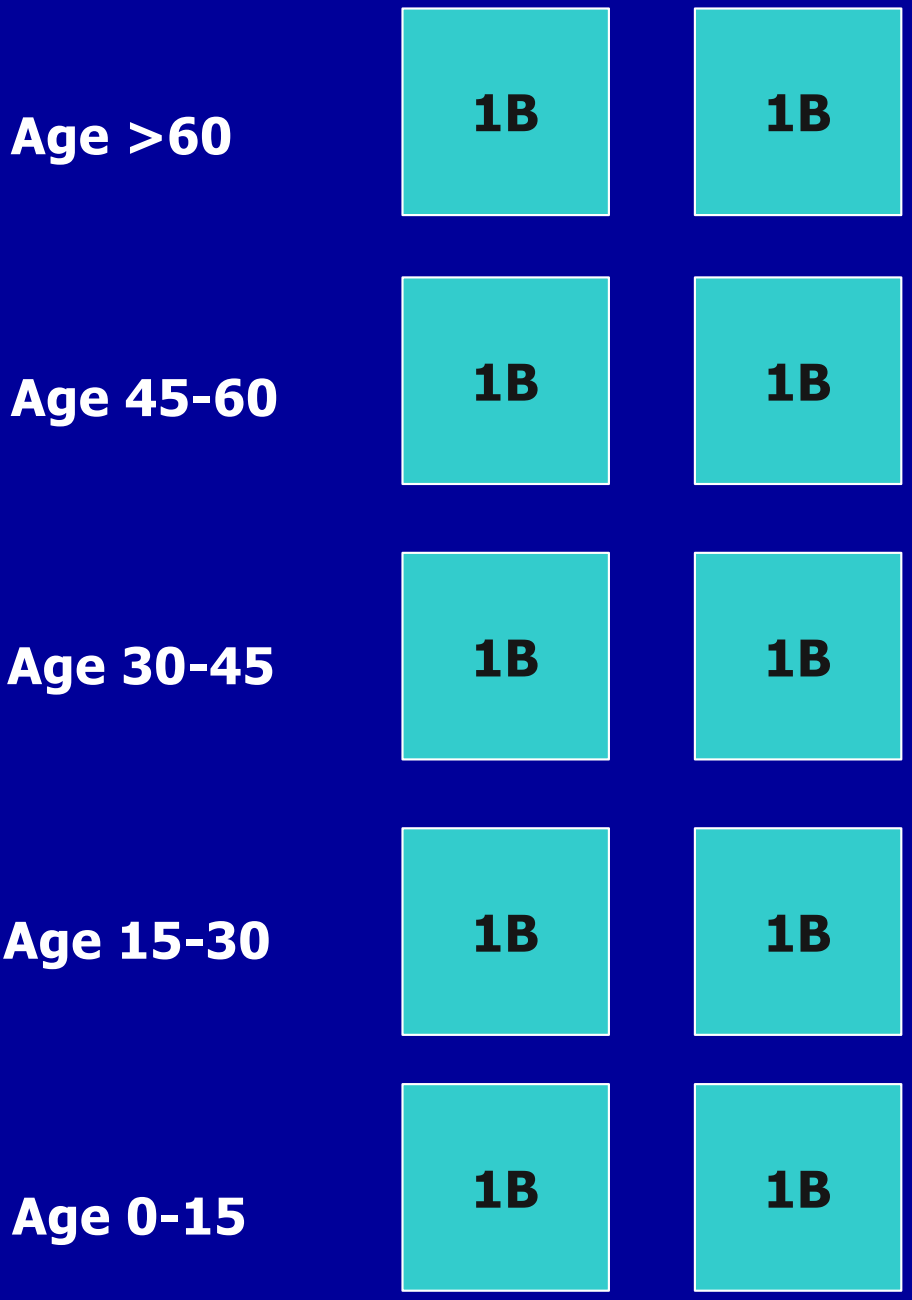


And 30 years later, the year is 2050

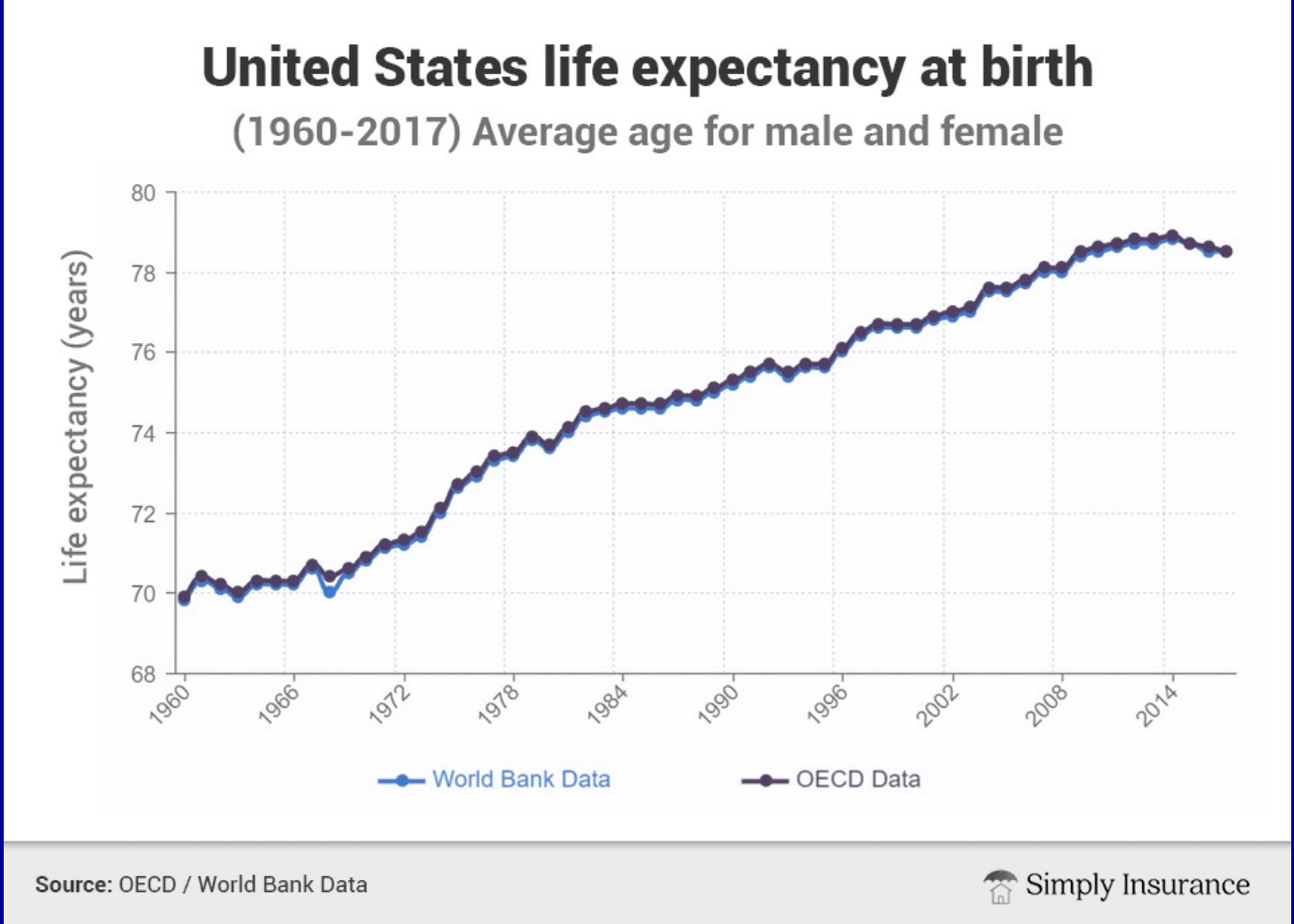
and the population is 10 B

This assumes 2 babies per woman worldwide.

1B

11 B by 2100

One more box is added because life expectancy is slowly increasing.



Population's future

- We will reach ~11 billion unless some catastrophe occurs
- Empower women to bring the poorest 2 B out of poverty, else growth will continue
- Assuming this happens, the age distribution will become more uniform and potentially stable
- Main issue is the carrying capacity of the Earth: How many can we water and feed?

Babies per woman decrease when

- Children survive
- Children not needed for work
- Women get education and join the workforce
- Family planning is accessible

Empower women

Credit Hans Rosling, TED talk 2012

Daily per capita consumption of energy (footprint)

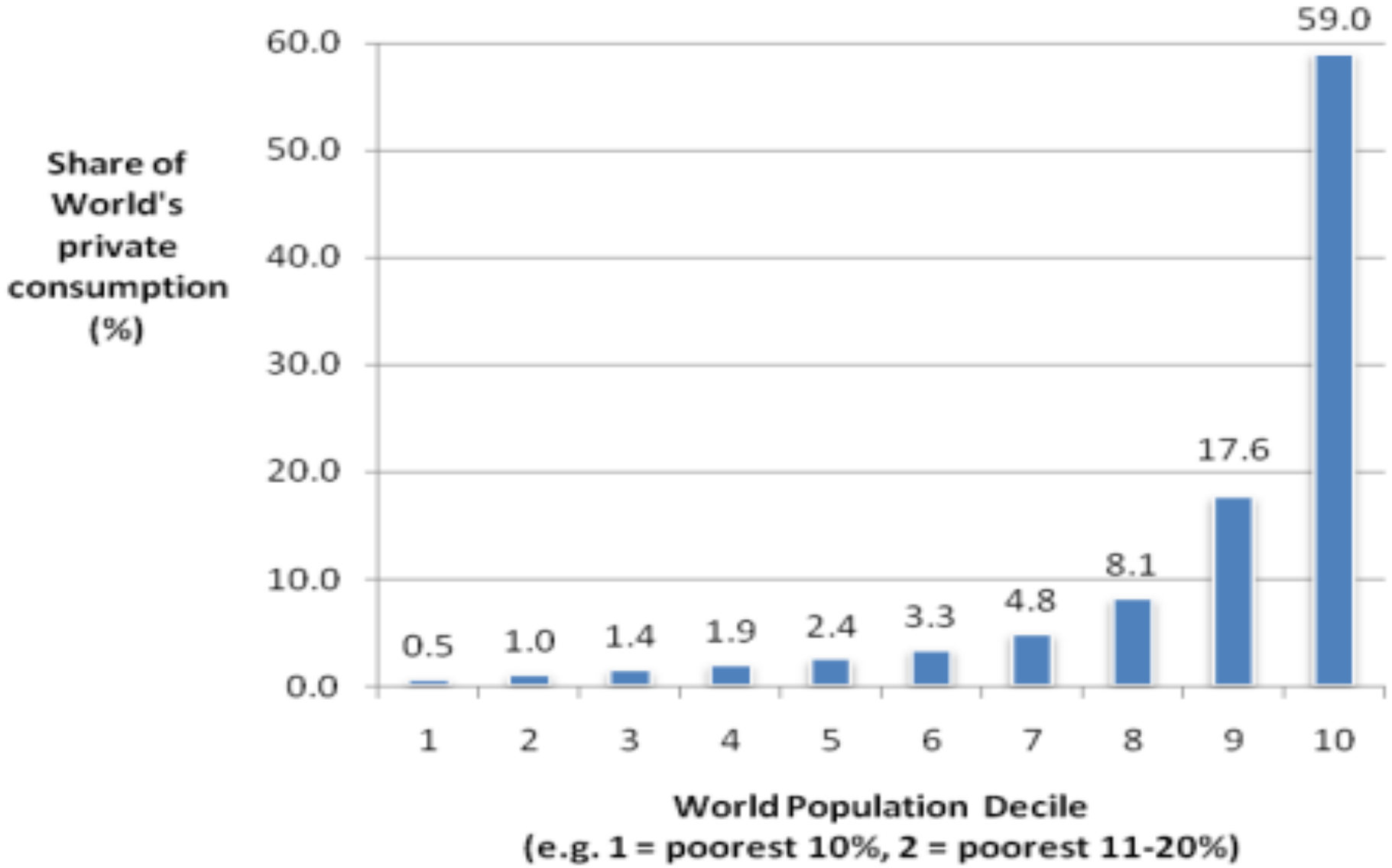
	Primitive society	Hunting society	Primitive agriculture	Advanced agriculture	Industrial society	Technological society
Food	2	2	4	6	7	10
Home and commerce		3	4	12	32	66
Agriculture and industry			4	7	24	91
Transportation				1	14	63
Total	**2**	**5**	**12**	**26**	**77**	**230**

Units: kWhr per person per day = 860 calories/person/day
2 in this chart = 1720 calories/day
Subsistence: 2000 calories/woman/day; 2500 calories/man/day
USA: 230 kWhr/person/day was in 2005; now about 270 kWhr/person/day

Global average now: 58 kWhr/person/day = 50,000 calories/person/day

Adapted from: E. Cook, "The Flow of Energy in an Industrial Society" Scientific American, 1971 p. 135.

Inequality of Consumption, 2005



Source: World Bank Development Indicators 2008

We use >100 x more energy per capita in the USA than the subsistence level.

Footprint: We found bigfoot and it is us.

We use >100 x more energy per capita in the USA than the subsistence level.

- Would it be possible for us to cut back?
  - Eat less red meat
  - Take fewer airplane trips
- Should we try to cut back?
- Is this moral?
- How does pressure to do this make you feel?
- Would you personally be willing to cut back if you thought humanity was at risk?

Do you agree with this statement?

"There is very good reason to believe that, in a generation or so, capitalism itself will no longer exist -- most obviously, as ecologists keep reminding us, because it's impossible to maintain an engine of perpetual growth forever on a finite planet."

David Graeber, Aug, 2011

Does Capitalism need Growth?

Is a zero-carbon climate compatible with growth?

Summary

There is a limit to how many people the planet can support.

Mother Nature will limit population

- How she does it might not be pretty
- Covid-19 has given us a peek into such a world

People require food: requires water and arable land

How many people can the planet support: aka "carrying capacity"

- Depends on lifestyle
  - Estimates vary from 2 to 40 billion
  - 2B if everyone on Earth lived like a middle-class American, consuming roughly
    - 100 times the subsistence level of food
    - 250 times the subsistence level of water
  - 40B if everyone on the planet consumed only what he or she needed to stay alive
- Can technology save us from Malthus?

Arable land is a finite resource

Global scale problem predicted within 70 years

UN Intergovernmental Technical Panel on Soils (ITPS like IPCC)

Threats

- Nutrient depletion
- Salinization
- Erosion
- Urbanization and suburbanization
- Chemical pollution

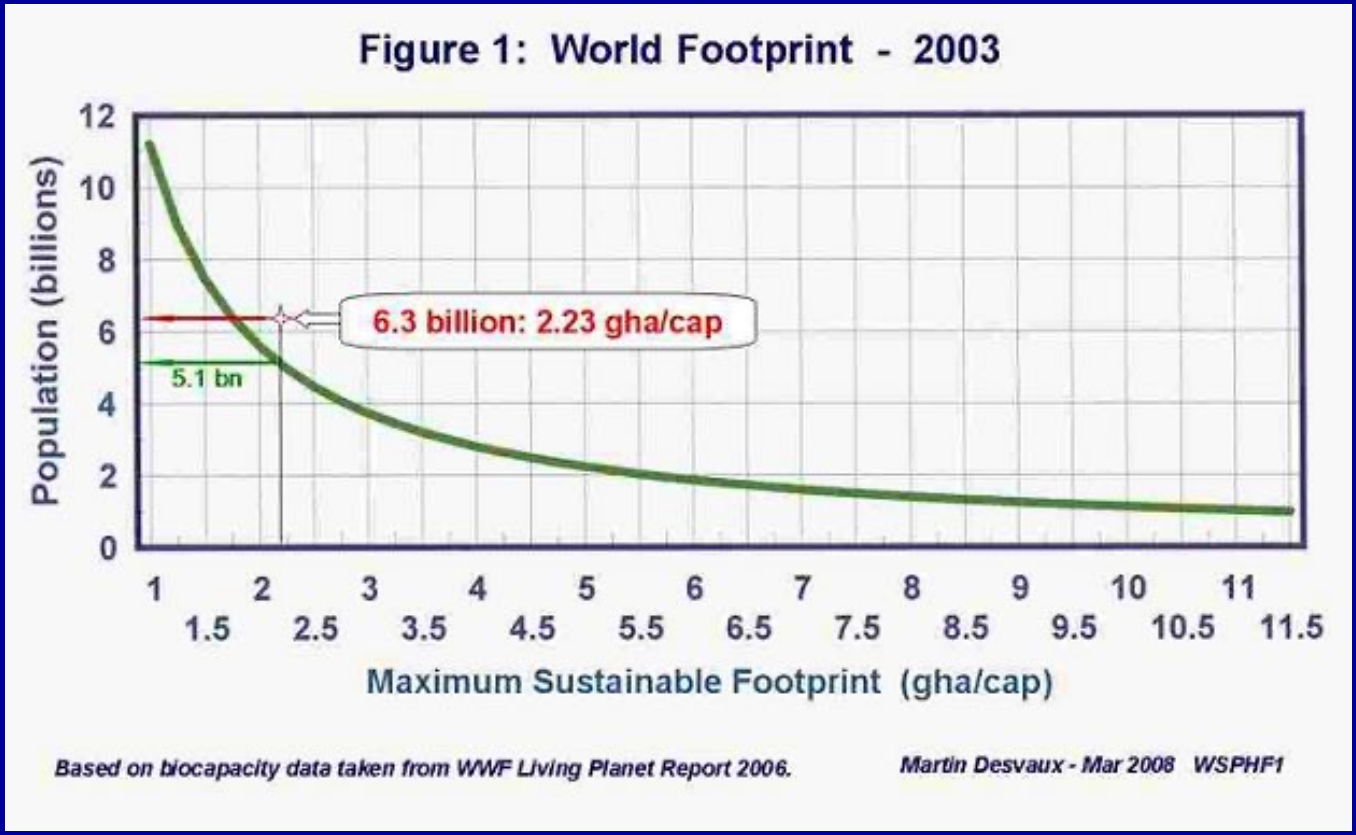
In hectares
1 hectare
= 2.47 acres

Bruce Sundquist, Carrying Capacity Committee, Allegheny Group, Sierra Club
Maximum Population, Aug. 23, 1999.

http://home.windstream.net/bsundquist1/

Biocapacity of the earth = 11.2 gha

= Maximum per capita footprint × number of capita



Available:
1.64 gha/cap

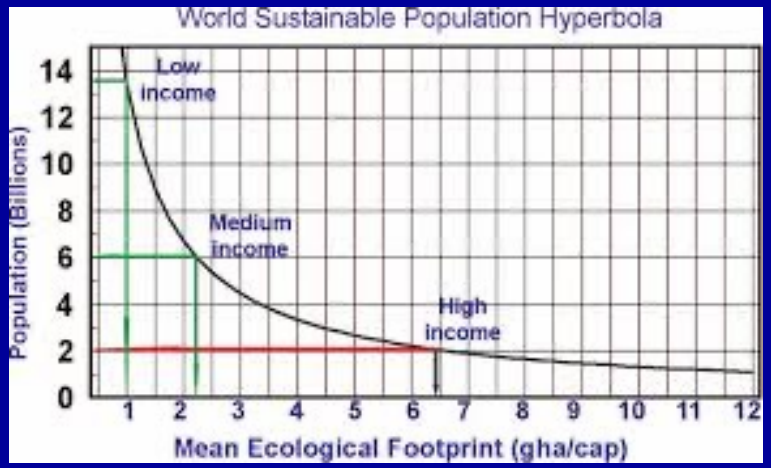
Use
Ave: 2.23 gha/cap
USA: 9.4 gha/cap
EU: 4.8 gha/cap
China: 1.6 gha/cap

gha/cap = global hectares per capita: Global total 11.2 gha

http://www.optimumpopulation.org/opt.optimum.html

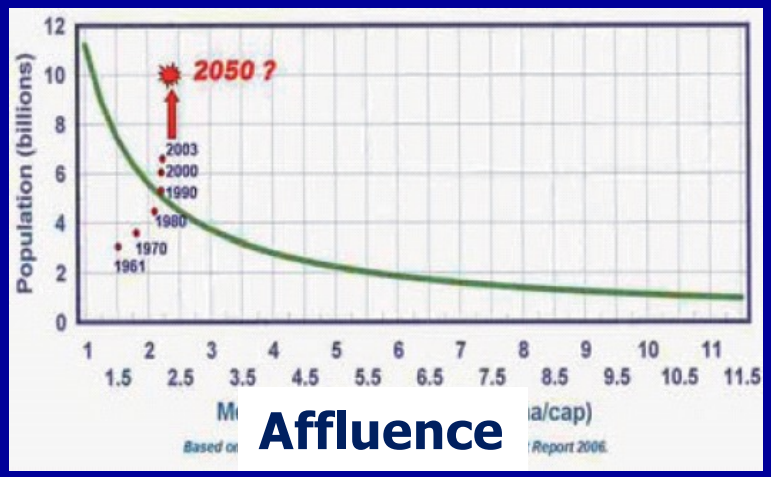
(1 hectare = 0.405 acres)

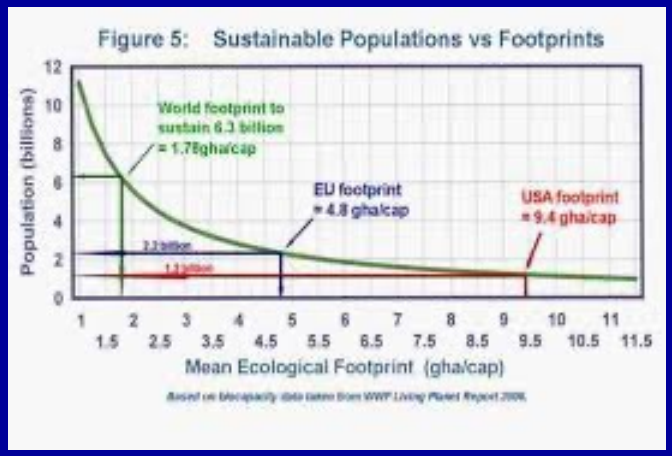
Sustainable Population Hyperbola



Biocapacity of the planet
gha/cap: Global hectares per capita.

For acres/person, multiply by 2.47





The location of the hyperbola is debated.

Vertical farming

Hydroponics: nutrients in water, no soil
Aquaponics: fish and plants in a closed system
Aeroponics: NASA inspired; grow in special nutrients

Need light, water and nutrients
Energy intensive (nuclear??)
Need water and maybe a CO_2 source

Summary

- Water and land determine the carrying capacity
- We are arguably using more resources than the planet can provide
- Must "borrow" from the Earth to support additional people temporarily (how long??)
  - finite resources provide limit
- More for us, less for other species

What we discussed today

- Population history and projections
  - Why 11 billion is "baked in"
- Affluence
  - Whose problem is this?
- Arable land
  - Vertical farming

The existential question: can all of humanity afford to live the lifestyle of a technological society and is it morally right to ask that they don't.

Can technology save us?

The end