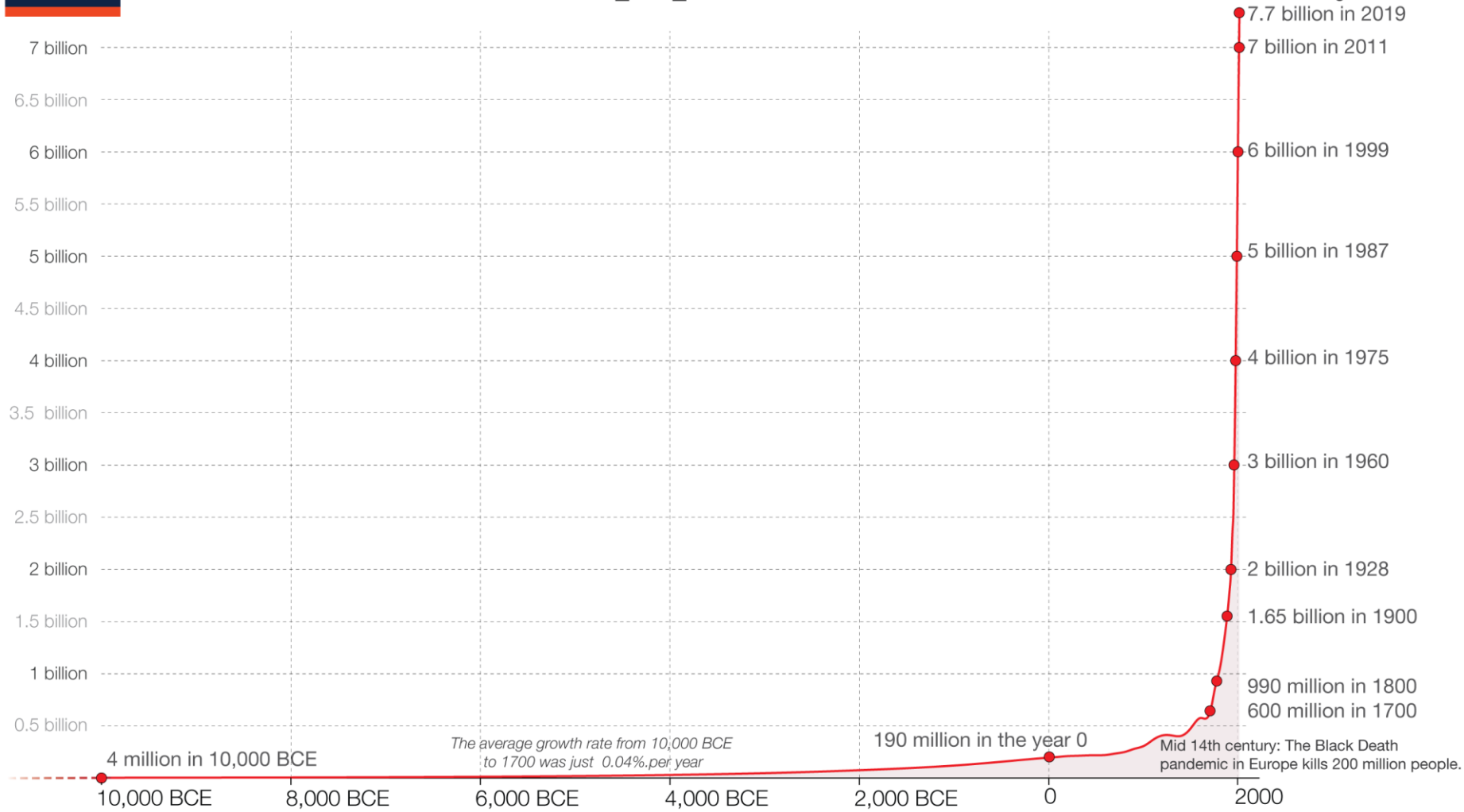


# Population growth and energy

# The size of the world population over the last 12,000 years

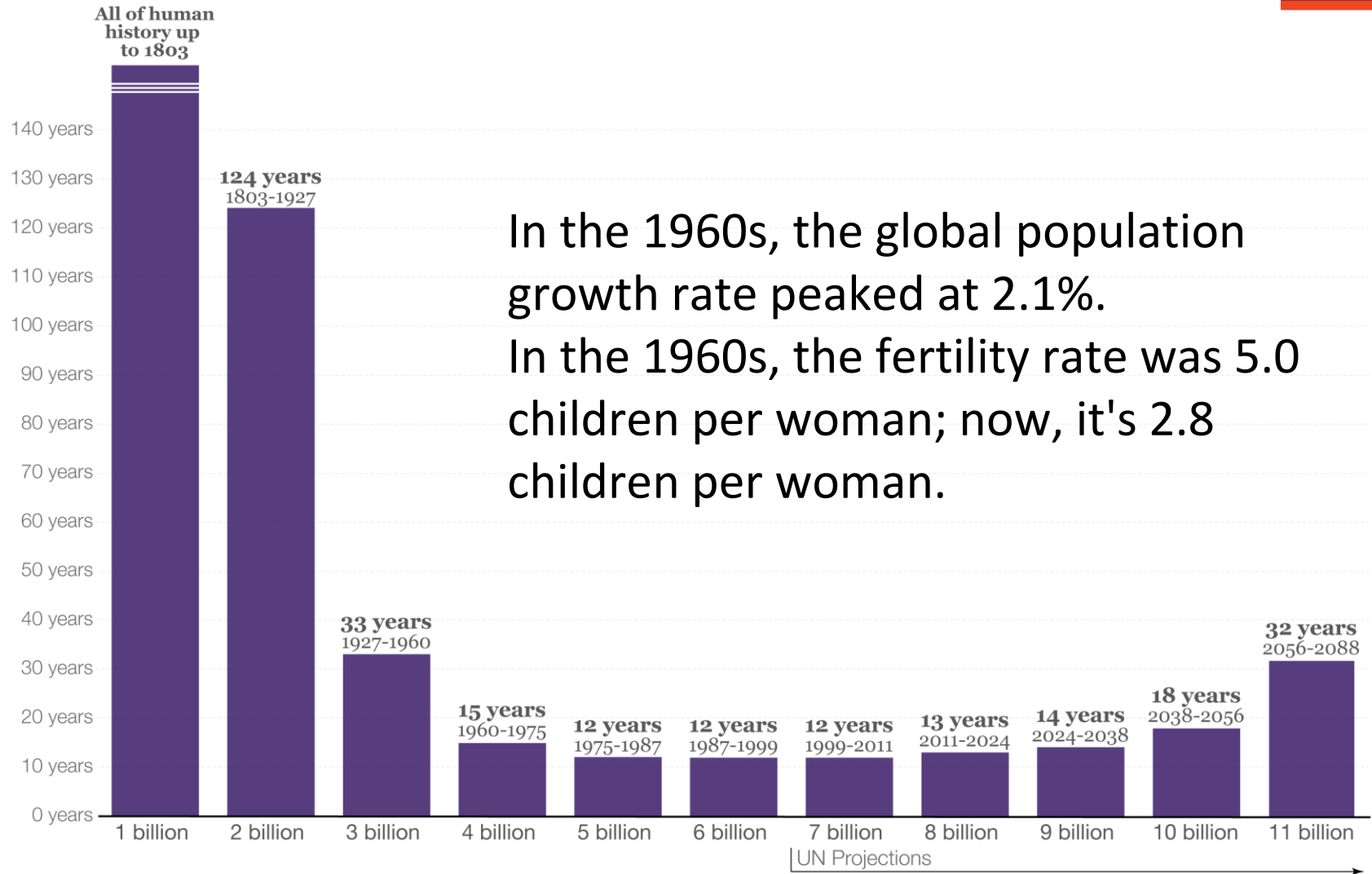


Based on estimates by the *History Database of the Global Environment* (HYDE) and the United Nations. On [OurWorldinData.org](https://OurWorldinData.org) you can download the annual data.

This is a visualization from [OurWorldinData.org](https://OurWorldinData.org), where you find data and research on how the world is changing.

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# Time it took for the world population to increase by one billion



In the 1960s, the global population growth rate peaked at 2.1%.  
In the 1960s, the fertility rate was 5.0 children per woman; now, it's 2.8 children per woman.

Data source: History Database of the Global Environment (HYDE); UN World Population Prospects (2015 Revision); UN Medium Projection (2015 Revision)  
This is a visualization from [OurWorldinData.org](https://www.ourworldindata.org), where you find data and research on how the world is changing.

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# Malthusian trap

- Thomas Malthus (1766 – 1834), cleric, economist, scholar.
- An Essay on the Principle of Population (1798).

„The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race.“

„Humans had a propensity to utilize abundance for population growth rather than for maintaining a high standard of living“ -> „Malthusian catastrophe“.

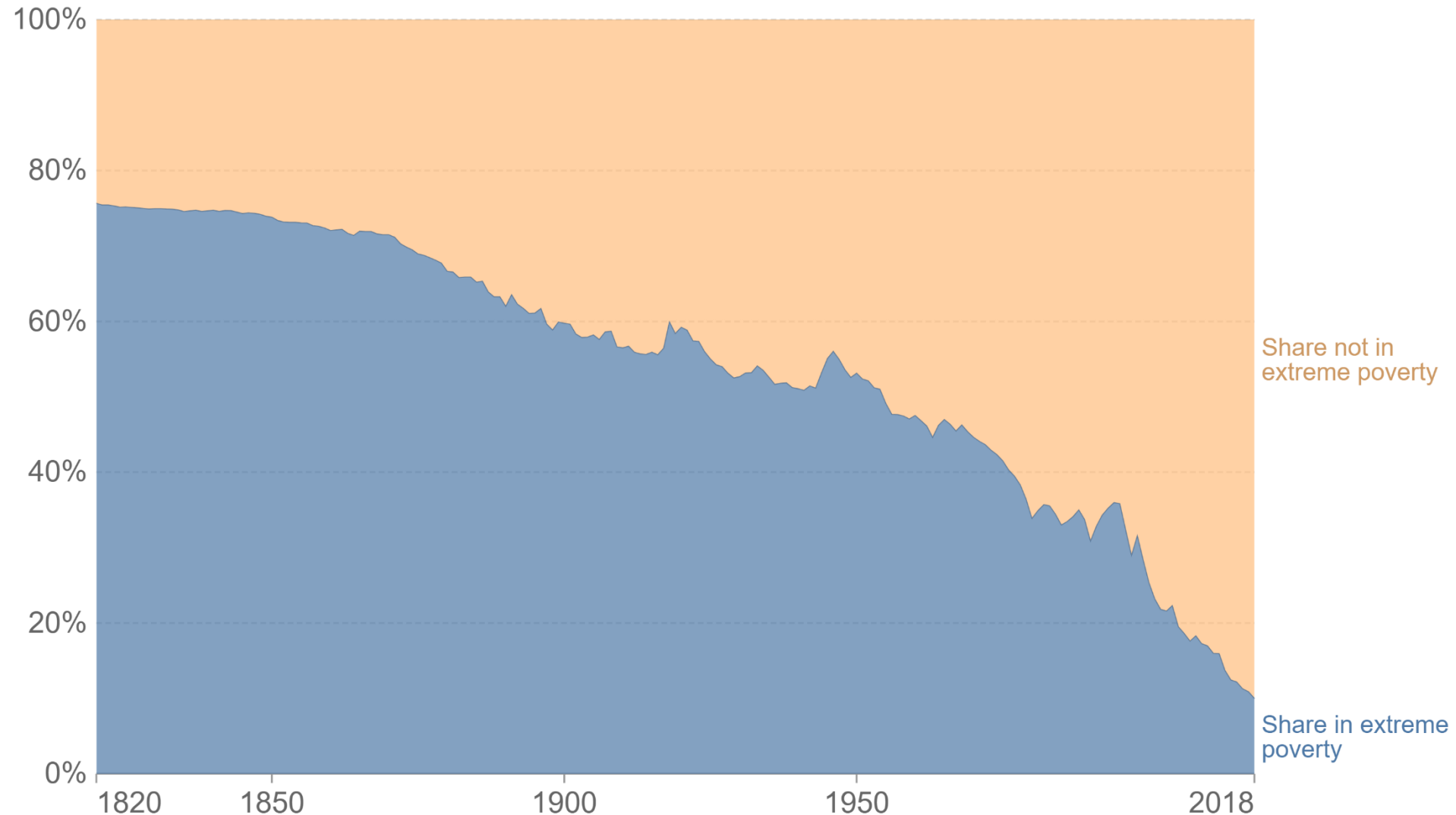
- Irish Famine (1845 – 1849).

# Malthusian trap

- Paul R. Ehrlich and Anne Ehrlich.
- The Population Bomb (1968); The Population Explosion (1990); Optimum Human Population Size (1994).
- "The battle to feed all of humanity is over. In the 1970s, hundreds of millions of people will starve to death in spite of any crash programs embarked upon now. At this late date, nothing can prevent a substantial increase in the world death rate ...,"
- „We must have population control at home, hopefully through a system of incentives and penalties, but by compulsion if voluntary methods fail.“

# Share of population living in extreme poverty, World, 1820 to 2018

This data is calculated based on a 'cost of basic needs' approach. It represents the share of the population unable to meet basic needs (including minimal nutrition and adequately heated shelter) according to prices of locally-available goods and services at the time.



# Principles of Population Growth in Ecological Systems

# Population growth

- Driven by fecundity (reproductive rate) – how many offspring individual may have in their lifetime.
- A population doesn't grow to its full potential (indefinitely).
- Limits of population growth (limiting factors) – conditions necessary for life and reproduction.
- Carrying capacity – number of inhabitants (also people) that ecosystem can sustain with available resources.

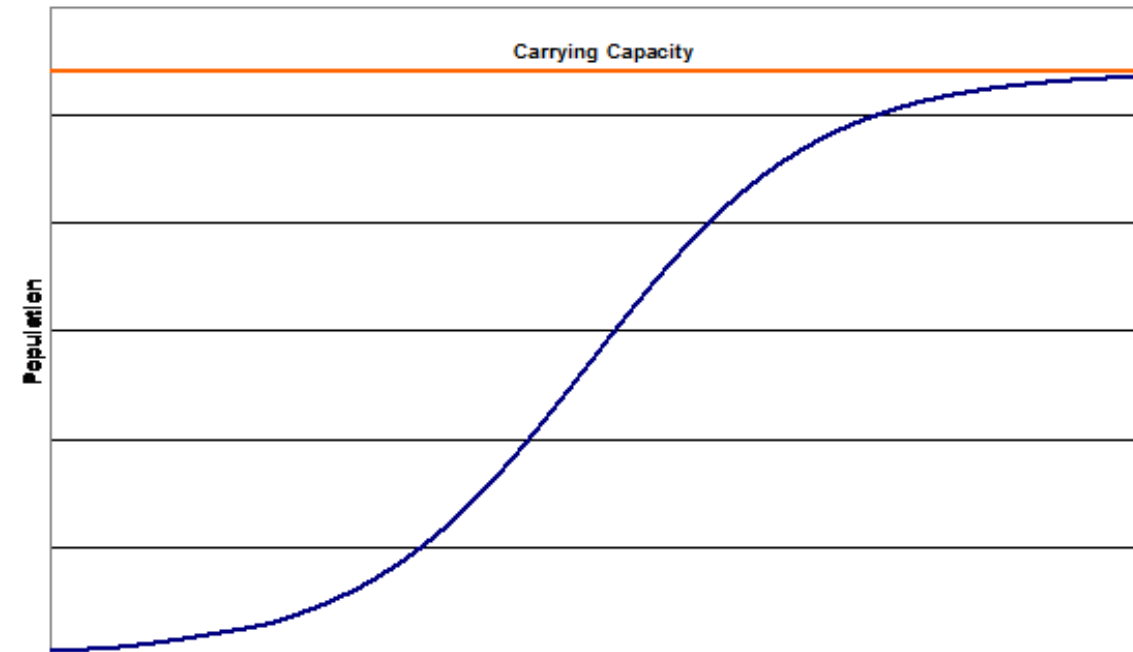


# What factors determine carrying capacity?

- Density dependent factors
- Density independent factors

# Population growth



- Early populations grow rapidly due to ample resources
- .As population increases, competition for resources intensifies.
- Mature populations reach equilibrium and fluctuate around the carrying capacity.
- If the population exceeds the carrying capacity, factors like famine or emigration reduce it.
- If below the carrying capacity, birth rates increase, leading to population growth.



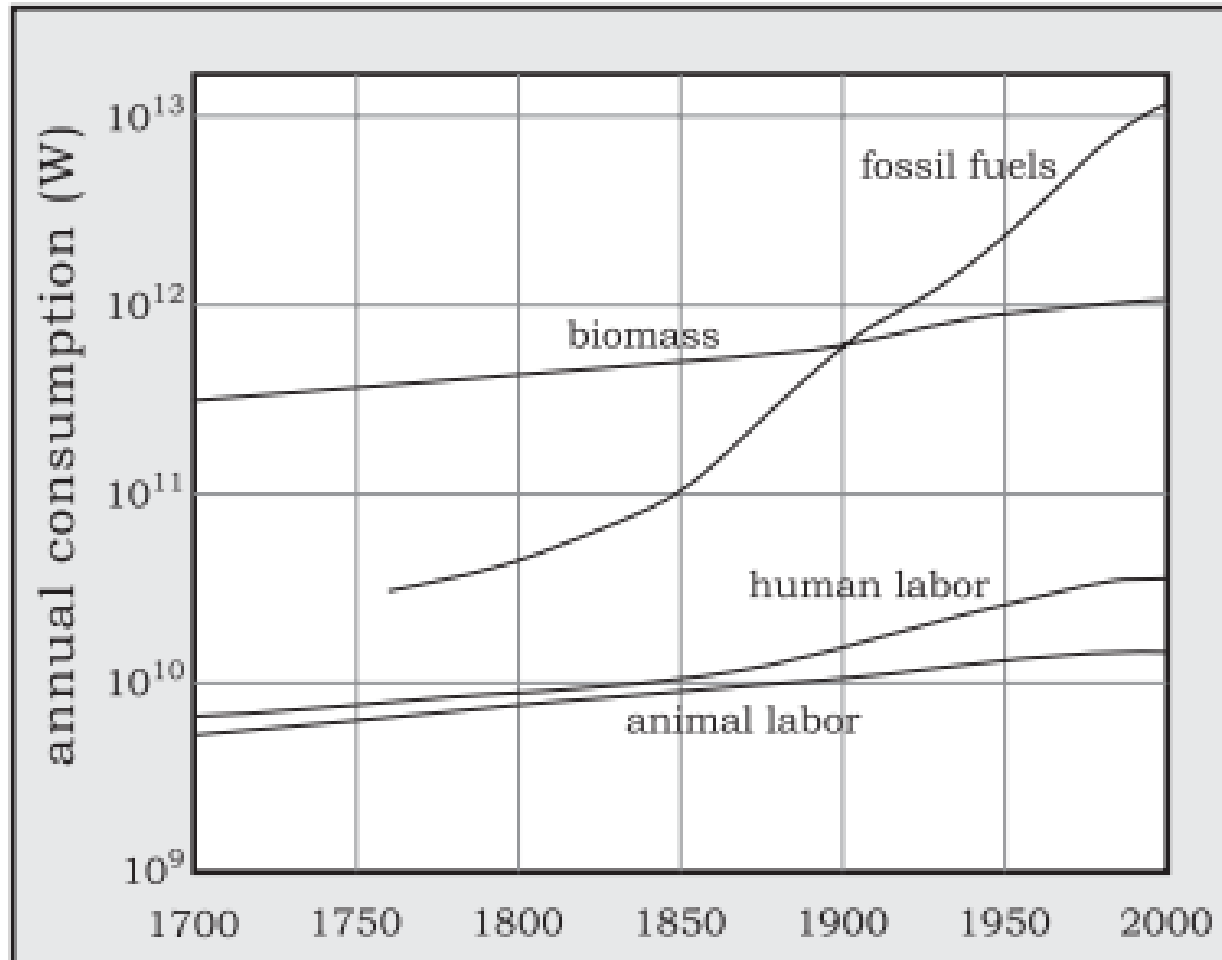
# Population and energy relationship

# Hypothesizing the energy-population relationship

- Limits of growth are suppressed by „infinite“ amount of energy from fossil fuels (mechanisation of agriculture + medical advances + sewage systems + living in previously uninhabitable places, etc.).

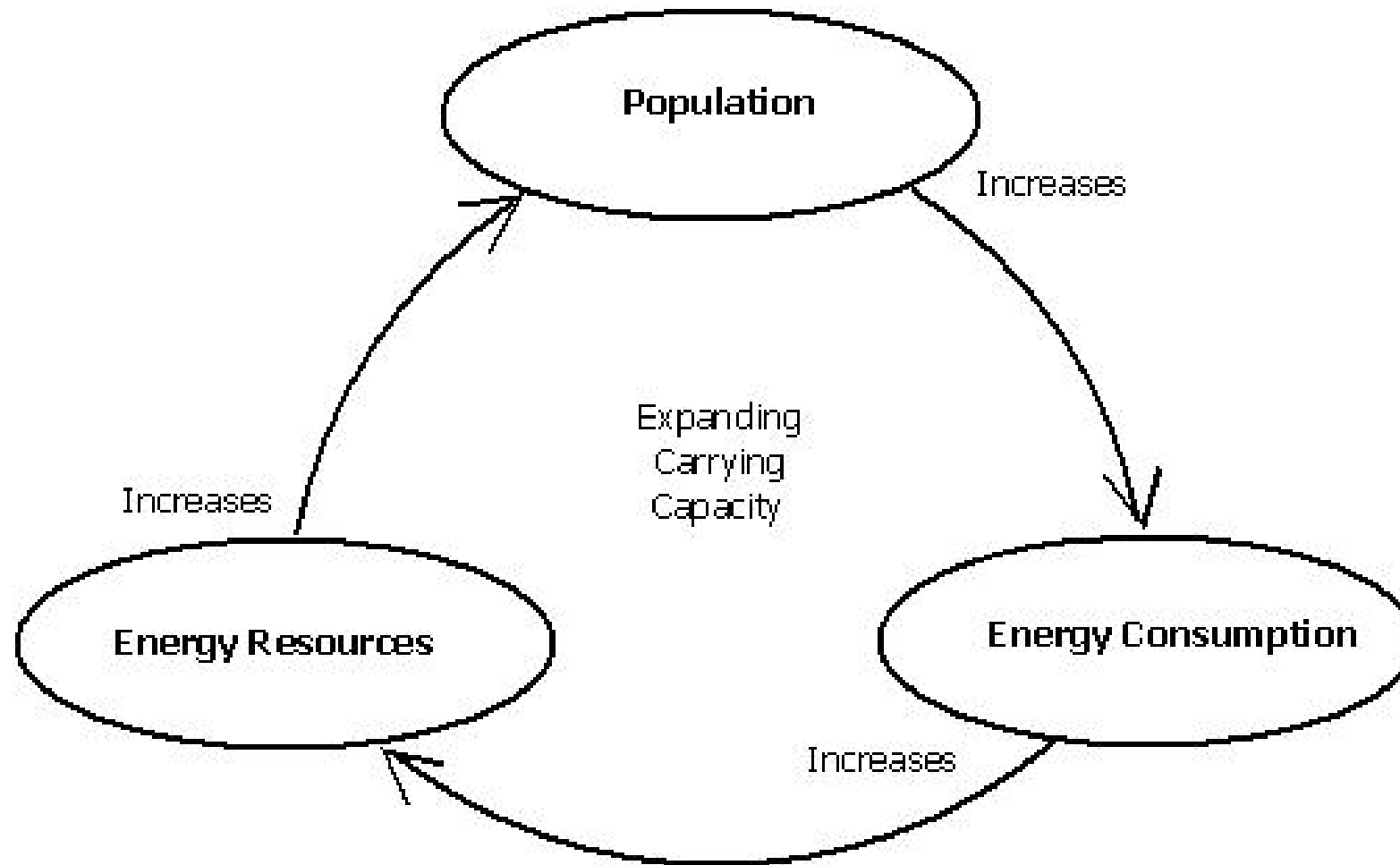
Society	Energy Sources (additive)	Energy Type	Energy Quality	Carrying Capacity
Hunter-gatherers	stone and iron tools	Traditional and Biomass		
Agriculturalists	+ wind, water and draught animals			
Pre-industrial societies	+ wood			
Industrial societies	+ coal	Fossil Fuels		
Modern Economy	+ oil and gas			

# Development in energy consumption



Global consumption of primary energy, 1750–2000.

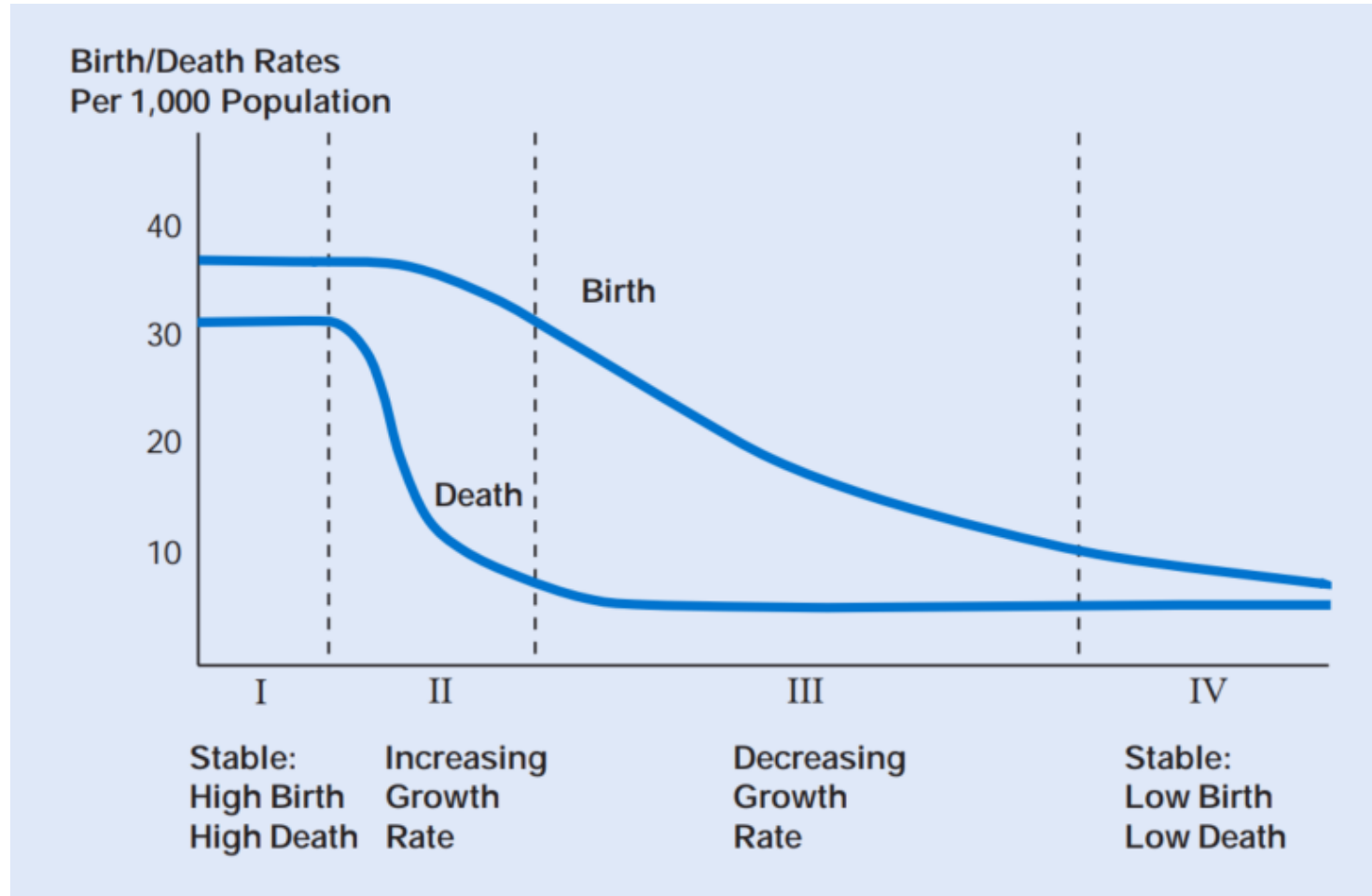
# Energy-population relation



# The future of human population dynamic



# Demographic transition model



Global population growth, which peaked at 2.2% in 1962, has been steadily declining to approximately 1.1% today, with further decrease (in the growth pace!) expected.

# Traditional drivers of (human) population growth

## Economic:

- Agricultural-based economy where children serve as a labor force; children viewed as a form of pension security.

## Socio-cultural:

- Status of women, traditions, and religious beliefs.

## Biological:

- Natural human drive for sexual activity.

# (Modern) factors limiting population growth

## Economic:

- Shift to an industrial economy.
- Higher housing and education costs, Rising living standards and opportunity costs of parenting.

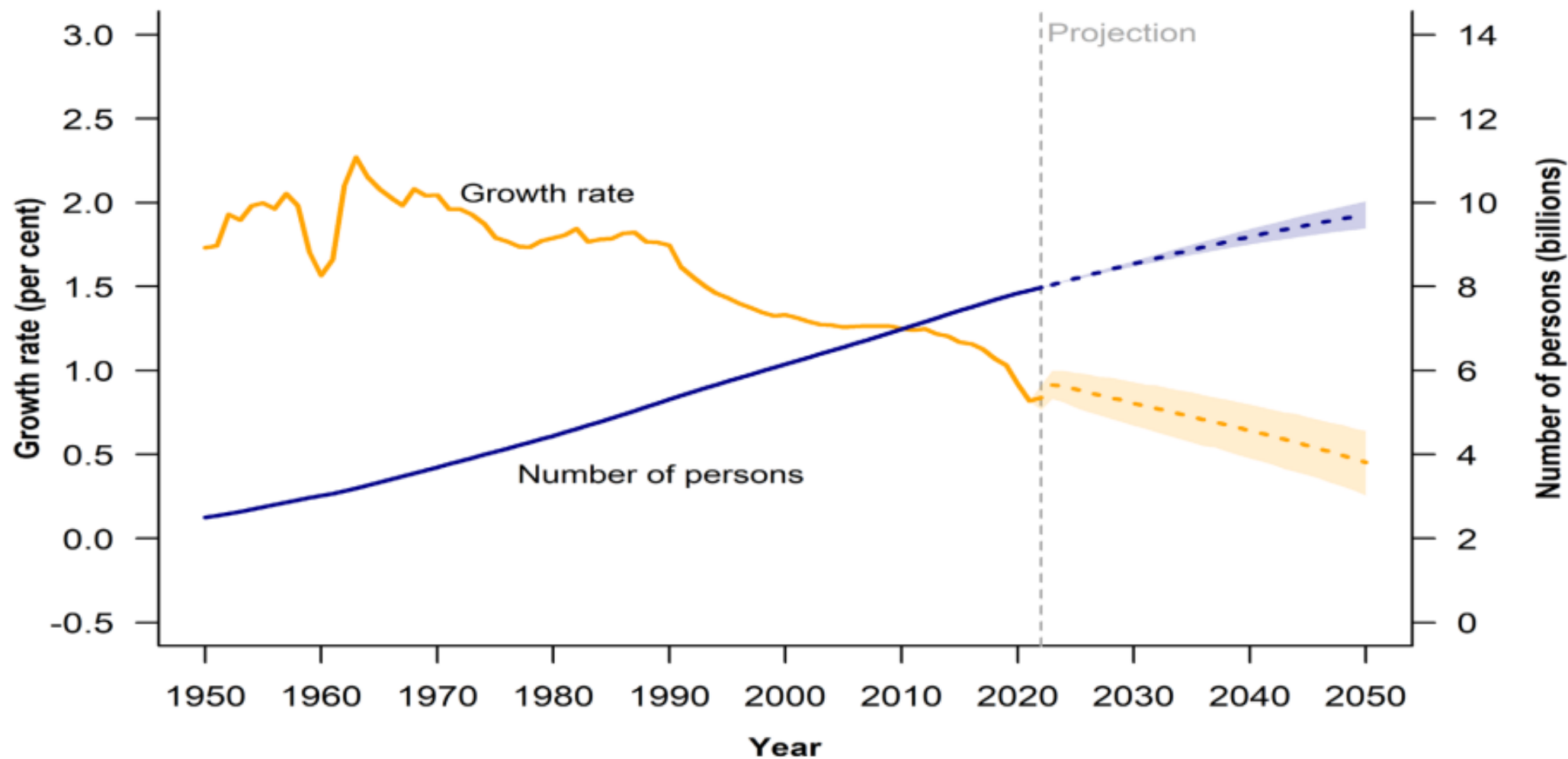
## Socio-cultural:

- Greater education and career opportunities for women, decline in traditional values supporting large families.

## Other:

- Availability of contraception, access to family planning services.
- Delayed marriage and childbearing.
- Improved healthcare, reducing the need for large families.

## Global population size and annual growth rate: estimates, 1950-2022, and medium scenario with 95 per cent prediction intervals, 2022-2050



Population estimates, 1950-2022, and projections with 95 per cent prediction intervals, 2022-2050, by region

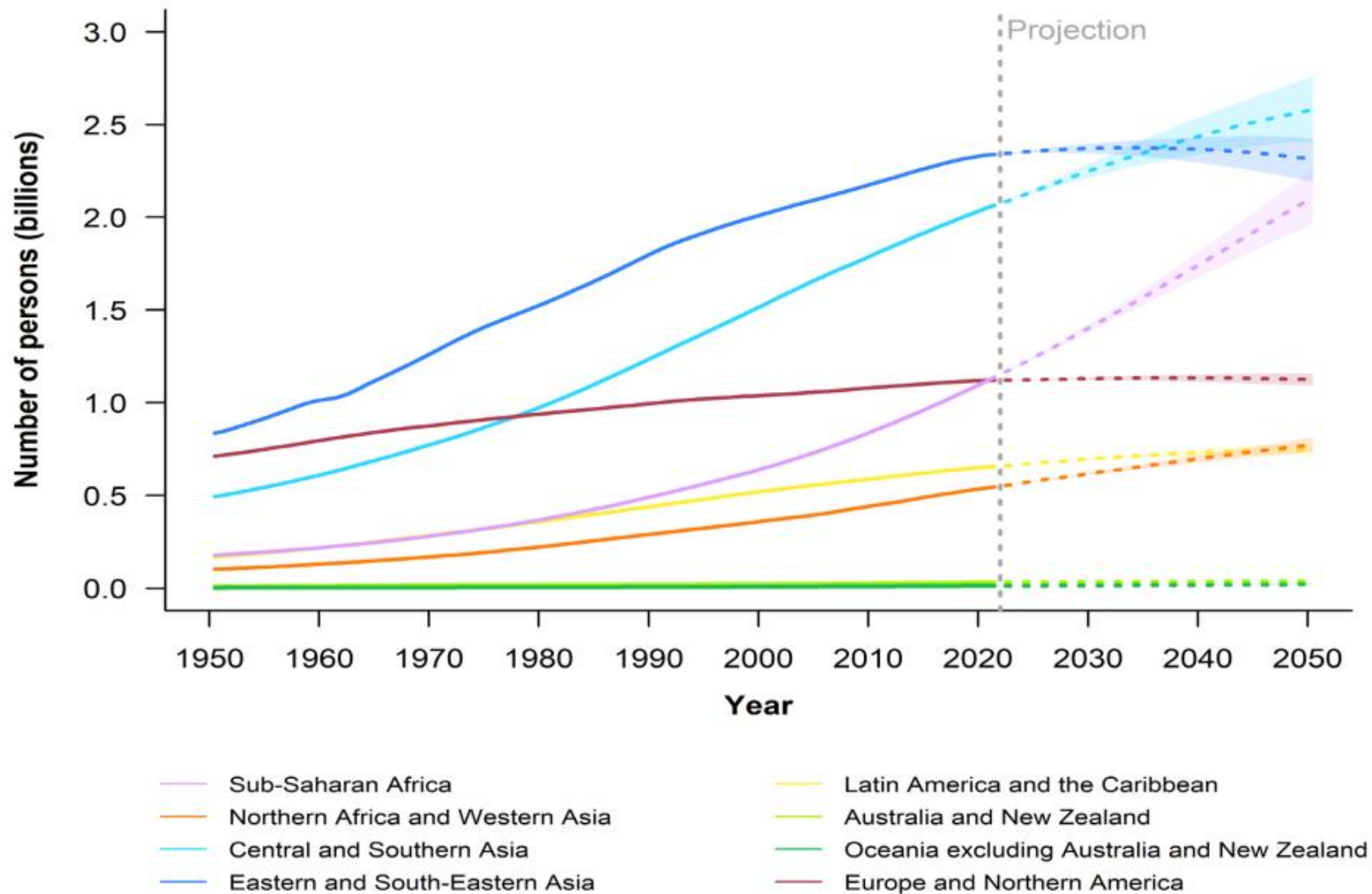
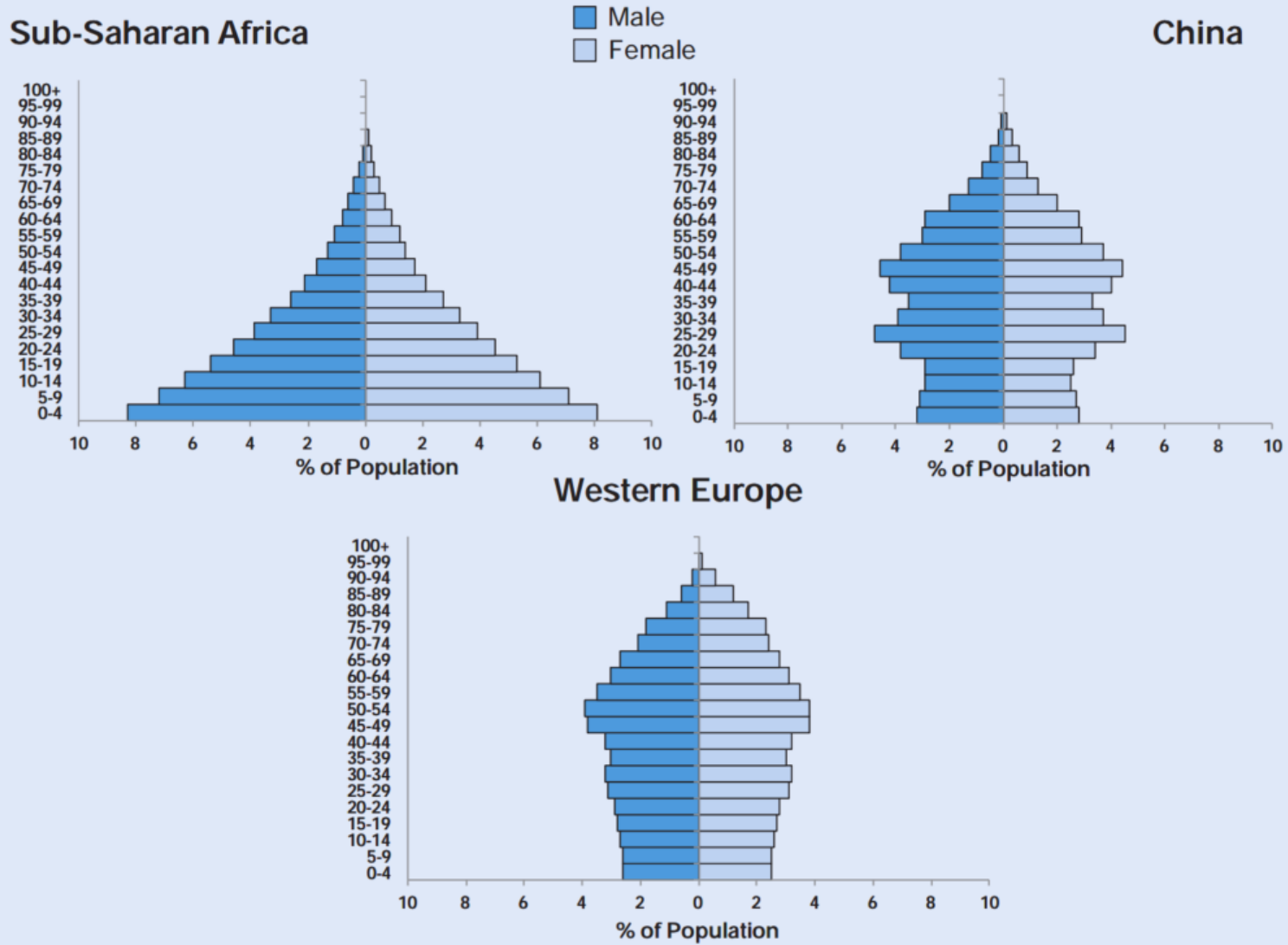


Figure 15.7 Population Age Structures for Sub-Saharan Africa, Western Europe, and China, 2015



## Key takeaways

- To thrive, humanity needs vast amounts of concentrated and cheap energy.
- The availability of this energy makes it possible to overcome environmental limits that would otherwise constrain population growth and well-being.

## Sources

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Nathan, D. et.al. (2015): Estimating Physical Activity Energy Expenditure with the Kinect Sensor in an Exergaming Environment.

UN, Department of Economic and Social Affairs, Population Division (2022): World Population Prospects 2022.