Human population at 8.1 billion: past, present, [future]

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JEC Wagon Wheel Gap, Catskill Mountains, NY 20241031_172407

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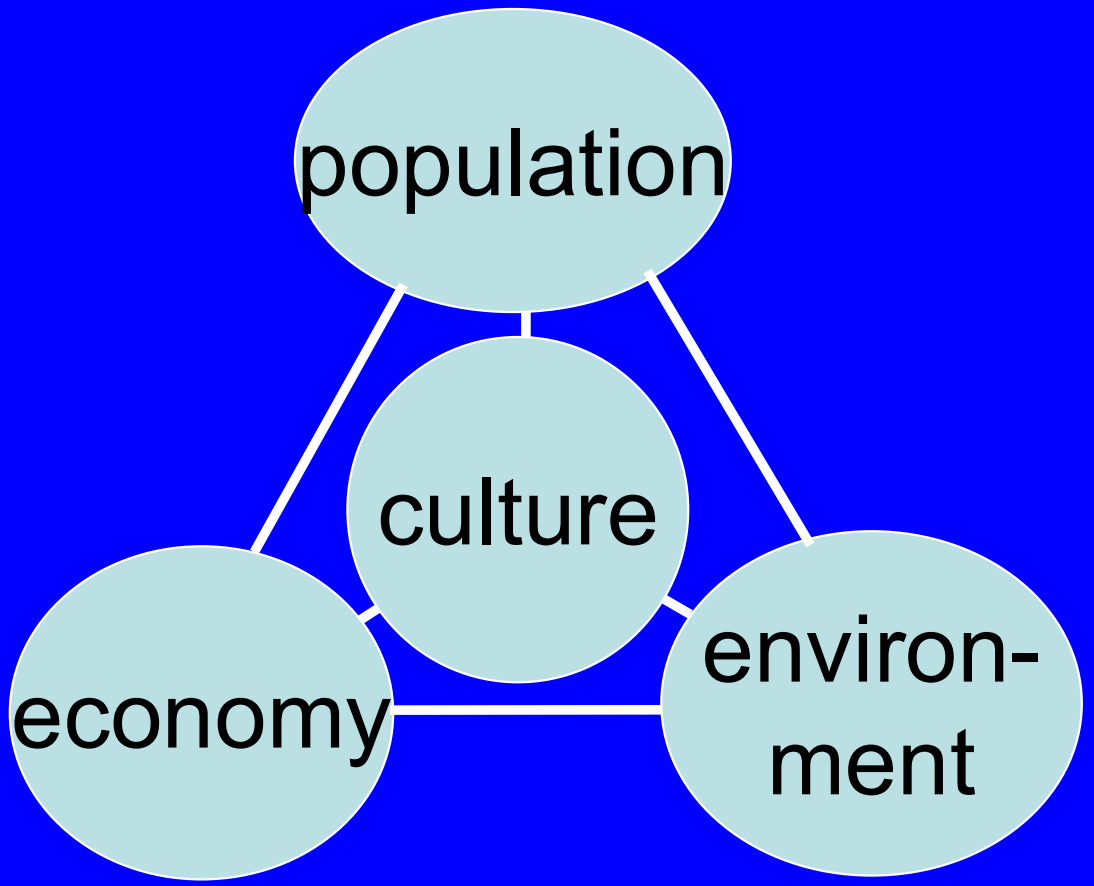
Population
Economy
Environment
Culture
interact.



Global human population: summary

- Very recent past: 200 years: 8X (1B → 8B); since 1974: 2X (4B → 8B). Growth was super-exponential, then sub-exponential.
- Present: 8.1B population grows by ~70 million/year (another USA in ~4.5 years), ~0.9%/year. >1 child in 5 under 5 years old is stunted from chronic hunger.
- Future (to 2050, excluding nuclear war, plague, climate catastrophe, comets): more people, older, more urban, more Asian, more African, more migrant; slower growth, ending.

Past

Genus *Homo* evolved early in Pleistocene Epoch, starting 2.58 million years ago. *Homo* left Africa 4 times; only 4th survived.

By end of the Pleistocene Epoch 11,700 years ago, modern humans, *Homo sapiens*, had displaced all other species of humans & migrated from Africa to all continents except Antarctica.

Holocene history (11,700 before present to now) omits >99.5% of human history.

Population history in round numbers

Early (Pleistocene, 2.58 millon years):

human population 1,000→10 million

10,000-fold growth =

average annual growth of 0.0004%/year

Recent (Holocene, 11,700 years):

human population 8 million→8 billion

1,000-fold growth =

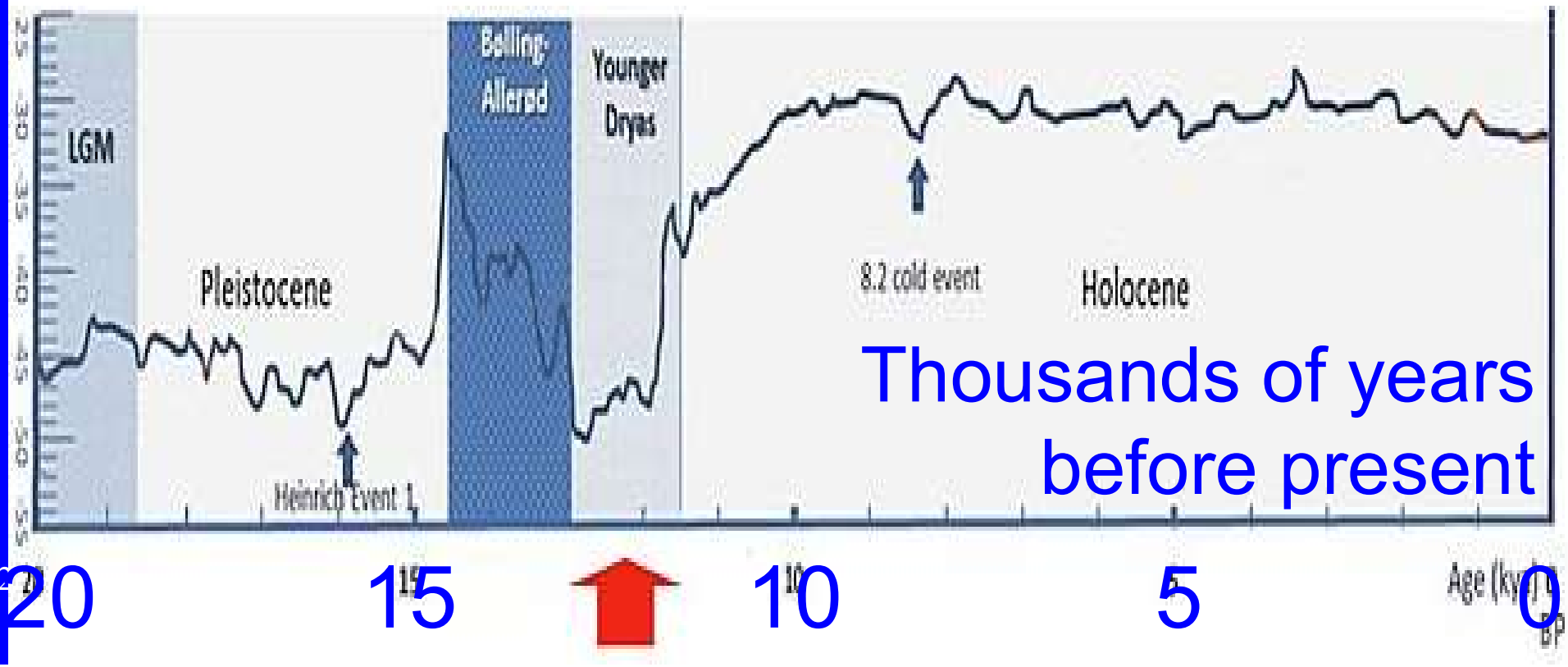
average annual growth of 0.06%/year

150-fold acceleration from early to recent

Holocene 11.7 ka to now

(11,700 years before present to now)

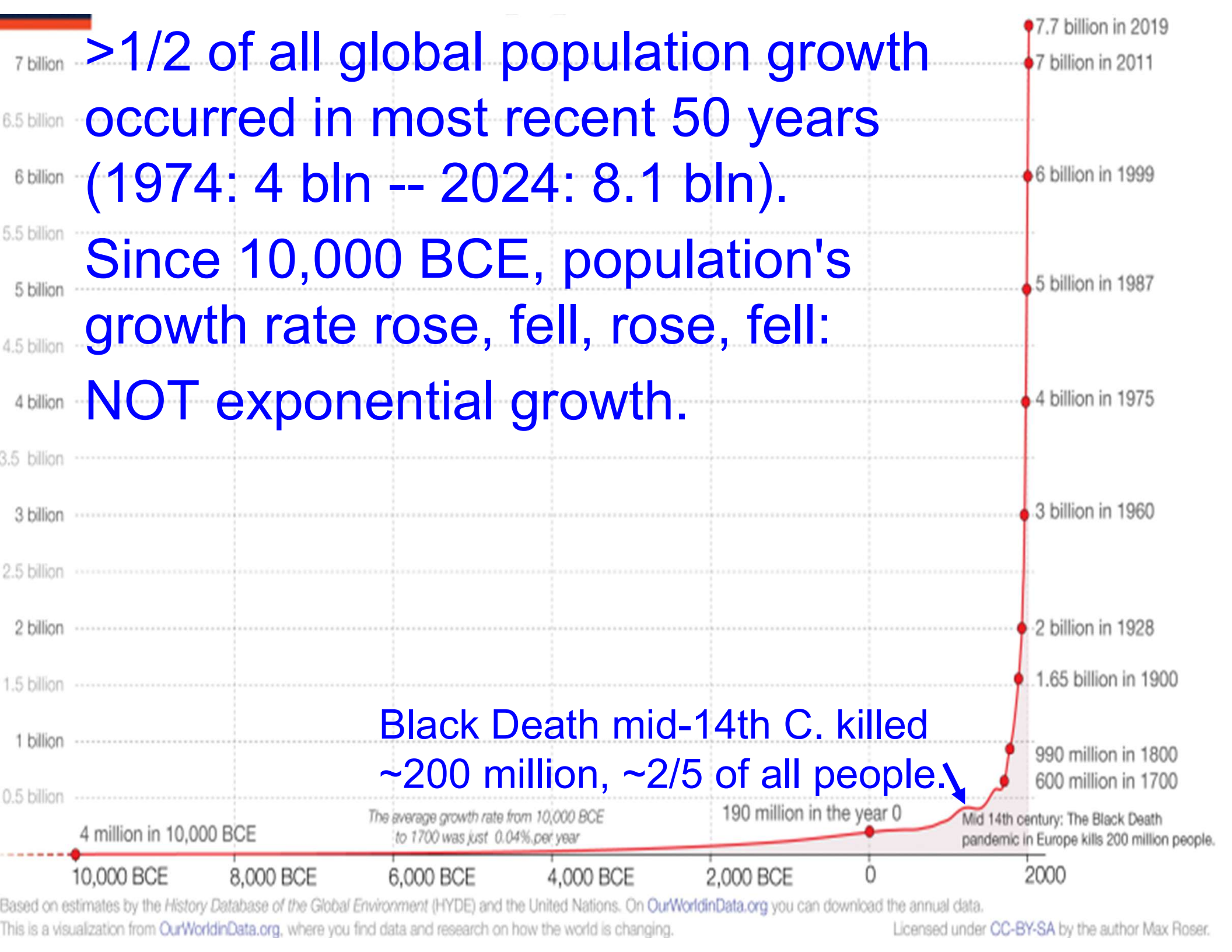
At the end of Younger Dryas, ~11.7ka, global average temperatures rose 10°C (18°F) in 10 years. Platt et al. *Sci. Rep.* 2017



4 changes in population growth

1. independent inventions of agriculture in Middle East, Asia, Africa, Americas
2. exchanges of plants, animals, & people between Old World & New World
3. reduced death rates of children in poor countries
4. decline in fertility rates

			doubling time (years)	
invention	dates	people	before	after
local agriculture	10,000-6,000 BCE	1-10 million	35,000-350,000	1,400-3,000
global agriculture	1750	750 million	750-1,800	100-130
public health	1950	2.5 billion	87	36
fertility control	1970	3.7 billion	34	50


>1/2 of all global population growth occurred in most recent 50 years (1974: 4 bln -- 2024: 8.1 bln).
Since 10,000 BCE, population's growth rate rose, fell, rose, fell:
NOT exponential growth.
Black Death mid-14th C. killed ~200 million, ~2/5 of all people.
7 billion
6.5 billion
6 billion
5.5 billion
5 billion
4.5 billion
4 billion
3.5 billion
3 billion
2.5 billion
2 billion
1.5 billion
1 billion
0.5 billion
7.7 billion in 2019
7 billion in 2011
6 billion in 1999
5 billion in 1987
4 billion in 1975
3 billion in 1960
2 billion in 1928
1.65 billion in 1900
990 million in 1800
600 million in 1700
190 million in the year 0
4 million in 10,000 BCE
The average growth rate from 10,000 BCE to 1700 was just 0.04% per year
Mid 14th century: The Black Death pandemic in Europe kills 200 million people.
10,000 BCE
8,000 BCE
6,000 BCE
4,000 BCE
2,000 BCE
0
2000
Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations. On OurWorldinData.org you can download the annual data.
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.
Licensed under CC-BY-SA by the author Max Roser.

Milestones of population growth

people	year	years to add 1B
1-10 million	-10,000	
100-300 million	0	
500 million	1500	
1 billion	1800-20	~300,000
2	1927-30	110-130
3	1959-60	30
4	1974	14
5	1987	13
6	1999	12
7	2011-12	12-13
8	2022	10

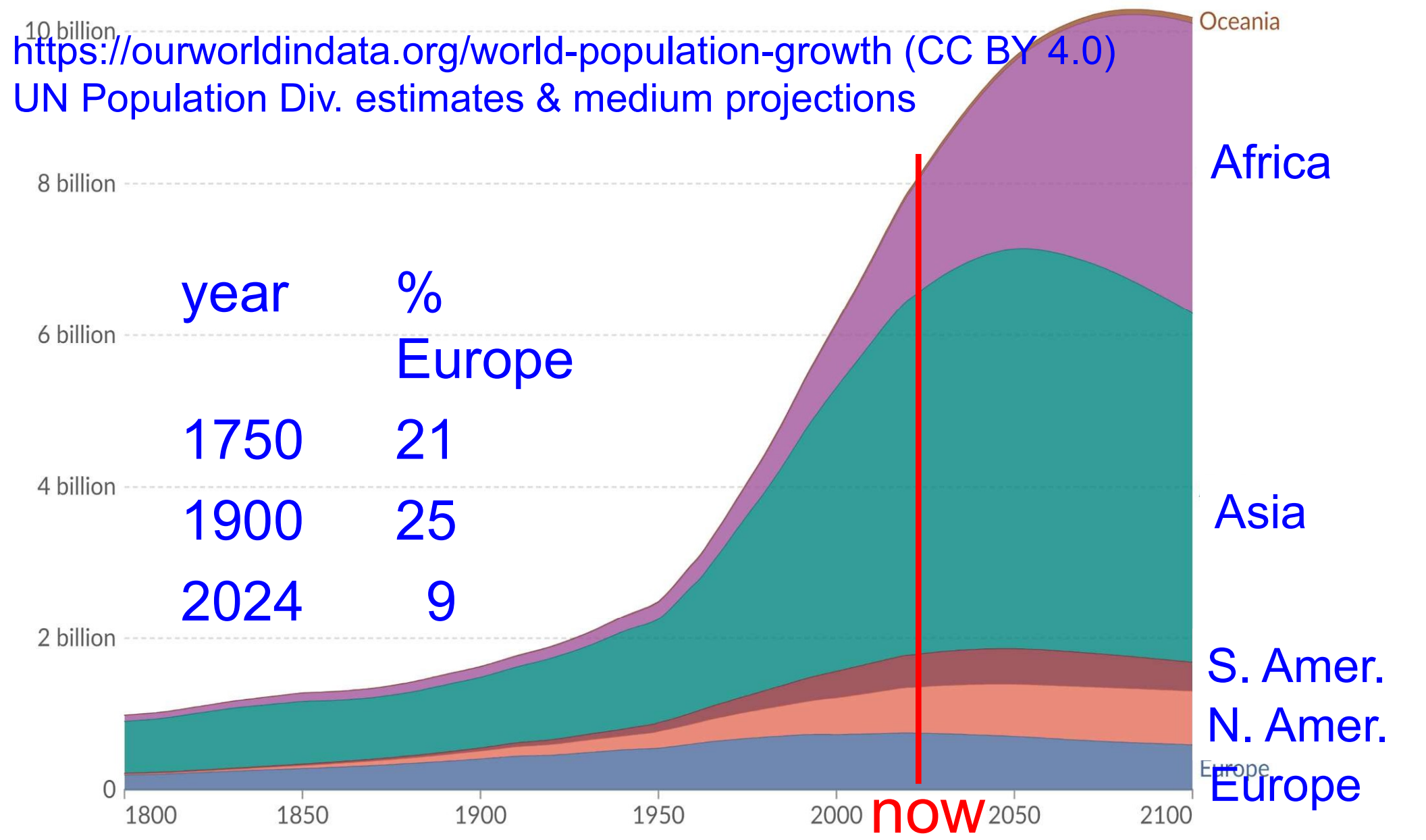
Growth rate -10,000 to 1500 was 0.03-0.05%/y.

Growth rate from 1950 (2.5B) to 1974 (4.0B) was ~2%/y, ~50 times growth rate up to 1500.

20th century was unique demographically.

1. Highest global population growth rate in history: 3.8 x. Only century in which global population even doubled.
2. Largest voluntary decline in fertility
3. Last century with more young people than old people
4. Last century with more rural people than urban people

World population by region 1800-2024



Data source: HYDE (2023); Gapminder (2022); UN WPP (2024)

OurWorldinData.org/population-growth | CC BY

Note: Historical country data is shown based on today's geographical borders.

Peak population

By 2024, 2.27 billion people lived in countries & areas with populations that had peaked.

"Due to faster-than-anticipated declines in fertility for some of the world's most populous countries, the size of the global population now appears likely, with a probability of 80%, to peak within the current century. … one decade ago, … the estimated probability that global population growth would end during the twenty-first century was around 30%."

UN Pop. Div., *World Population Prospects 2024*

Fertility = number of children born

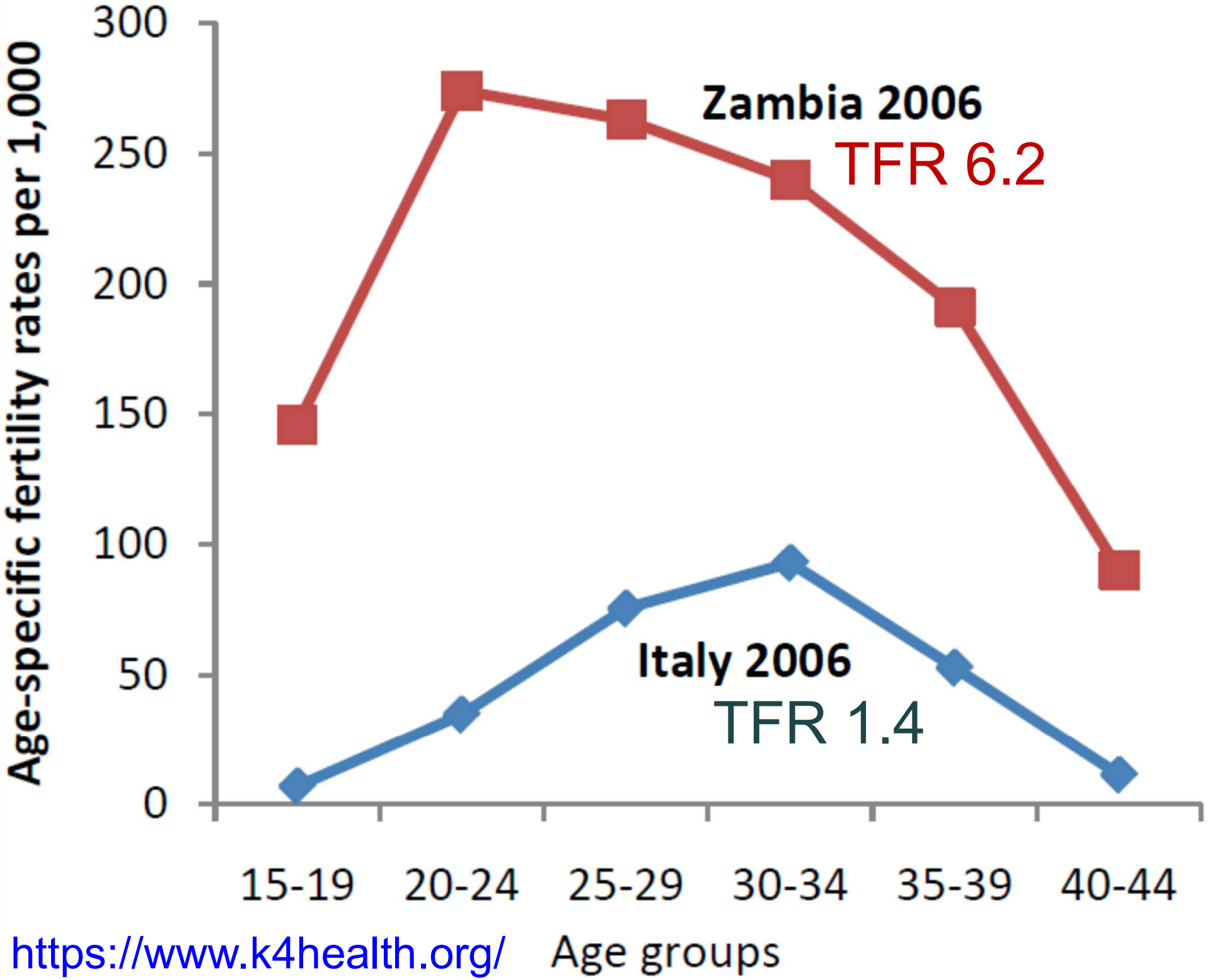
Fecundity = potential for fertility

Total fertility rate (TFR)

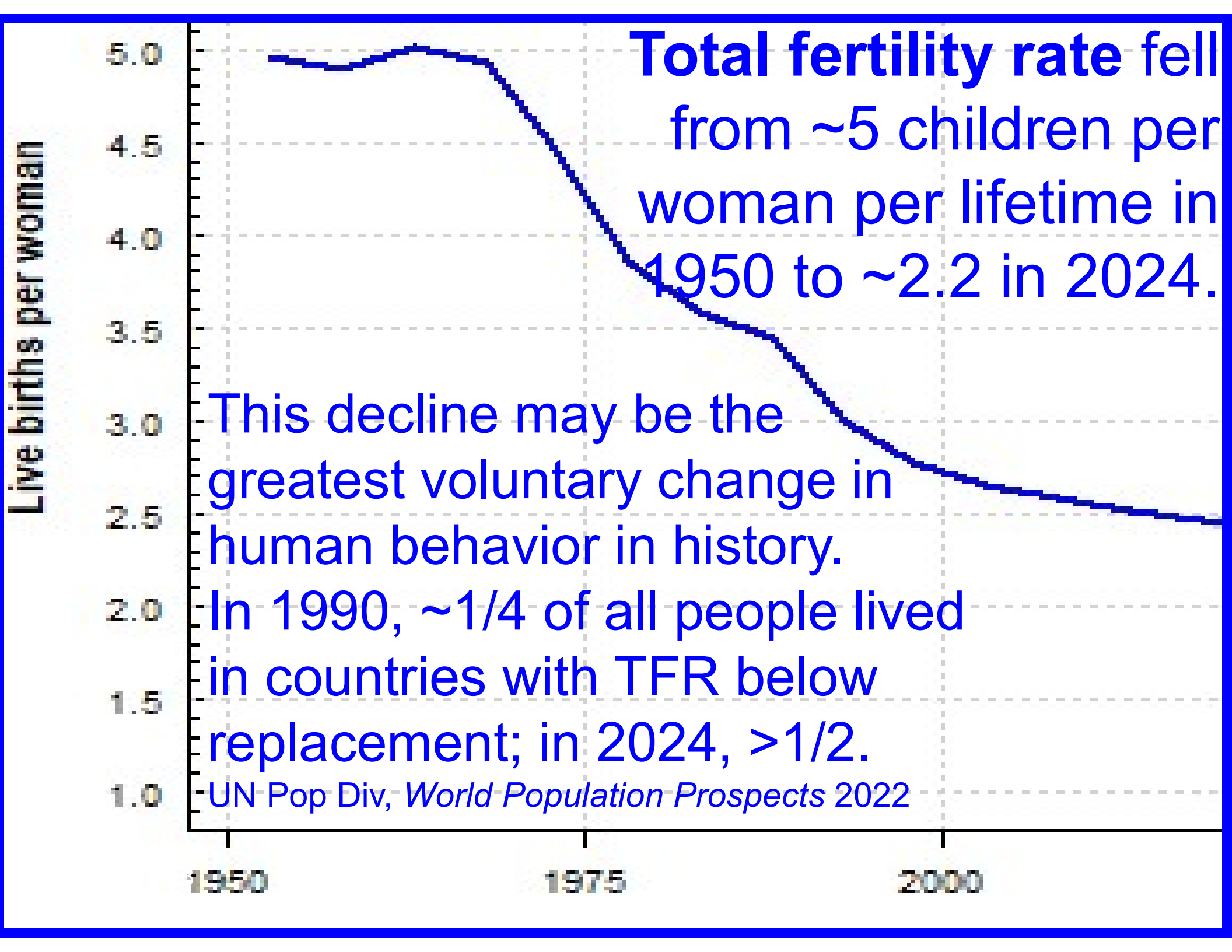
TFR is the most widely used measure of fertility. It assumes no maternal deaths during childbearing ages.

TFR = sum of age-specific birth rates

= average number of children born per woman who lives to last age of reproduction.

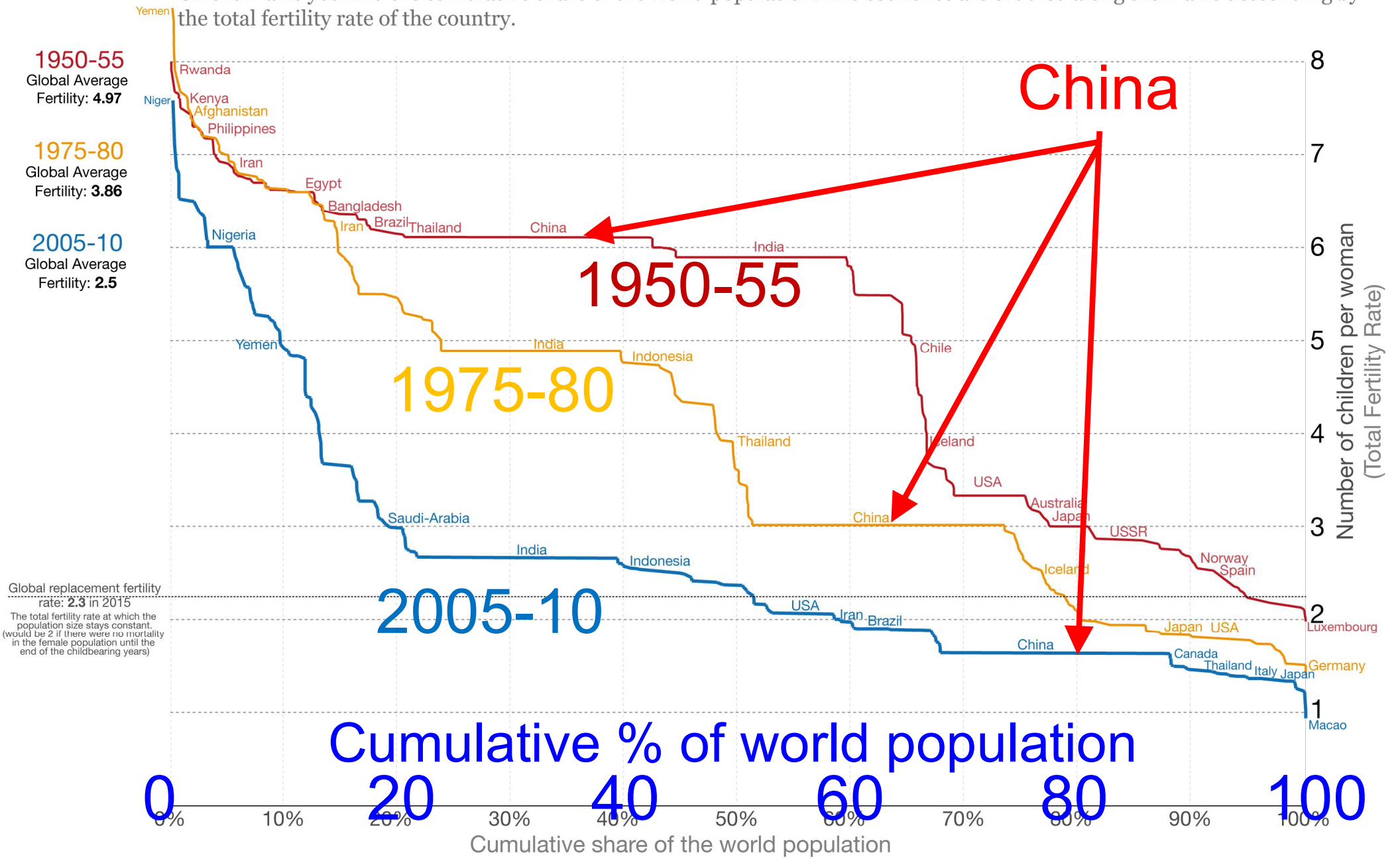


https://www.k4health.org/


Live births per woman
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
1950
1975
2000
Total fertility rate fell from ~5 children per woman per lifetime in 1950 to ~2.2 in 2024.
This decline may be the greatest voluntary change in human behavior in history.
In 1990, ~1/4 of all people lived in countries with TFR below replacement; in 2024, >1/2.
UN Pop Div, *World Population Prospects* 2022

World population by level of fertility over time (1950-2010)

On the x-axis you find the cumulative share of the world population. The countries are ordered along the x-axis descending by the total fertility rate of the country.



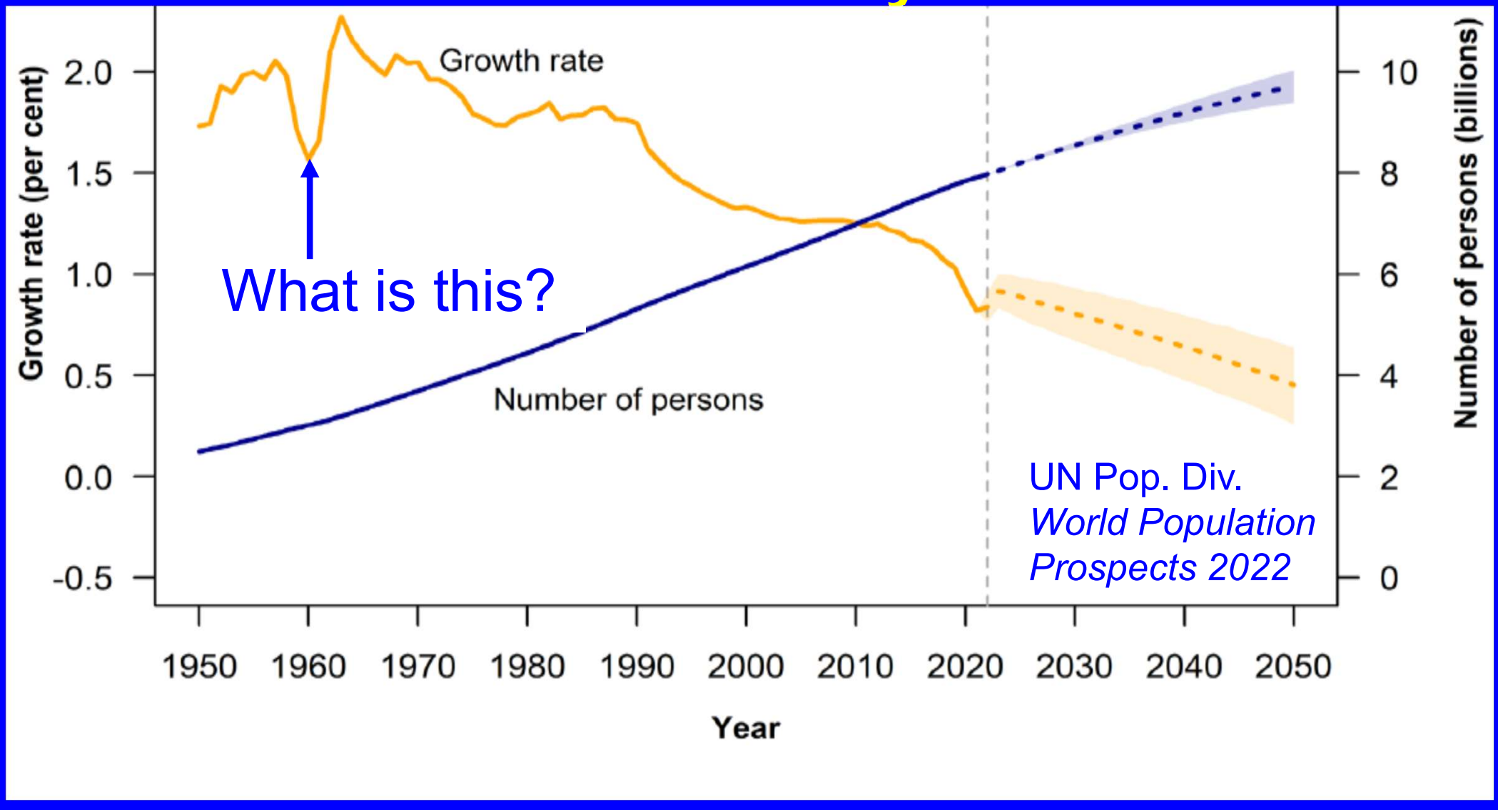
Data source: United Nations Population Division (2012 revision).

The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.

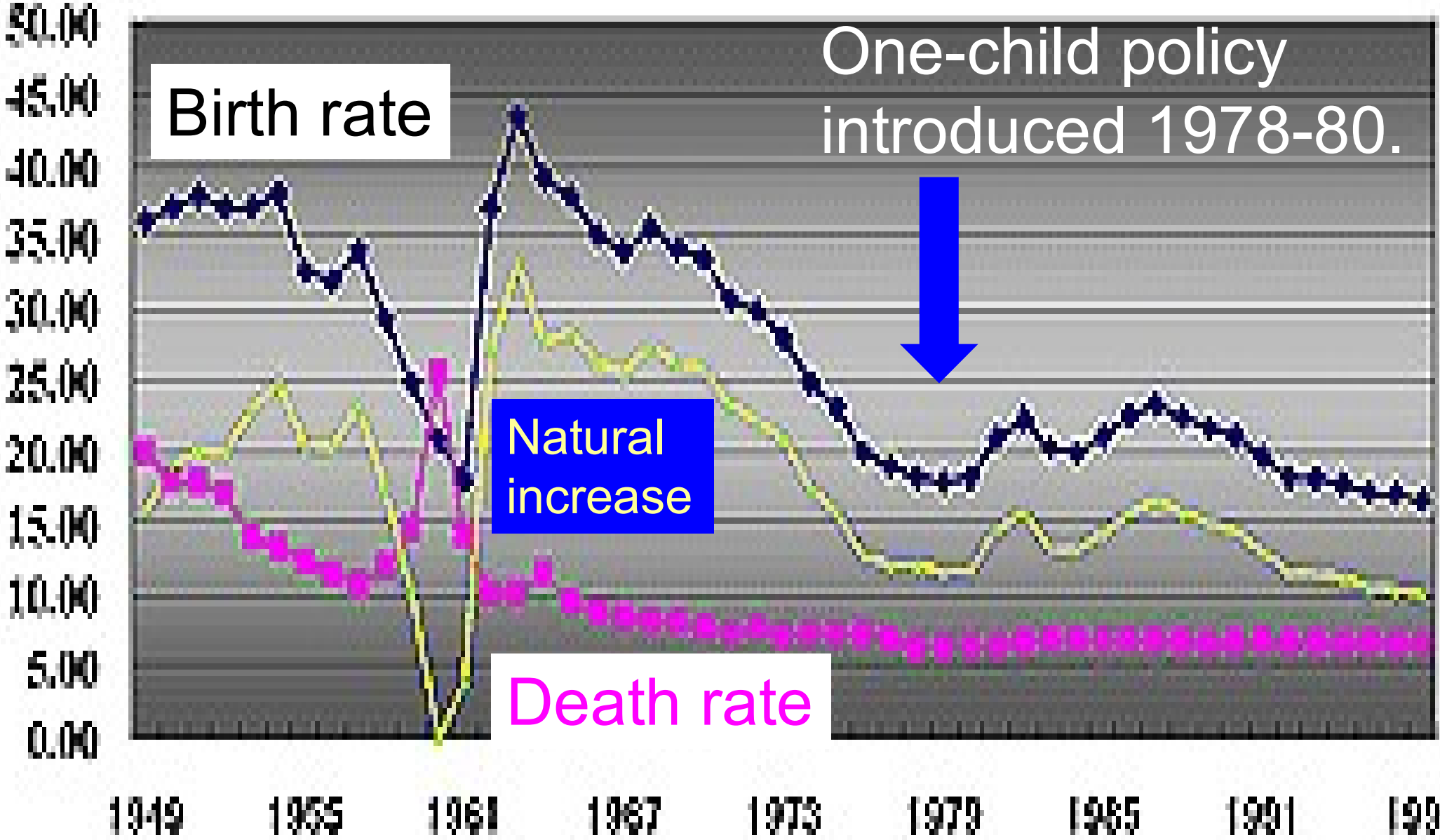
3 measures of fertility

1. Birth rate (BR) = number of births (of both sexes) per year per person (of both sexes, including non-reproductive ages)
2. Total fertility rate (TFR) = average number of births (both sexes) per woman's lifetime at age-specific birth-rates, no female mortality
3. Net rate of reproduction (NRR) = average number of daughters per woman's lifetime at age-specific female birth- & female death-rates (includes effects of sex-ratio at birth)

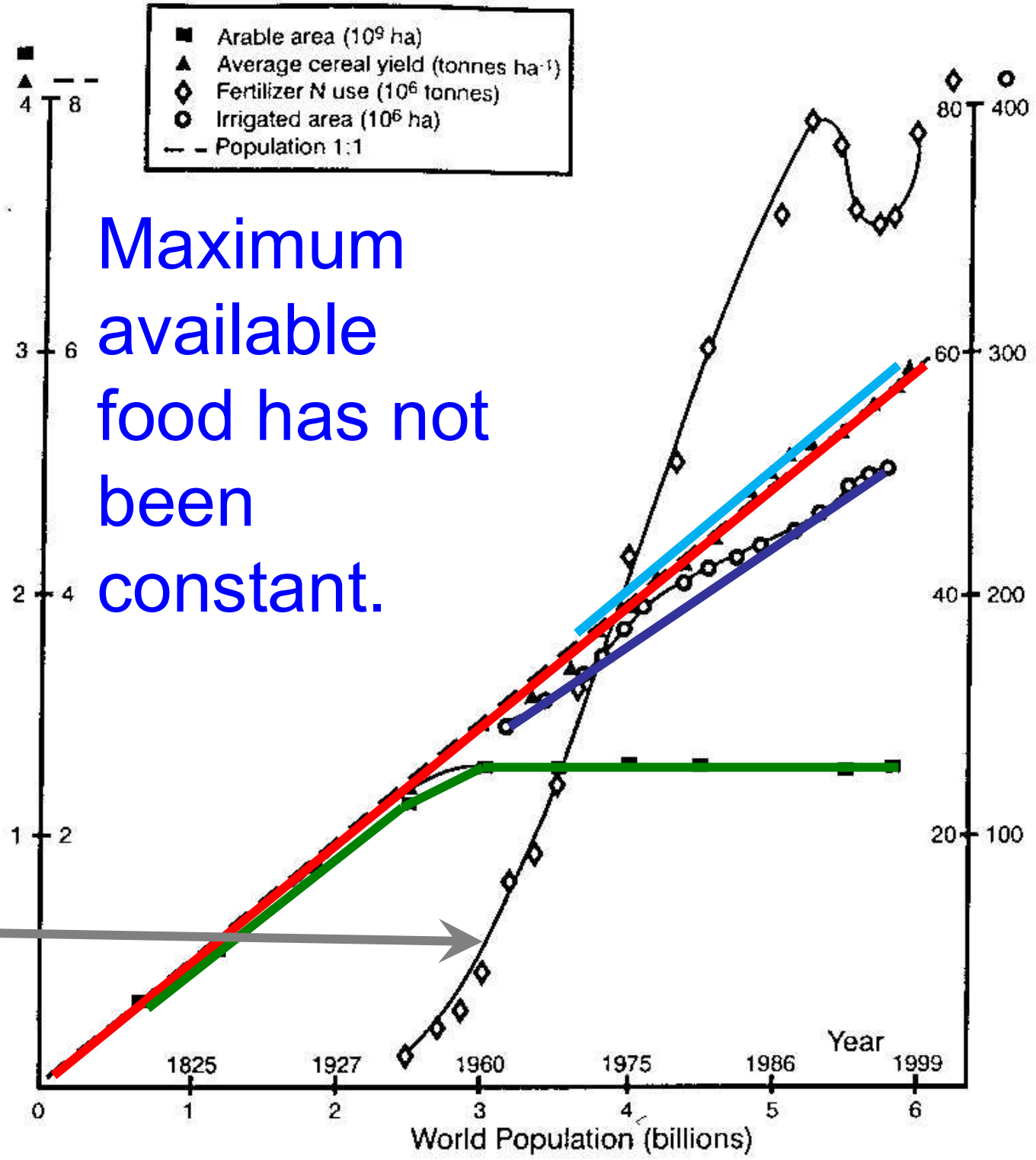
Global population growth rate peaked at 2.1-2.2%/y in 1962-1963, fell to ~0.9%/y now.



China's rates of birth, death, & natural increase (per 1,000 people), 1949-1997



As population surpassed 3 billion in 1960, arable area leveled off, but average cereal yield rose with increasing use of fertilizer nitrogen ~~and~~ irrigated area.

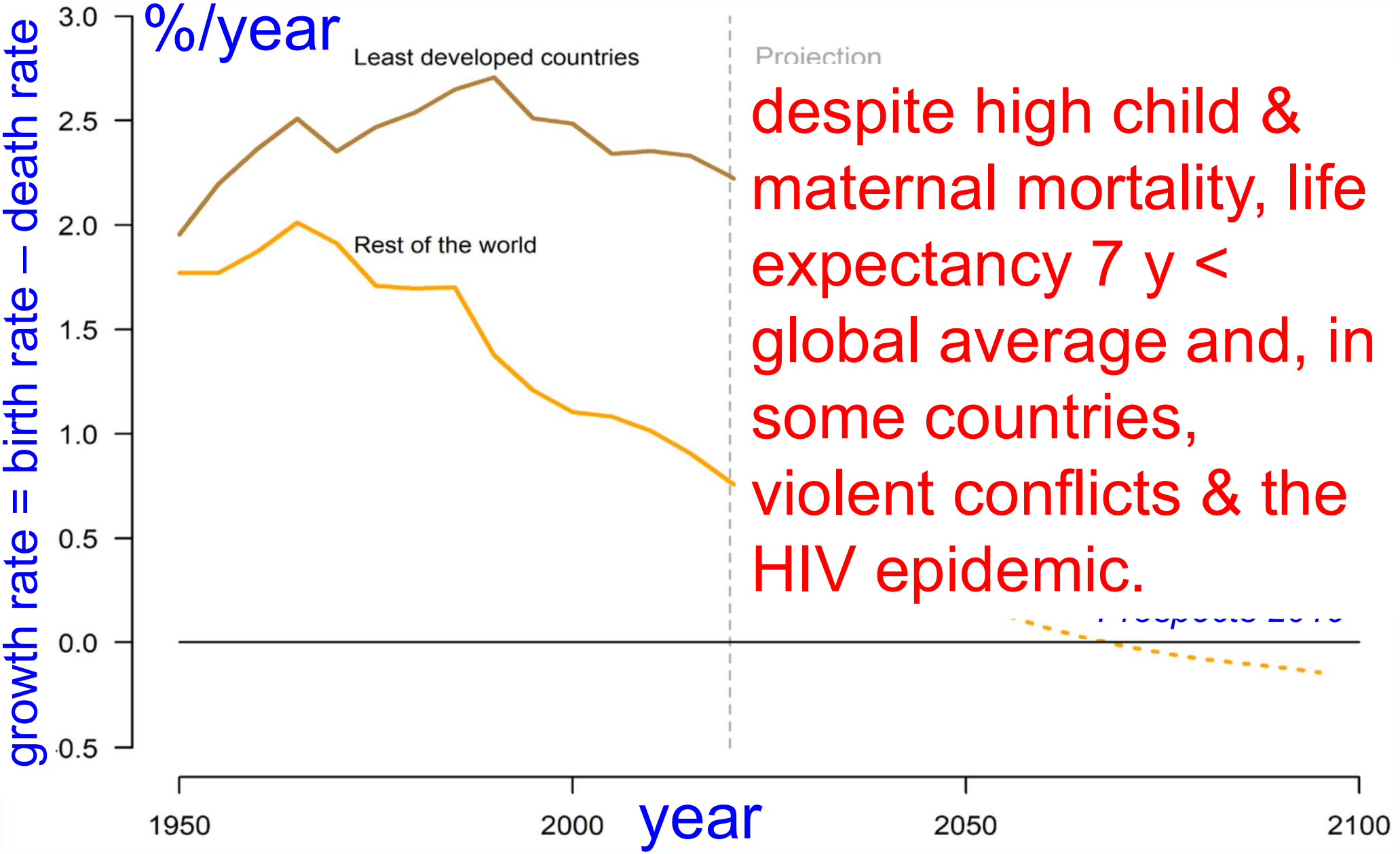


Green revolution (mid-1960s+) coincided with decline of population growth rate. Malthus was wrong.

Population growth rates fell in countries with more abundant food because of lower child mortality & lower birth rates.

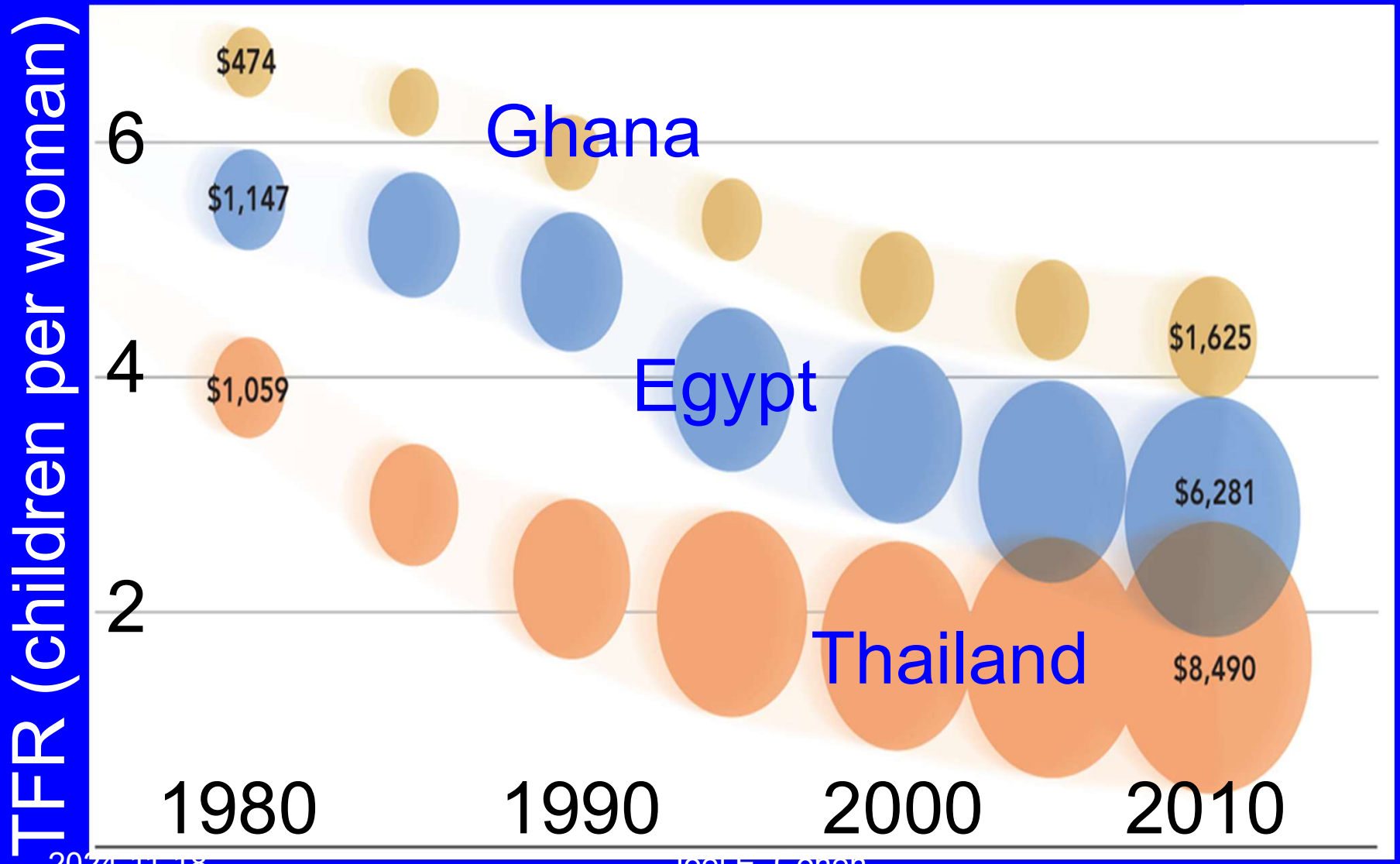
The 1960s marked both the peak of the global population growth rate, which has since fallen by half, & the beginning of the "green revolution."

47 least-developed countries grow almost 3x as fast as rest of world …



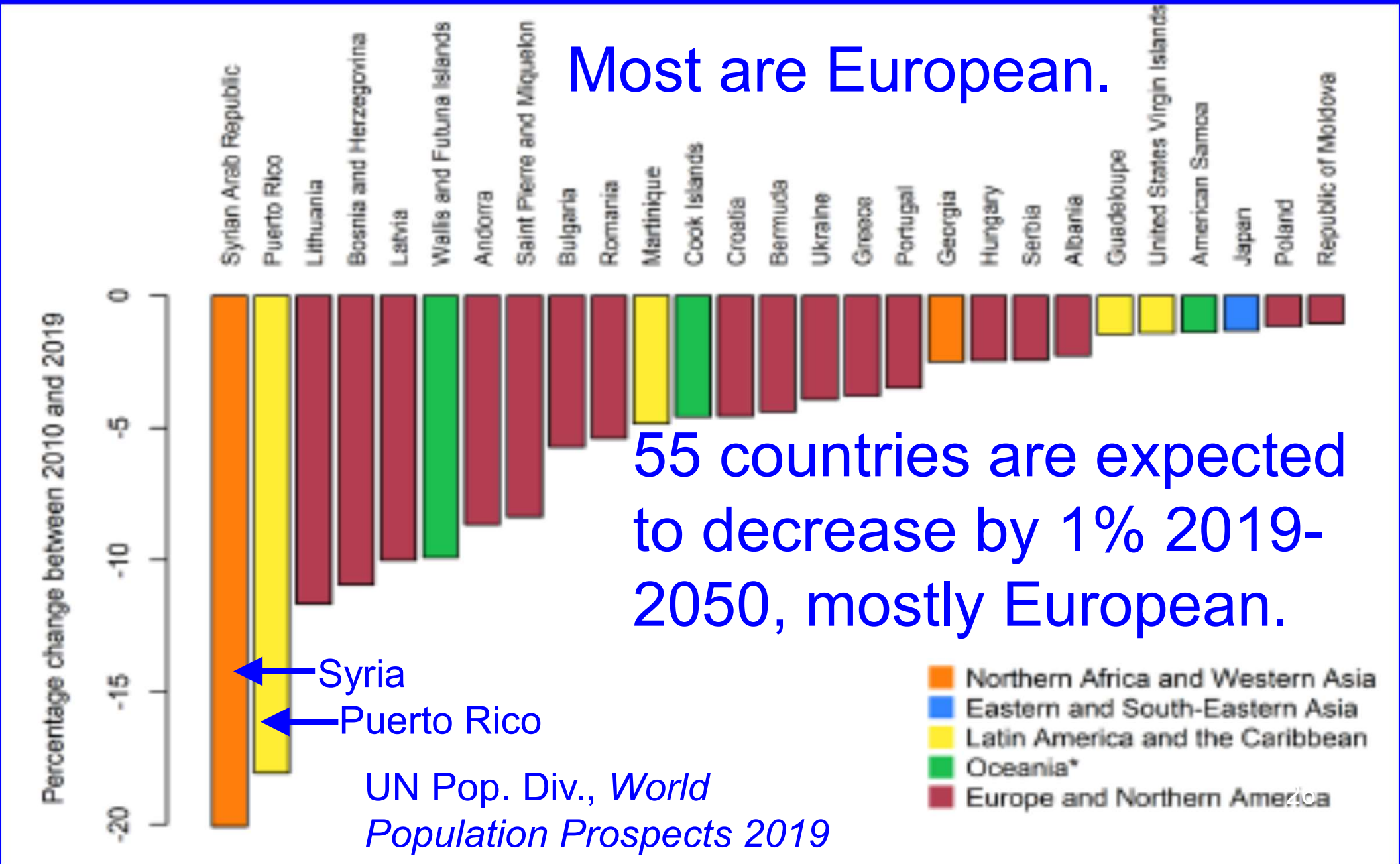
despite high child & maternal mortality, life expectancy 7 y < global average and, in some countries, violent conflicts & the HIV epidemic.

GDP per capita rose faster with lower total fertility rates.



SOURCES: United Nations Population Division, World Population Prospects: The 2010 Revision (2011); and World Bank, World Development Indicators Database. Population Reference Bureau

Population size fell by at least 1% in 27 countries 2010-2019.

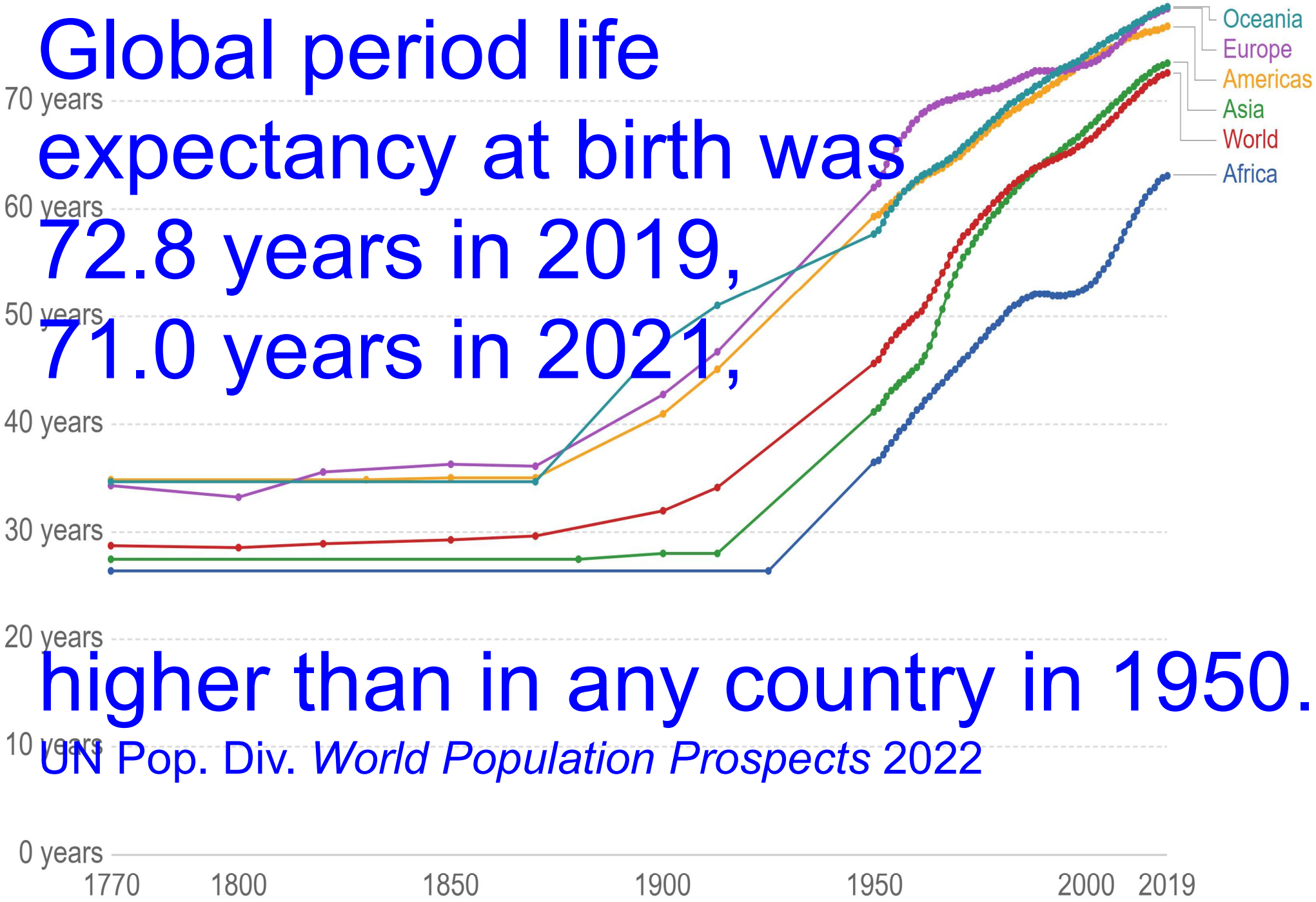


UN Pop. Div., *World Population Prospects 2019*

Population aging

Global period life expectancy at birth was 72.8 years in 2019, 71.0 years in 2021, higher than in any country in 1950.

UN Pop. Div. *World Population Prospects* 2022

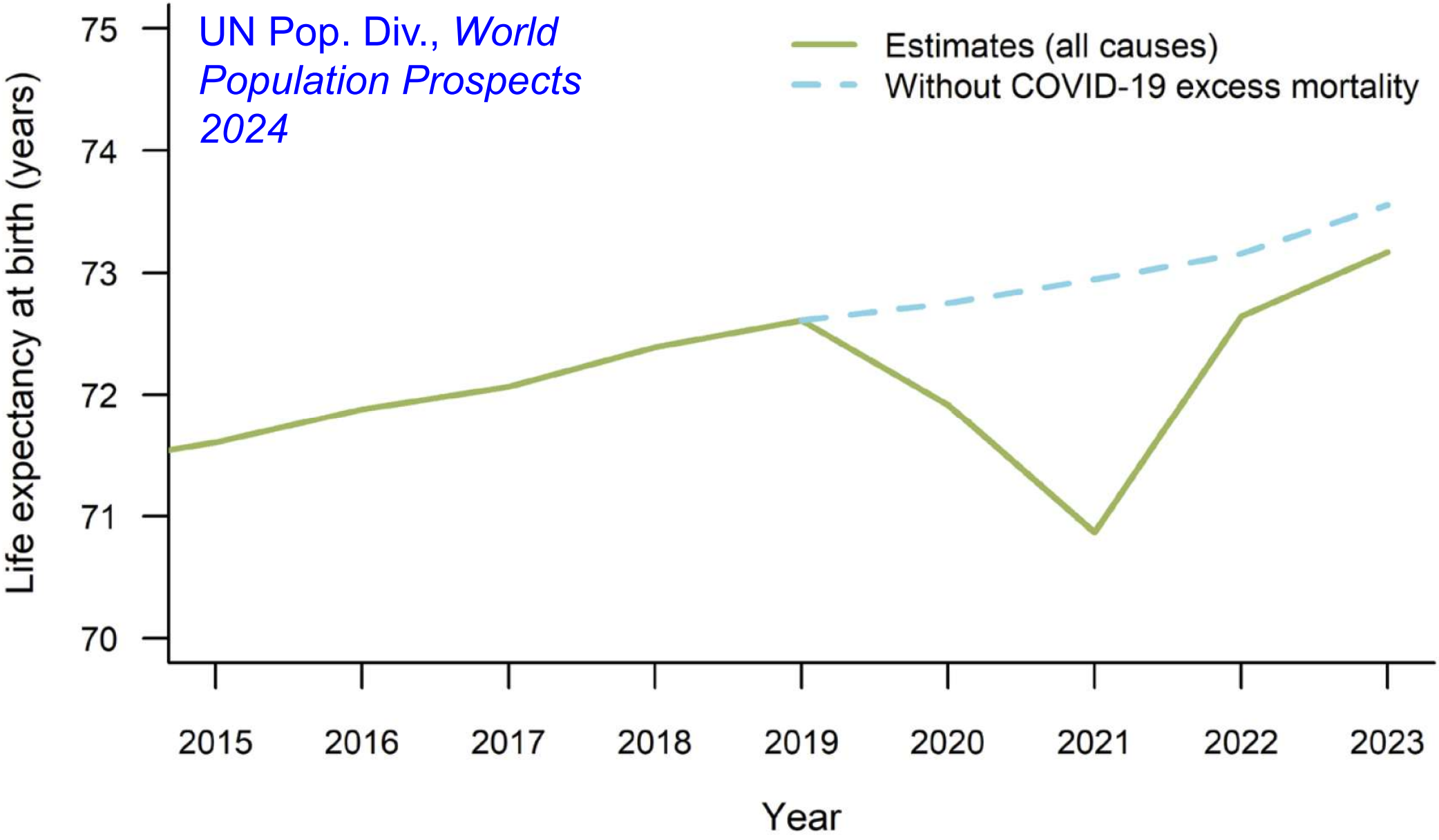


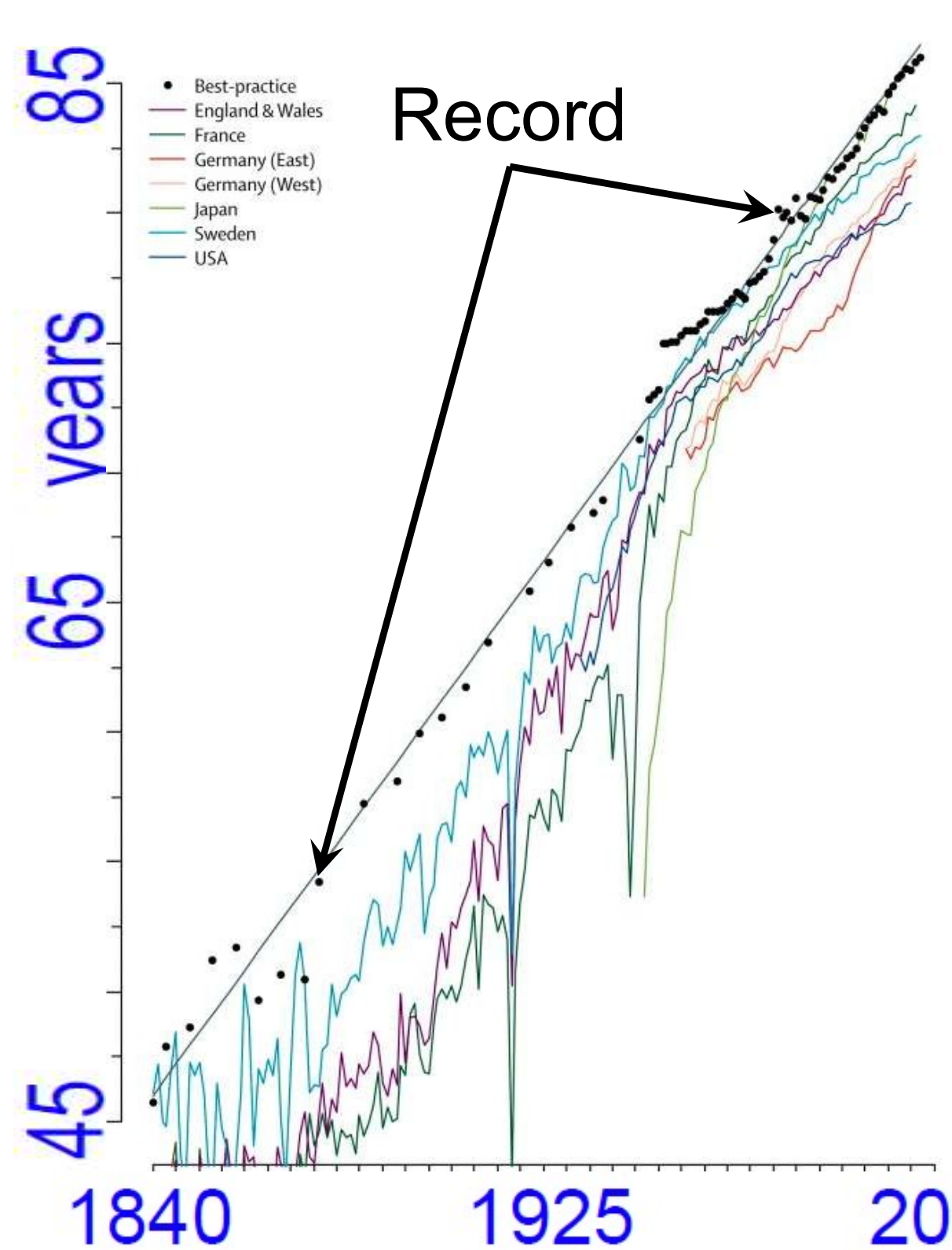
Source: Riley (2005), Clio Infra (2015), and UN Population Division (2019)

OurWorldInData.org/life-expectancy • CC BY

Note: Shown is period life expectancy at birth, the average number of years a newborn would live if the pattern of mortality in the given year were to stay the same throughout its life.

Global life expectancy at birth, observed & without COVID-19

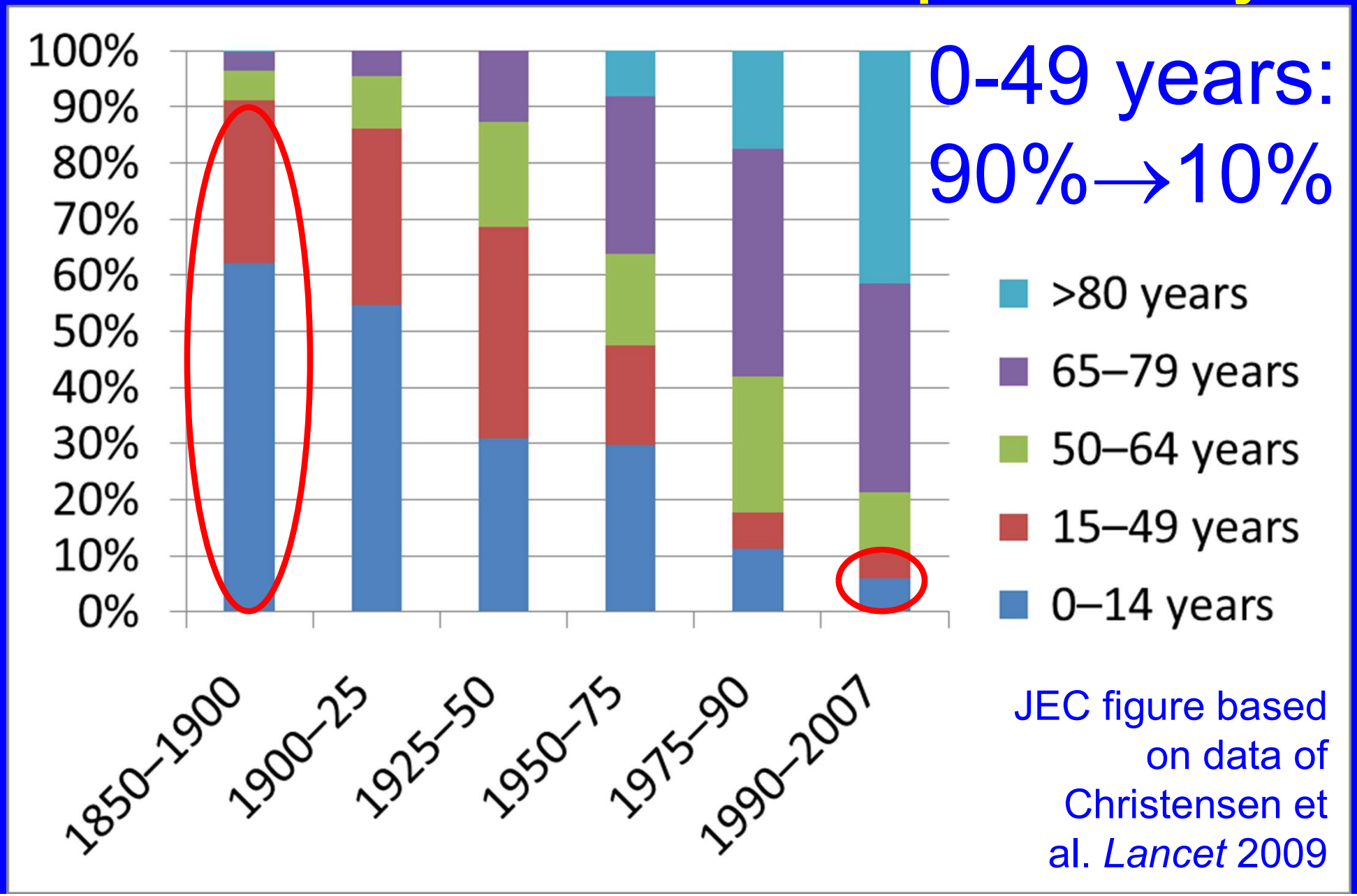




Record national period female life expectancy at birth rose 0.24 years of life per calendar year, 1840-2007.

Christensen et al.
Lancet 2009

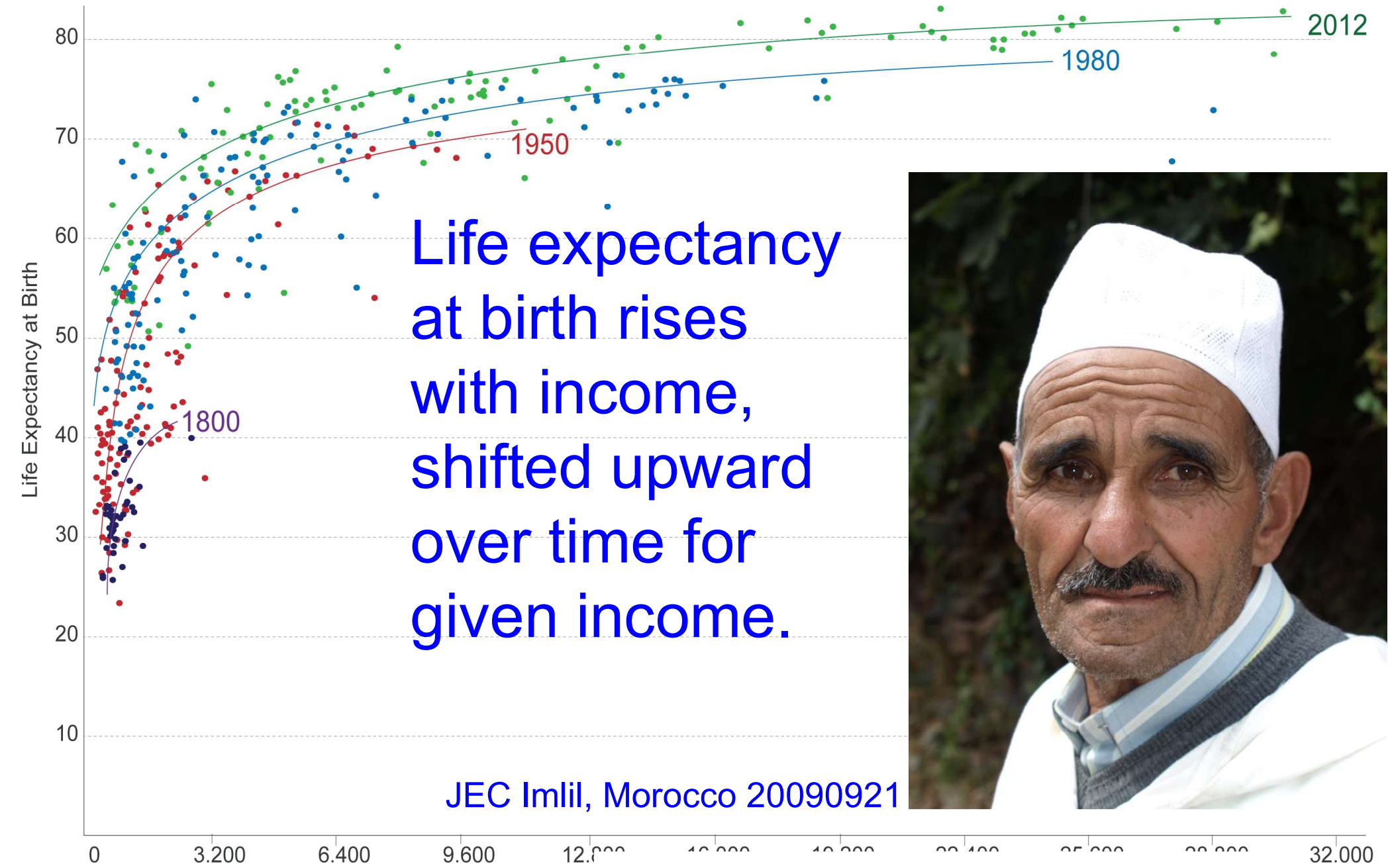
Which age groups contributed to rise in record life expectancy?



Life Expectancy vs. GDP per capita in 1800, 1950, 1980 and 2012

To allow comparisons of GDP per capita over time and between different countries the measure is adjusted for price differences between countries and inflation.

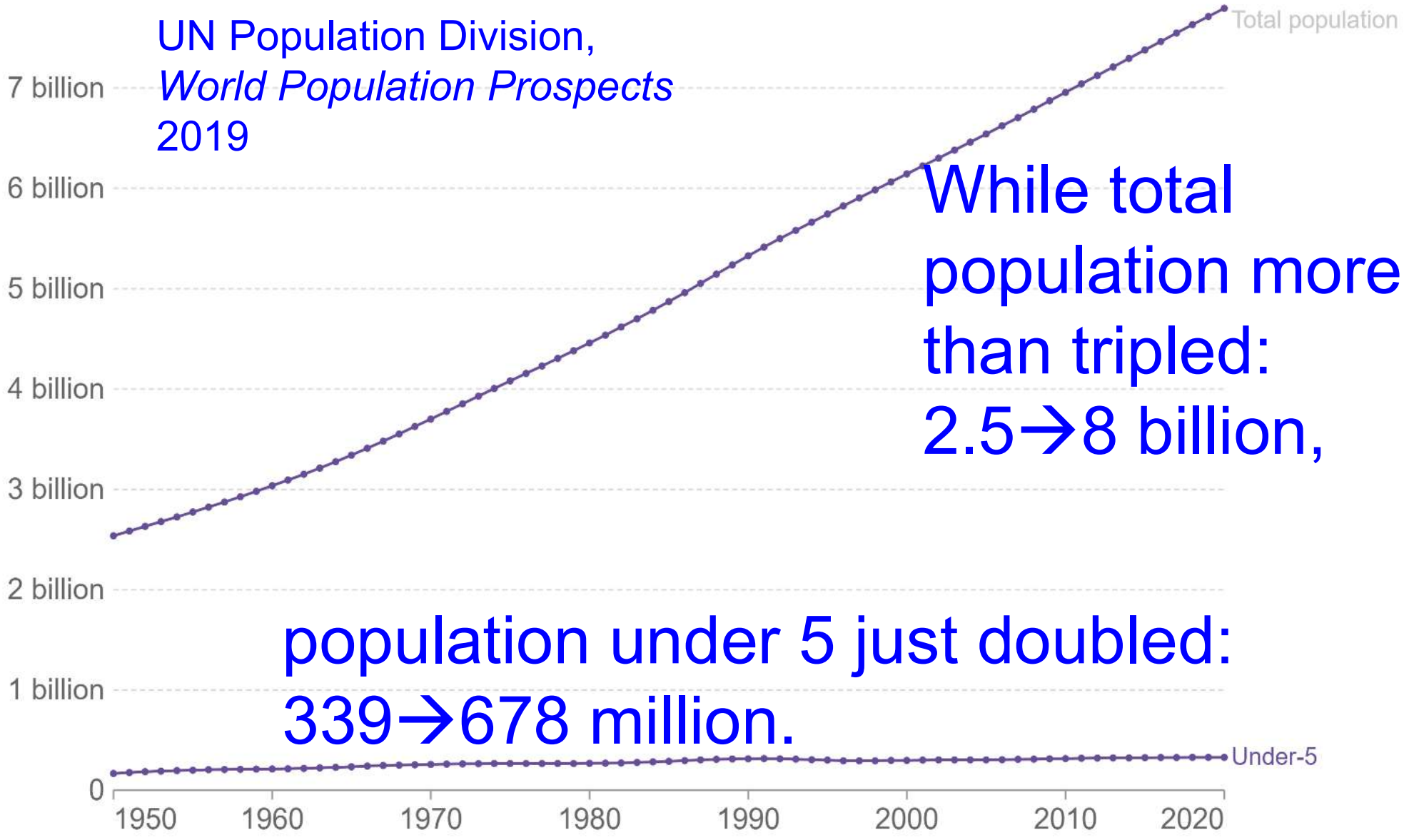
Our World in Data



Data sources: Data on life expectancy are from Gapminder.org; data on GDP per cap

OurWorldinData.org – Research and data to make progress against the world's largest problems.

The world grew older, 1950-2020.



While total population more than tripled: 2.5→8 billion,

population under 5 just doubled: 339→678 million.

Source: UN Population Division (2019 Revision)

OurWorldInData.org/world-population-growth/ • CC BY

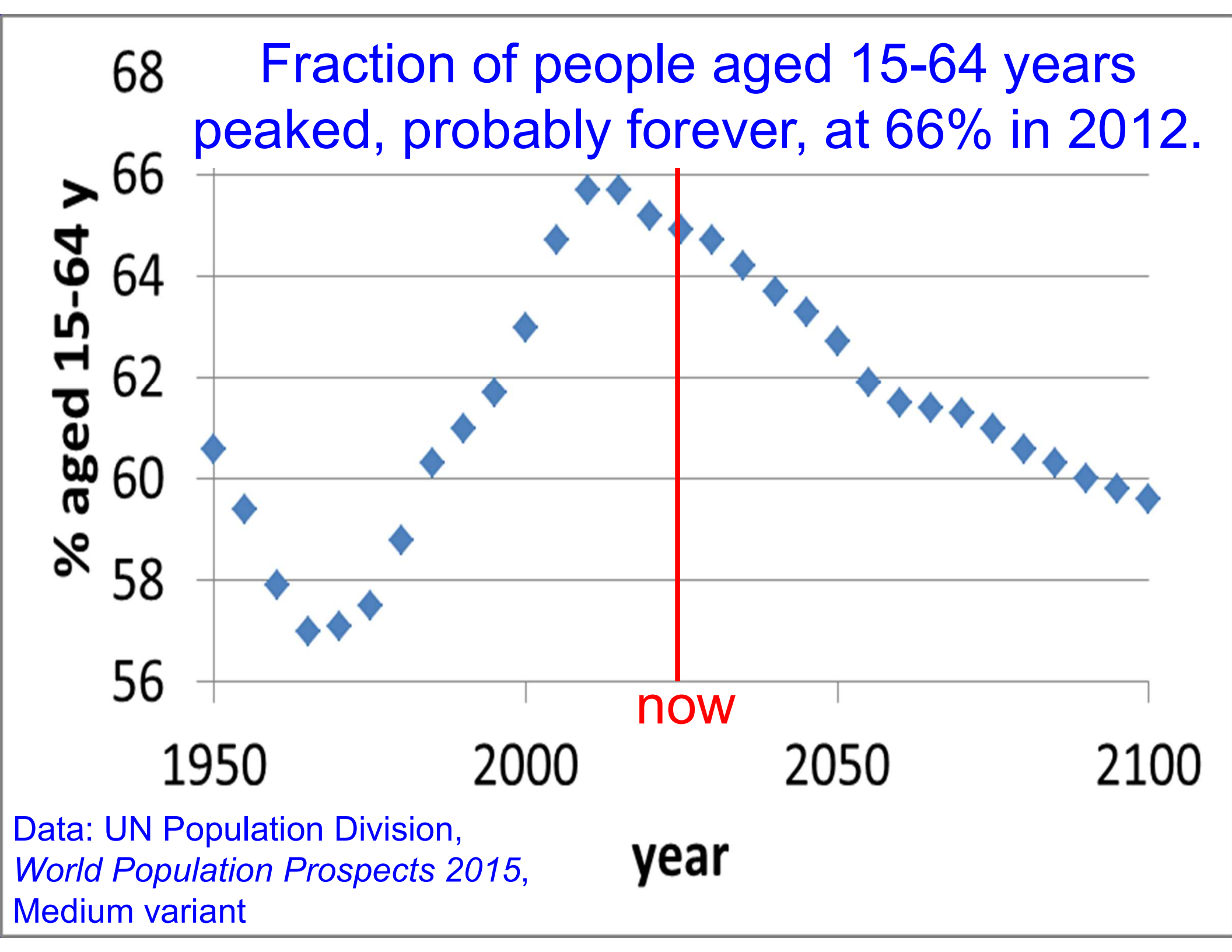
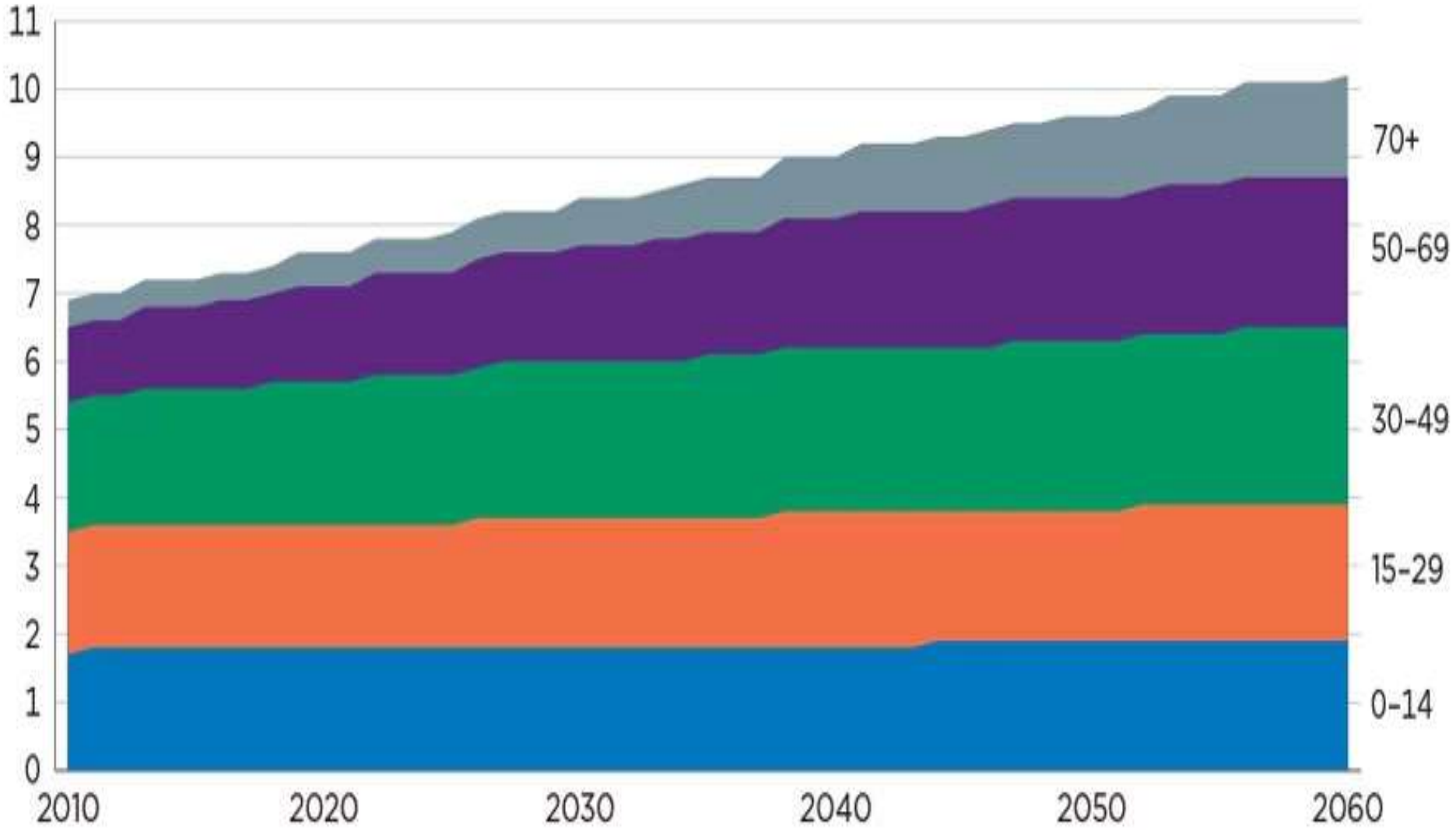

Fraction of people aged 15-64 years peaked, probably forever, at 66% in 2012.
% aged 15-64 y
68
66
64
62
60
58
56
now
1950
2000
2050
2100
year
Data: UN Population Division,
World Population Prospects 2015,
Medium variant

Figure 4. % 65+: 10% in 2023 to 20% in 2060

Estimated and Projected World Population by Age Group: 2010-2060

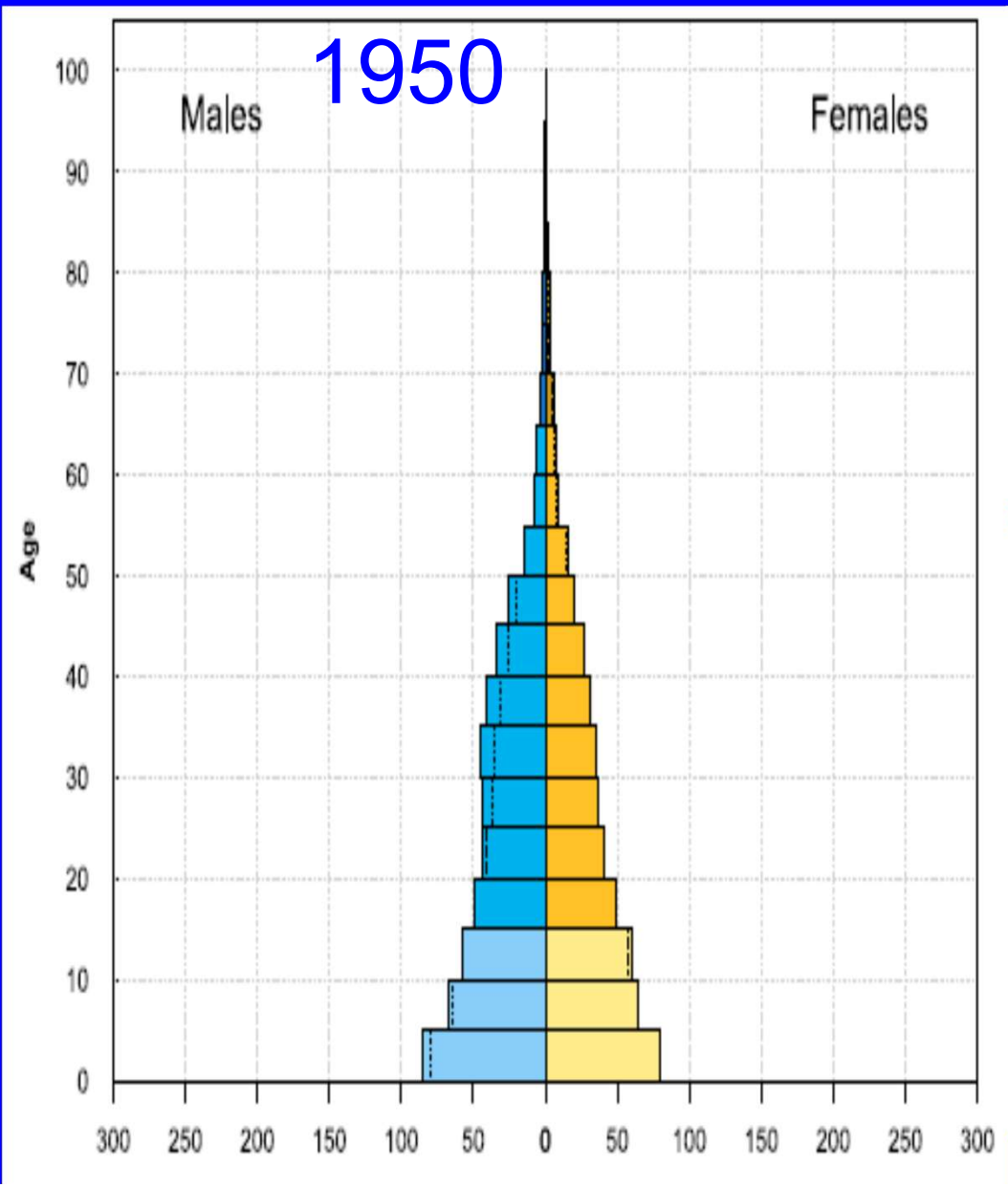
(In billions)

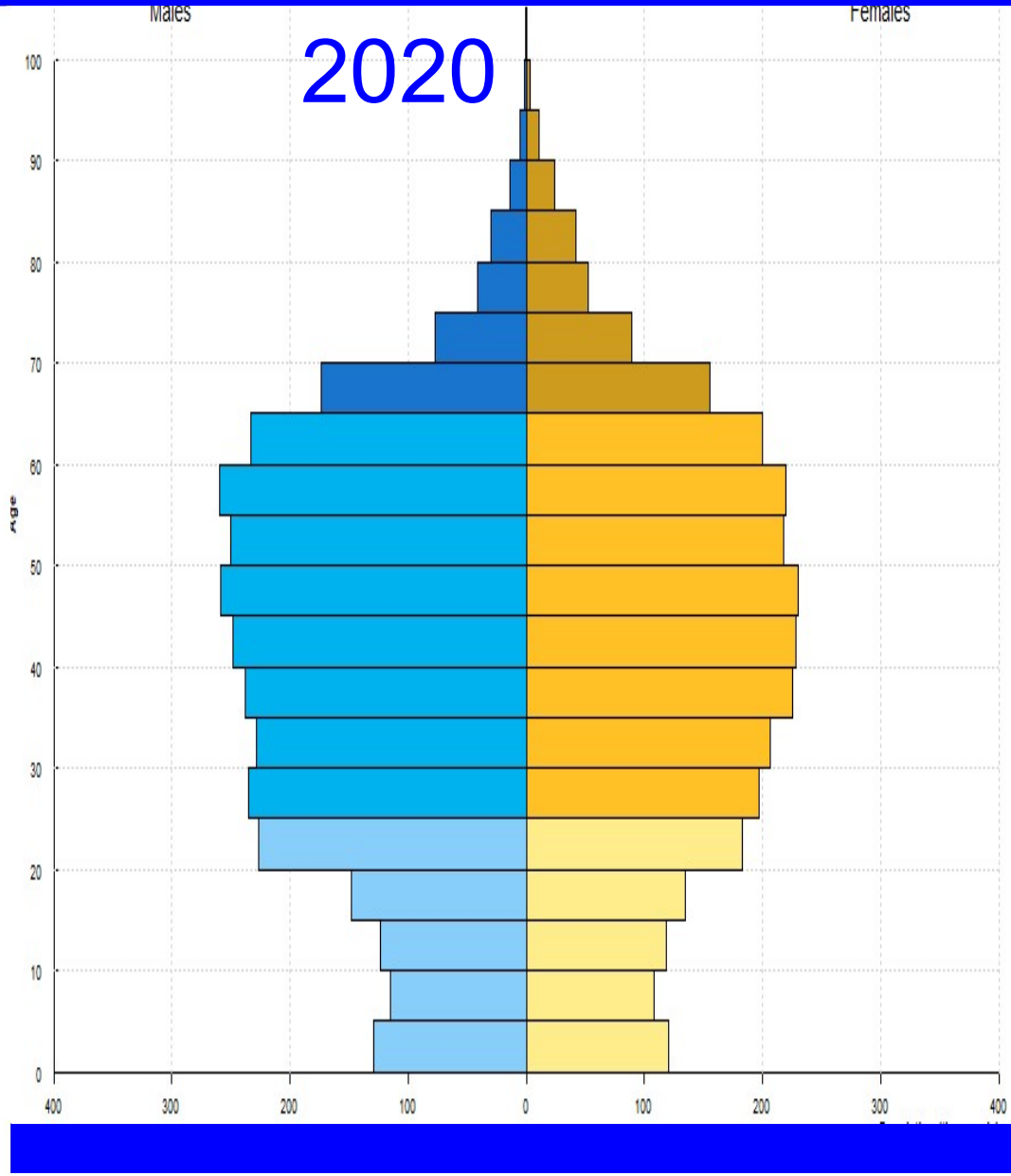


Source: U.S. Census Bureau, International Database.

Singapore: low fertility, long life

UN Population Division, *World Population Prospects: 2019, II: Demographic Profiles*





The fraction of old people (e.g., %65+ years) in a population depends more on its fertility rates than on its death rates.

Why? Most people are born at age 0.

Birth rates control the size of the bottom of the age pyramid.

Immigration cannot keep a population young because immigrants age, too.

https://ourworldindata.org/grapher/life-expectancy-vs-gdp-per-capita?time=2020

<iframe src="https://ourworldindata.org/grapher/life-expectancy-vs-gdp-per-capita?time=2021&tab=chart" loading="lazy" style="width: 100%; height: 600px; border: 0px none;" allow="web-share; clipboard-write"></iframe>

70 is the new 60.

In USA, people (of both sexes) aged 70-74 in 2005-2009 had remaining life expectancy of people aged 60-64 years in 1935-39.

Year	Age	Remaining life expectancy
1935-1939	70-74	9.95
1935-1939	60-64	15.72
2005-2009	70-74	15.24

http://www.mortality.org/hmd/USA/STATS/bltper_5x5.txt

Cities

How many people are "urban"?

UN Population Division estimates about 55% of people live in urban areas.

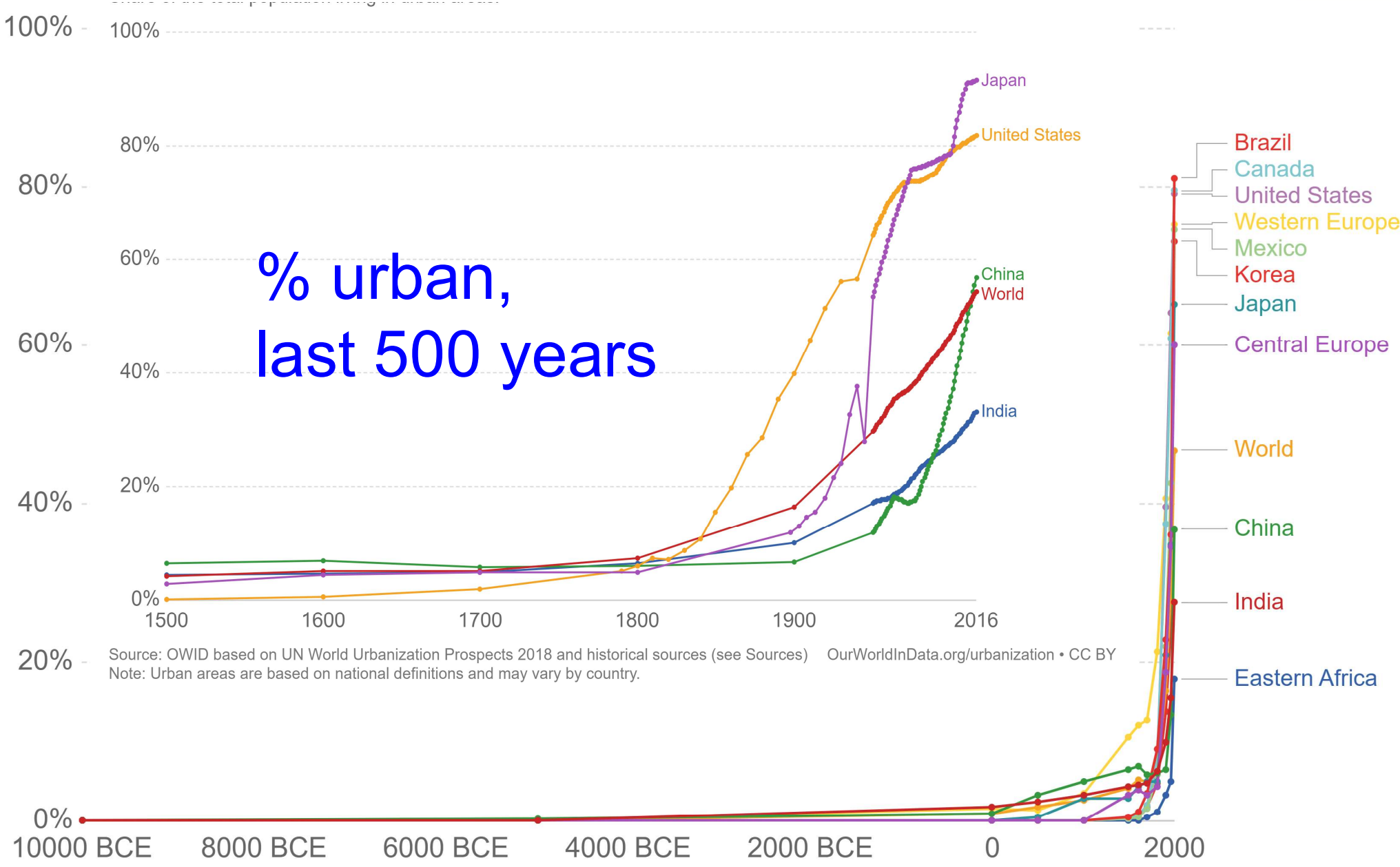
UN Population Division, *World Urbanization Prospects 2018*

European Commission estimates about 85% of people live in urban areas.

Pesaresi, M., et al. (2016). Atlas of the human planet … *JRC103150. Publications Office of the European Union*

There is no international standard or consensus on the definition & measurement of "urban."

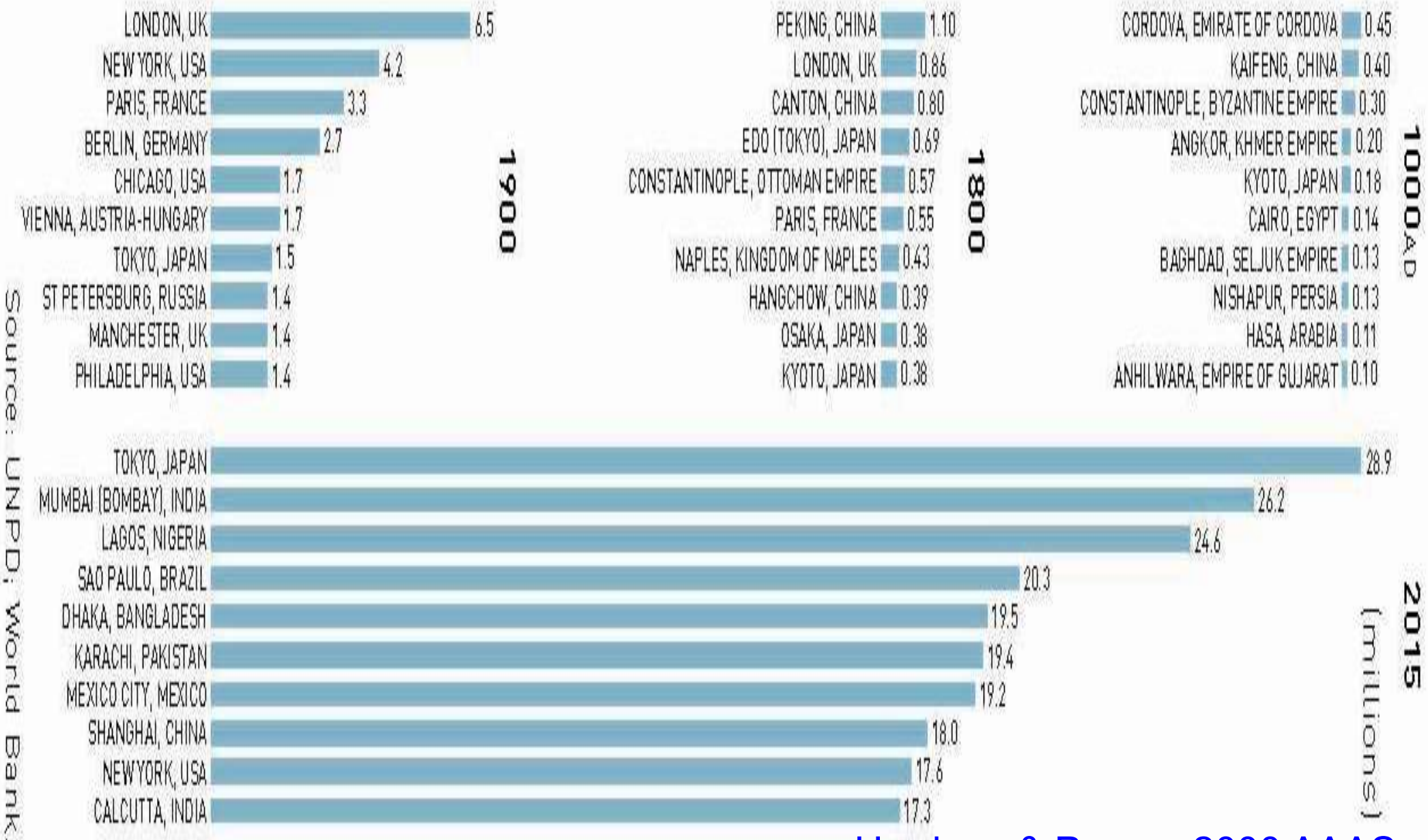
% urban, last 12,000 years



Source: HYDE 3.1 (2010)

OurWorldInData.org/urbanization • CC BY

10 cities with most people in 1000 have no overlap with top 10 cities in 2015.

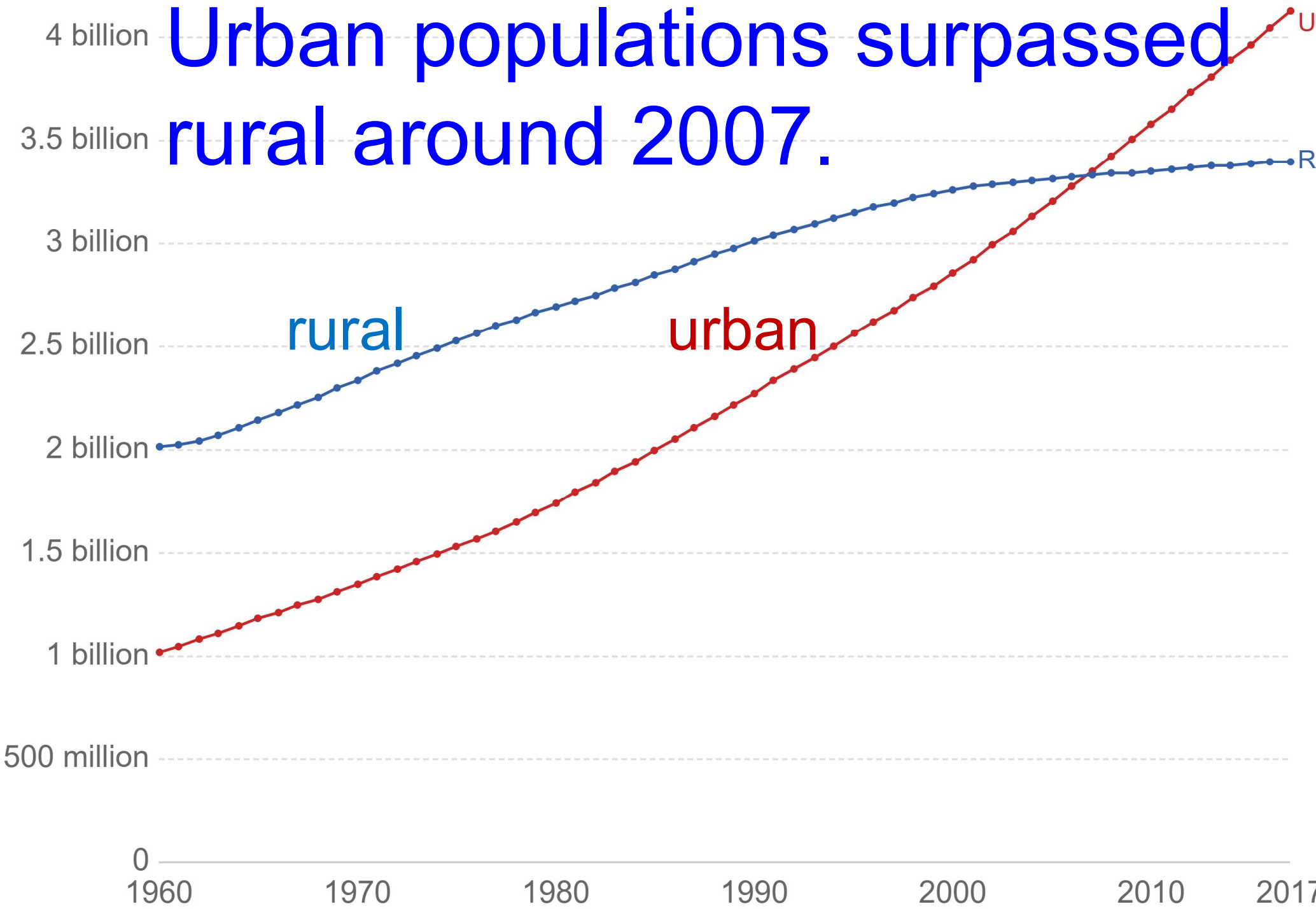


Harrison & Pearce 2000 AAAS

Cities grew in 20th century.

	1900	1950	2000
Urban population (billions)	0.21	0.75	2.87
% of total	13%	30%	47%
Number of cities with ≥10 million people	0	1	20
% of urban people living in cities with ≥10 million people	0	1.6	9.6

Urban populations surpassed rural around 2007.



Source: UN World Urbanization Prospects (2018) OurWorldinData.org

Note: Urban populations are defined based on the definition of urban areas by national statistical offices.

Urban expansion competes with surrounding farms.

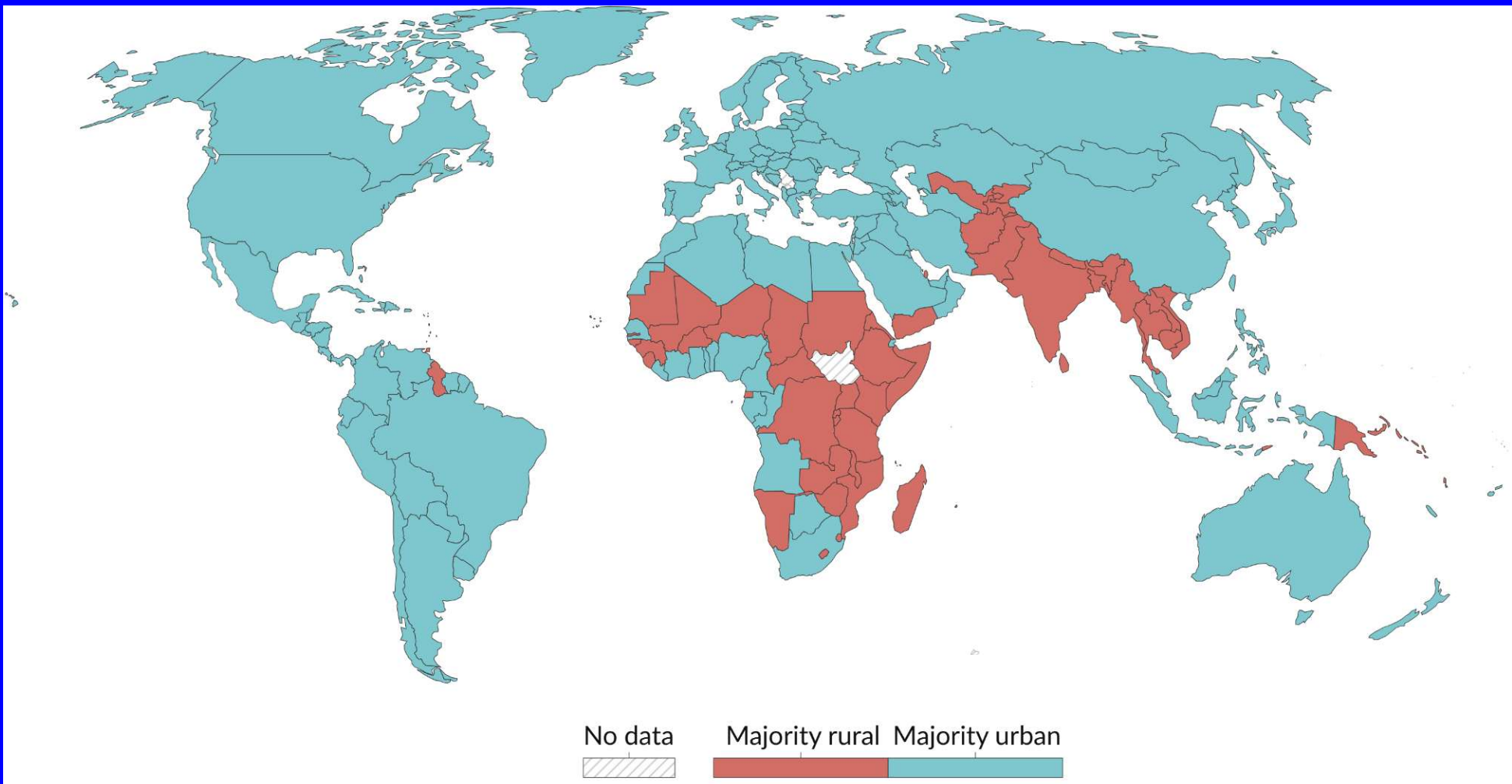
Rice field, Fuji City, Japan 2006-01-22, Michiko Shimoda

Urban growth could affect food supply.

Many cities (~3% of land) are located on prime agricultural land (~10% of land).

If doubling of urban population doubles urban area, prime agricultural land could be removed from food production.

Few areas remain >50% rural.



Data source: United Nations, Department of Economic and Social Affairs, Population Division (2018); HYDE (2023)

Note: Because the estimates of city and metropolitan areas are based on national definitions of what constitutes a city or metropolitan area, cross-country comparisons should be made with caution.

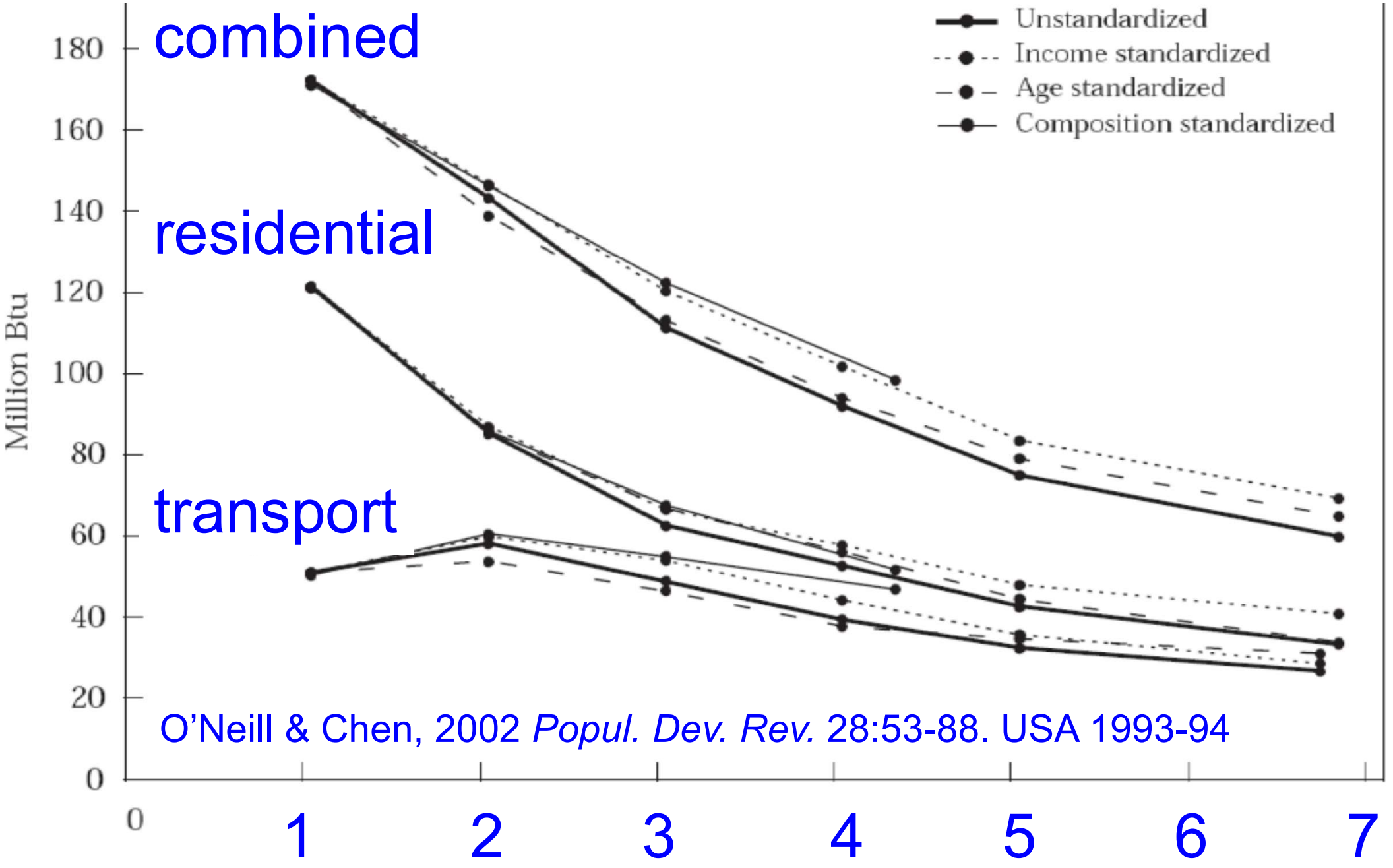
OurWorldinData.org/urbanization | CC BY

Number of households grew faster than number of people.

Average people per household 1970-2000 fell
in less-developed countries, from 5.1 to 4.4,
in more-developed countries, from 3.2 to 2.5.

Reasons: lower fertility, greater longevity, later marriage, more divorce, rising wealth, urbanization, changing preferences

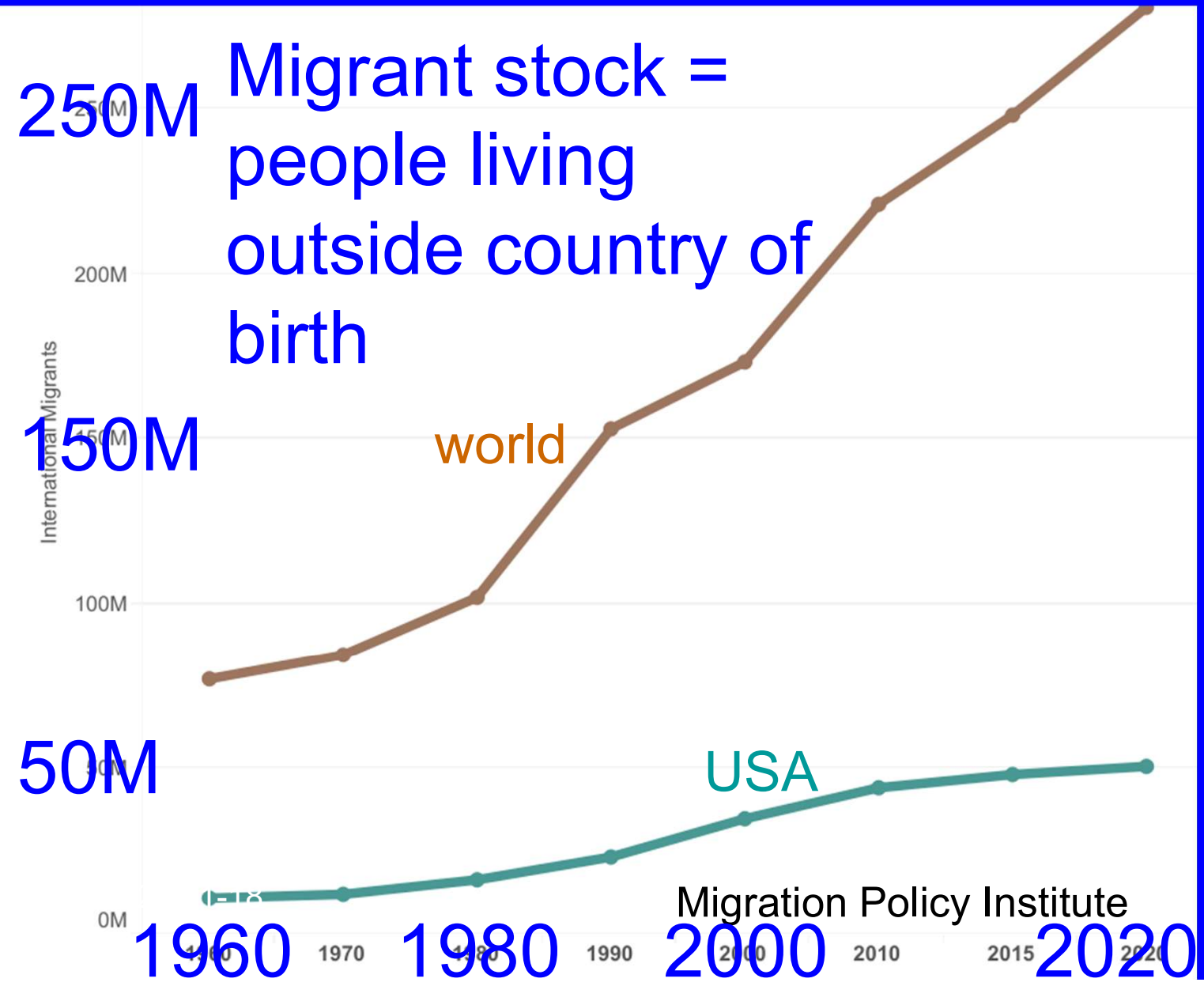
Energy use per person was greater in U. S. households with fewer people.



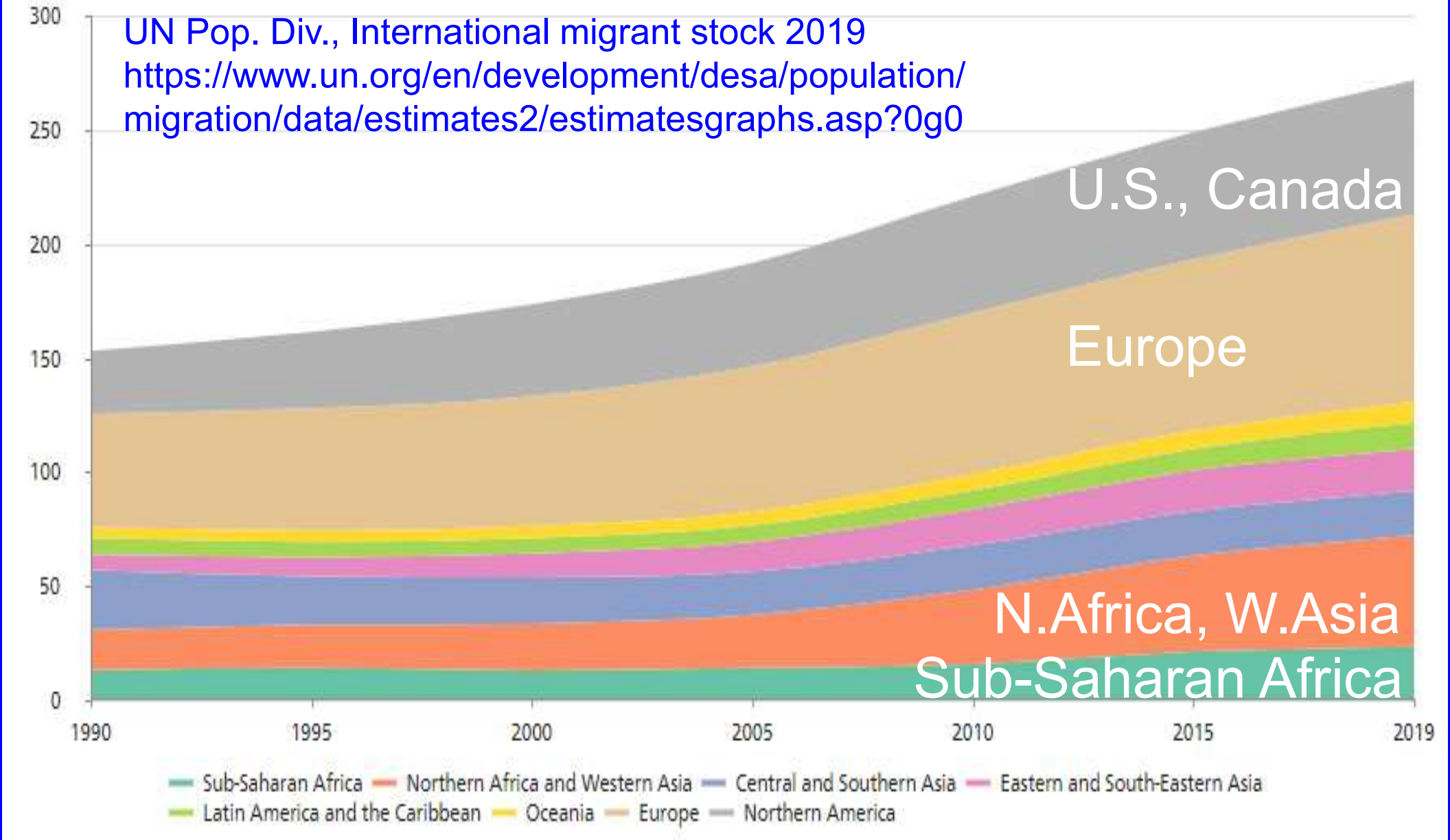
O'Neill & Chen, 2002 *Popul. Dev. Rev.* 28:53-88. USA 1993-94

Migrants

International migrant stock grew >3x globally & in USA, 1960-2020.



Most migrant stock lived in North America & Europe, 1990-2019.



900 million people (16% of adults) in 2023 “said they would like to leave their own country permanently, if they could.” Gallup

% who would like to move perma-nently to another country

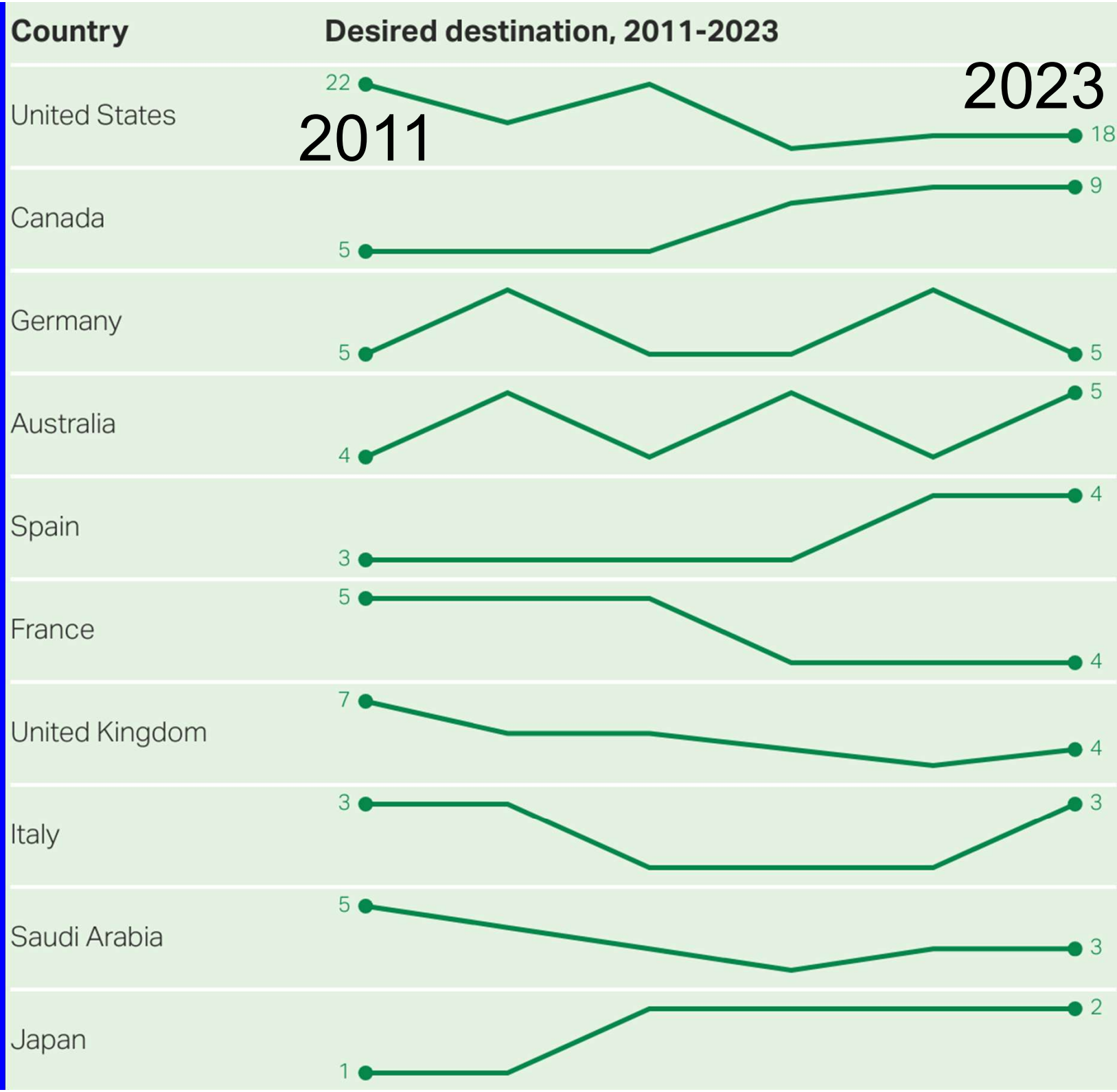
Gallup

2024-11-18

Destinations desired among those who would like to move permanently

Gallup

2024-11-18



Gallup's bottom line, 2024-10-31

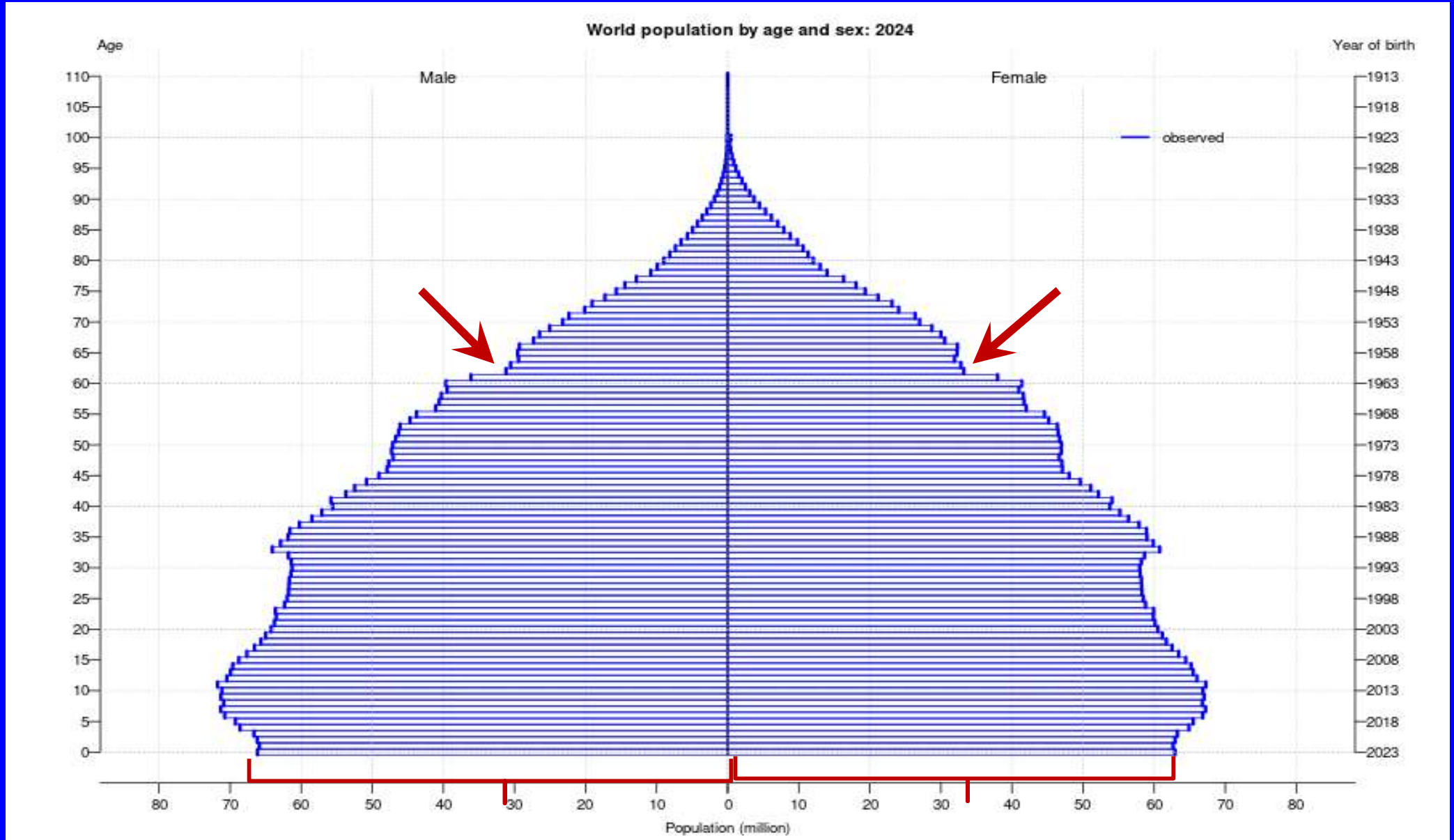
"The key takeaway from the latest data is that increased desire to migrate is a phenomenon not only in migrant-sending regions but also in ones typically on the receiving end. While many of those receiving countries are focused on migrants coming in, they also need to be conscious that many of their own citizens would leave if they could -- and consider what that means and what could happen if they did."

Present

Three worlds, one planet

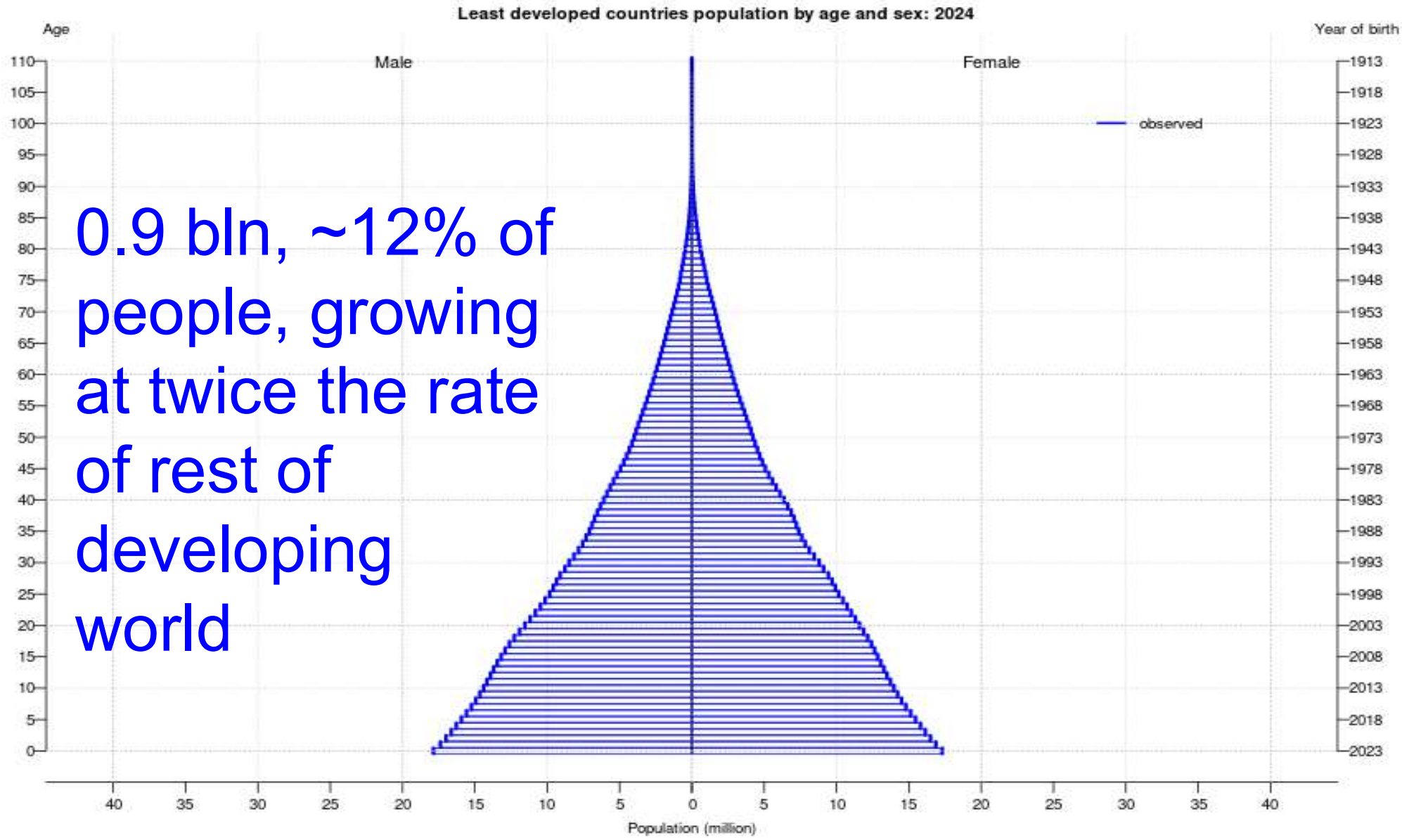
Berber girl, Atlas mountains, Morocco, 20090919, JEC photo

2024 world population pyramid: past rapid growth, recent slowing



United Nations, DESA, Population Division. *World Population Prospects 2024*. http://population.un.org/wpp/

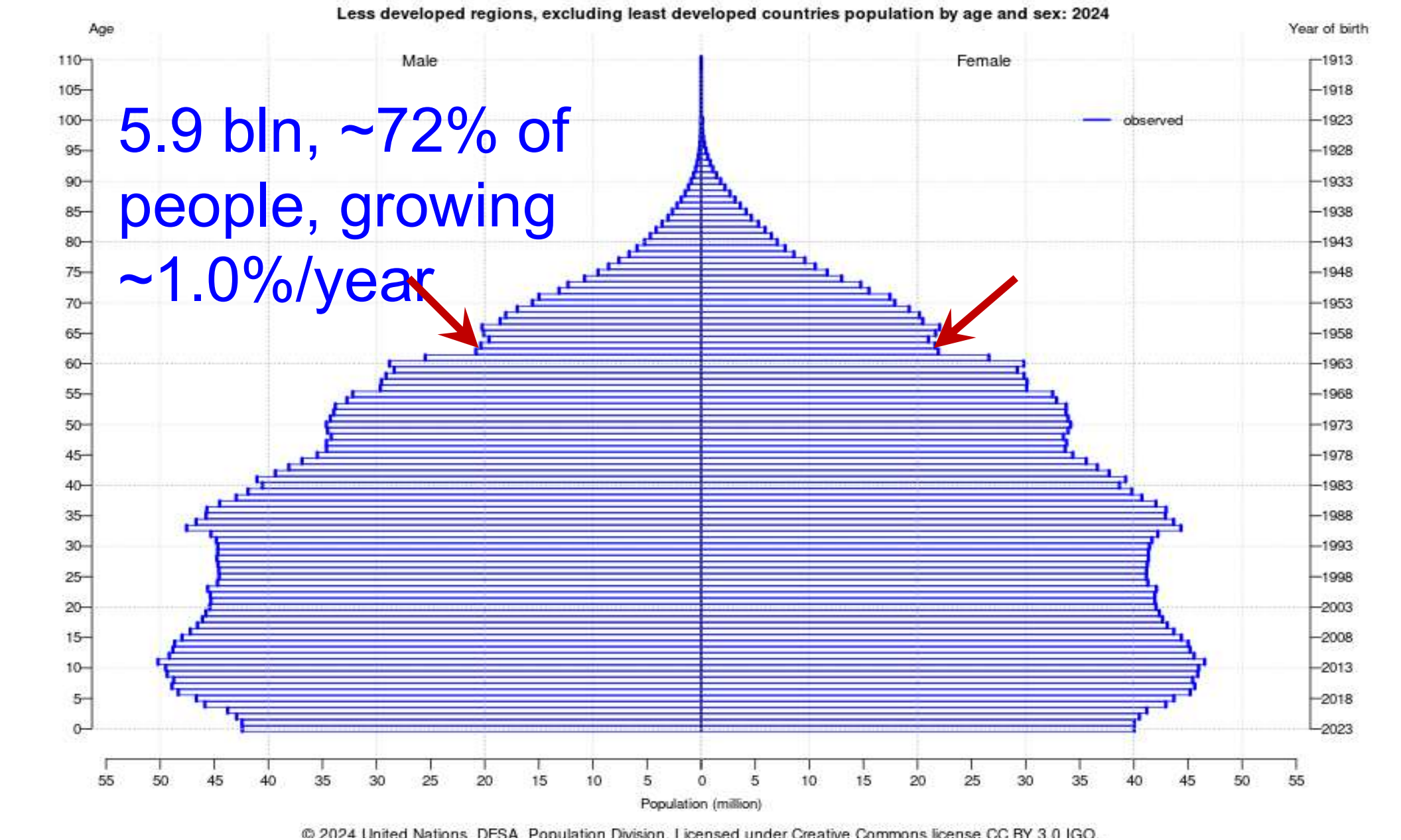
Least developed countries



0.9 bln, ~12% of people, growing at twice the rate of rest of developing world

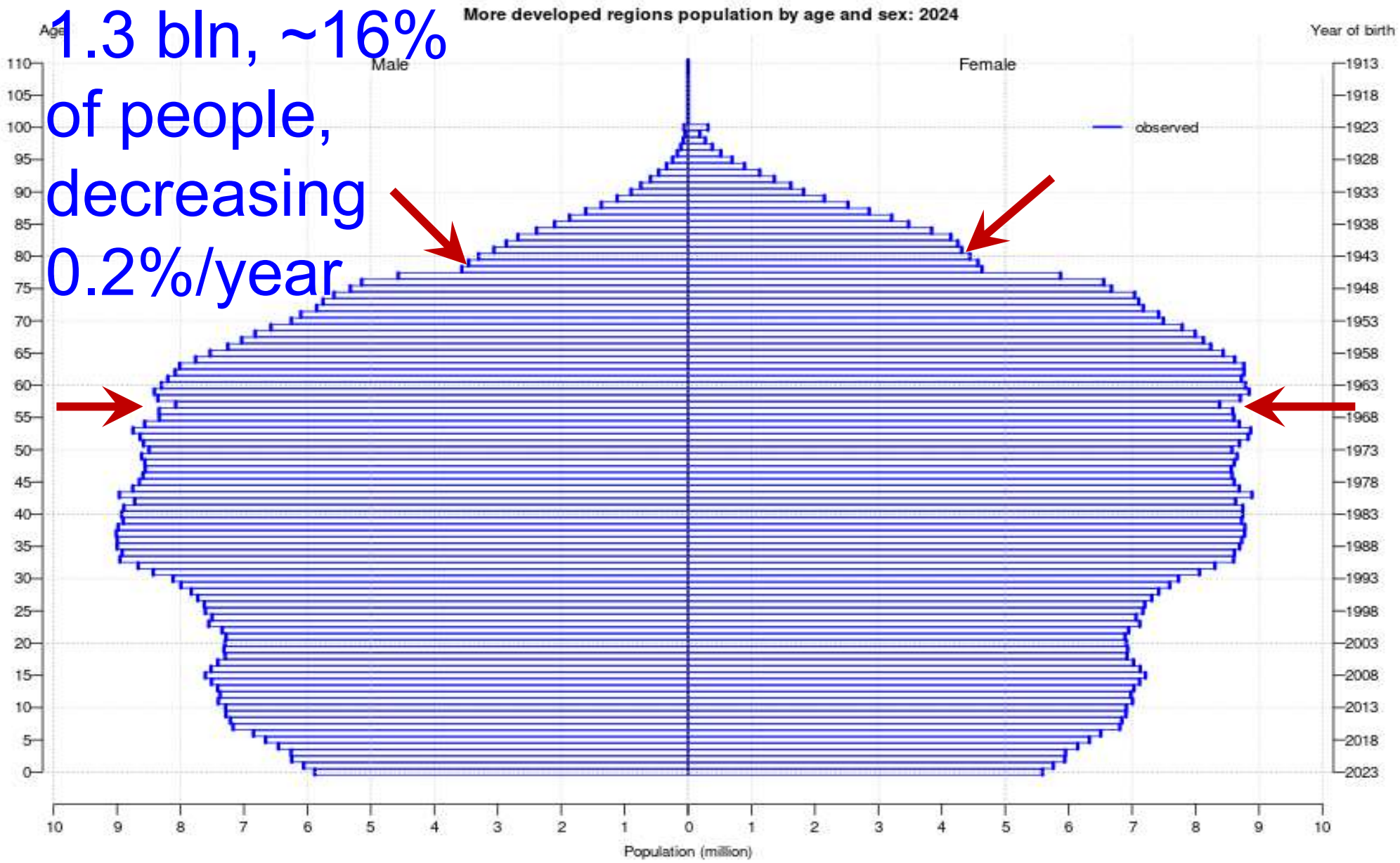
United Nations, DESA, Population Division. *World Population Prospects 2024*. http://population.un.org/wpp/

Less developed, excluding least developed countries



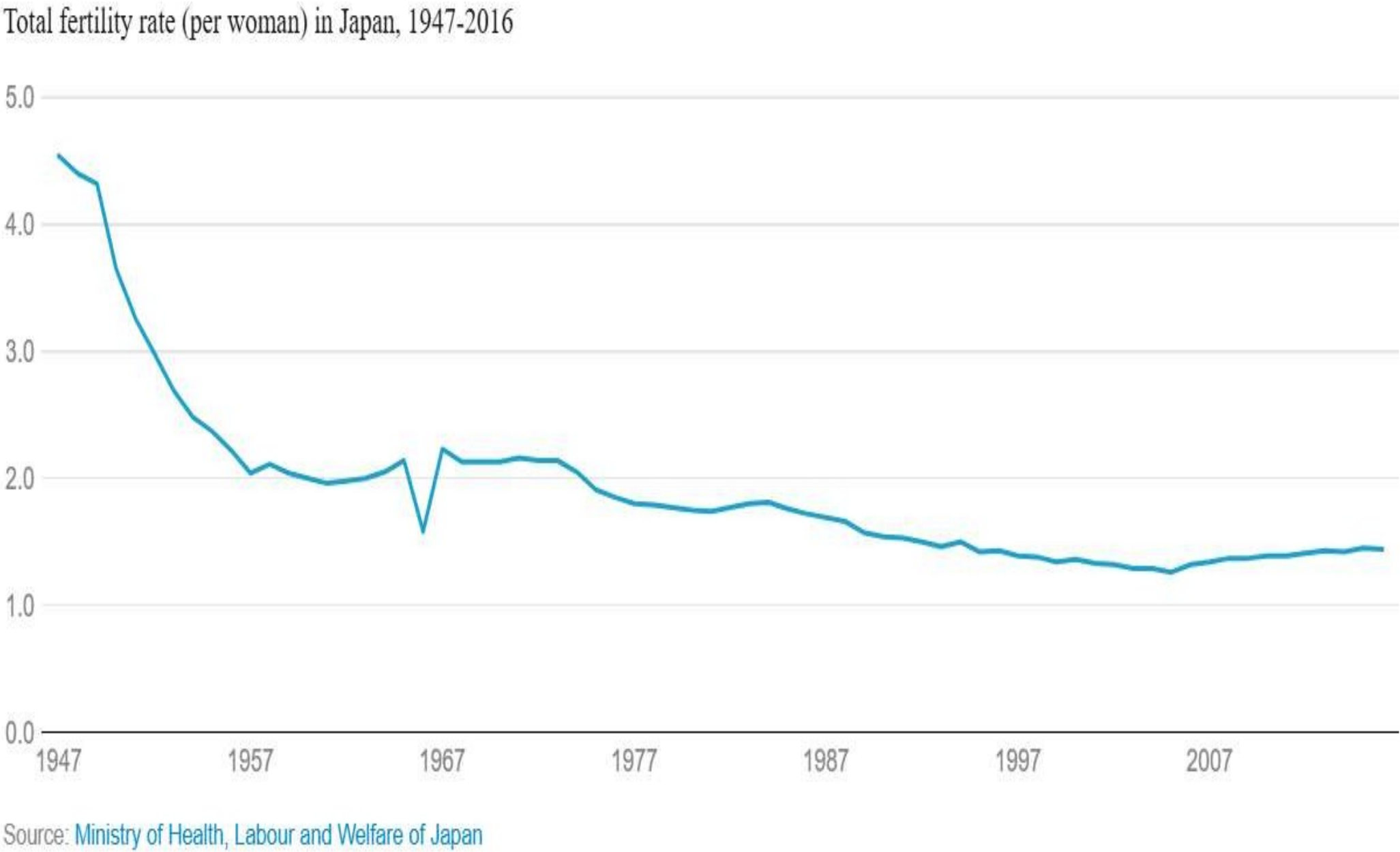
More developed countries

1.3 bln, ~16% of people, decreasing 0.2%/year



United Nations, DESA, Population Division. *World Population Prospects 2024*. http://population.un.org/wpp/

1966 = year of Fire-Horse "Hinoe Uma"

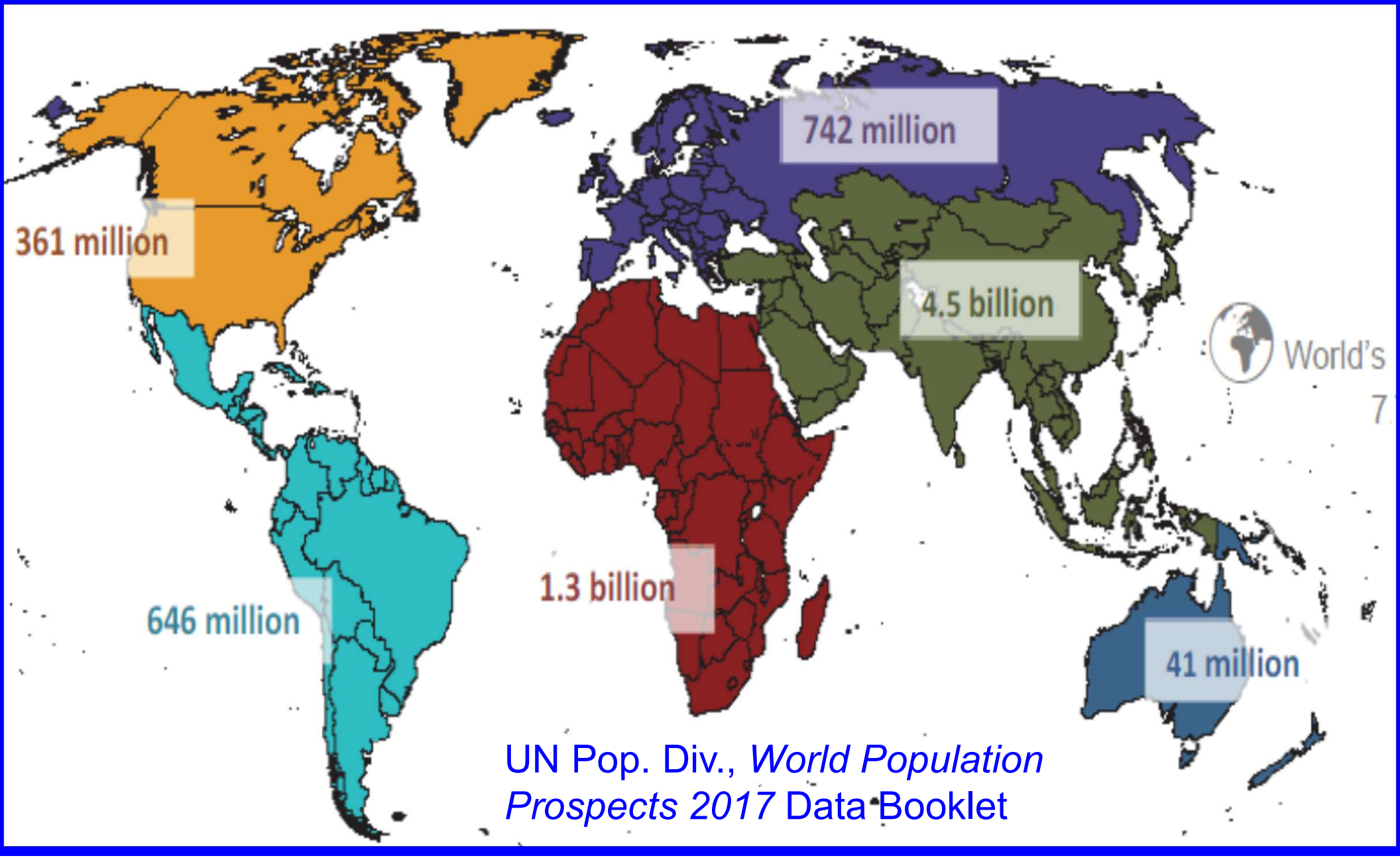


Three worlds, one planet

Population Reference Bureau, *World Population Data Sheet 2024*	High Income	Middle Income	Low Income
Population (billions, mid-2024)	1.3	6.0	0.75
Infant Mortality Rate (deaths/1000 born)	4	26	42
Total Fertility Rate (children/woman)	1.4	2.0	4.5
Urban Population (%)	81	55	34
Population per km^2 of Arable Land (2021)	362	648	508
GNI / person, USD PPP	$63,398	$15,725	$2,356

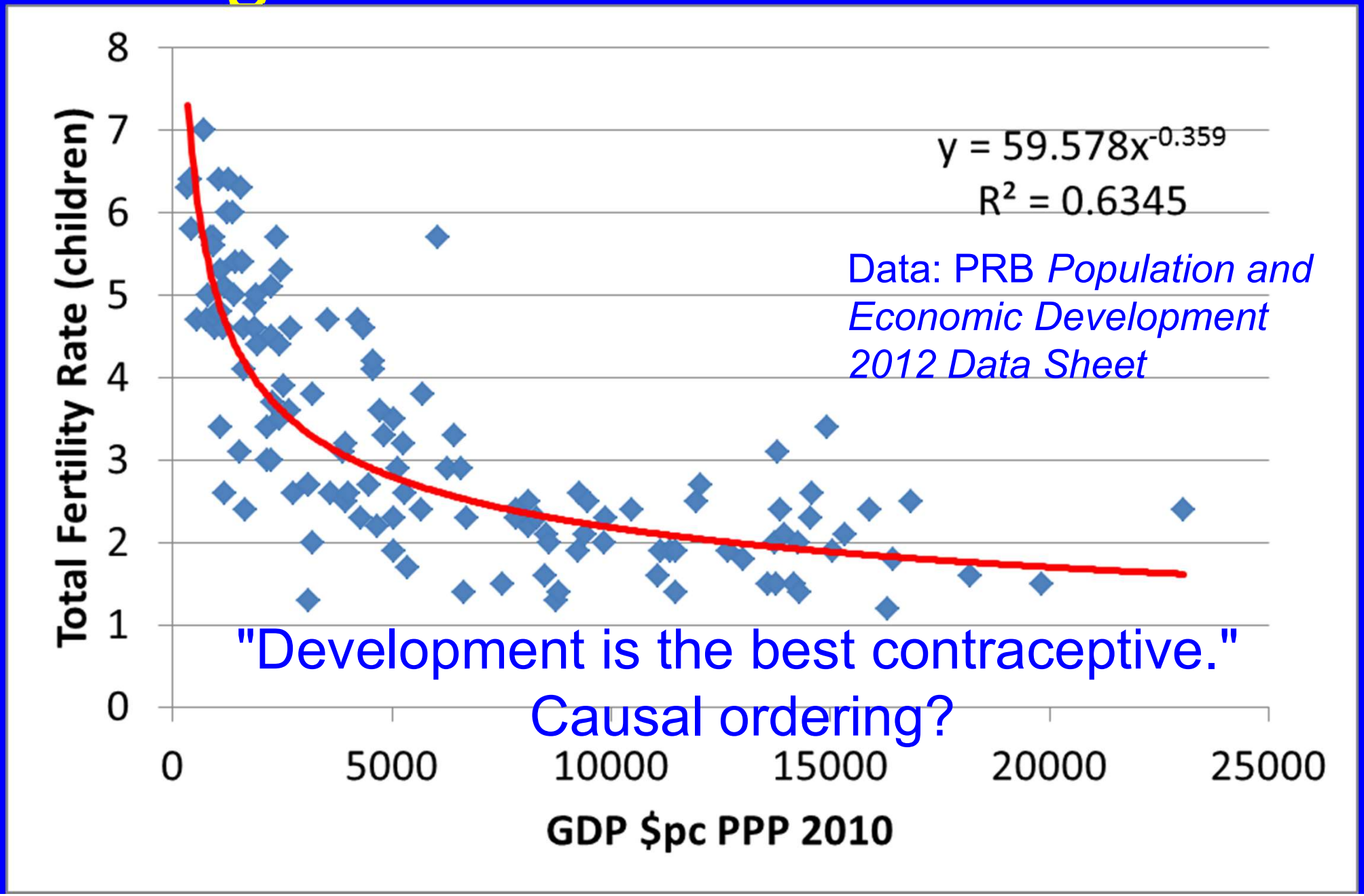
Ratio of High to Low income: 26.9

Of world's ~8 billion people, Asia has ~60%, Africa ~17% (2020).



UN Pop. Div., *World Population Prospects 2017* Data Booklet

In cross-section, 10x income ↑ goes with 0.44x TFR ↓.



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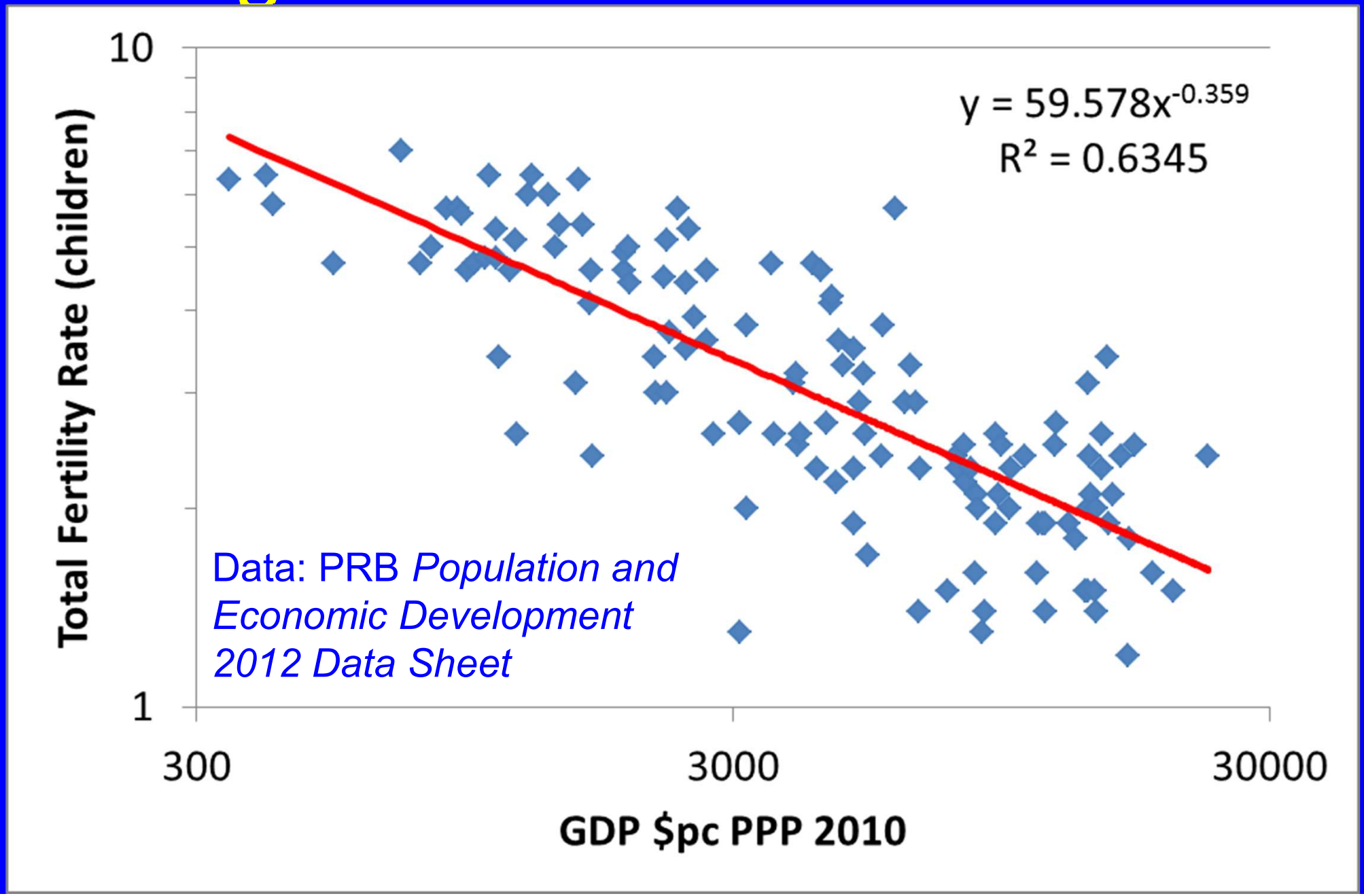
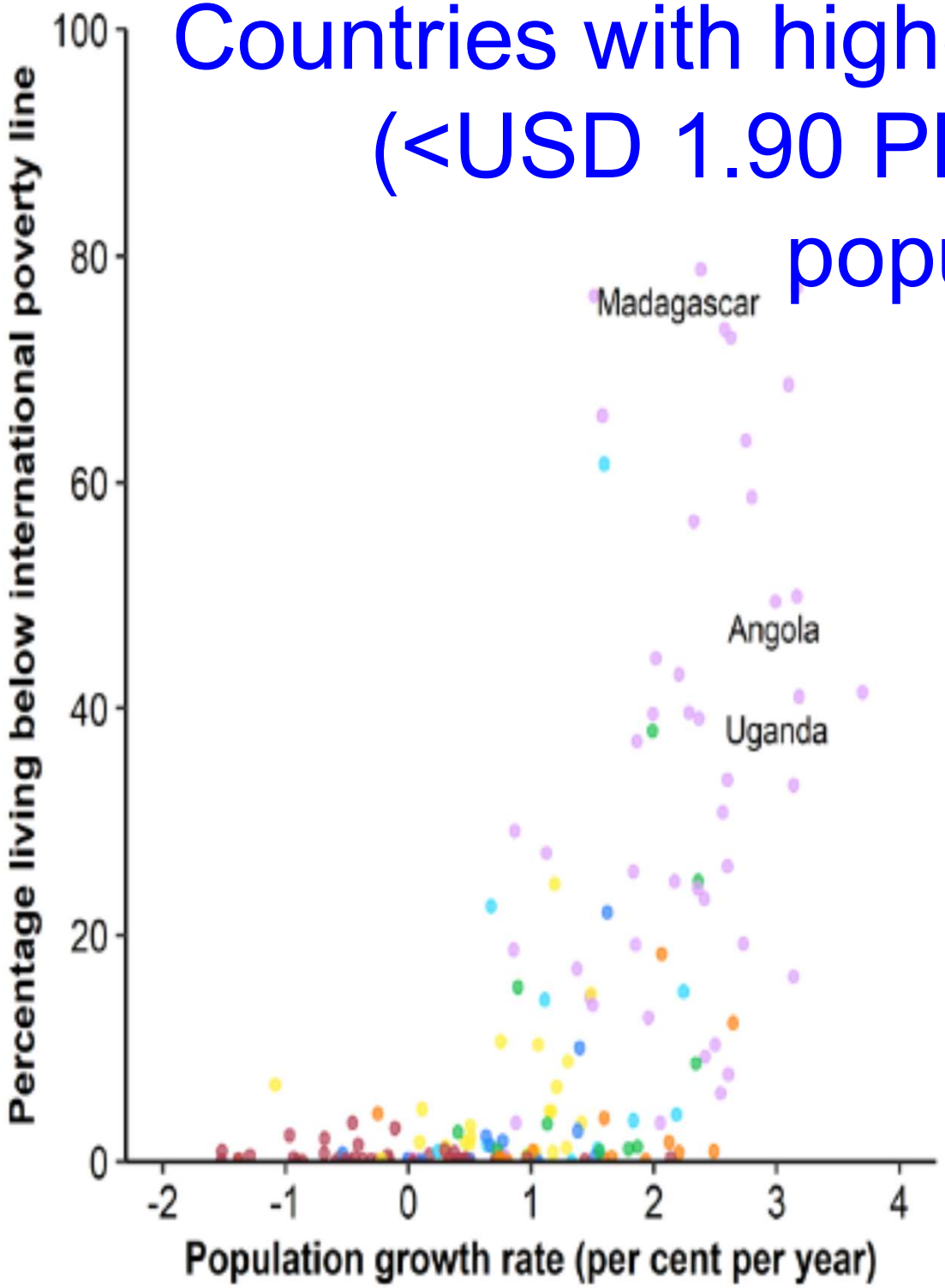


Countries with higher % extremely poor (<USD 1.90 PPP/day) have higher population growth rates.



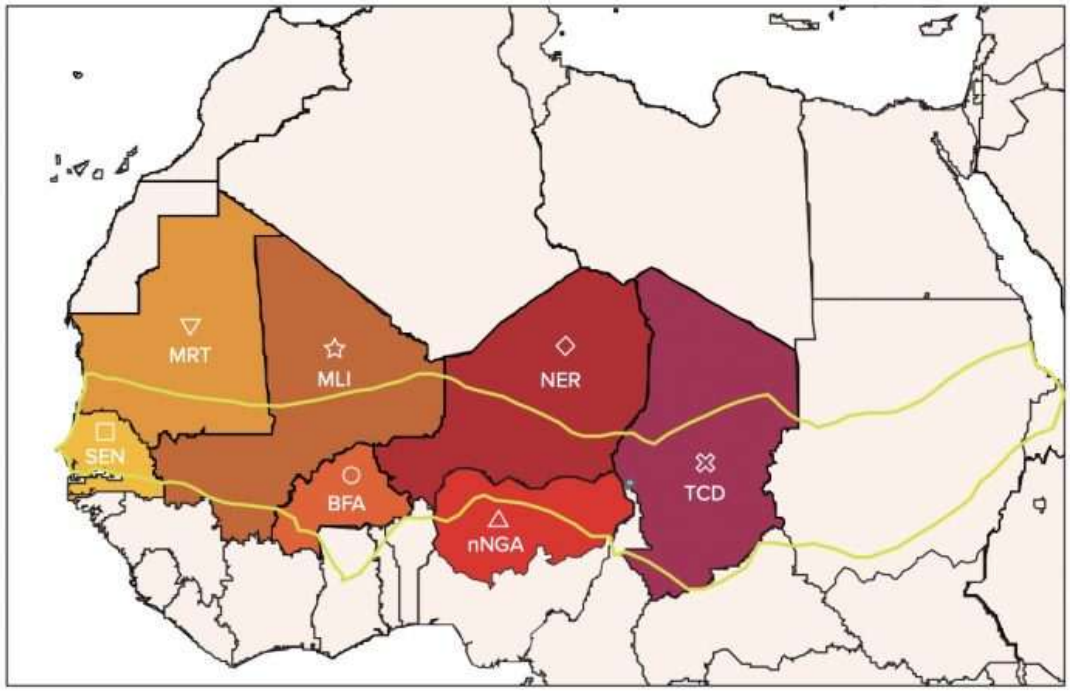
- Sub-Saharan Africa
- Northern Africa and Western Asia
- Central and Southern Asia
- Eastern and South-Eastern Asia
- Latin America and the Caribbean
- Australia and New Zealand
- Oceania excluding Australia and New Zealand
- Europe and Northern America

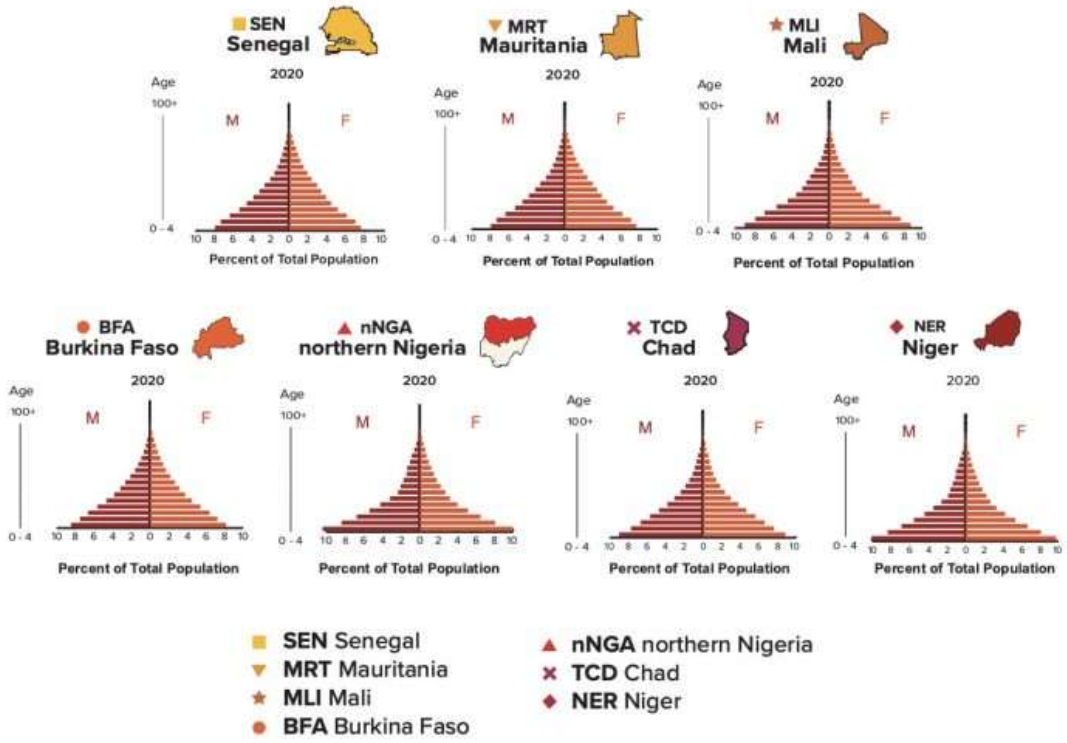
UN Population Div., *World Population Prospects* 2022

7 countries in the western Sahel have very high proportions of youth & very rapidly growing populations.

Source: Richard Cincotta & Stephen Smith, *What Future for the Western Sahel? The region's demography and its implications by 2045.*
2024-11-18

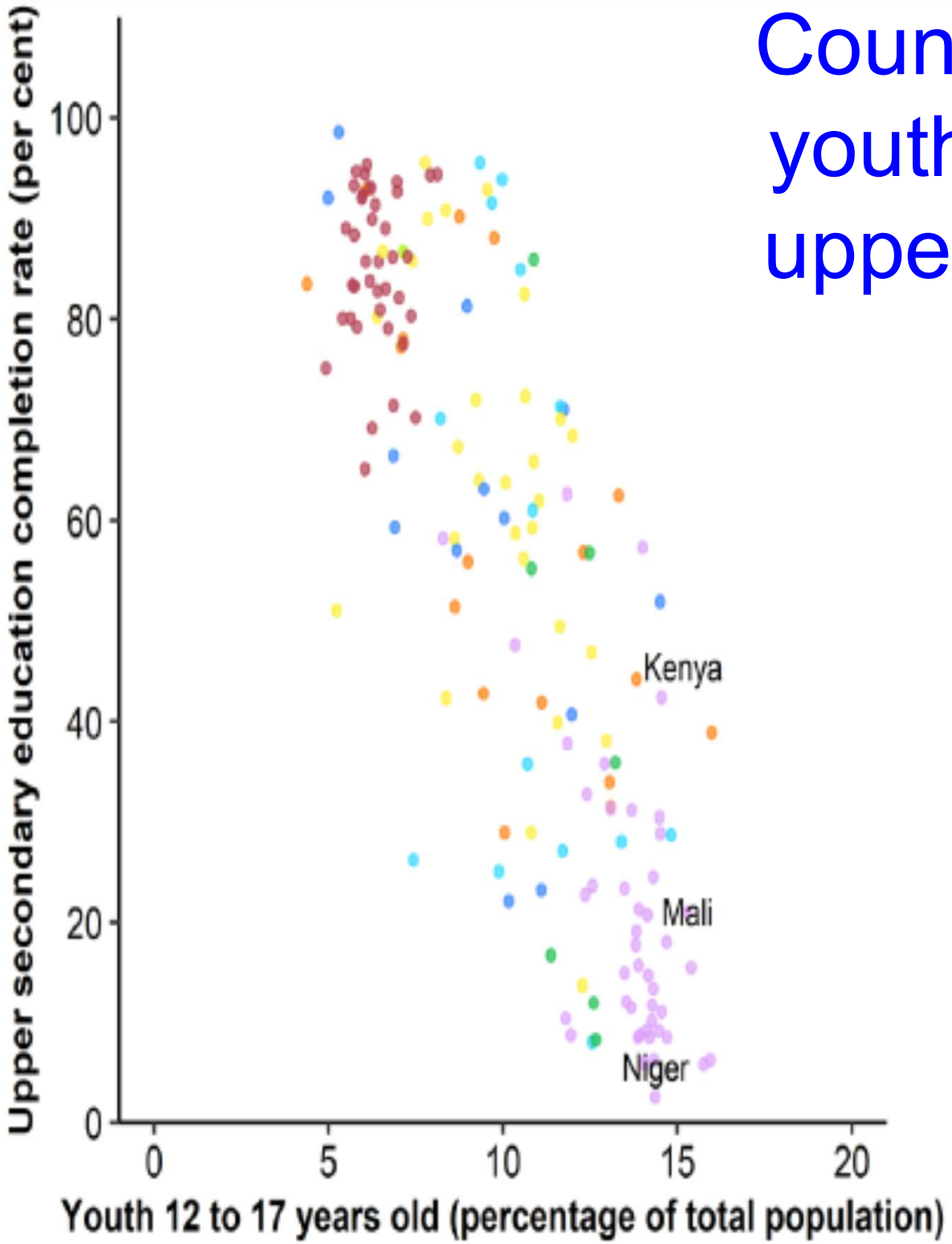
FIGURE 1. The Western Sahel and Sahel Climate Zone





Source: UNDESA/ Population Division, 2019; National Bureau of Statistics (Nigeria), 2017, author's model.

Countries with higher % youth 12-17 have lower upper 2dary completion rates.



- Sub-Saharan Africa
- Northern Africa and Western Asia
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- Latin America and the Caribbean
- Australia and New Zealand
- Oceania excluding Australia and New Zealand
- Europe and Northern America

UN Population Div., *World Population Prospects* 2022

Who has contributed most to global CO_2 emissions?

ENERGY FOR GROWTH HUB

2021-10-01

North America 29% / 5%

457 billion tonnes CO_2
29% global cumulative emissions

Asia 29% / 60%

457 billion tonnes CO_2
29% global cumulative emissions

USA
399 billion tonnes CO_2
25% global cumulative emissions

Canada
32 billion t
2%

Mexico
19 billion t
1.2%

China
200 billion tonnes CO_2
12.7% global cumulative emissions

Japan
62 billion t
4%

CO_2 %
/ population %

EU-28
353 billion tonnes CO_2
22% global cumulative emissions

Russia
101 billion tonnes
6% global emissions

India
48 billion t
3%

South Korea
16 billion t
1%

Taiwan
8 billion t
0.5%

Thailand
7 billion t
0.45%

Uzbekistan
6 billion t
0.4%

Saudi Arabia
14 billion t
0.9%

Malaysia
5 billion t
0.33%

Pakistan
4.4 billion t
0.28%

North Korea
5 billion t
0.32%

UAE
4 billion t
0.26%

Indonesia
12 billion t
0.8%

Iraq
4 billion t
0.25%

Azerbaijan
2.5 billion t
0.16%

Turkmenistan
2.2 billion t
0.14%

Israel
2.2 billion t
0.14%

Singapore
1.8 billion t
0.12%

Vietnam
3 billion t
0.2%

Qatar
1.9 billion t
0.12%

Philippines
3 billion t
0.2%

Syria
1.8 billion t
0.11%

Kuwait
2.6 billion t
0.17%

Hong Kong
1.6 billion t
0.1%

Iran
17 billion t
1%

Kazakhstan
12 billion t
0.8%

Ukraine
19 billion t
1.2%

Turkey
9.6 billion t
0.6%

Belarus
2.5 billion t
0.17%

Switzerland
2.5 billion t
0.17%

Serbia
2.4 billion t
0.16%

Norway
2.6 billion t
0.17%

Brazil
14.2 billion t
0.9%

Venezuela
7.6 billion t
0.5%

Colombia
3.1 billion t
0.2%

Chile
2.7 billion t
0.17%

Argentina
8 billion t
0.5%

Australia
17.4 billion t
1.1%

New Zealand
1.6 billion t
0.1%

South Africa
19.8 billion t
1.3%

North Africa
14 billion t
0.88%

Nigeria
2.3 billion t
0.15%

47 Sub-Saharan Countries
5.97 billion t
0.34%

Africa

43 billion tonnes CO_2
2.73% global emission

1 Billion+ People

Europe

514 billion tonnes CO_2
33% global cumulative emissions

33% / 10%

South America

20 billion tonnes CO_2
1.3% global emissions

Oceania

20 billion tonnes CO_2
1.2% global emissions

Cumulative carbon dioxide (CO_2) emissions over the period from 1751 to 2017. Figures are based on production-based emissions which measure CO_2 produced domestically from fossil fuel combustion and cement, and do not correct for emissions embedded in trade (i.e. consumption-based). Emissions from international travel are not included.

Figures for the 28 countries in the European Union have been grouped as the 'EU-28' since international targets and negotiations are typically set as a collaborative target between EU countries. Values may not sum to 100% due to rounding.

Data source: Calculated by Our World in Data based on data from the Global Carbon Project (GCP) and Carbon Dioxide Analysis Center (CDIAC).

No population at COP26, COP27.

COP27:

mitigation, adaptation, finance, collaboration

https://ukcop26.wpenginepowered.com/wp-content/uploads/2021/07/COP26-Explained.pdf

Topics.

Action for Climate Empowerment & Children and Youth

Adaptation and resilience

Capacity-building

Climate Finance

Climate Technology

Cooperative activities and SDGs

Gender

Global Stocktake

Innovation

Just Transition

Land Use

Local Communities and Indigenous Peoples Platform

Market and Non-Market Mechanisms

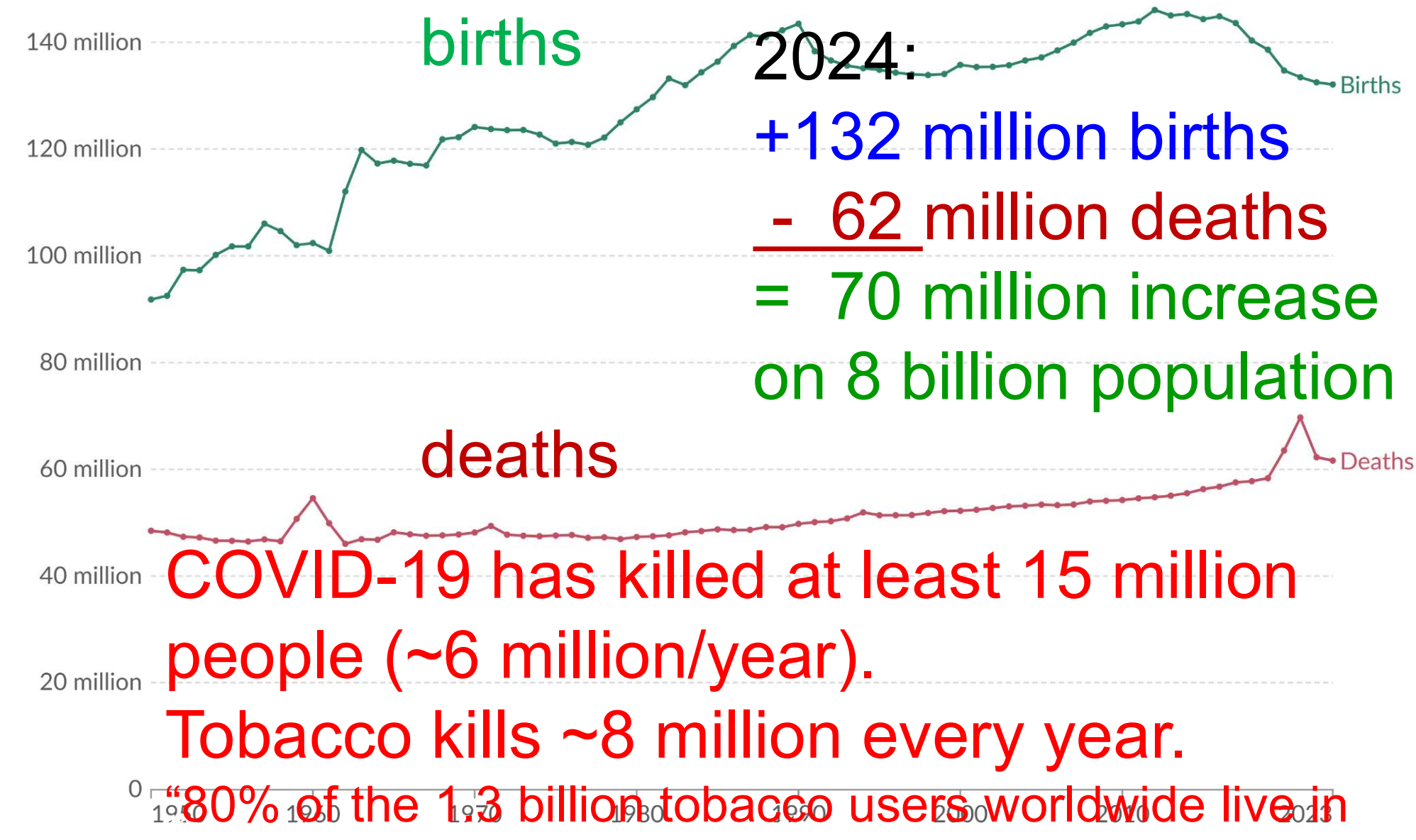
Mitigation

Pre-2020 Ambition and Implementation

Science

The Ocean

Population grows ~70 million/year.



COVID-19 has killed at least 15 million people (~6 million/year).

Tobacco kills ~8 million every year.

"80% of the 1.3 billion tobacco users worldwide live in low- and middle-income countries" W.H.O.

Fertility

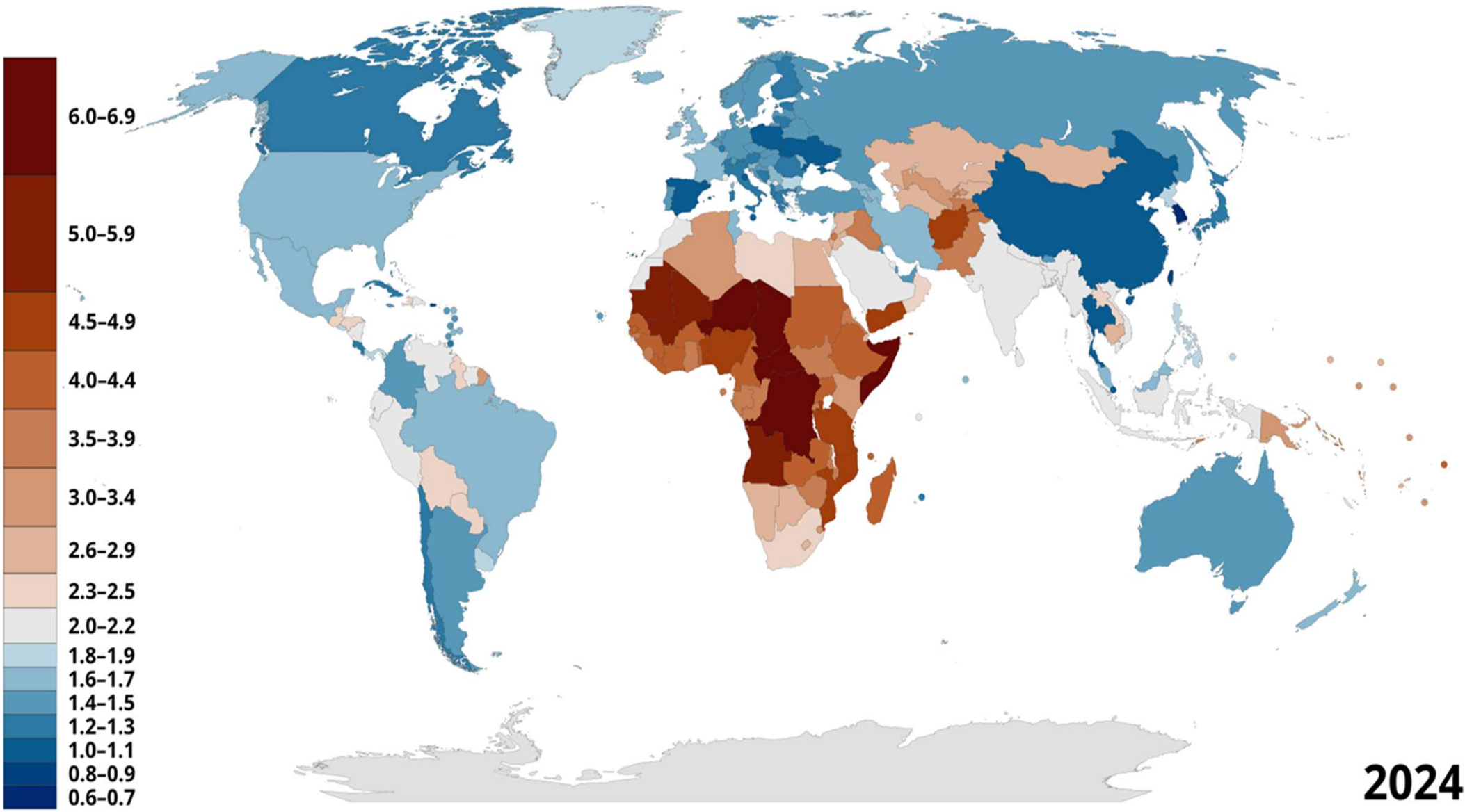
Replacement (level) fertility

Replacement fertility is the TFR (number of live-born children per woman's lifetime) required to replace one new-born girl by one new-born girl in the next generation.

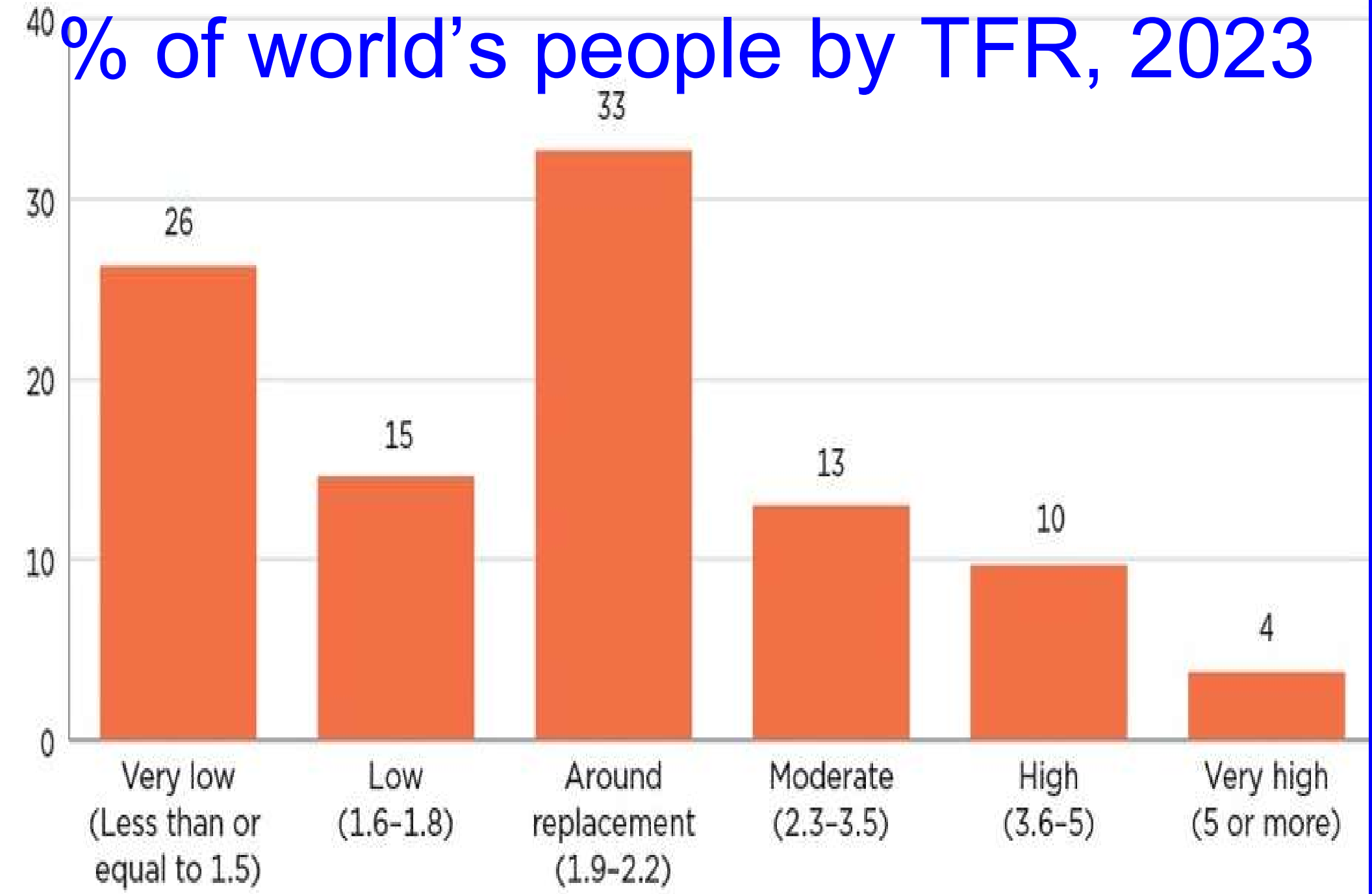
Because 106 boys are born per 100 girls, & because not all girls survive through reproductive ages, replacement TFR ranges from 2.1 to 2.4 in most cases, & as high as 3 in areas of very high mortality.

Total fertility rate by country, 2024

Maybe ~2/3 of people live where TFR is below replacement, but global average TFR is maybe ~2.2 children/woman.



% of world's people by TFR, 2023



Source: U.S. Census Bureau, International Database.

Large regions of high fertility remain.

In 2019, fertility remains above replacement level, on average, in

sub-Saharan Africa (4.6),

Oceania except Australia, New Zealand (3.4),

Northern Africa and Western Asia (2.9),

Central and Southern Asia (2.4) (Afghanistan 4.5; Pakistan 3.6).

40% of global pregnancies are unintended.
45% of pregnancies in USA

213 million pregnancies occurred worldwide in 2012, 190 million (89%) in developing world.

85 million pregnancies (40%) were unintended,

- 47% unintended in more developed,
- 39% unintended in less developed,
- 35% unintended in Africa,
- 56% unintended in LAC.

Sedgh, et al. 2014

45% of US pregnancies are unintended.

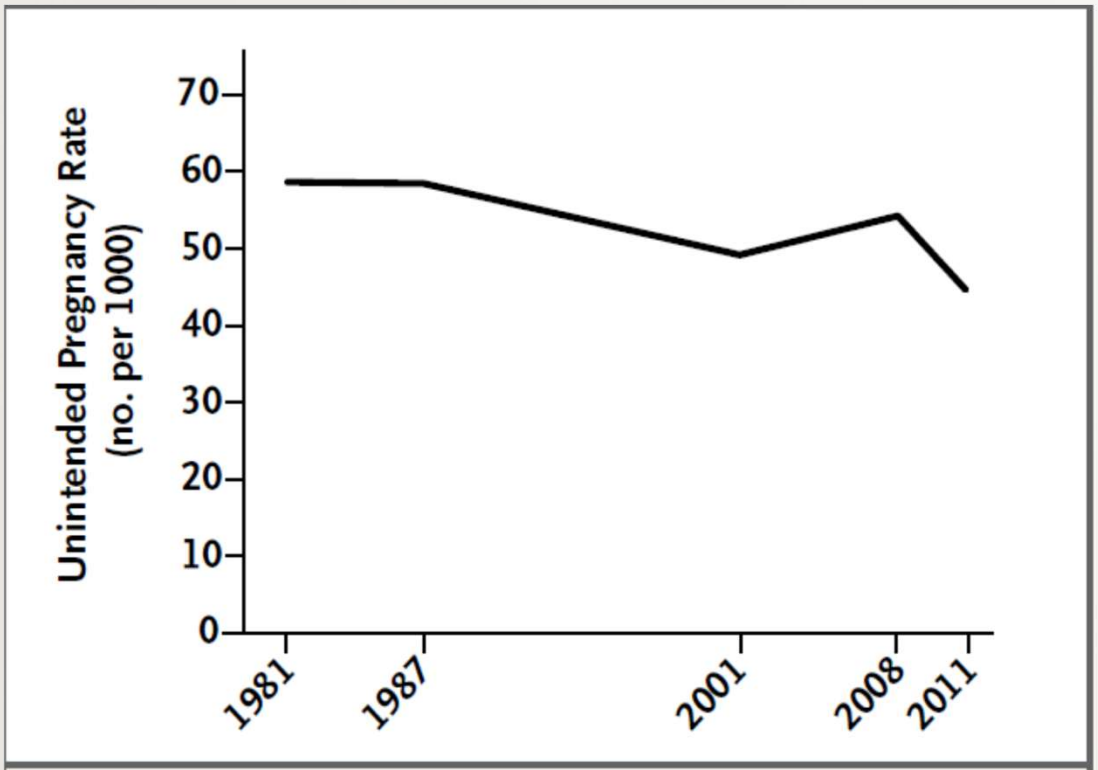
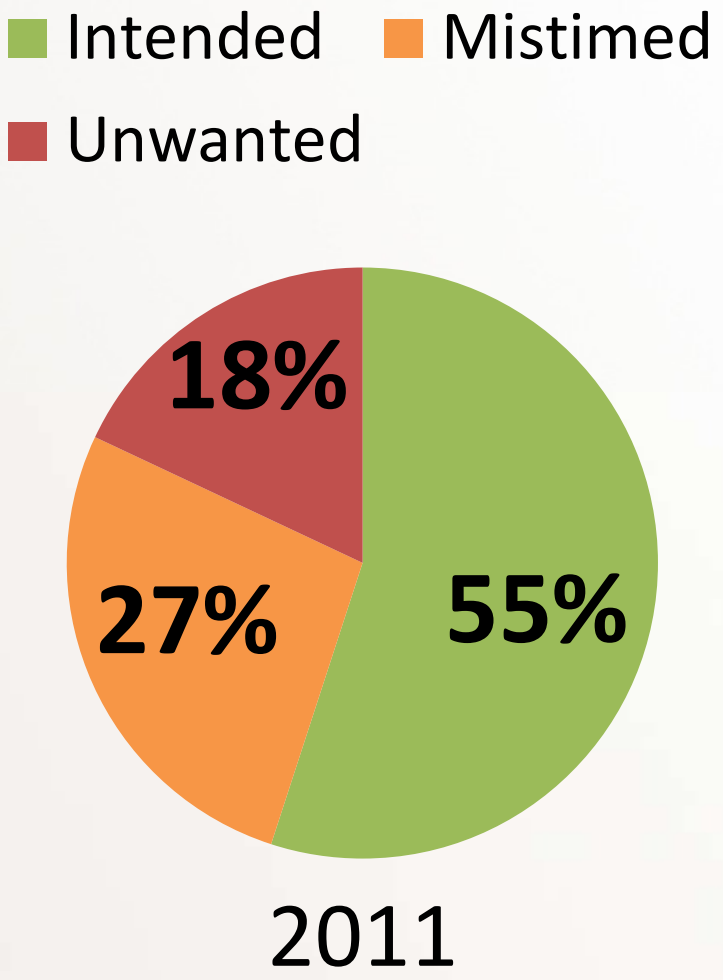


Figure 1. Rates of Unintended Pregnancy, 1981–2011.

Rates are reported as the number of unintended pregnancies per 1000 women and girls 15 to 44 years of age.



2011

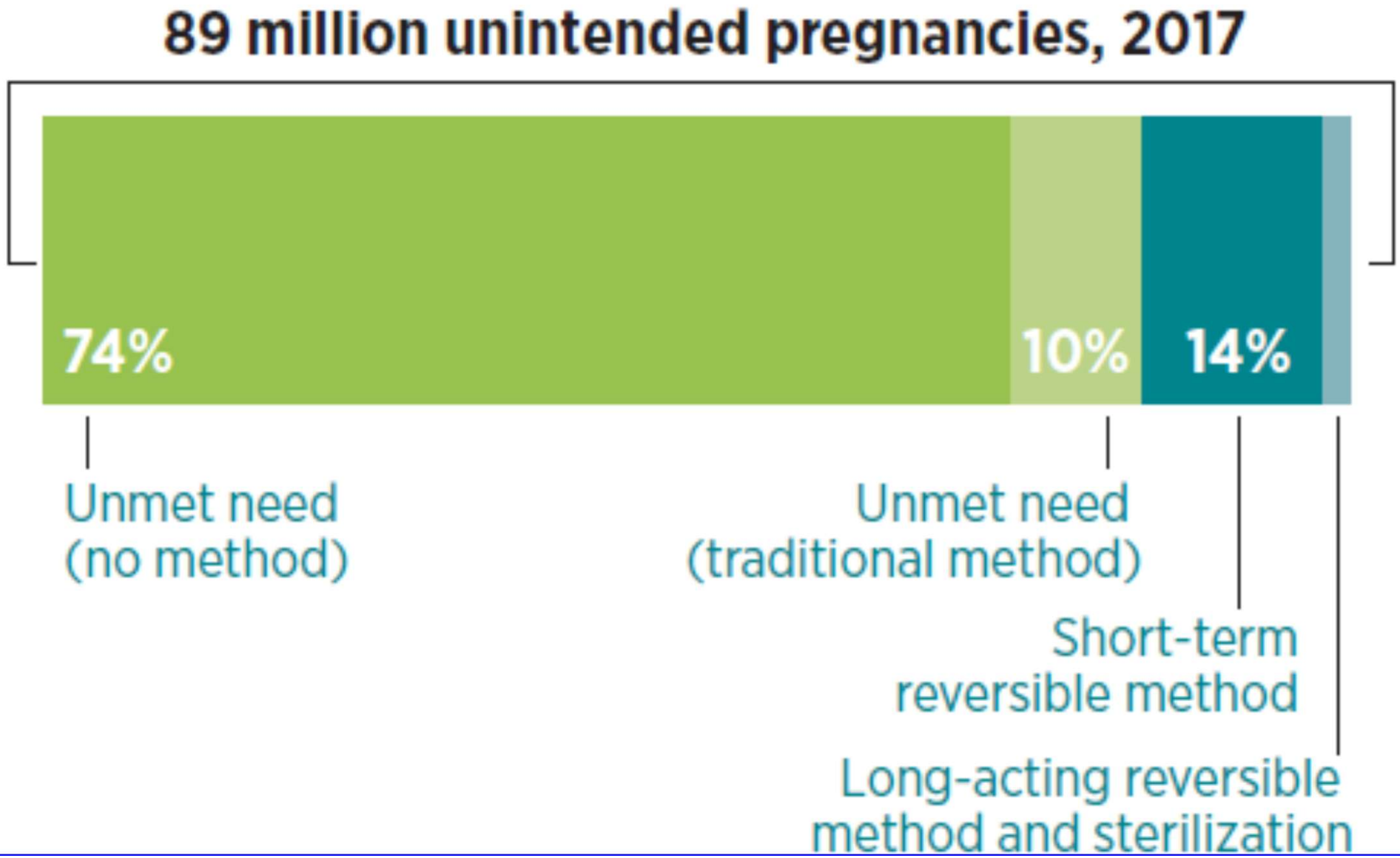
Finer and Zolna, NEJM, 2016

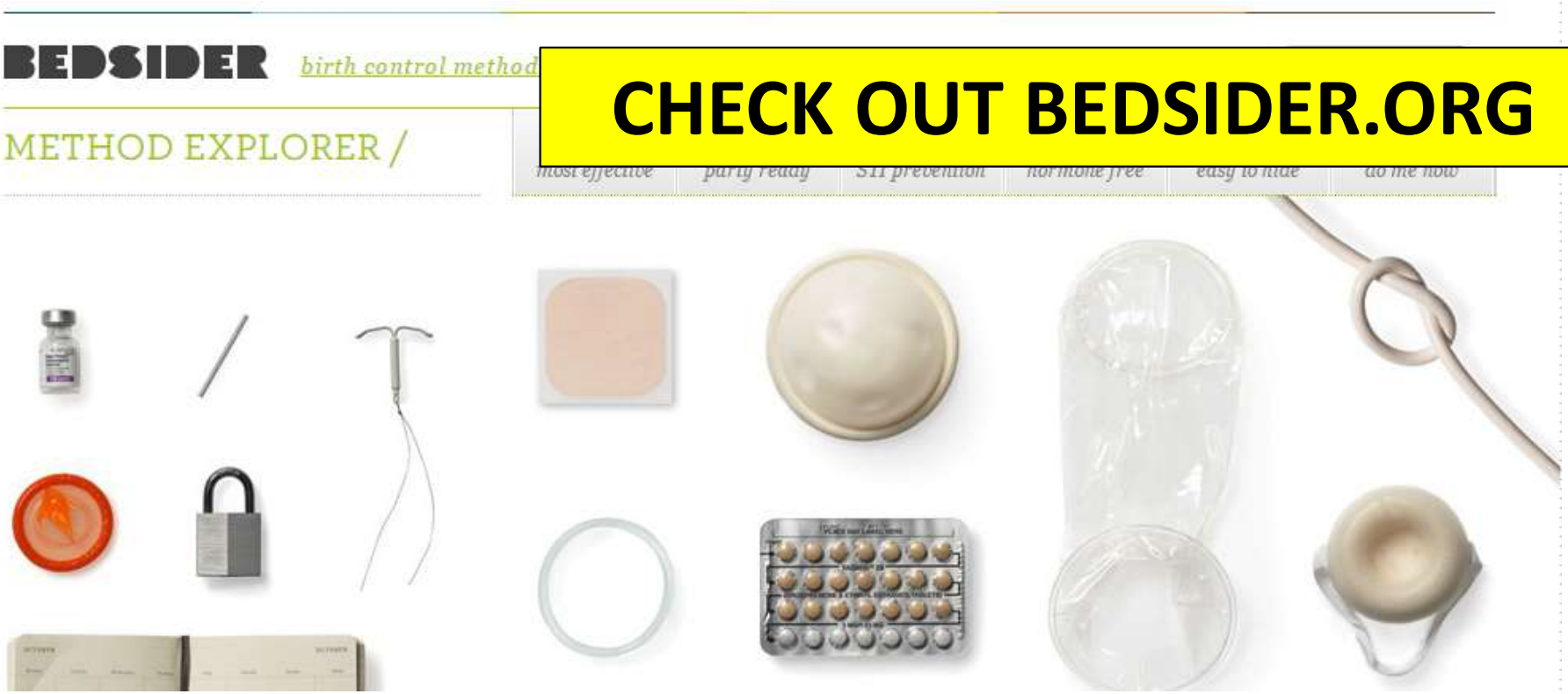
Chicago JEC
2014-05-11

JEC Chicago
2014-05-13

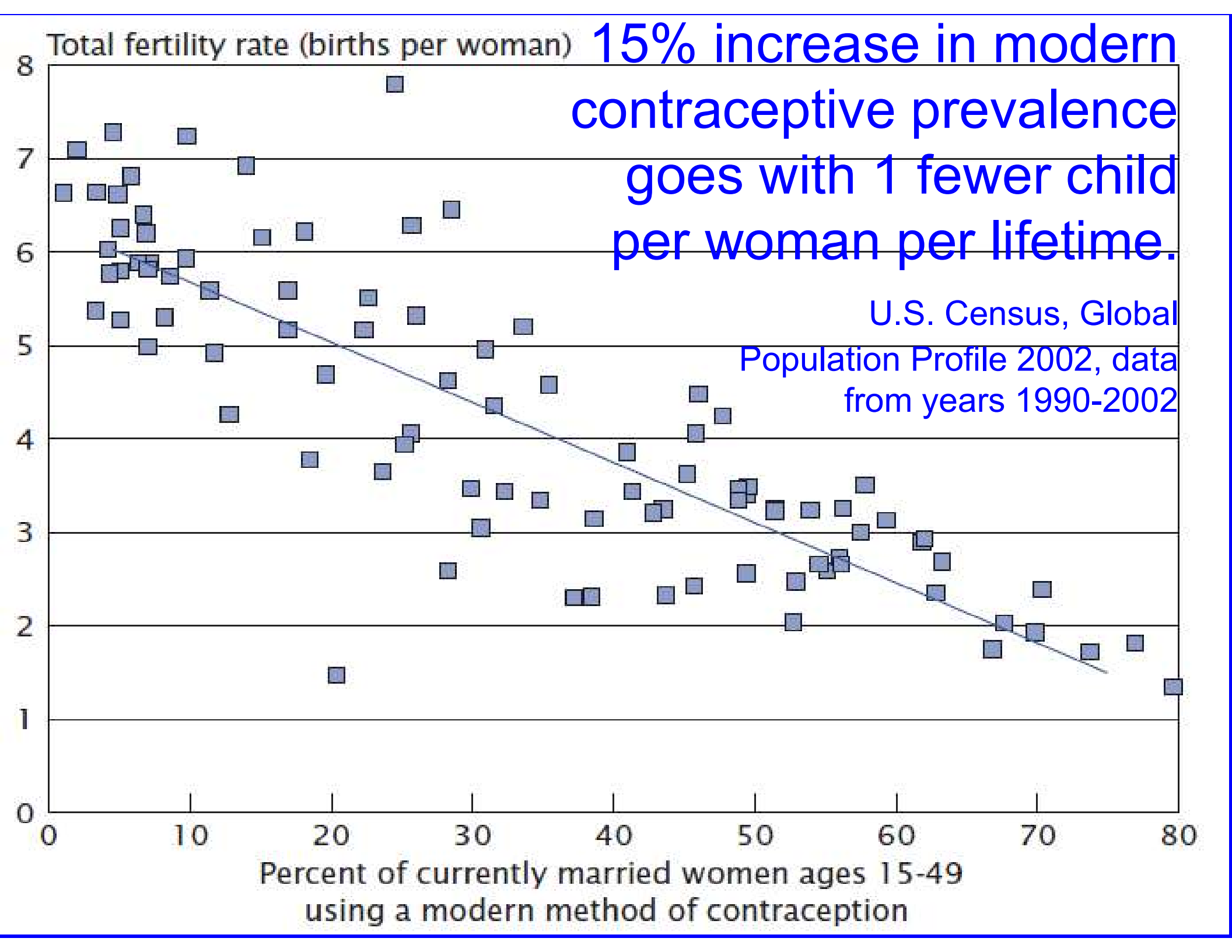
Women with unmet need for modern contraceptive methods account for 84% of unintended pregnancies.

Gantmacher Institute, Adding It Up, December 2017

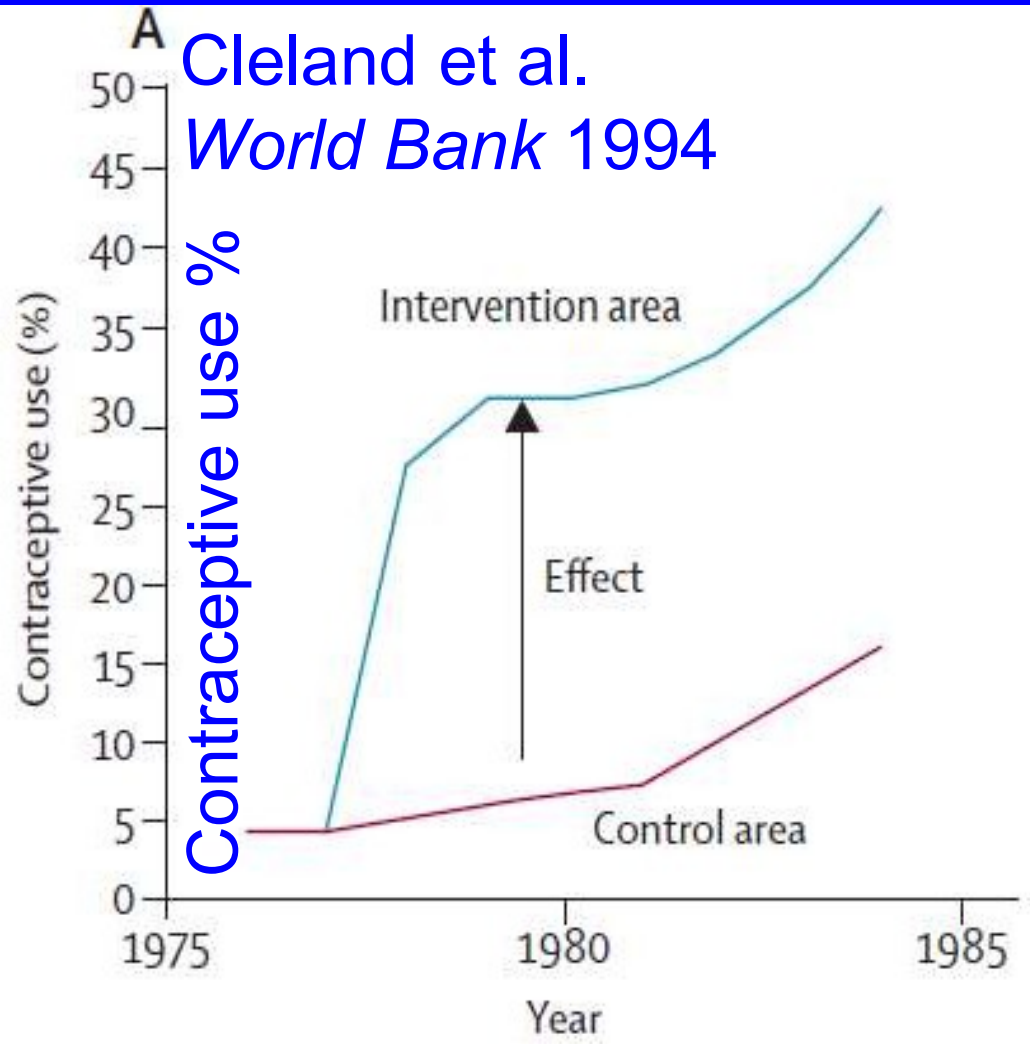


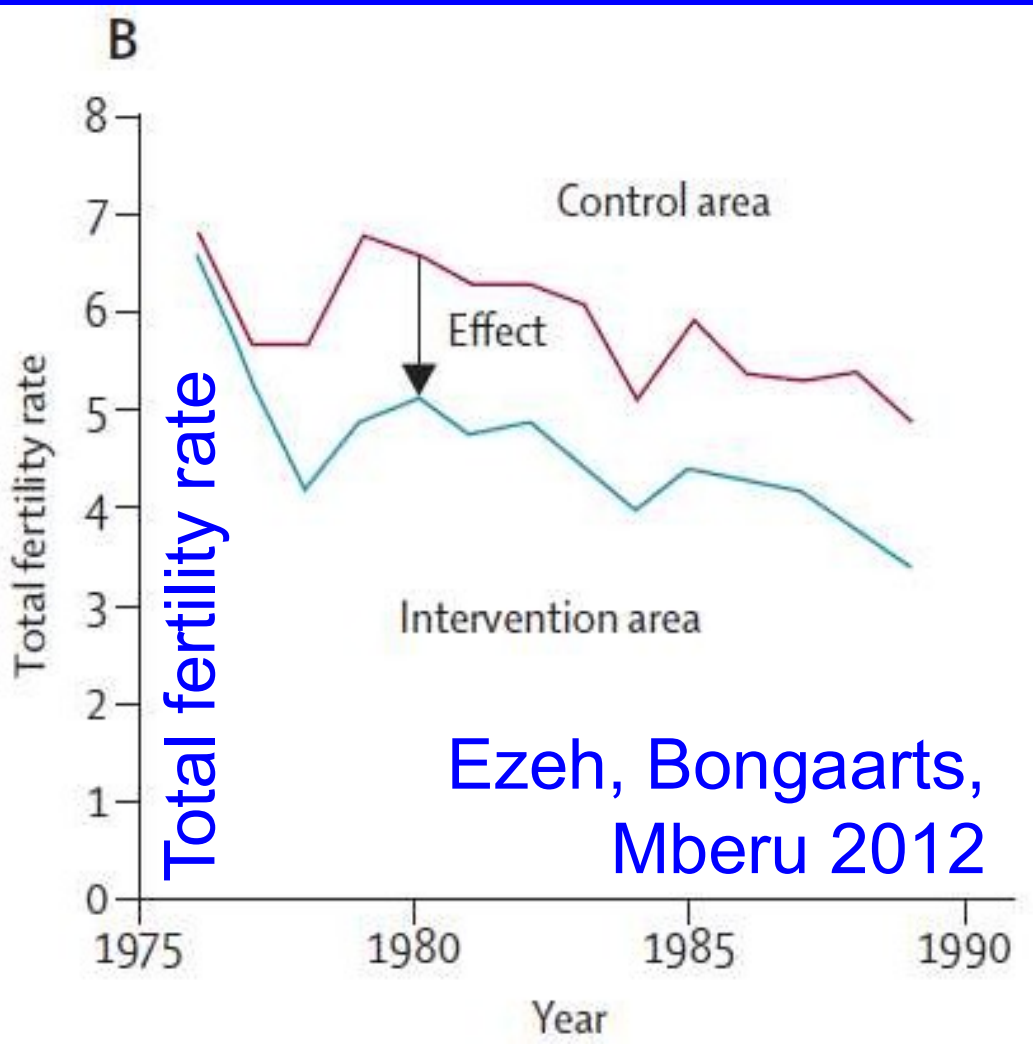


- Random assignment to Bedsider vs. control group found women in Bedsider group less likely to have a pregnancy scare, an unintended pregnancy, or unprotected sex as compared to the control group (Antonishak et al. 2015)

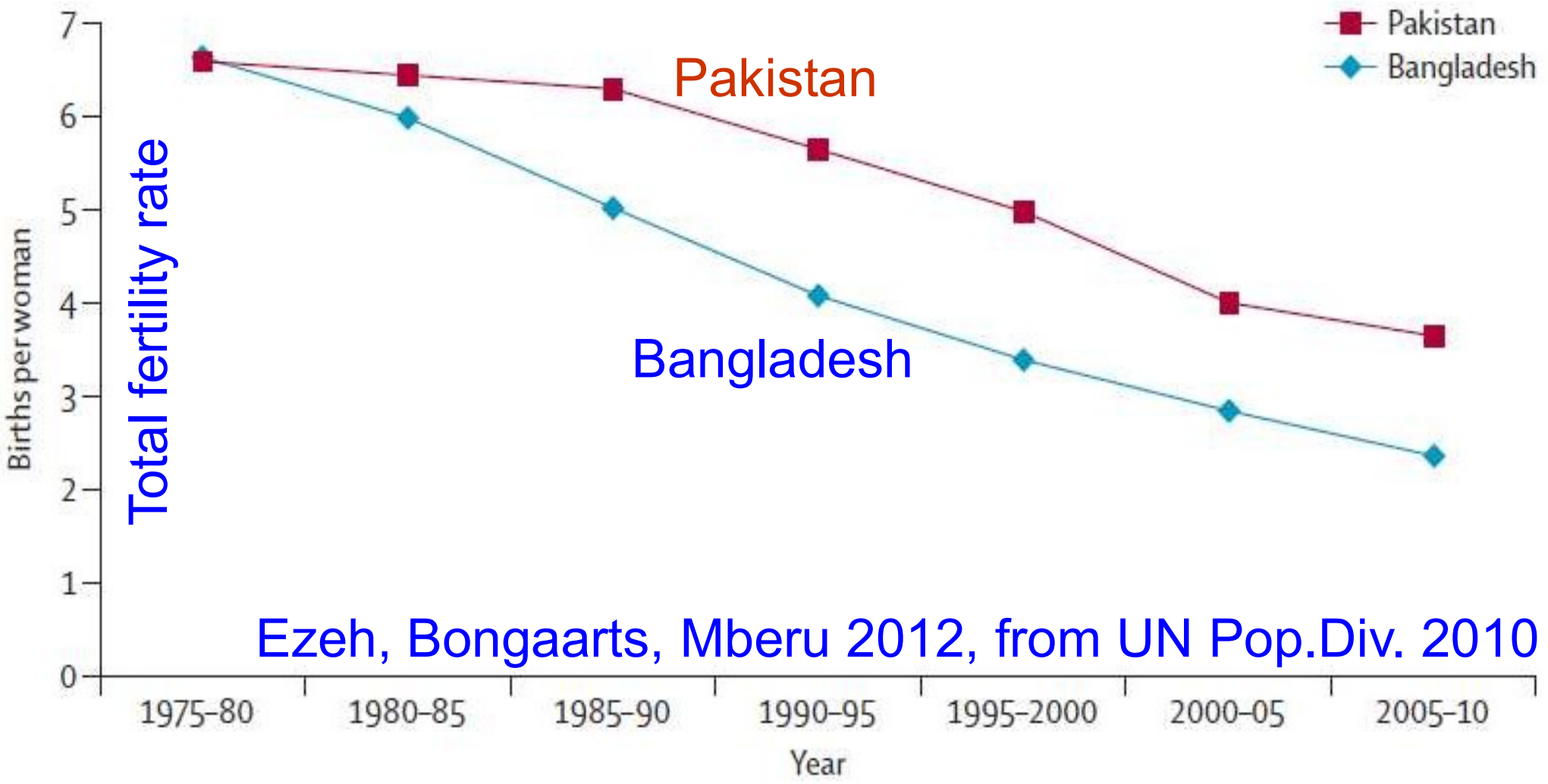

Total fertility rate (births per woman)
15% increase in modern contraceptive prevalence goes with 1 fewer child per woman per lifetime.
U.S. Census, Global Population Profile 2002, data from years 1990-2002
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
Percent of currently married women ages 15-49 using a modern method of contraception

Contraceptive use lowered fertility in Matlab, Bangladesh.

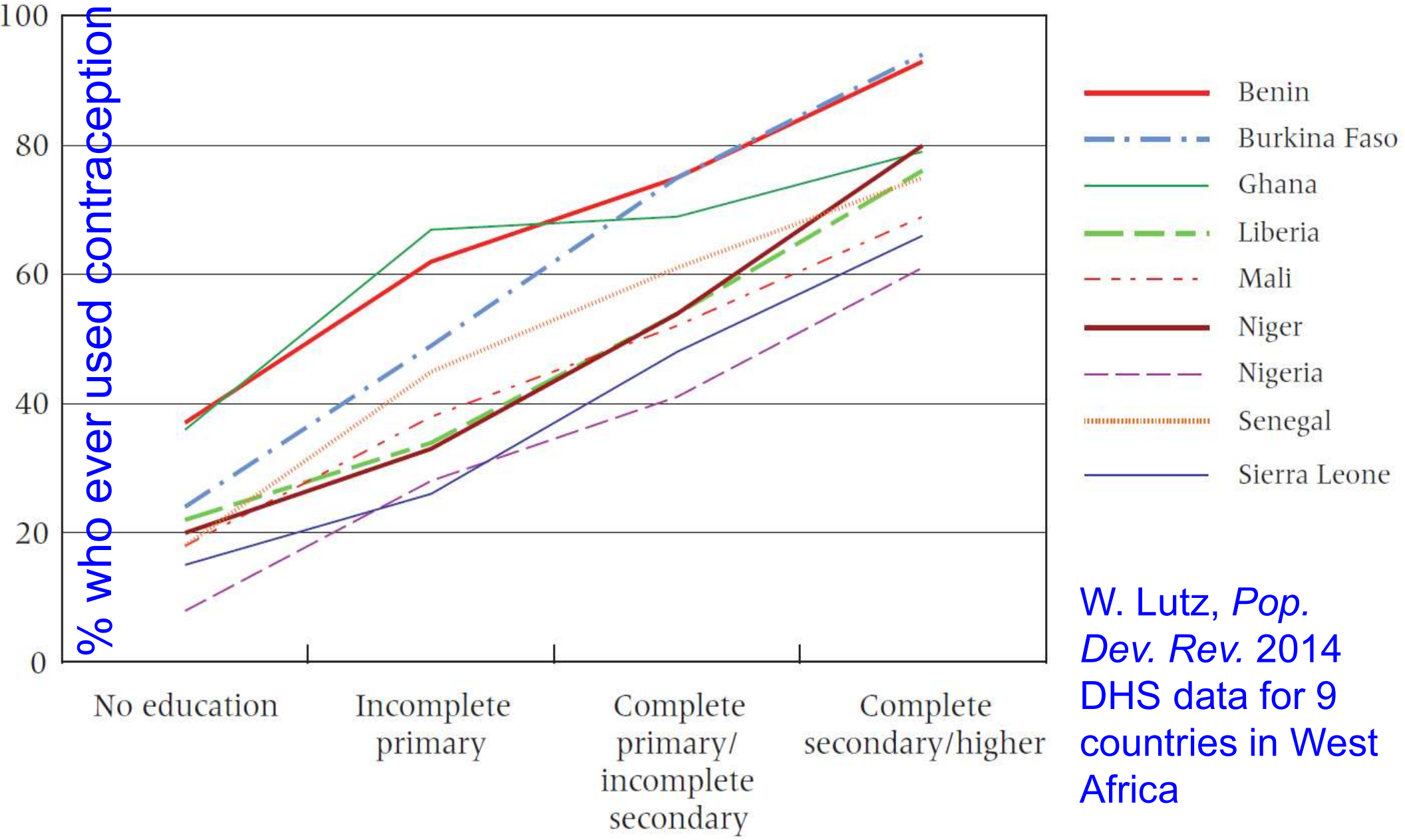




National policy affected fertility.

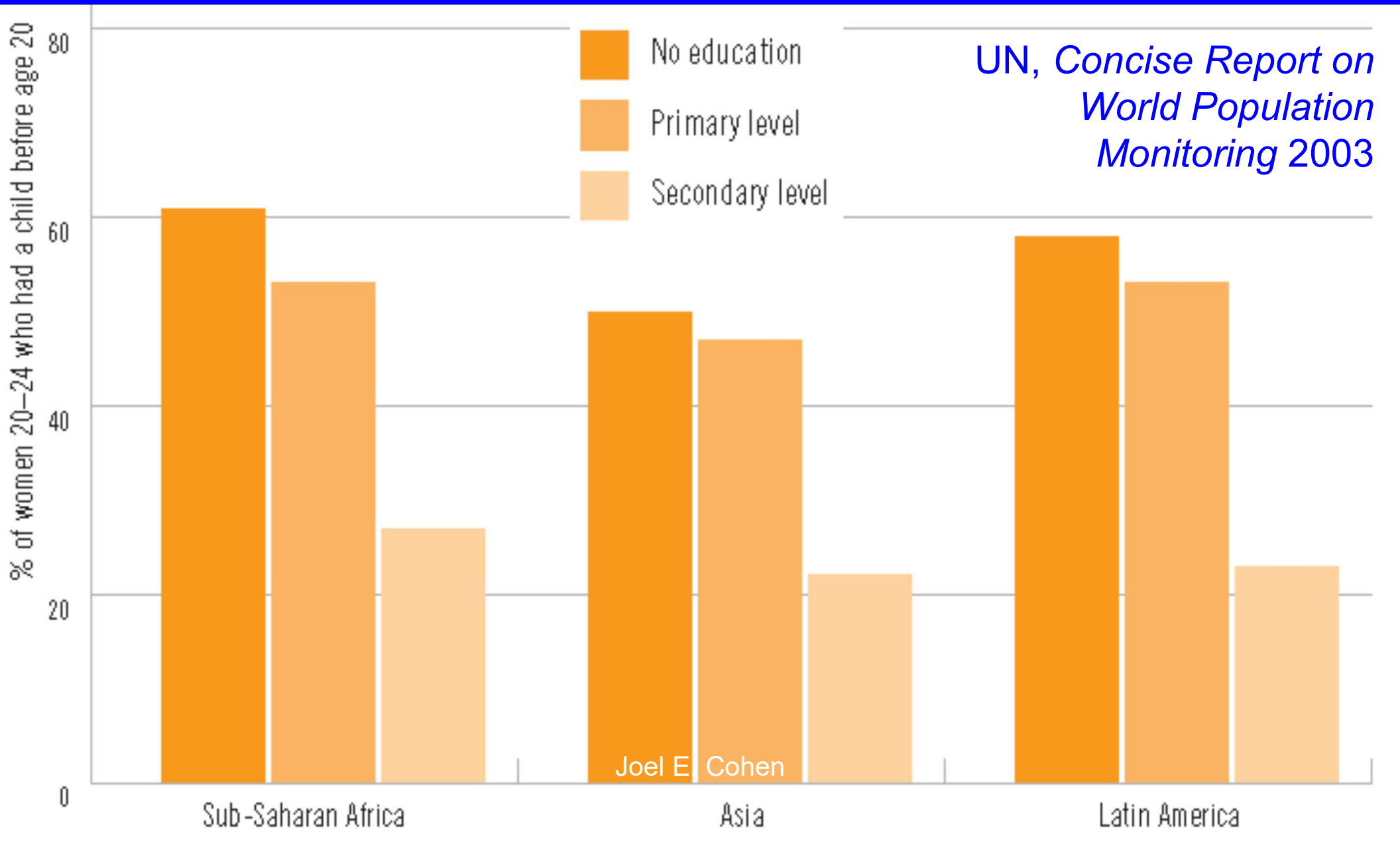


More educated women use contraception more.



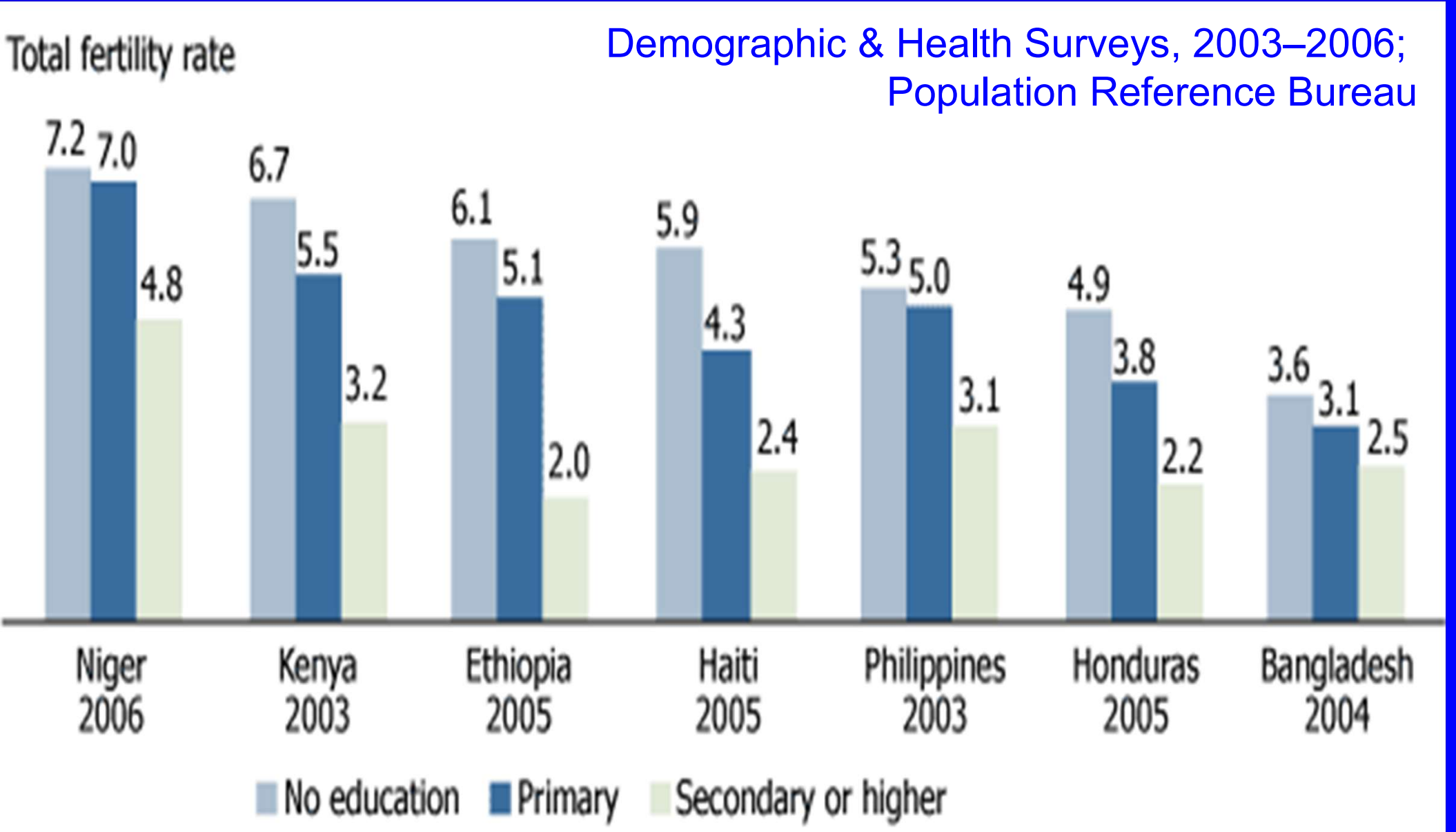
W. Lutz, *Pop. Dev. Rev.* 2014
DHS data for 9 countries in West Africa

Women with more education are less likely to have children before age 20.



UN, *Concise Report on World Population Monitoring* 2003

More educated women have fewer children almost everywhere.




Shibuya, Tokyo, 2014-10-26
JEC
Cities
CINEMAS

1/3 of urban people live in "slum" households. UN Habitat

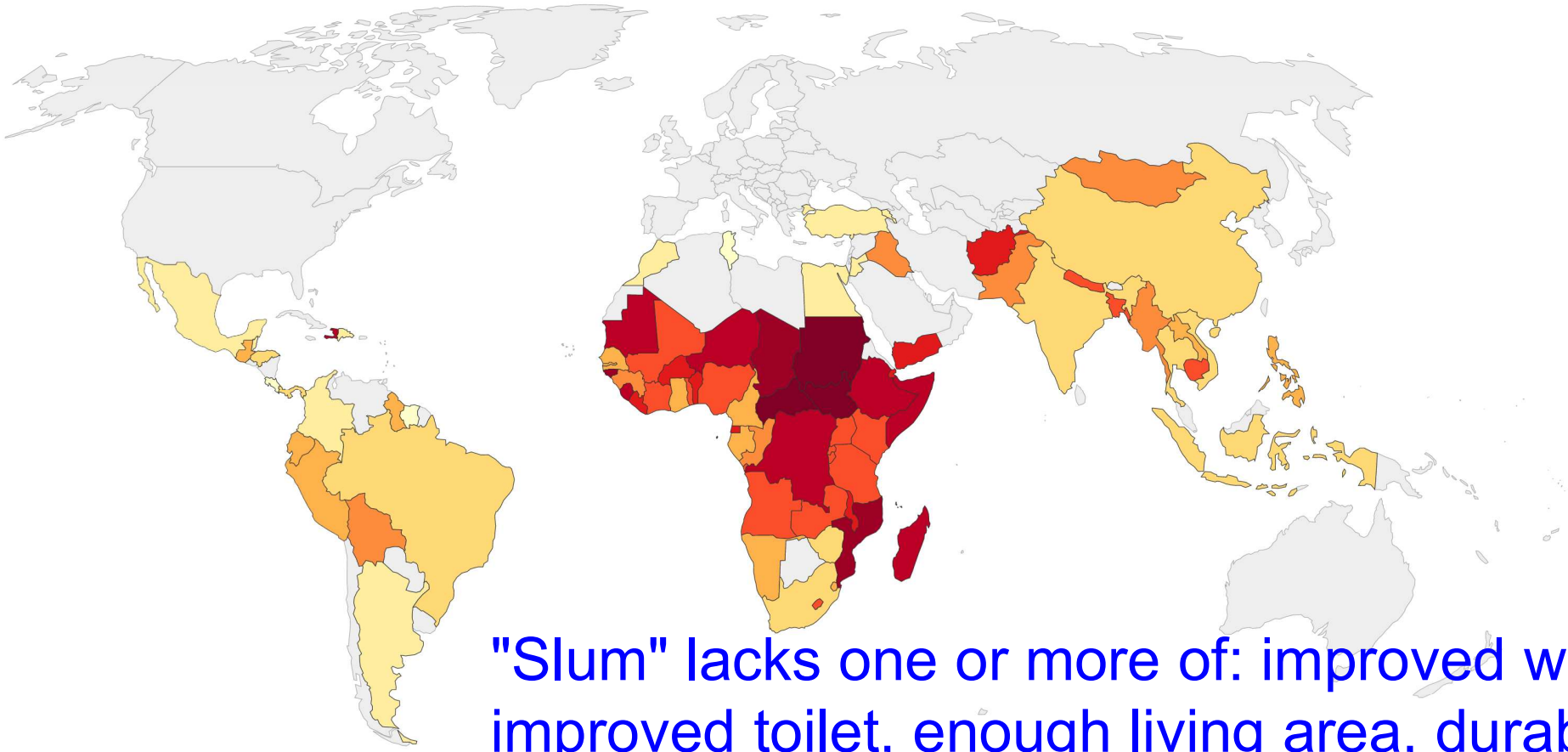
Definition: "slum" household is a group of individuals living under the same roof in an urban area who lack one or more of:

1. Durable permanent housing that protects against extreme climate conditions.
2. No more than 3 people sharing same room.
3. Easy access to sufficient, safe, affordable water.
4. Access to private or public toilet shared by a reasonable number of people.

Sometimes: 5. Security of tenure against forced evictions.

1/3 of urban people live in "slums."

2018, UN Habitat via World Bank



"Slum" lacks one or more of: improved water, improved toilet, enough living area, durability of housing.

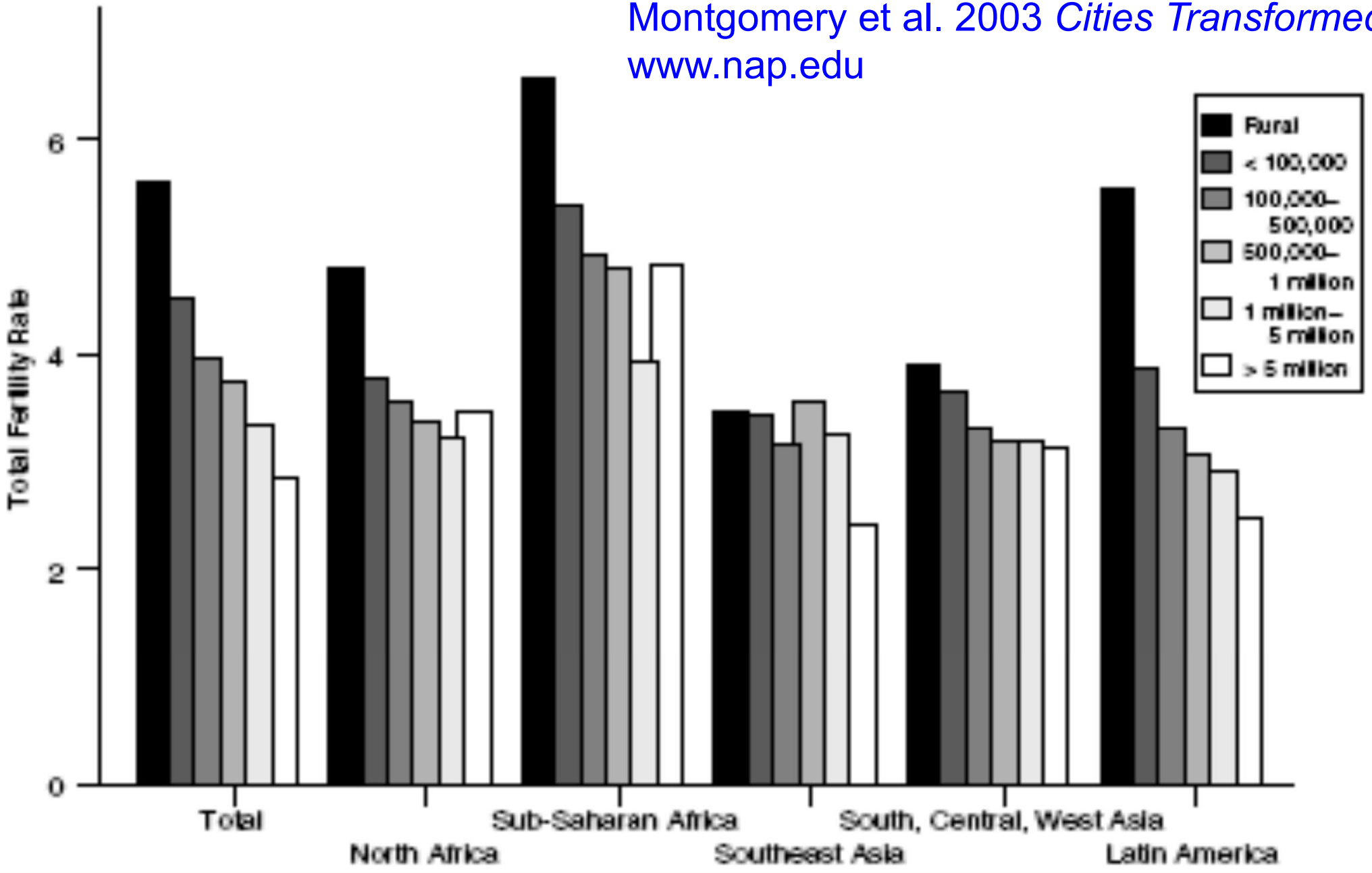
No data 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Source: UN HABITAT


Bangalore, India, JEC 2003-07-27
2003 7 27
2024-11-18
Joel E. Cohen

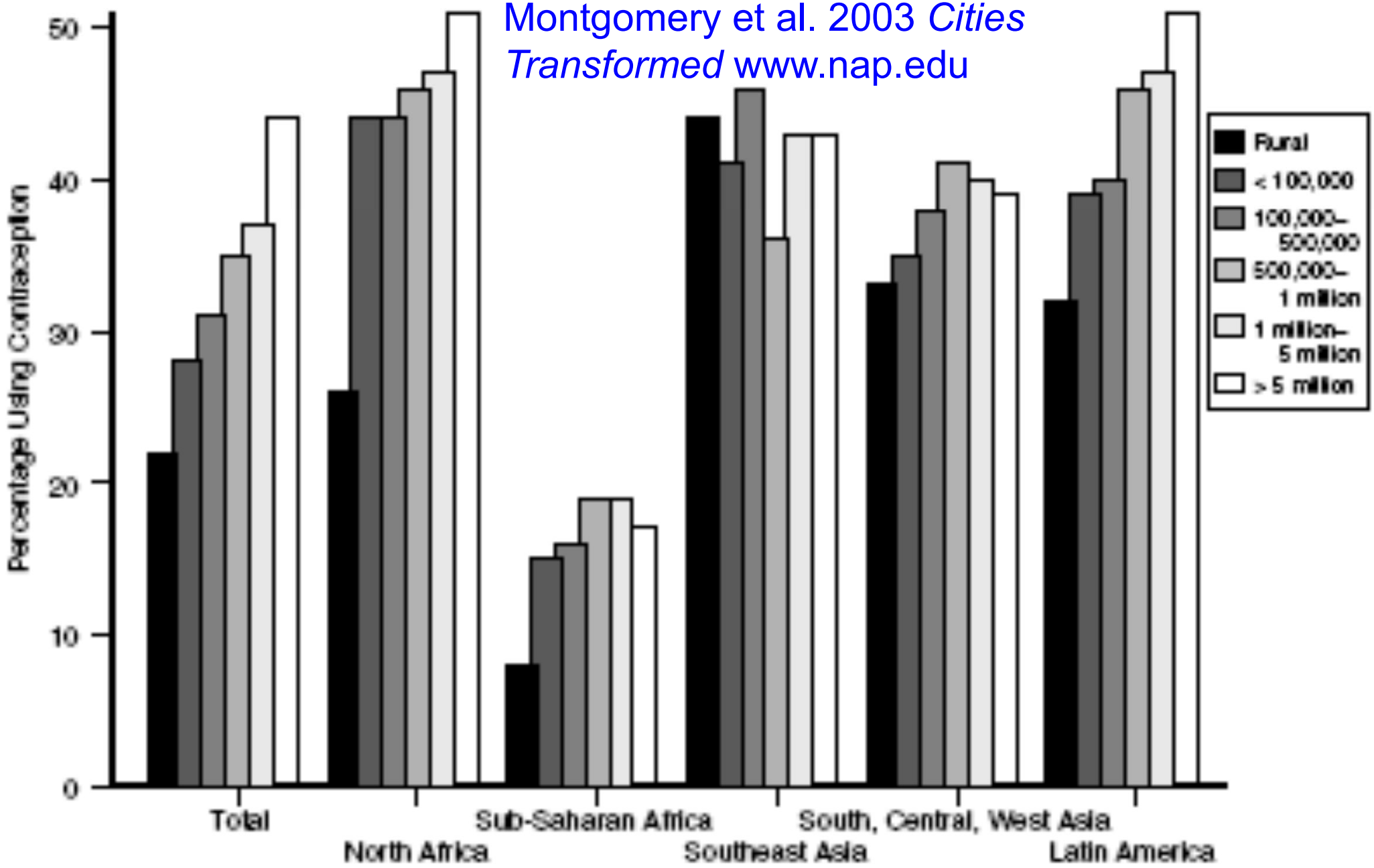
Total fertility rates decline from rural to urban areas.

Montgomery et al. 2003 *Cities Transformed*
www.nap.edu



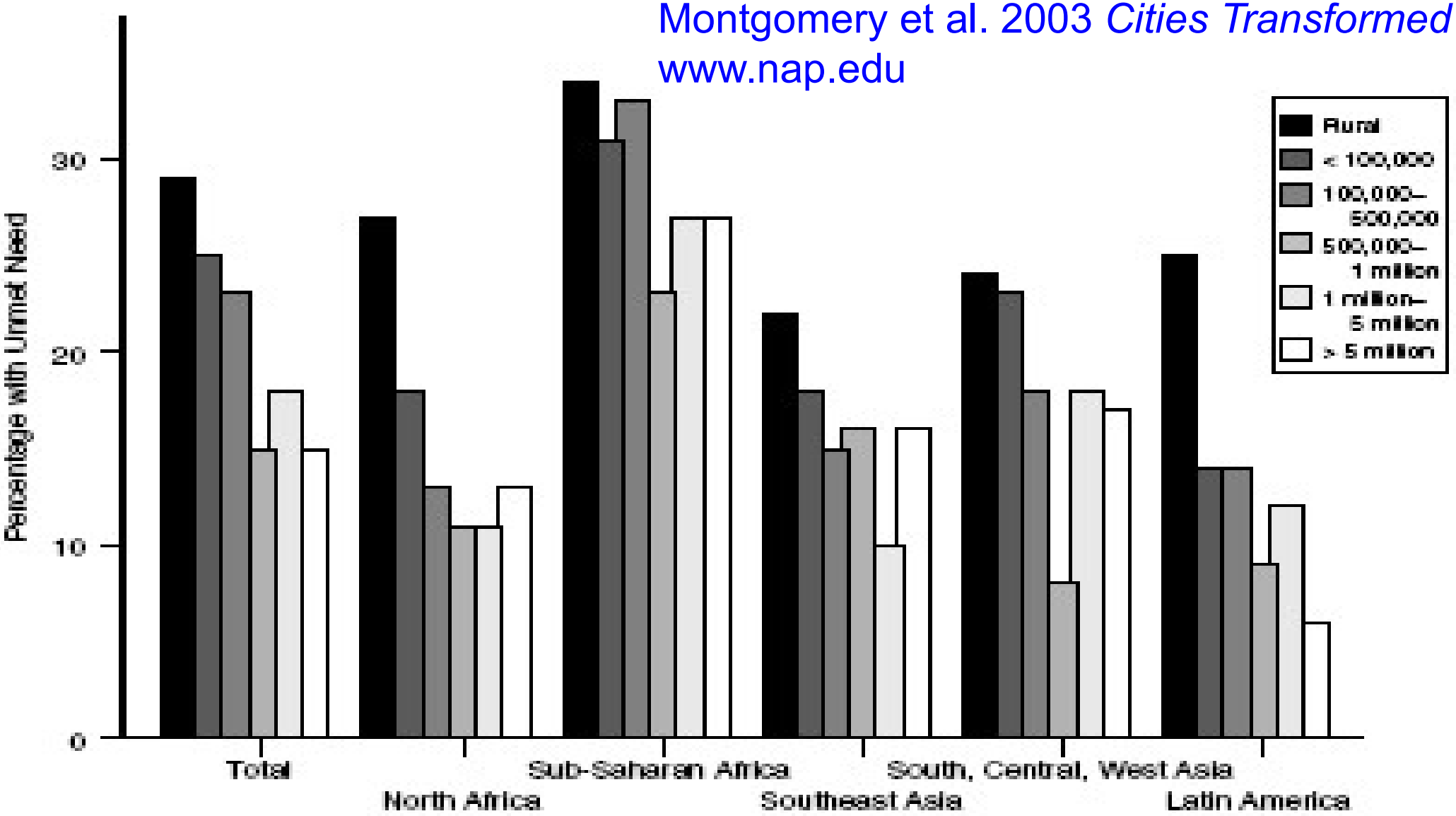
Modern contraceptive use increases from rural to urban areas in most regions.

Montgomery et al. 2003 *Cities Transformed* www.nap.edu



Unmet need for contraception is greatest in rural & small urban areas.

Montgomery et al. 2003 *Cities Transformed*
www.nap.edu



634 million people live in coastal areas at <10 m (33 ft) above sea level.

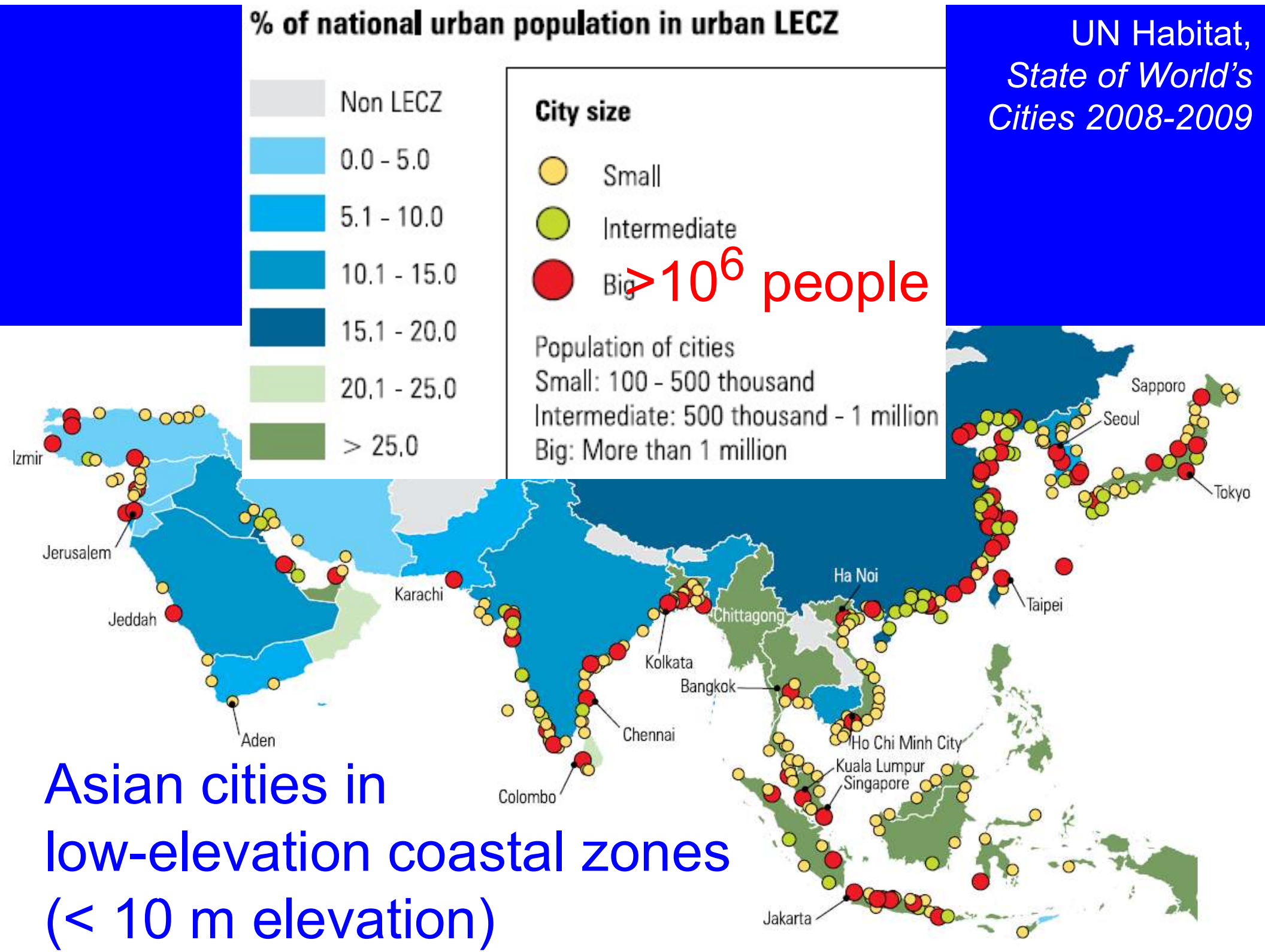
Of those 634 million, 360 million are urban.

>180 countries have people in low coastal zones. 2/3 of those countries have urban areas of more than 5 million people in low-elevation coastal zones.

McGranahan, Balk, Anderson *Environment & Urbanization* 2007

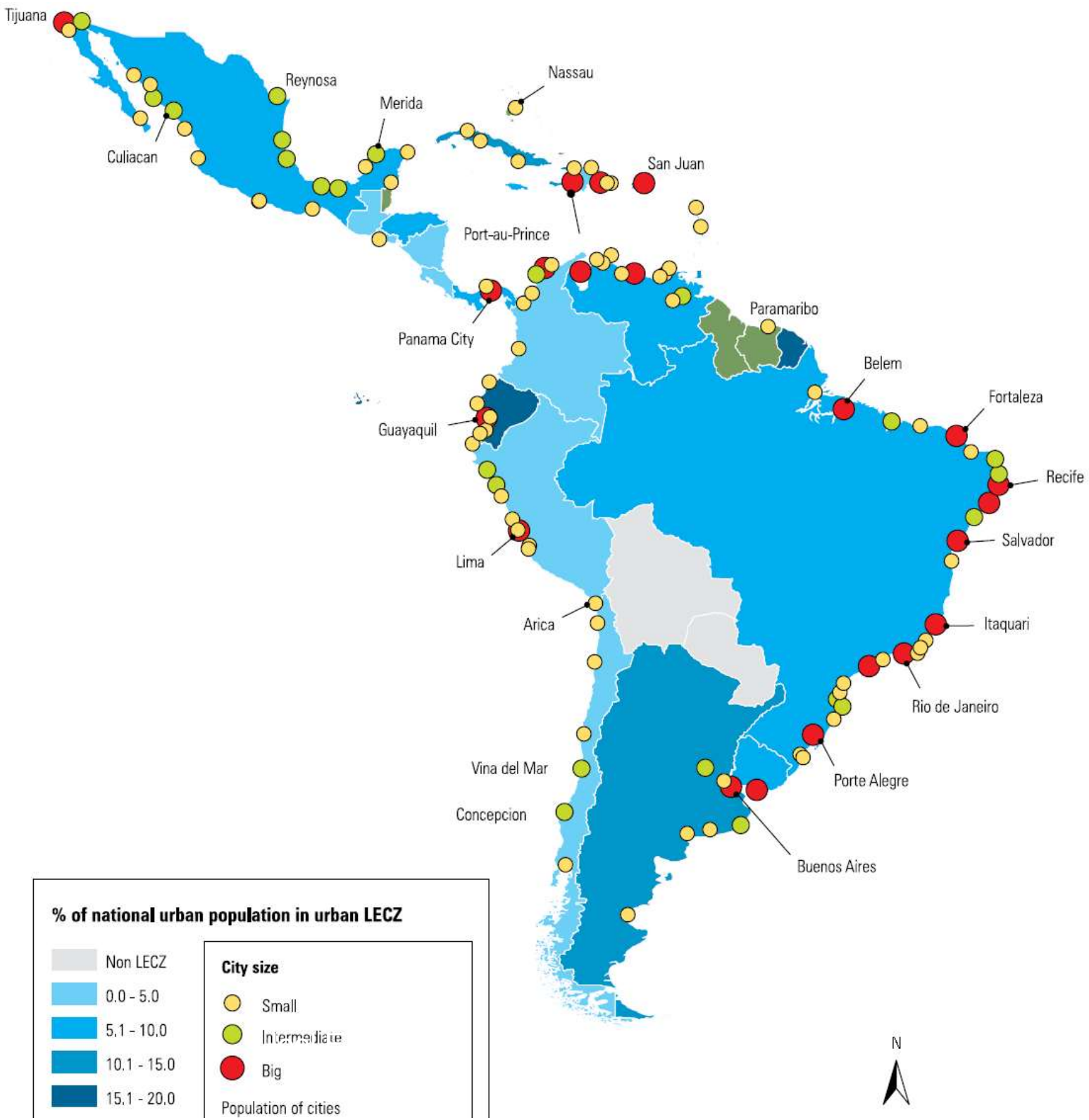
In last interglacial (Eemian, 130-115 ka), global sea level was ~6 m higher. Migration?

UN Habitat,
State of World's Cities 2008-2009



Asian cities in low-elevation coastal zones (< 10 m elevation)

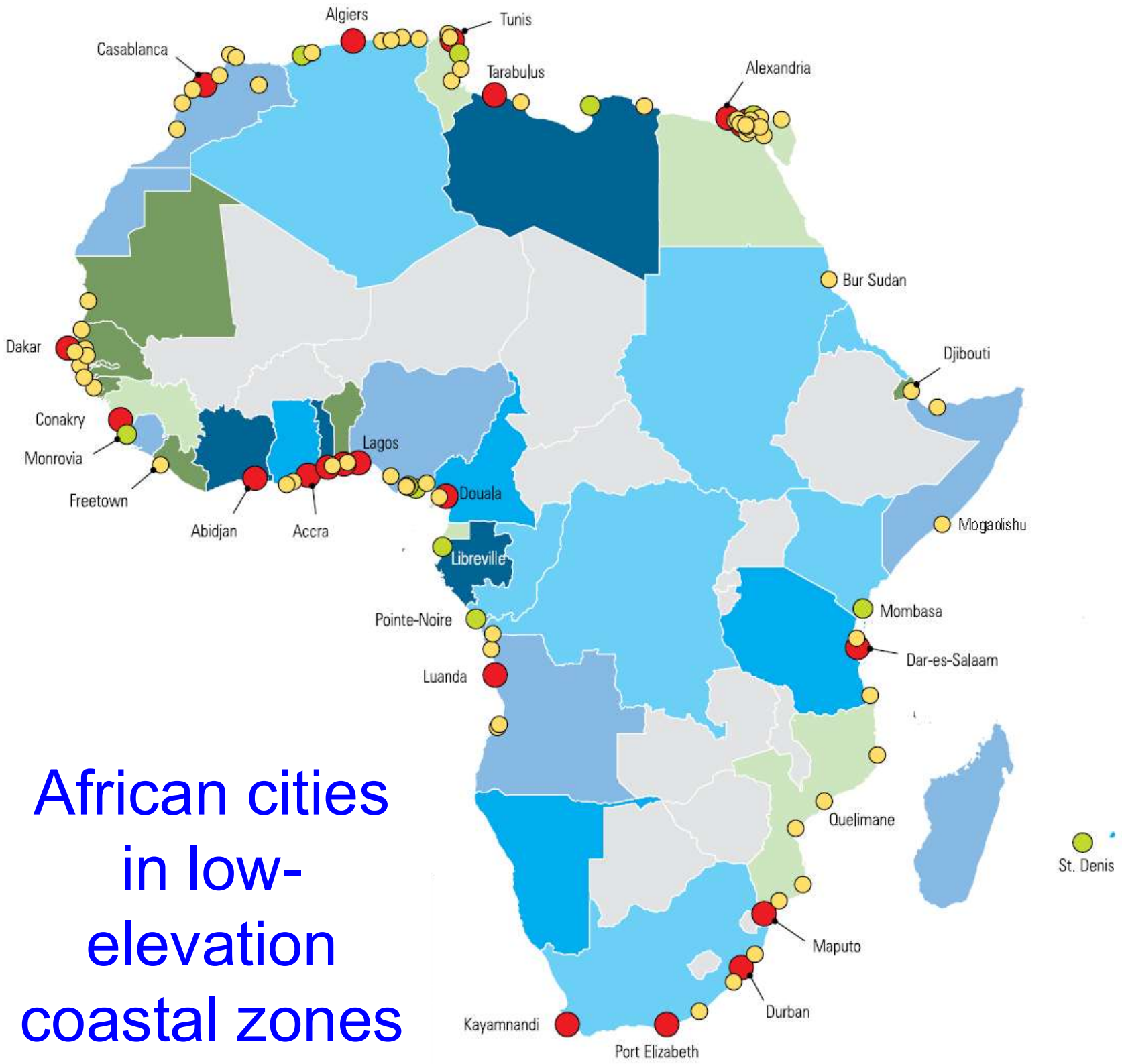
Latin American & Caribbean cities in low-elevation coastal zones



UN Habitat, *State of World's Cities 2008-2009*

2024-11-18

African cities in low-elevation coastal zones



UN Habitat, *State of World's Cities 2008-2009*

2024-11-18


New Haven
Montauk
New York City
Long Beach
from Sassen & Schroeder
Atlantic City
Sea Level +6M
Weiss and Overpeck, University of Arizona
Joel E. Cohen
Wildwood

Katrina, New Orleans, 2005-08-31

Sandy, New York City, 2012-10-28/29

"largest hurricane ever recorded in the Atlantic basin"--Wikipedia

Storm surge at Battery Park of ~4.25 m (14 feet)

Future

High confidence (next 25-30 years, excluding nuclear war, plague, climate catastrophe, comets): larger by >1 billion, older, more urban, more slowly, more Asian, more African, more migration

Controversial (beyond 2050):

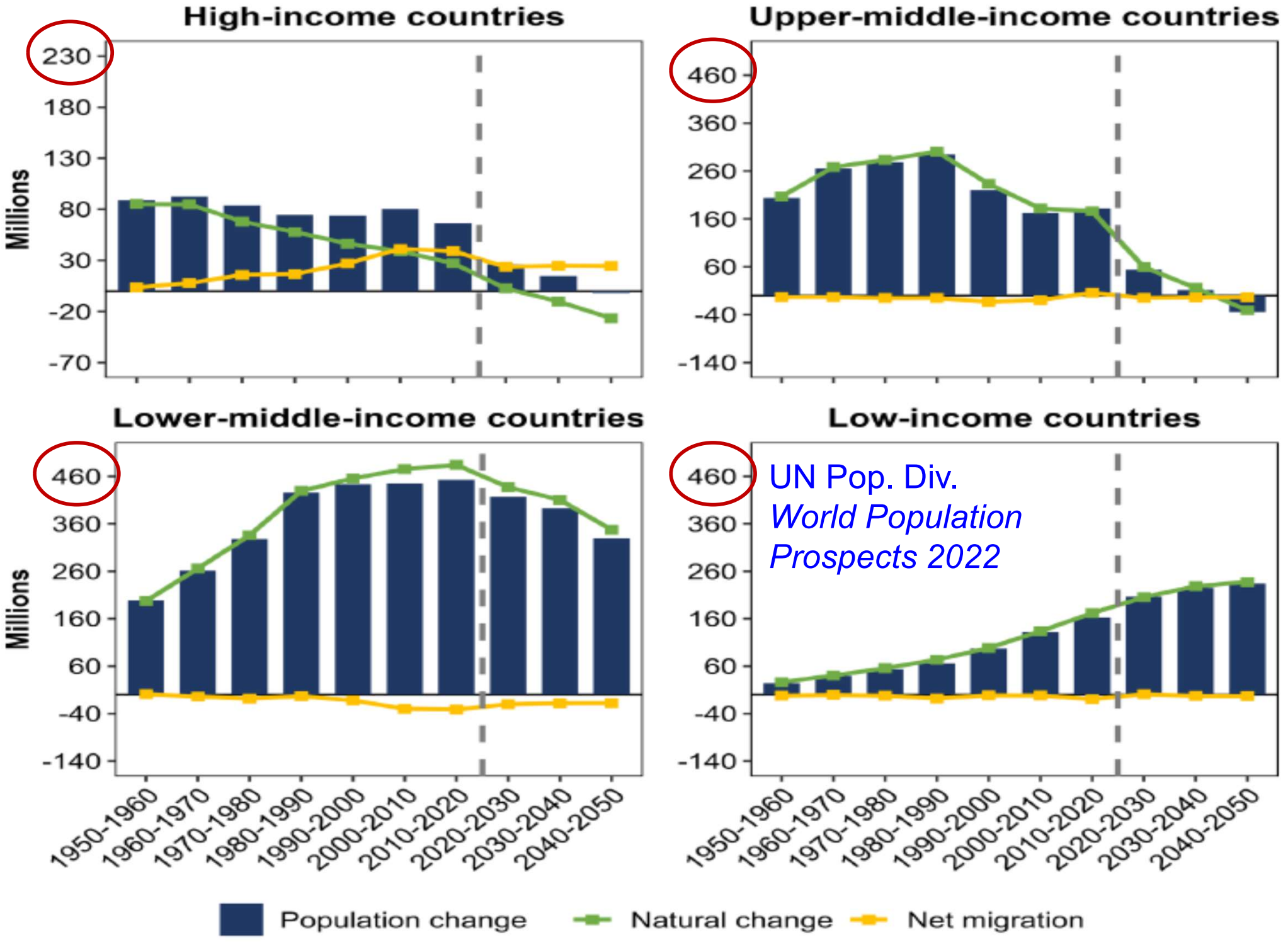
When will population growth end?

At what peak population size?

% people aged 65+ varies widely.

Region	2022	2030	2050
World	9.7	11.7	16.4
Sub-Saharan Africa	3.0	3.3	4.7 57% increase
Europe, Northern America	18.7	22.0	26.9 44% increase

UN Pop.Div. *World Population Prospects 2022*


High-income countries
Upper-middle-income countries
Lower-middle-income countries
Low-income countries
Millions
230
180
130
80
30
-20
-70
460
360
260
160
60
-40
-140
1950-1960
1960-1970
1970-1980
1980-1990
1990-2000
2000-2010
2010-2020
2020-2030
2030-2040
2040-2050
UN Pop. Div.
World Population Prospects 2022
Population change
Natural change
Net migration

"Long-range population projections to 2100" from UN WPP 2022

"Long-range population projections are highly uncertain, especially for high-fertility countries still in the early stages of the demographic transition."

95% probability of global population:

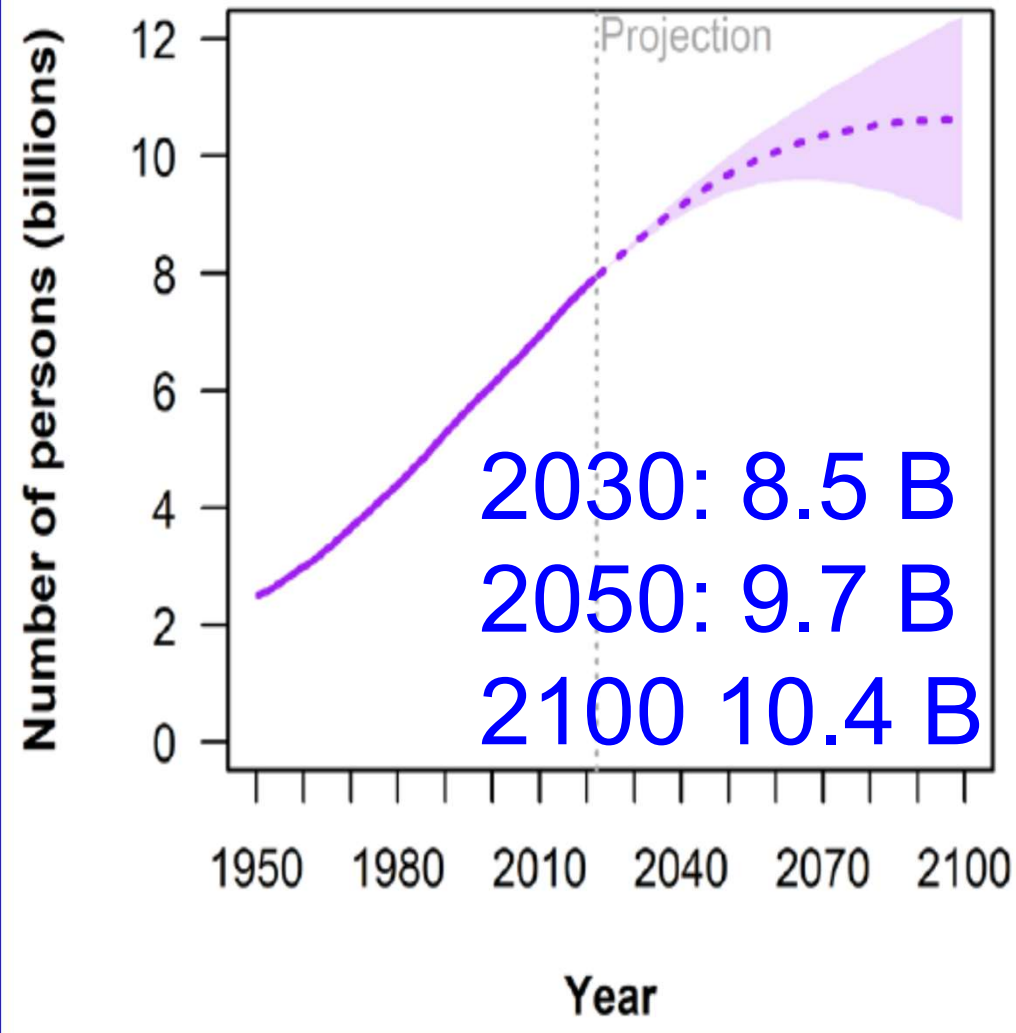
9.4-10.0 billion in 2050;

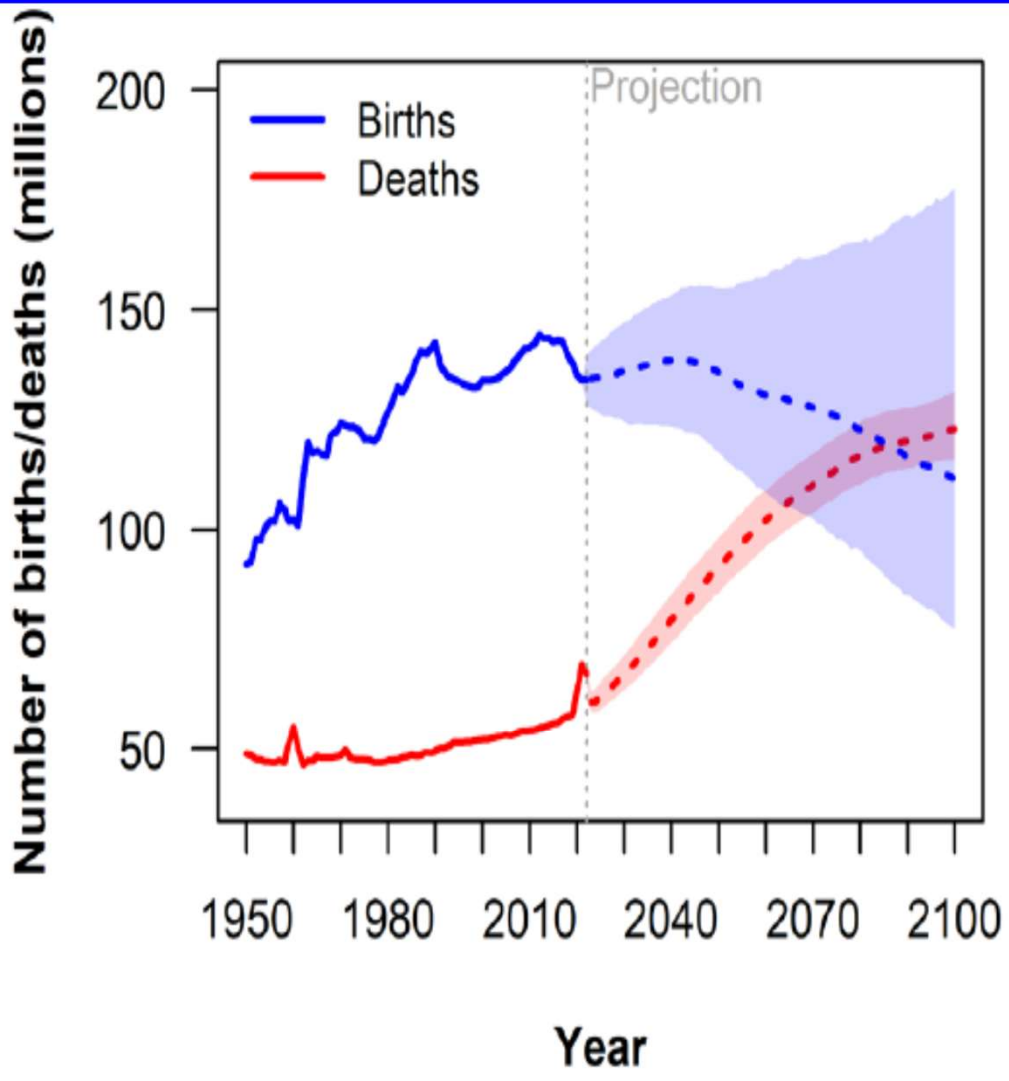
8.9-12.4 billion in 2100.

"Long-range population projections to 2100" from UN WPP 2022

"Thus, the size of the world's population is almost certain to rise over the next several decades, as is the degree of uncertainty associated with these projections. Later in the century, there is about 50 per cent chance that the world's population will peak—that its size will stabilize or begin to decrease— before 2100."

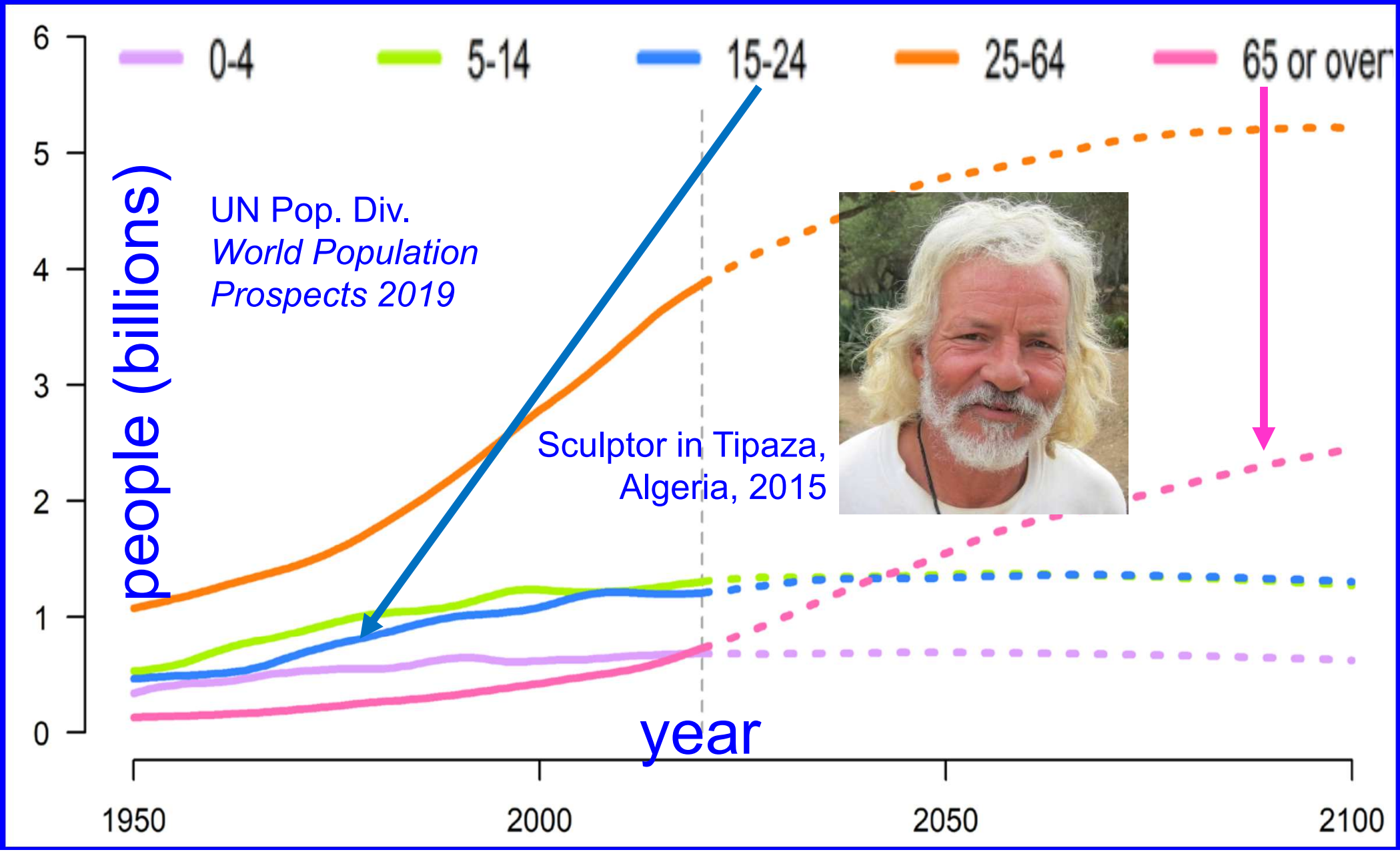
UN WPP 2022 estimates & medium scenario with 95% prediction intervals, 2022-2100





Aging

People 65+ are fastest growing age group.



What does “old” mean?

Age 65+ years? OR

Remaining life expectancy (RLE) of 15 years or less? Norman Ryder 1975

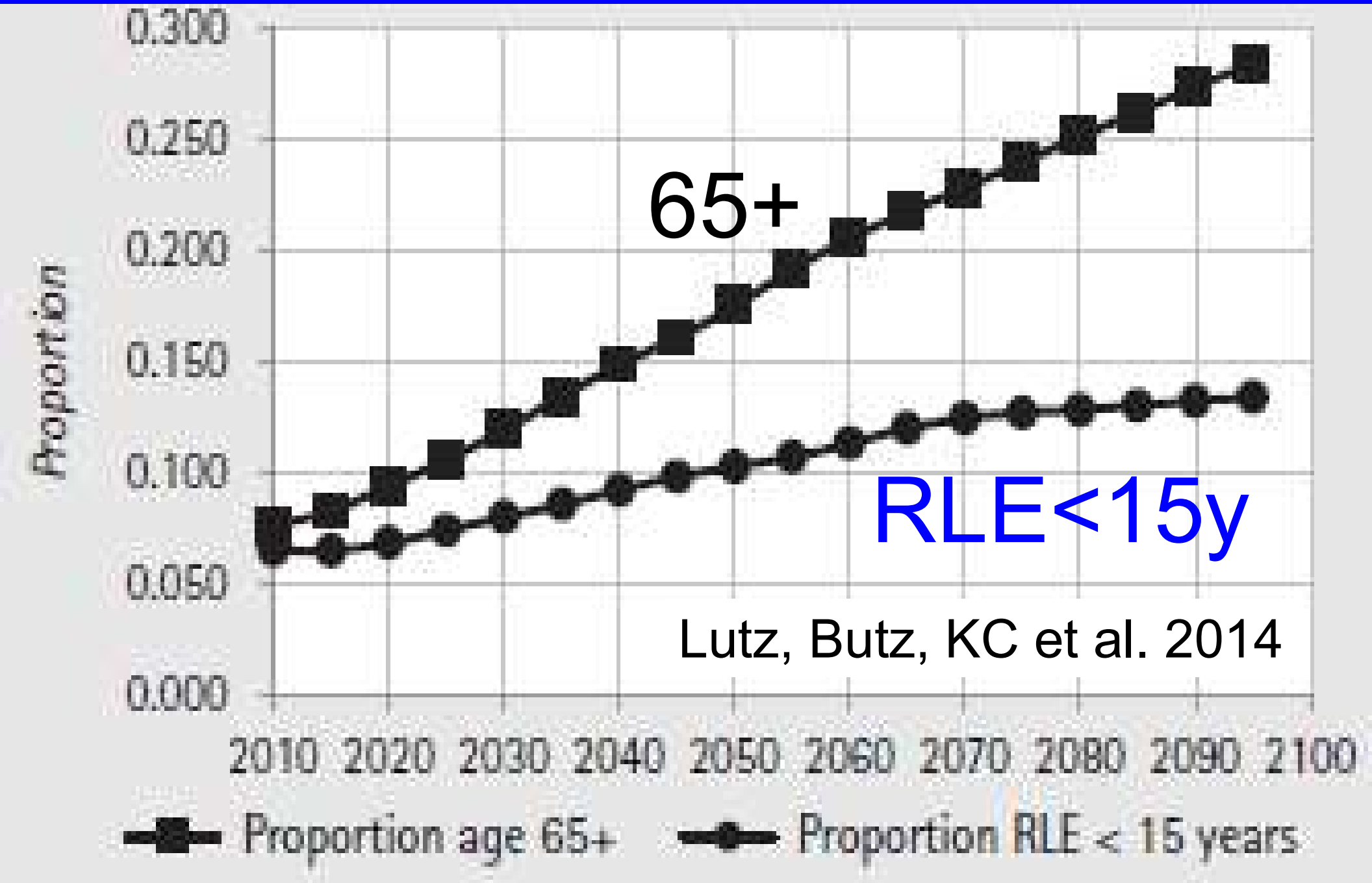
In 2010, people had RLE of 15 years at age:

71 in North America,

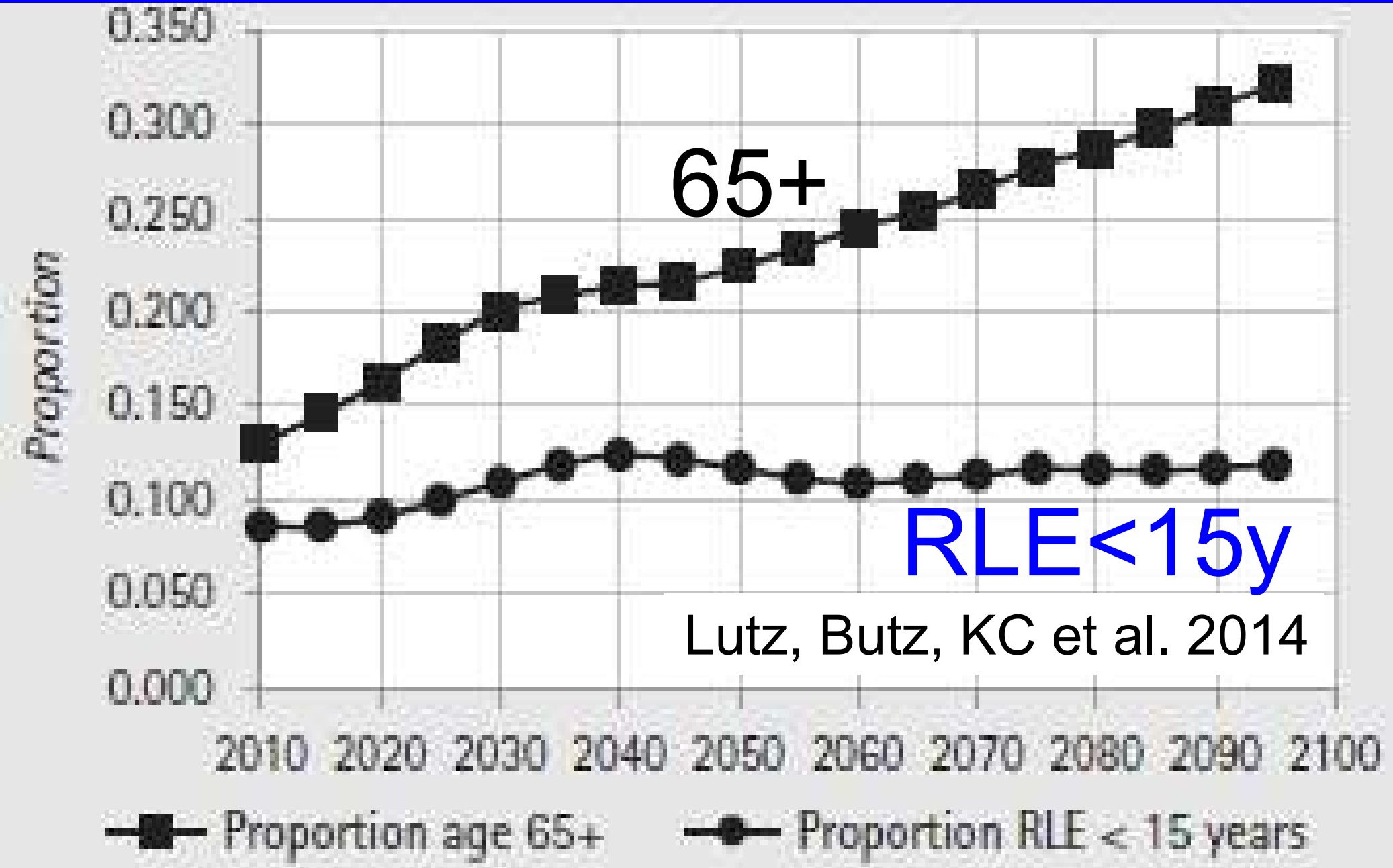
63 in Africa,

67 in world. Lutz et al. 2014

World


0.300
0.250
0.200
0.150
0.100
0.050
0.000
Proportion
65+
RLE<15y
Lutz, Butz, KC et al. 2014
2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
Proportion age 65+
Proportion RLE < 15 years

USA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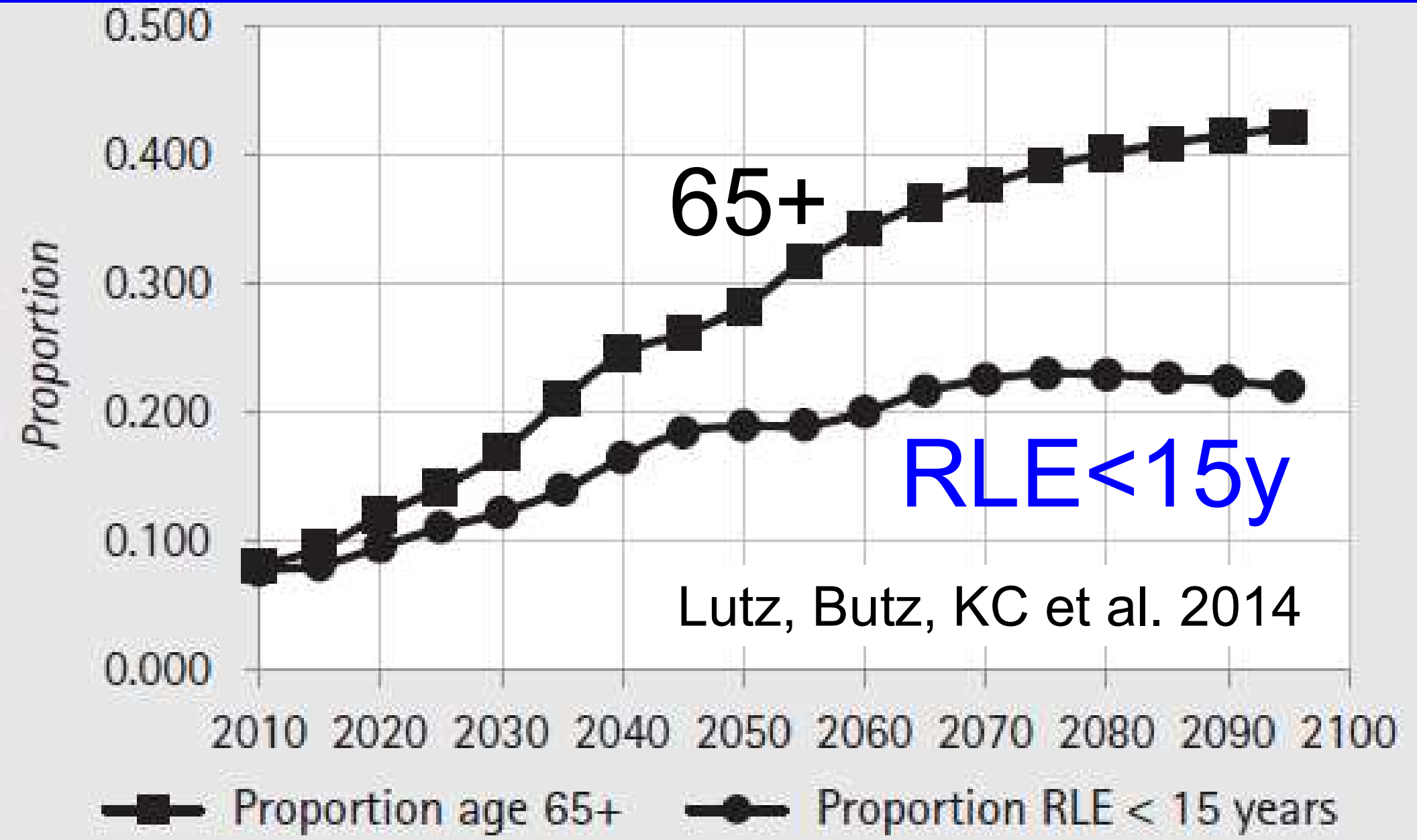
Proportion
65+
RLE<15y
Lutz, Butz, KC et al. 2014
2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
Proportion age 65+
Proportion RLE < 15 years

China


0.500
0.400
0.300
0.200
0.100
0.000
Proportion
65+
RLE<15y
Lutz, Butz, KC et al. 2014
2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
Proportion age 65+
Proportion RLE < 15 years

“What can grow younger as it grows older?”

“Because of education changes and scientific advances, human populations can grow in productivity, creativity, and remaining life expectancy, even as the median age of the population increases. Functionally, human populations can become younger even as they grow older chronologically. This is the key to understanding what ageing will really be like in the twenty-first century.”

Lutz, Butz, KC et al. 2014

Cities

World: Urban and rural Population: 2010-2100

The 20th century was the last with more rural than urban people.

Add 5 billion in 90 years ≈ 1.1 million per week

Urban

Rural

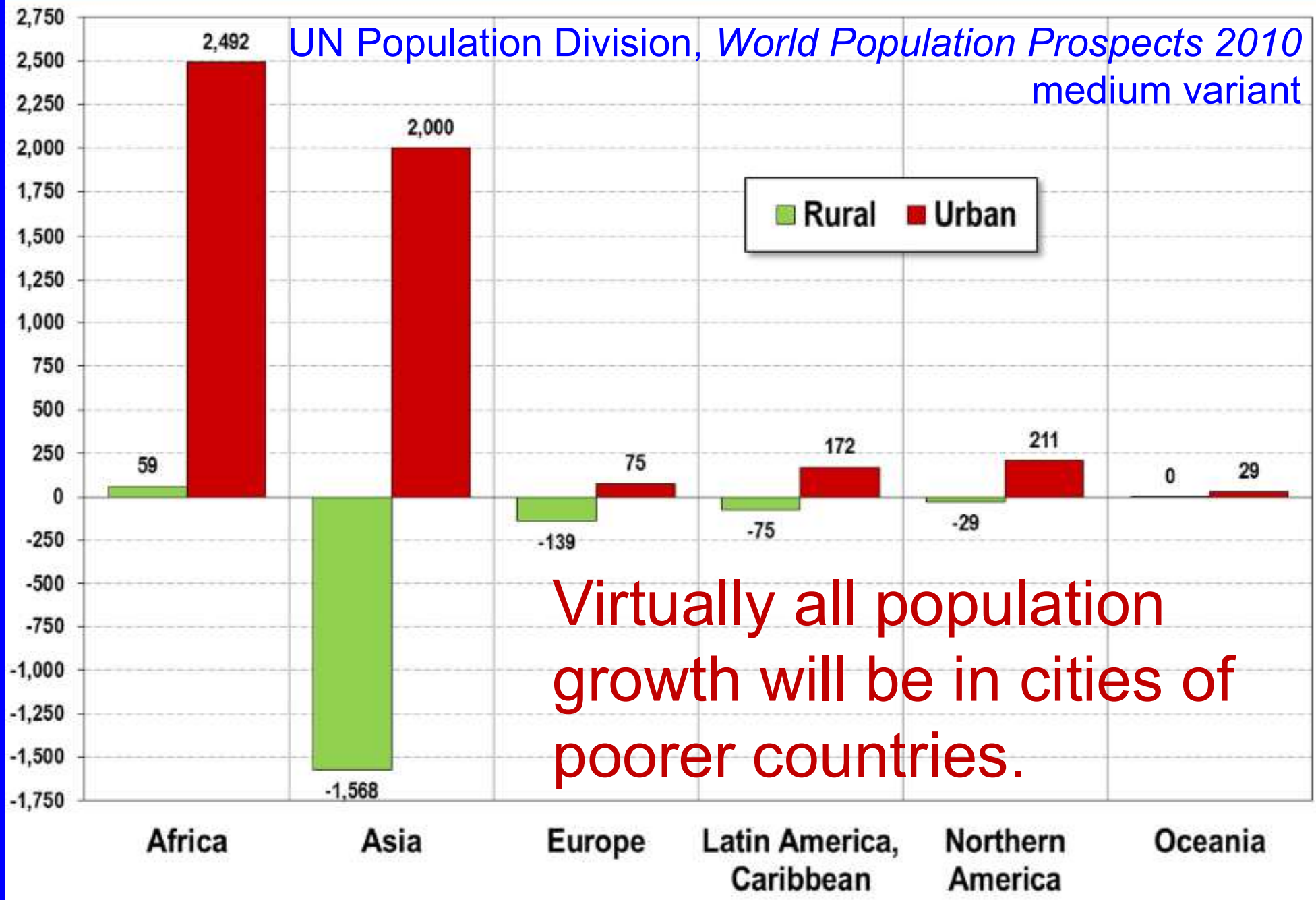
now

UN Population Division *World Population Prospects 2010* medium variant

United Nations Department of Economic and Social Affairs – Population Division

Source: United Nations, Department of Economic and Social Affairs, Population Division (2012): World Urbanization Prospects, the 2011 Revision. New York

Urban and Rural Population Change: 2010-2100



Source: United Nations, Department of Economic and Social Affairs, Population Division (2012): World Urbanization Prospects, the 2011 Revision. New York

Cities of the future will

- Have higher % of older people than now
- Be increasingly located in poor countries
- Have smaller household sizes
- Be concentrated along tectonic fault lines
- Be located coastally at low elevation
- Face energy & water limitations
- Demand more food from agricultural areas

Projections of future population size

Nobody knows

1. when global population growth will end; or
2. how big global population will be when growth ends.

Projections to 2100: 3 methods, 3 results

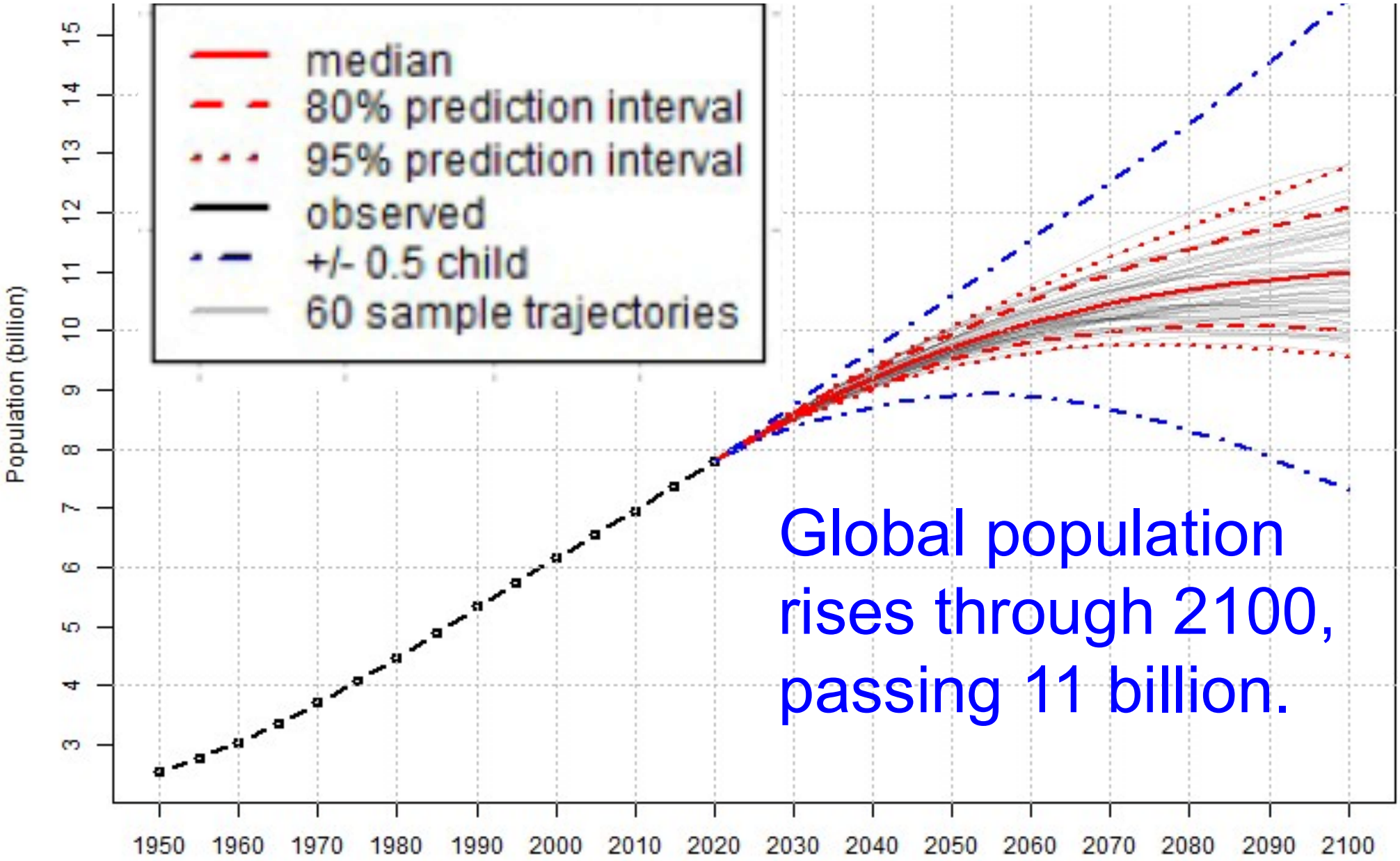
UN Pop.Div. (Adrian Raftery): Bayesian time-series models of TFR, life expectancy, migration

IIASA et al. (Wolfgang Lutz): Expert judgment of TFR & life expectancy

Global Burden of Disease (Christopher Murray): model TFR as function of education & unmet need for contraception

The view from New York: UN Population Division

2019

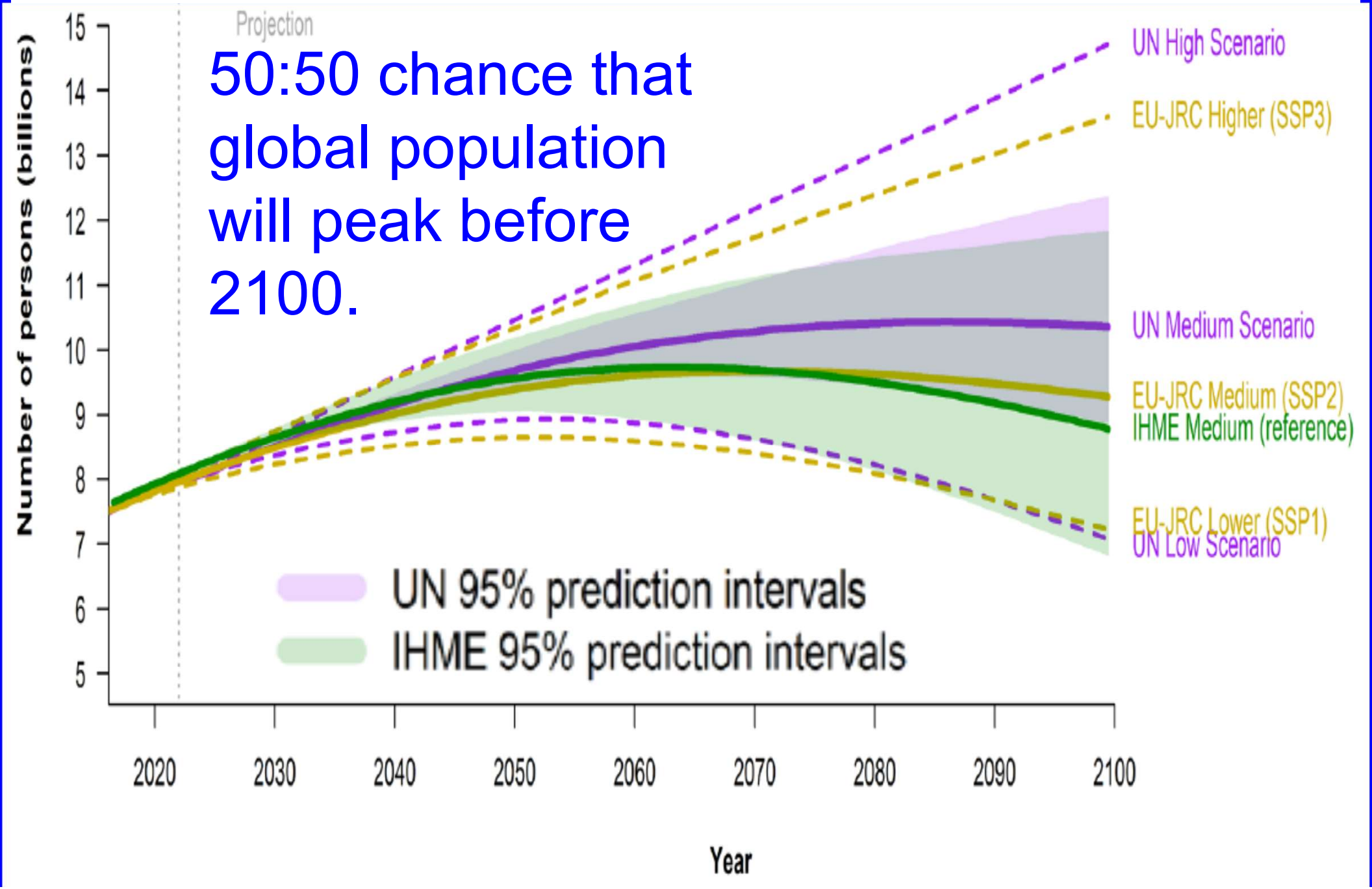


Global population rises through 2100, passing 11 billion.

United Nations, DESA, Population Division. *World Population Prospects 2019*. http://population.un.org/wpp/

The view from New York: UN Population Division

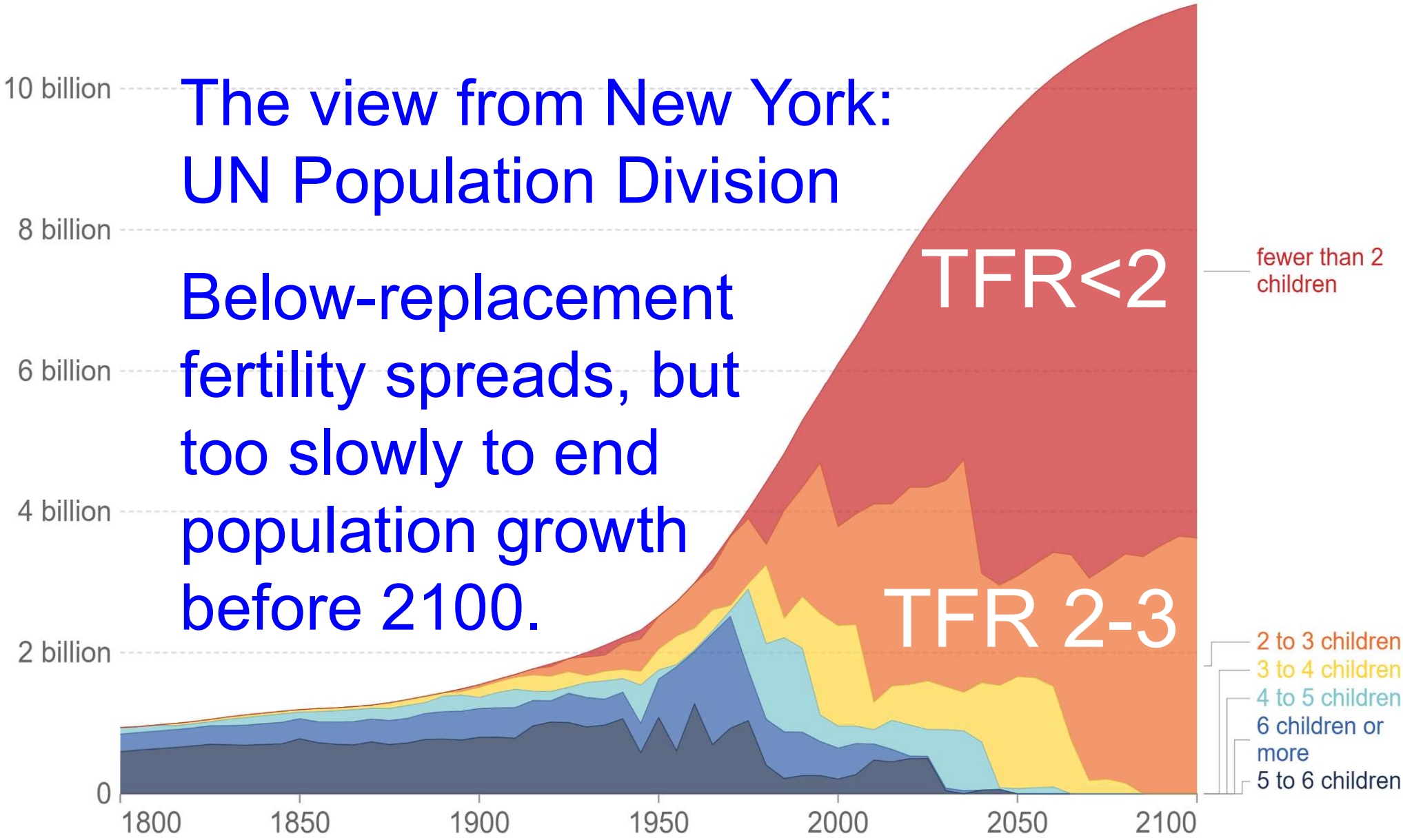
World Population Prospects 2022



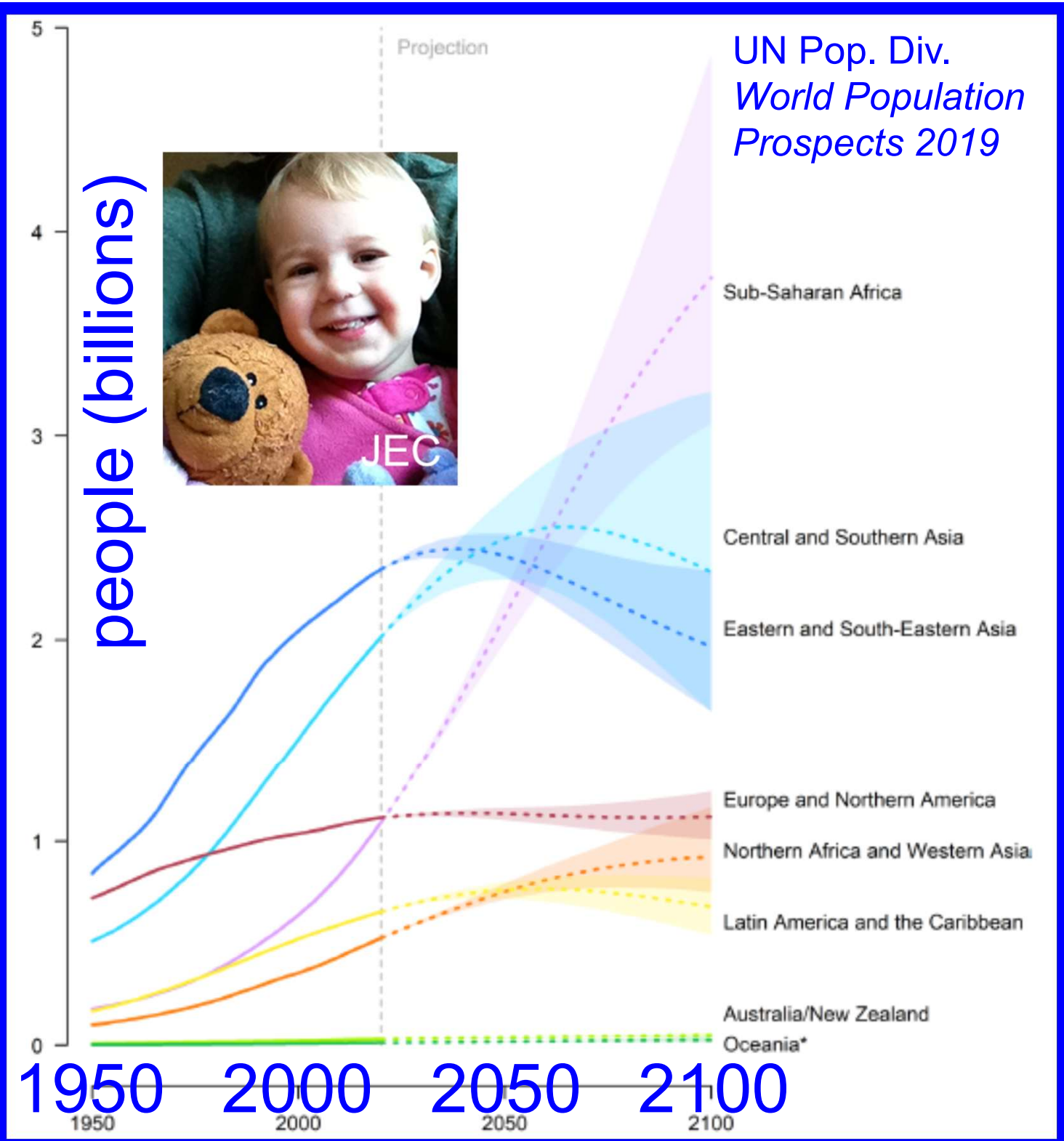
History and Future of the World Population by Total Fertility

Shown is the estimated total fertility rate – the number of children per woman – for each country in the world over time. Future projections are based on the UN Population Division Medium Variant projection.

Our World in Data



Source: World Population by Fertility dataset - OWID (2016)

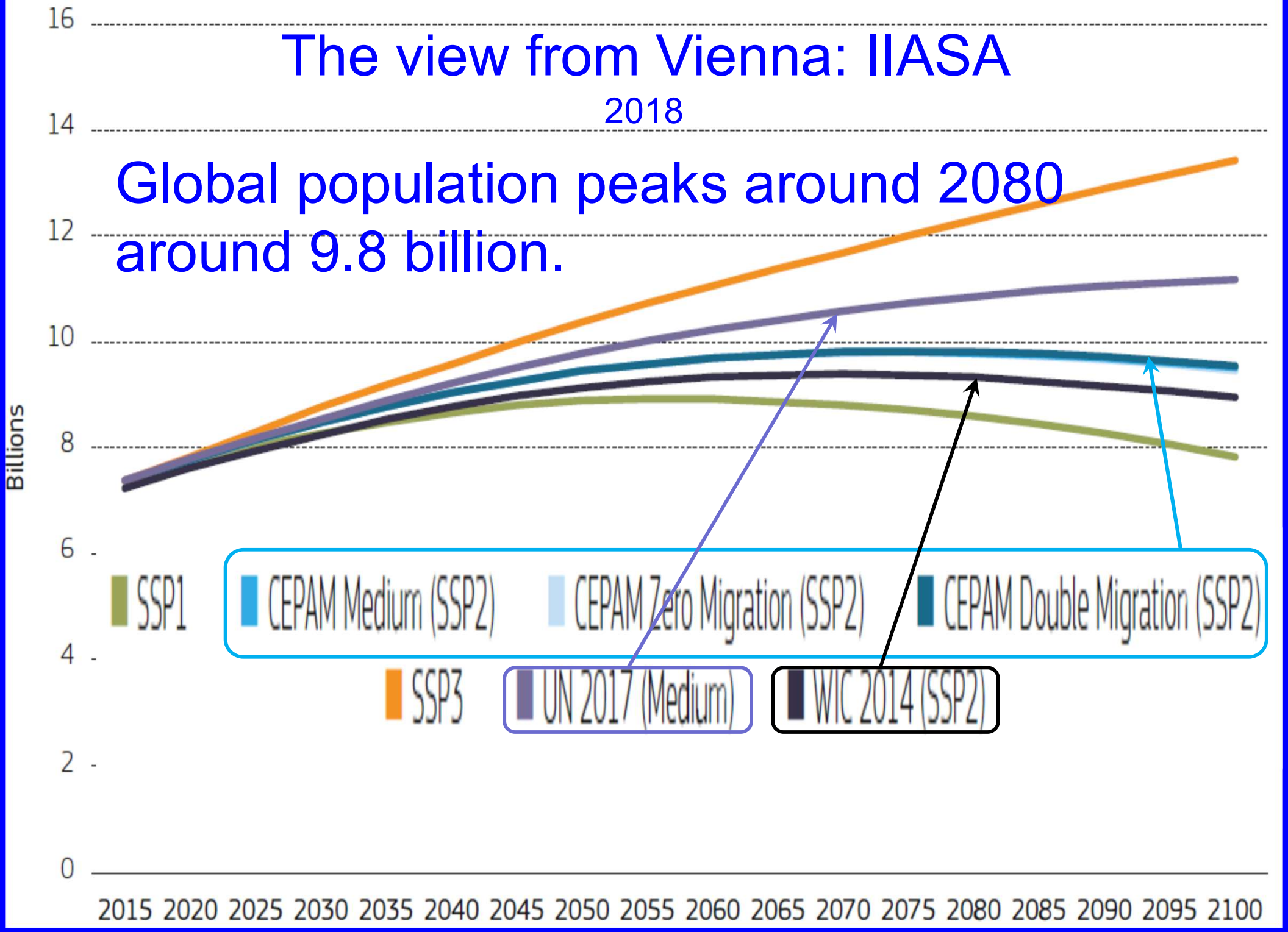


Only sub-Saharan Africa is projected to grow through end of 21st century.

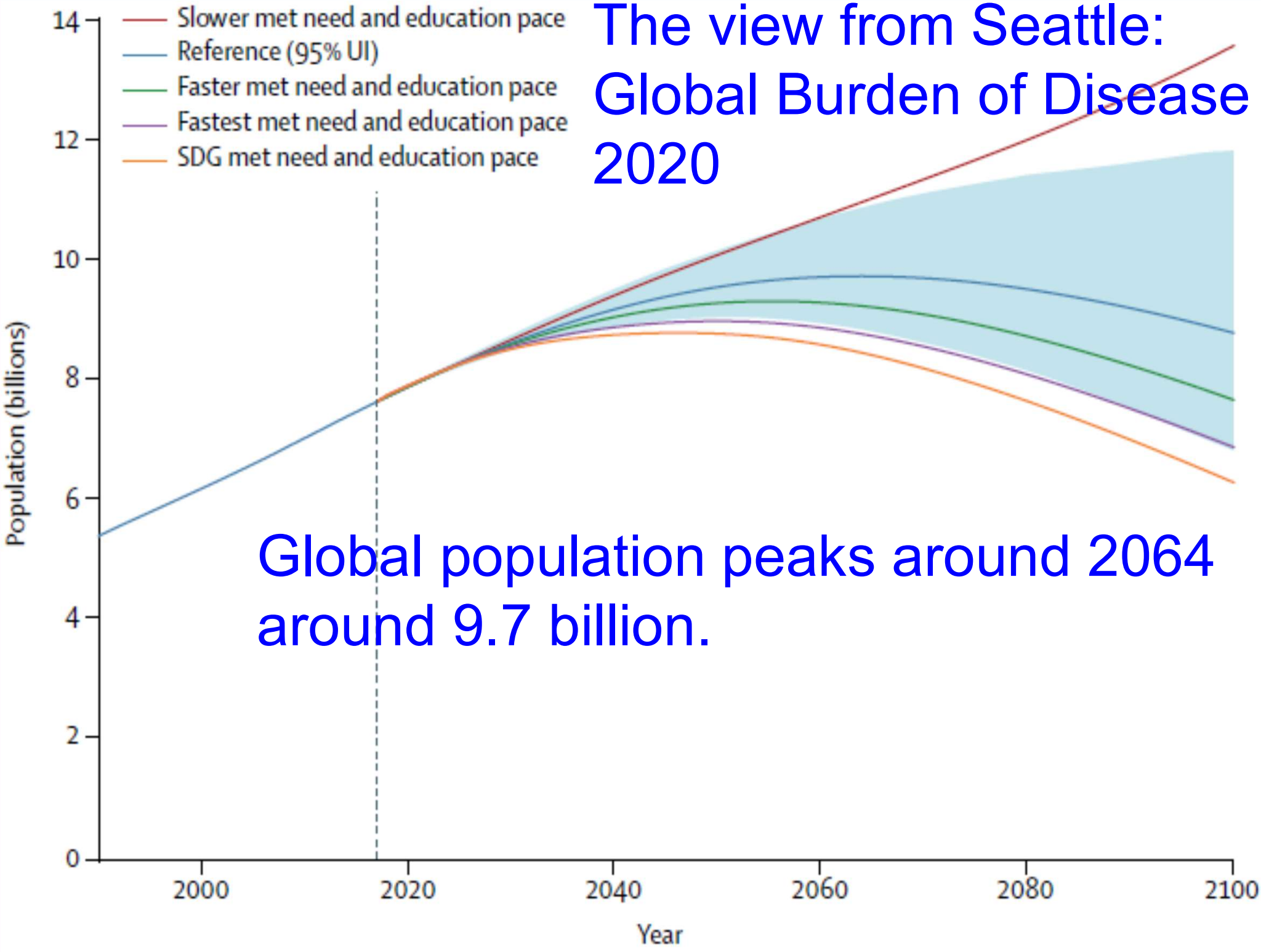
The view from Vienna: IIASA

2018

Global population peaks around 2080 around 9.8 billion.

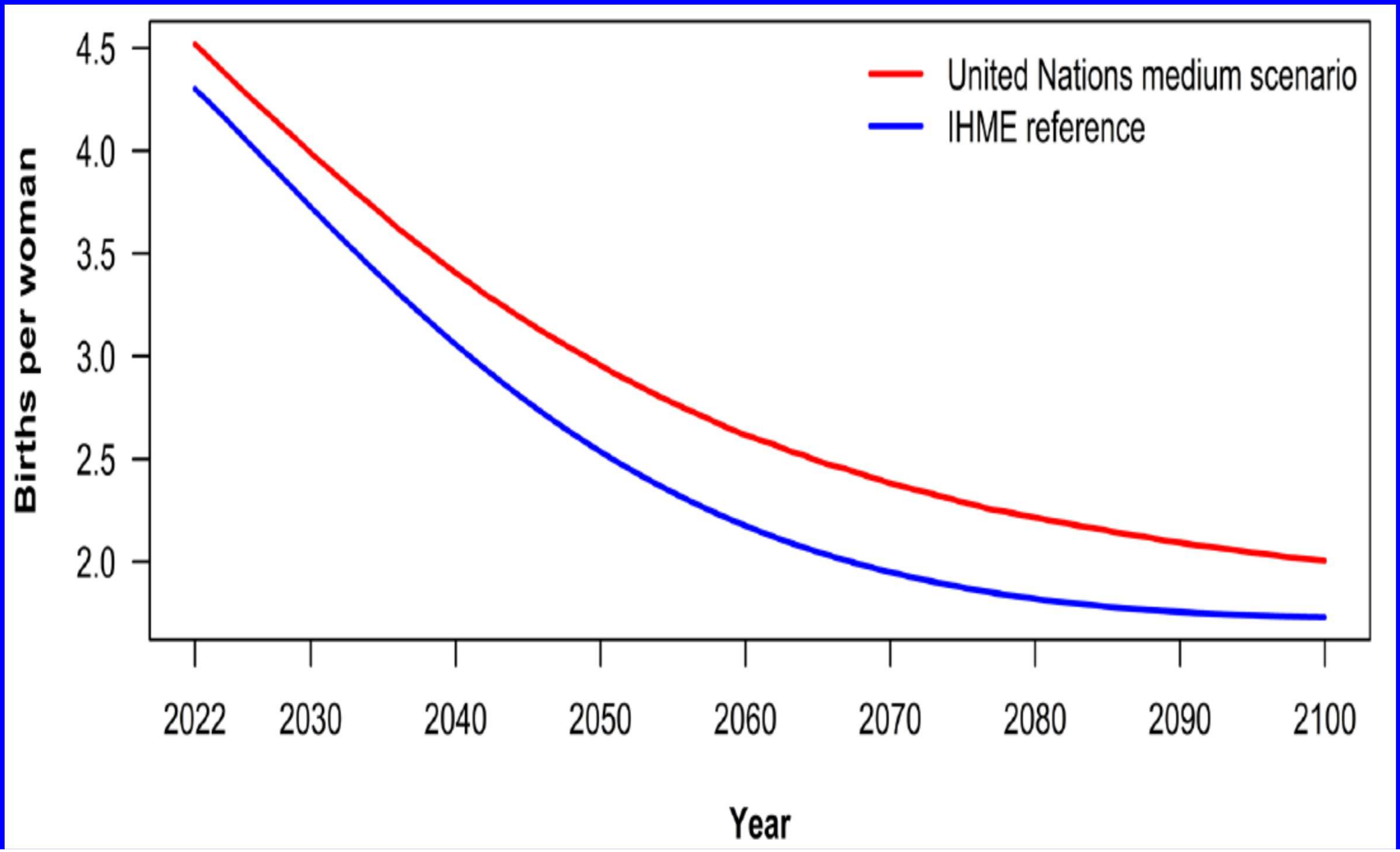


The view from Seattle: Global Burden of Disease 2020



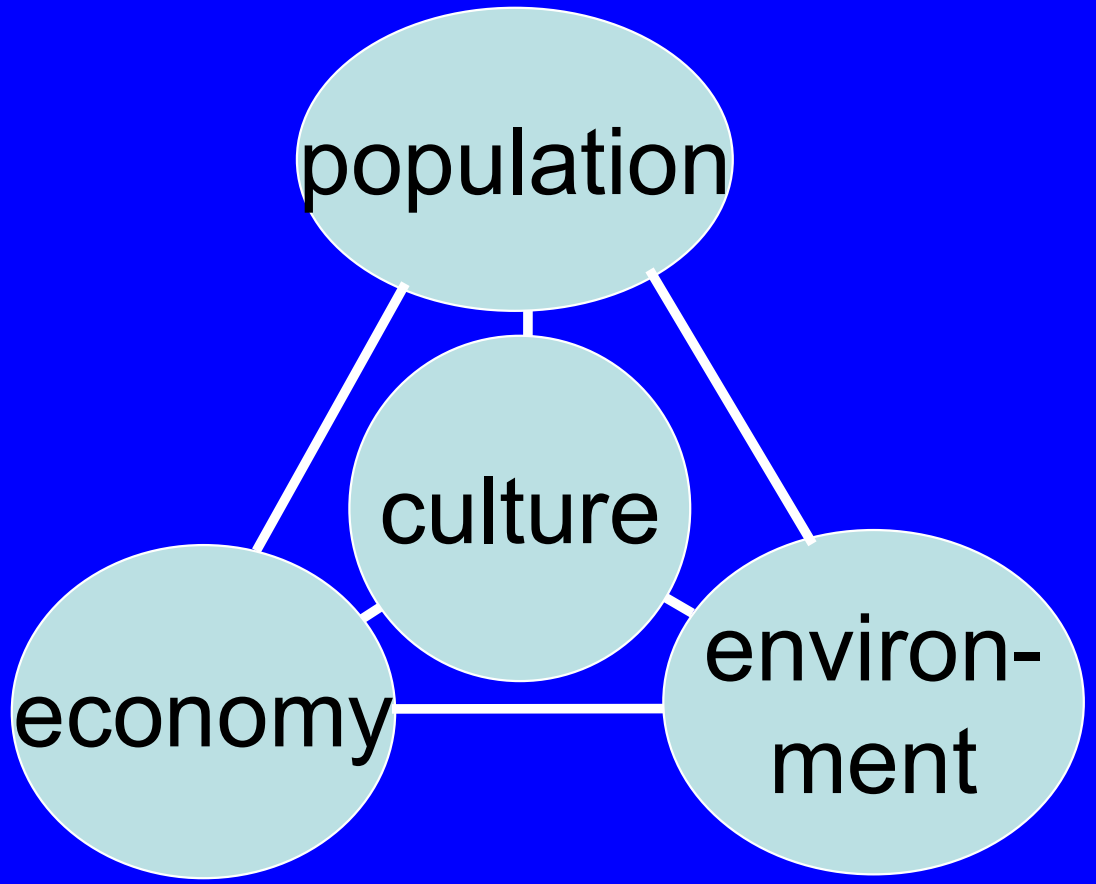
Global population peaks around 2064 around 9.7 billion.

TFR projections for sub-Saharan Africa: UN medium model > IHME reference model



Fundamental difficulty of forecasting:
Population interacts with economics, the environment & culture.

Culture, economics & environment are at least as hard to forecast as population. Choices influence the future.



Recommendations (based on science plus values)

5 targets for food security policy: the most vulnerable people

1. 200 million women or couples with unmet need for contraception
2. Pregnant women
3. Lactating women & nursing children
4. Weaned infants to 2-3 years
5. Teenage girls & boys

5 targets need 3 programs, as part of food security policy.

Target	Family planning info, services, materials	Nutrition education for self & children	Balanced adequate diet
Unmet need	yes	yes	
Pregnant		yes	yes
Lactating	yes	yes	yes
Infants to 3			yes
Teenagers	yes	yes	

Thank you! Questions?