Population pressure

- Environmental health II (1) on 24 June 2026
- Key concepts
  - Fertility rates are falling in some regions, global population still grows, especially in low income countries
  - Global population is becoming increasingly urban. Modern public health is tied to urban planning and land-use.
  - Population growth with affluence/technology (using resource) exerts pressures on natural resources and ecosystem integrity
  - Ecological footprint is to measure impact of population and resource use on the ecosystem
  - Carrying capacity = No. people who an ecosystem or the entire Earth can support
  - Limiting population growth and reducing per capita resourse use contribute to environmental health

Population and resource use are uneven

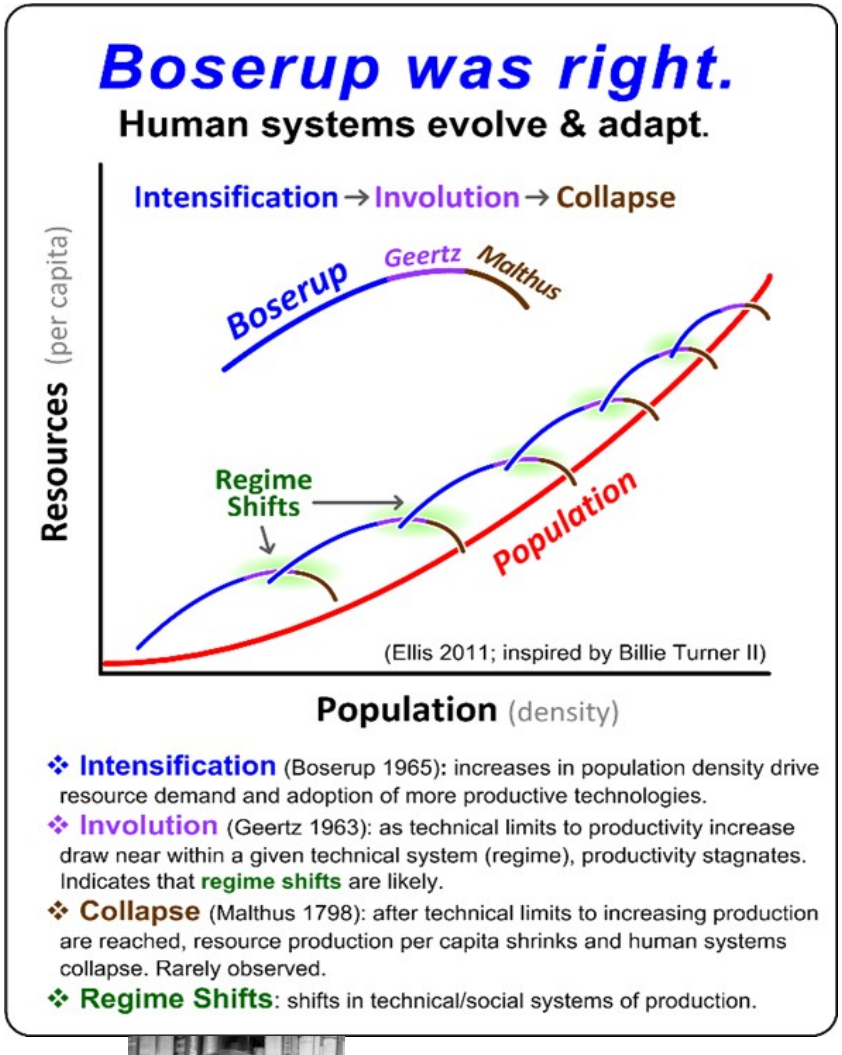
Year (July 1)	Population	Yearly % Change	Yearly Change	Median Age	Fertility Rate	Density (P/Km²)
2025	8231613070	0.85%	69640498	30.9	2.24	55
2024	8161972572	0.87%	70237642	30.6	2.25	55
2023	8091734930	0.88%	70327738	30.4	2.25	54
2022	8021407192	0.84%	66958801	30.1	2.27	54
2021	7954448391	0.86%	67447099	29.8	2.29	53
2020	7887001292	1.09%	83301884	29.6	2.32	53
2015	7470491872	1.25%	89751945	28.3	2.54	50
2010	7021732148	1.29%	86952403	27.2	2.6	47
2005	6586970132	1.31%	83053428	26.1	2.63	44
2000	6171702993	1.39%	82564802	25.1	2.75	41

- Current world population https://www.worldometers.info/world-population/
- Fertility declines in virtually every region of the world
  - Rapid in Europe, Asia, North America "birth dearth"
  - Africa's fertility drops due to HIV/AIDS (40 million people are HIV positive, 75% of them live in sub-Sahara), but the drop is attenuated due to international programs incl. UNAIDS
- UN-DESA (United Nations Department of Economic and Social Affairs), population division's report
  - Annual population growth ~ 78 million ~ slightly more than 100 million during 2014-2017
  - Projection: 8 billion by 2025, 9.1 billion by 2050
  - 99% growth occurs in the world's poor, developing countries (sub-Saharan Africa, Middle East, South Asia).
  - 90% of 1.2 billion teenagers live in developing countries

Measuring population impact

See, https://ecotope.org/blog/saved-by-ester-boserup/

- Malthus T (1803): Human populations have a tendency to increase exponentially, unless limited by starvation, disease or fertility limitation policies, but agriculture only increased its productivity in linear fashion, resulting in famines
- Neo-malthusians: Population is a driver of negative environmental changes
- Boserup E (1965): Population growth is the force stimulating technological change and intensification. Increases of population density resulted in land scarcity, which triggered agricultural intensification through application of improved technology (e.g. better tools, irrigation, terracing, shortening of fallows)
- Ehrlich PR, Holdren JP (1971): Developing countries have large impact on environment due to rapid population growth, developed countries do so due to high affluence and technology level.
  * Impact = Population x Affluence x Technology (I=PAT)
  see, Ehrlich PR, Ehrlich AH (1990) The Population Explosion, Touchstone, too.

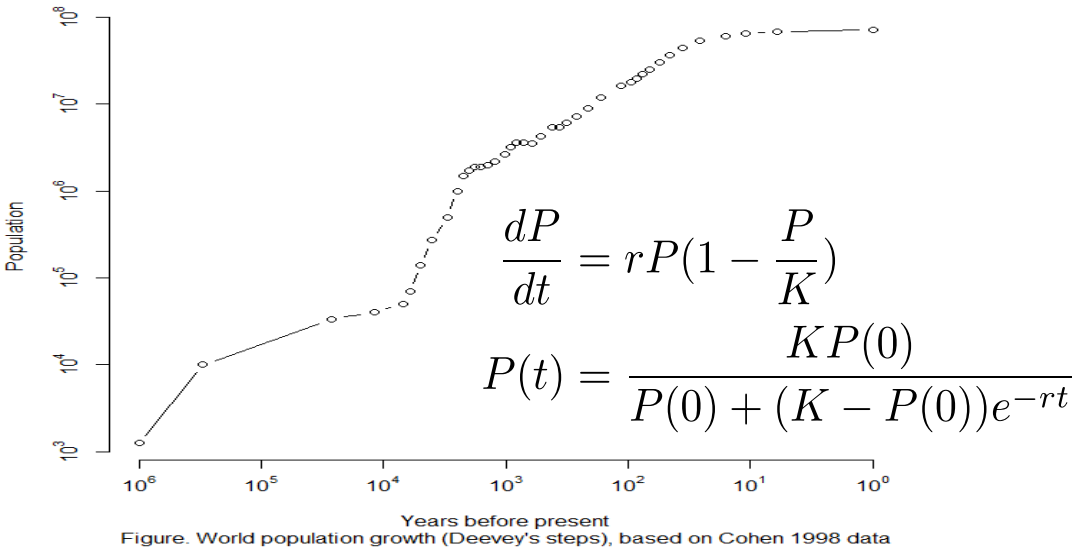


Ester Boserup
1910-1999
Danish Economist

Debates between optimists and pessimists

- Bjørn Lomborg's "The Skeptical Environmentalist: Measuring the Real State of the World", Cambridge University Press, 2001
  - https://lomborg.com/skeptical-environmentalist
  - The book raised a doubt on the prevailing alerts of environmental crisis from famous NGOs (Worldwatch Institute, World Wide Fund for Nature, Greenpeace) based on statistical data https://catdir.loc.gov/catdir/samples/cam031/00068915.pdf
  - The book insisted the steady improvement of situation
- Many mainstream scientists strongly criticized Lomborg
  - Scientific American https://www.scientificamerican.com/article/skepticism-toward-the-ske/
  - Jeroen C.J.M. van den Bergh (2010) https://doi.org/10.1080/1943815090353373O
  - John Bongaarts (as demographer, one of the pessimist side, relatively) wrote the overview in 2023. https://doi.org/10.1007/s11111-023-00424-5
- Still ongoing (eg. Donald Trump is one of the optimists, UNFCCC is basically so-called pessimists)

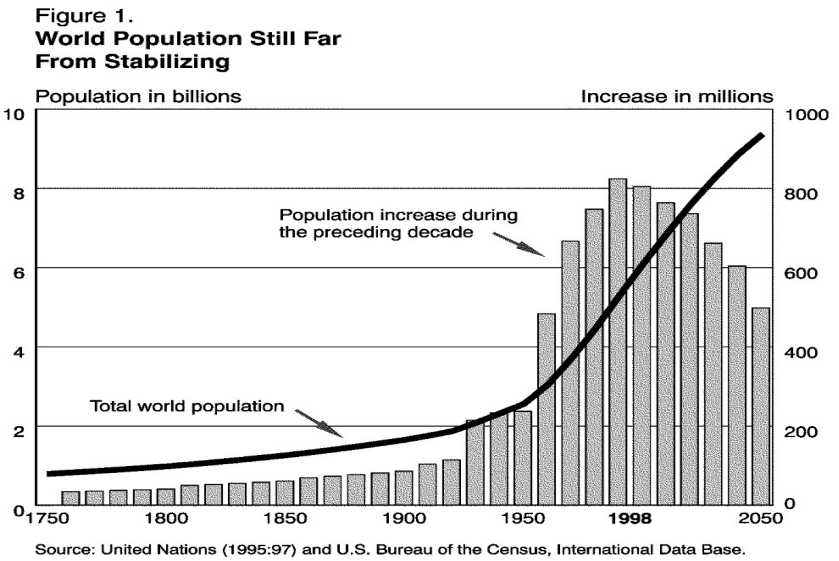
Long term history of world population growth



$$\frac{dP}{dt} = rP(1 - \frac{P}{K})$$

$$P(t) = \frac{KP(0)}{P(0) + (K - P(0))e^{-rt}}$$

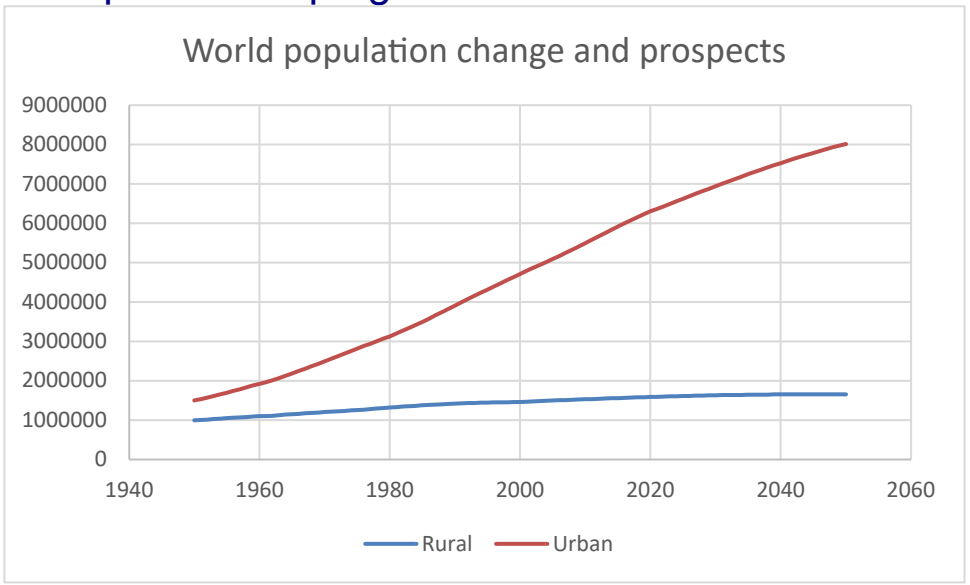
Figure. World population growth (Deevey's steps), based on Cohen 1998 data



- Deevey (1960) https://www.jstor.org/stable/10.2307/24940623
  - Log-log graph shows a sequence of multistep logarithmic growth
  - "Three population surges" correspond to cultural revolution (use of stone tools), agricultural revolution (farming with sedentary life), scientific-industrial revolution (use of fossil fuels and machinery)
- Annual increase rate since 1750 (bars in the Figure 1 top right)
  - Before 1750, less than 0.5%
  - 1750-1930, 0.5-1%
  - After 1950, higher than 1.6%, mostly in developing countries

Population and urbanization

- World is in the middle of urban revolution
- Global population live in urban area
  - More than 50% (2008) → 60% by 2030
  - UN-DESA: 3.3 billion (2007) → 6.4 billion (2050)
  - UN Data and prospects from https://population.un.org/wup/downloads (see, below)
- Big cities in Africa are growing at 4% per year. It will be double within 20 years
- Infrastructure of most cities in developing countries cannot keep pace with such rapid/continuous urban growth
- Urban growth ← fleeing collapsing rural economies, lack of rural infrastructure/services, landlessness, lack of rural employment opportunities (push factors)
- On the other hand, urban sprawl also occur in some places (emphasis on private spaces, large footprint).
- Urban development models: By implementing specific new urban design techniques, Traditional Neighborhood Development (TND) can gradually replace Conventional Suburban Development (CSD)
  https://www.epa.gov/sites/default/files/2014-07/documents/mbd-epa-infrastructure.pdf



Population and environment

https://assets.wwf.org.uk/downloads/city_footprint2.pdf

- Ecological Footprint
  - (Wackernagel and Rees, 1996; Wackernagel and Yount, 1998) A measure of how much area of **biologically productive land and water** an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices.
    - Wackernagel M, Yount JD (1998) The Ecological Footprint: an Indicator of Progress Toward Regional Sustainability. *Environ Monit Assess* 51: 511-529. https://doi.org/10.1023/A:1006094904277
  - Usually measured in global hectares. Because trade is global, an individual or country's footprint includes land or sea from all over the world.
- Carrying Capacity
  - Price D (1999) Carrying capacity reconsidered. *Popul Environ* 21: 5–26. https://doi.org/10.1007/BF02436118
  - The number of people the Earth (or specified region) can support. Estimates depend on what's included and how it's measured
    - See, Cohen JE (1995) *How many people can the earth support?* WW Norton & Co. NY., 532pp. https://lab.rockefeller.edu/cohenje/assets/file/196CohenHowManyPeopleDiscover1992.pdf https://www.uctv.tv/shows/How-Many-People-Can-the-Earth-Support-with-Joel-E-Cohen-23338
    - Vegetarian diet with 2500 kcal/day → 40 billion
    - Meat diets → 10 billion
    - If developing population live at the standard of developed → 2 billion

Population → Land Use (← Urbanization, Policy, Economic growth incl. industrialization) → Biodiversity loss, CO_2 emission

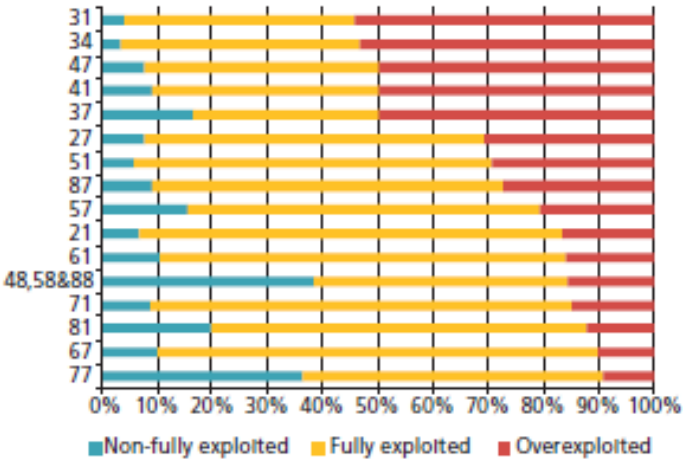
- Weber H, Sciubba JD (2019) The Effect of Population Growth on the Environment: Evidence from European Regions. *European Journal of Population*, 35(2): 379-402. https://dx.doi.org/10.1007%2Fs10680-018-9486-0
- de Leon Barido DP, Marshall JD (2014) Relationship between urbanization and CO2 emissions depends on income level and policy. *Environmental Science & Technology*, 48: 3632-3639. https://doi.org/10.1021/es405117n
- Foley JA et al. (2005) Global consequences of land use. *Science*, 309: 570-574. https://doi.org/10.1126/science.1111772
- Regression model in IUSSP conference (2001) states that the impact of population on CO_2 varies by affluence. https://iussp.org/sites/default/files/Brazil2001/s00/S09_04_Shi.pdf
- Casey G, Garol O (2017) https://doi.org/10.1088/1748-9326/12/1/014003
- D'Sauza R (2022) https://www.orfonline.org/expert-speak/population-drives-climate-change/
- Sarif MO et al. (2024) https://doi.org/10.1016/j.jenvman.2024.122469

Population-Environment Scoreboard

- "Earth Summit" (at Rio de Janeiro, 1992) : set specific goals
  * Rio+5 (UN General Assembly, 1997): little progress or worsened
  * Rio+20 (UN Conference on Sustainable Development, 2012)
- Poverty had increased, partly due to population growth
- Situation of environments
  - Arable Land: Degraded, Small scale farmers cannot produce enough food to feed their families
  - Freshwater: Growing populations place pressure on freshwater supplies. In 1995, 2.3 billion lived in water stressed areas. Lack of clean water: 1 billion in 1990, 1.2 billion in 2007. Chronic water shortages will be the most limiting factor on future economic development. World Resource Institute prospects 3.5 billion people live under water-shortage stress by 2025.
  - Oceans: Coastal wetland have deteriorated. 40% of coral reefs were lost. FAO (2009, 2011) reported 3/4 of world major commercial fish stocks are fully/over-exploited or depleted. 2 billion people depends on seafood for protein https://www.fao.org/3/i2389e/i2389e.pdf
  - Forests: Deforestation increased (Brazilian amazon, rate was 70% increased in 1992-2002). 37 million ha forest was lost in 2000-2005.
  - Biodiversity: Losing species at 100-1000 times faster than natural loss. During 1990s, 27,000/yr animal/plant species extinct. IUCN Red list: 41415 species. Species diversity is essential for human health as the source of medicine and food.
  - Climate Change: Population growth → energy use → CO2 → global warming and climate change. Though COP3 FCCC Kyoto Protocol → COP21 Paris Agreement, still ongoing

FIGURE A1
FAO marine major fishing areas for statistical purposes

FIGURE A12
Percentages of fish stocks in different status by major fishing areas in 2009



Poverty and population

- Rapid, unsustainable population growth = a principal contributor to poverty
- 1/4 ~ 1/5 of Earth's people live in extreme poverty (**absolute poverty**: spend less than US$1**/day/person** in 1985, $1.25 in 2008, $1.90 in 2015; Since 2017, different lines were applied the countries' income. In 2025, $3.00 in LIC, $4.20 in LMIC, $8.30 in UMIC: https://www.worldbank.org/en/topic/measuringpoverty) (cf.) **Relative poverty** (the poorest segment ~ 1/5 or 2/5 ~ of the population, sometimes **less than half of the median income**) should also be paid attention.
  https://openknowledge.worldbank.org/bitstream/handle/10986/11985/9780821376133.pdf
- Lower fertility and slower population growth have not brought an improved living standard for the average person. In 1980, about 2.5 billion people lived in less than $2 per day per person.
- Extreme poverty decreased during recent decades (from 1.9 billion in 1981 to 1.8 billion in 1990, 1.4 billion in 2005) partly due to MDG1

Environmental Distress Syndrome

- Population pressure and excessive resource use threats the health of the environment
- Deteriorating environmental conditions and concomitant threats to human health
- Five symptoms
  - Reemerging/Emerging infectious diseases
  - Loss of biodiversity
  - Growing dominance of generalist species
  - Declines of pollinators are intrinsic to the propagation of flowering plants.
  - Proliferation of harmful algal blooms along the world's coastlines → outbreaks?

Planetary Health to address the limit of growth

- Definition: “Planetary Health is a solutions-oriented, transdisciplinary field and social movement focused on analyzing and addressing the impacts of human disruptions to Earth’s natural systems on human health and all life on Earth.” https://planetaryhealthalliance.org/what-is-planetary-health/
- Proposed by Rockfellor Foundation and Lancet in 2015 https://www.thelancet.com/commissions-do/planetary-and-human-health
  - See, infographics https://www.thelancet.com/infographics-do/planetary-health and full commission https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60901-1/fulltext
- Planetary Health Alliance strongly promotes
  - https://planetaryhealthalliance.org/