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**Shrinking Global Population:
A futuristic scenario
or a current challenge.**

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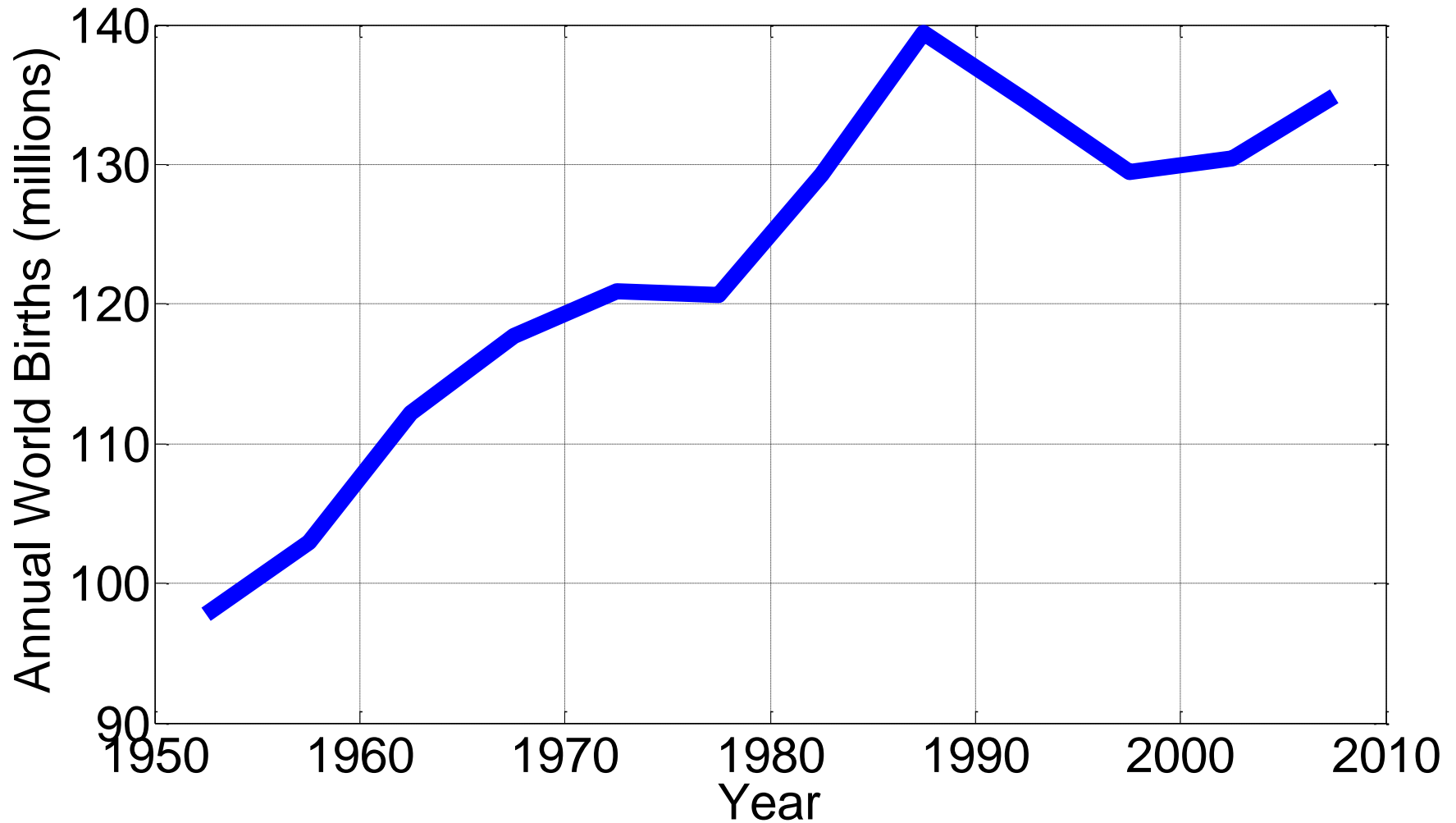
Ben-Gurion University of the Negev

The evolution of global population

Year	Global Population (Billions, Approx.)
-6000	0.01
-1000	0.05
0000	0.3
1800	1
1960	3
2000	6
Today	7 As of 10/31/11 (UN) or 3/12/12 (US)

<http://www.worldometers.info/world-population/>

The (recent) evolution of births



Total population and annual births

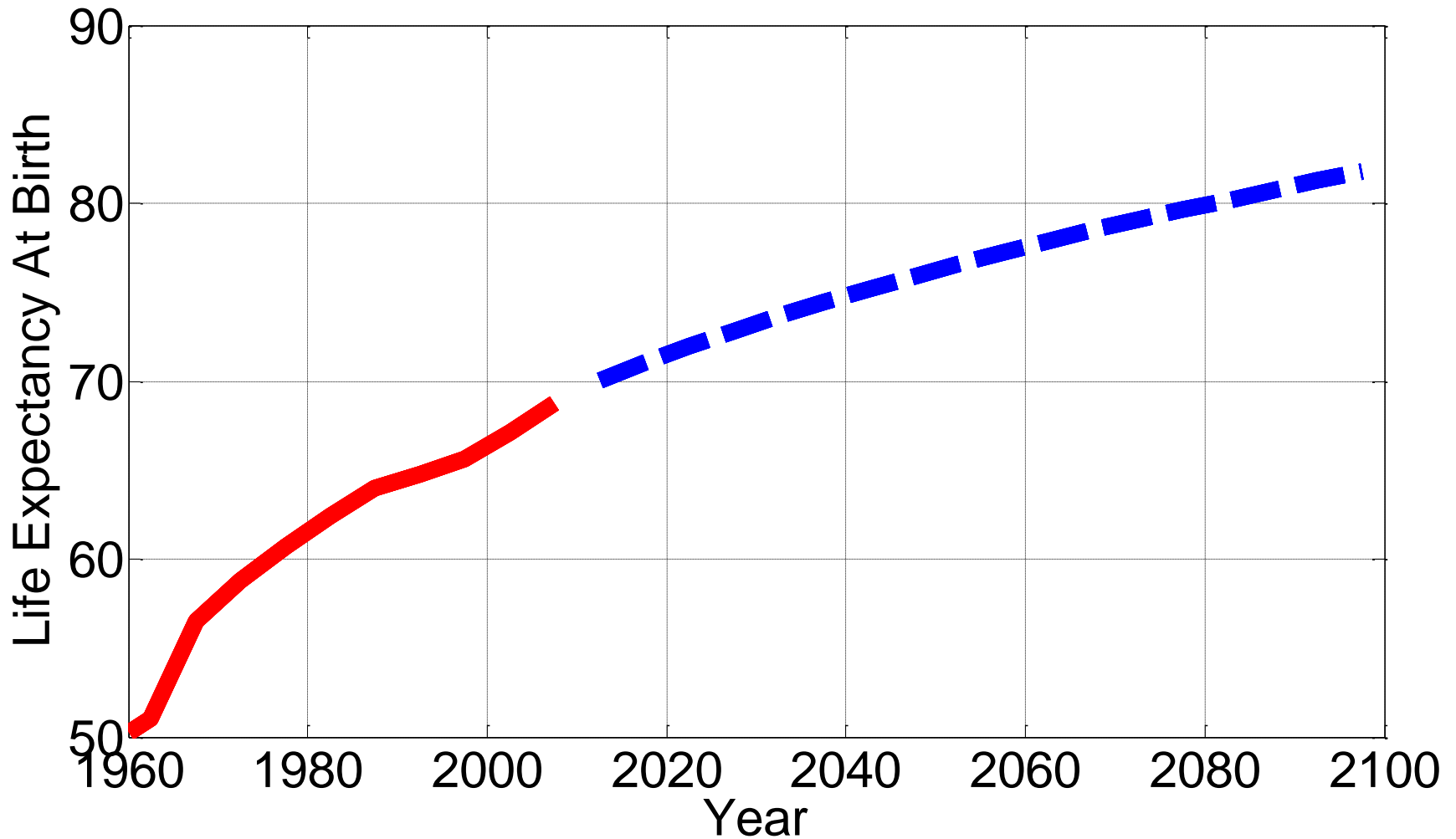
By Little's law (queuing theory), at steady state:

Arrival rate * Duration = Average Count

Annual births * Life expectancy = Total population

Annual Births (Millions)	Life Expectancy	Total population (Billions)	Corresponding year
100	80	8	
100	30	3	
130	70	10	2010 ?
40	25	1	1800 ?

Predicted life expectancy



Life expectancy and total population

Since 1800 life expectancy increased 200%.

From 1960 to 2000 life expectancy increased 50%.

Increasing life expectancy was a dominant factor in global population growth.

In the next century life expectancy is predicted to increase by 10-20%, thus in terms of total global population it will not be a game-changer.

Measures for changes in total births

1. Total Fertility Rate (TFR):

to be discussed later

2. Net Reproduction Rate (NRR):

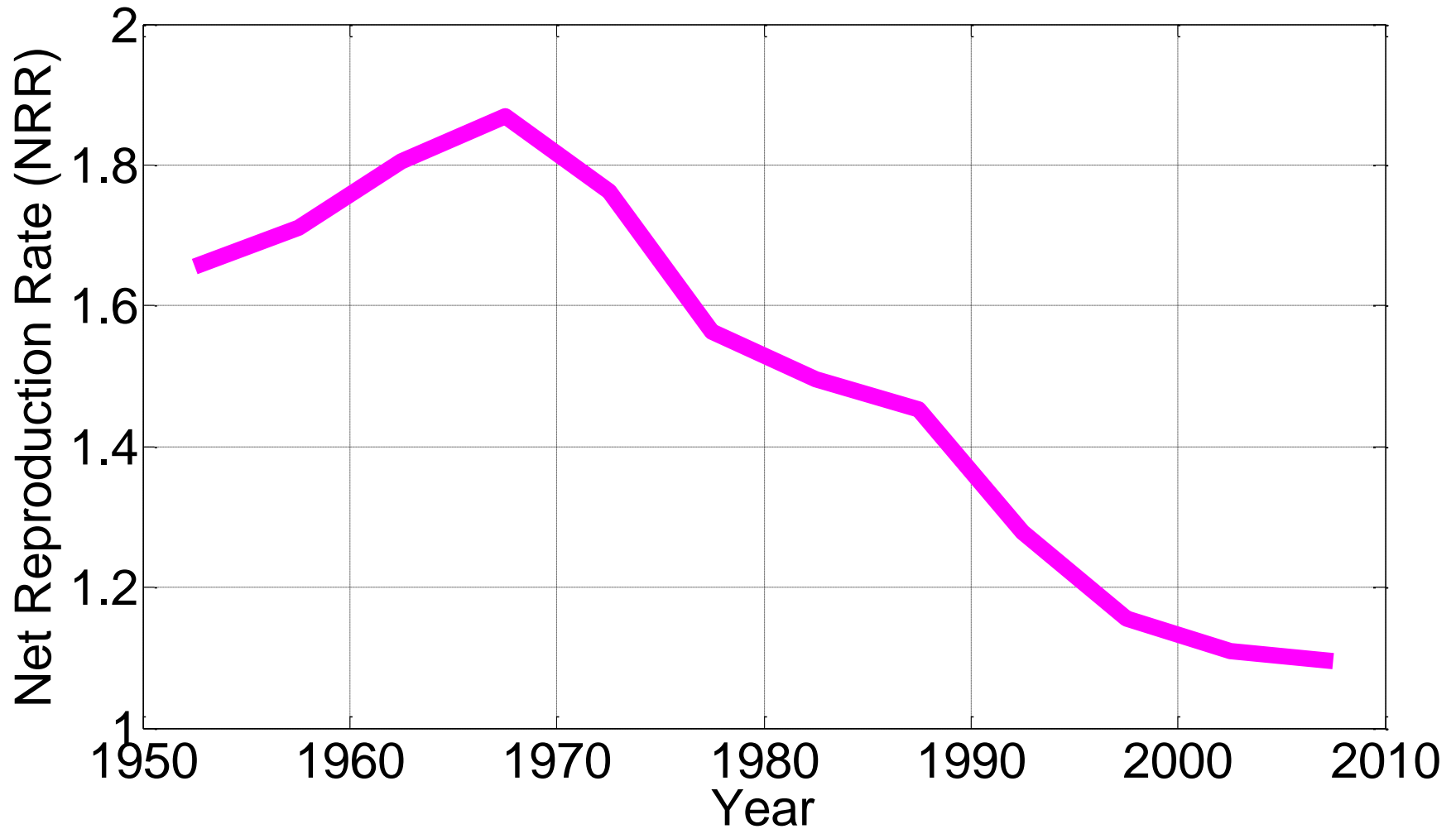
Simplified definition: daughters to mothers ratio.

$NRR=2$ implies 2 daughters, 4 granddaughters etc.

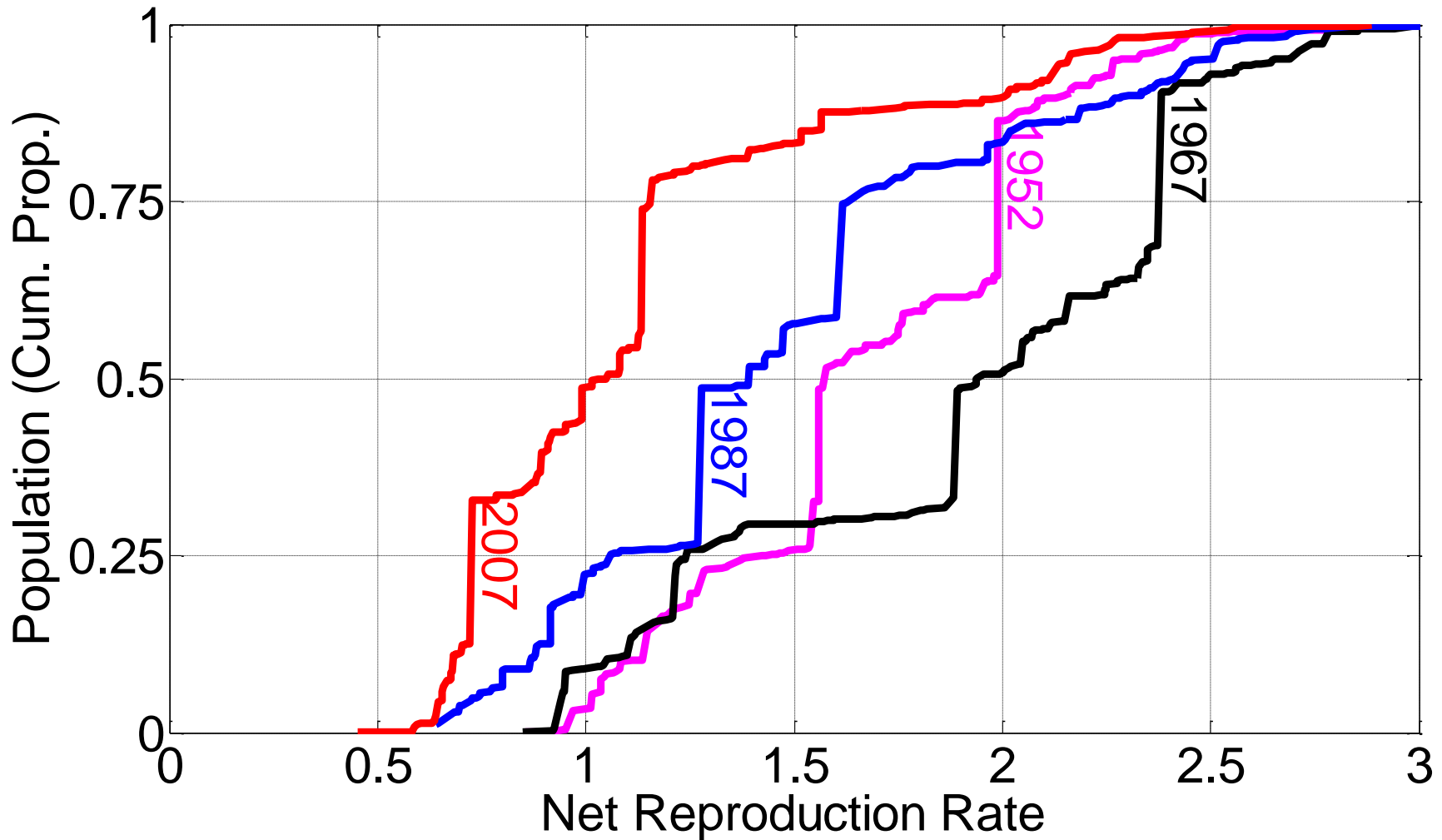
$NRR=1$ implies stable population.

$NRR<1$ implies shrinking population.

Net reproduction rate (NRR)



NRR distribution



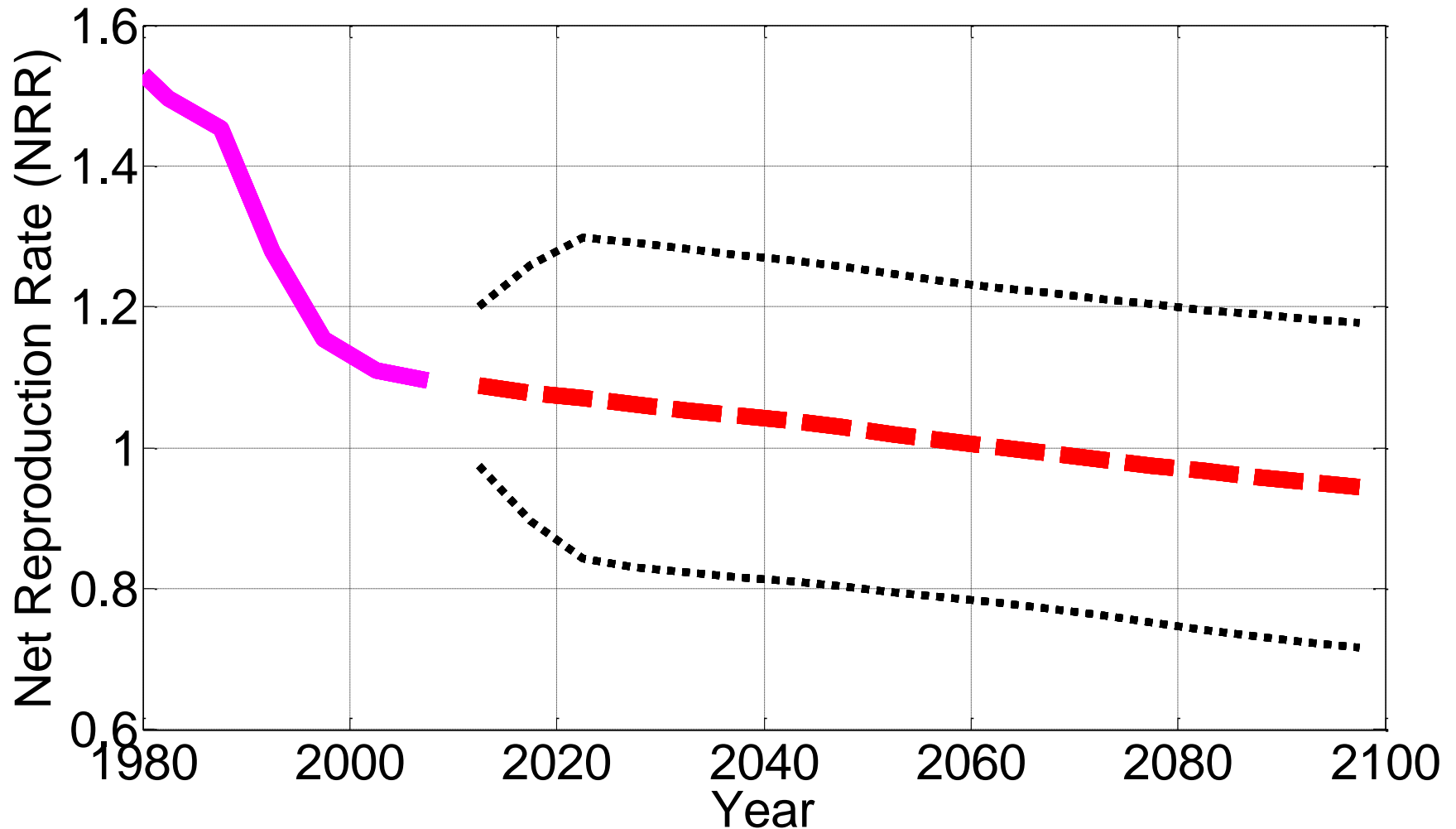
NRR implications

NRR=1.8 (and 25 years per generation) imply:

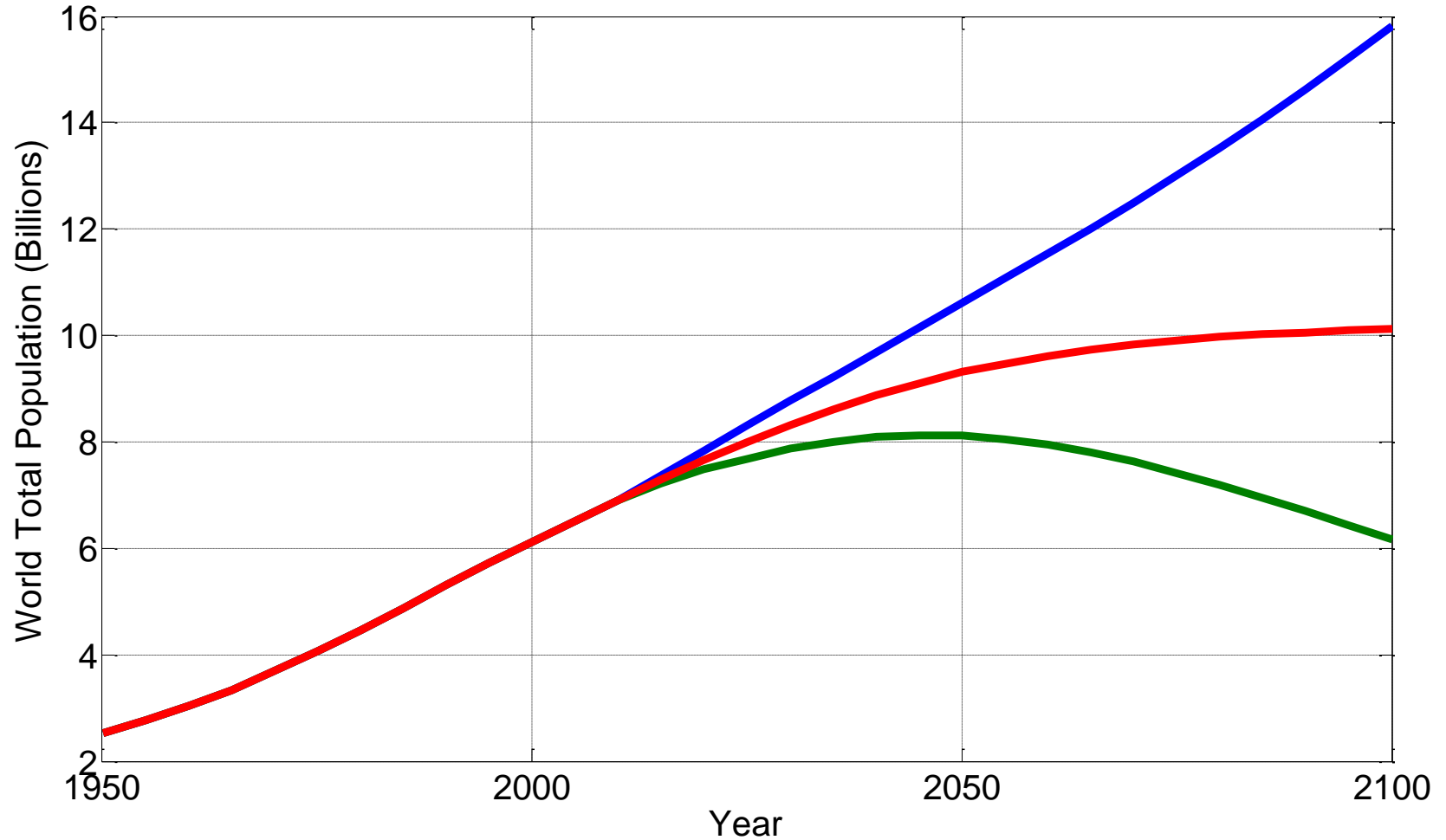
1. Tenfold population growth every century.
2. By 3000 the global population will be 10^{20} , that is density of one million per squared meter.
3. By 3400 the global population will be 10^{24} , beyond the air-limit. (7mg air per human lungs, $5 \cdot 10^{24}$ mg air in the atmosphere.)

NRR=0.8 imply “Back to One Billion” (BOB) during the 23rd century.

Predicted net reproduction rate (NRR)



Global population – UN predictions



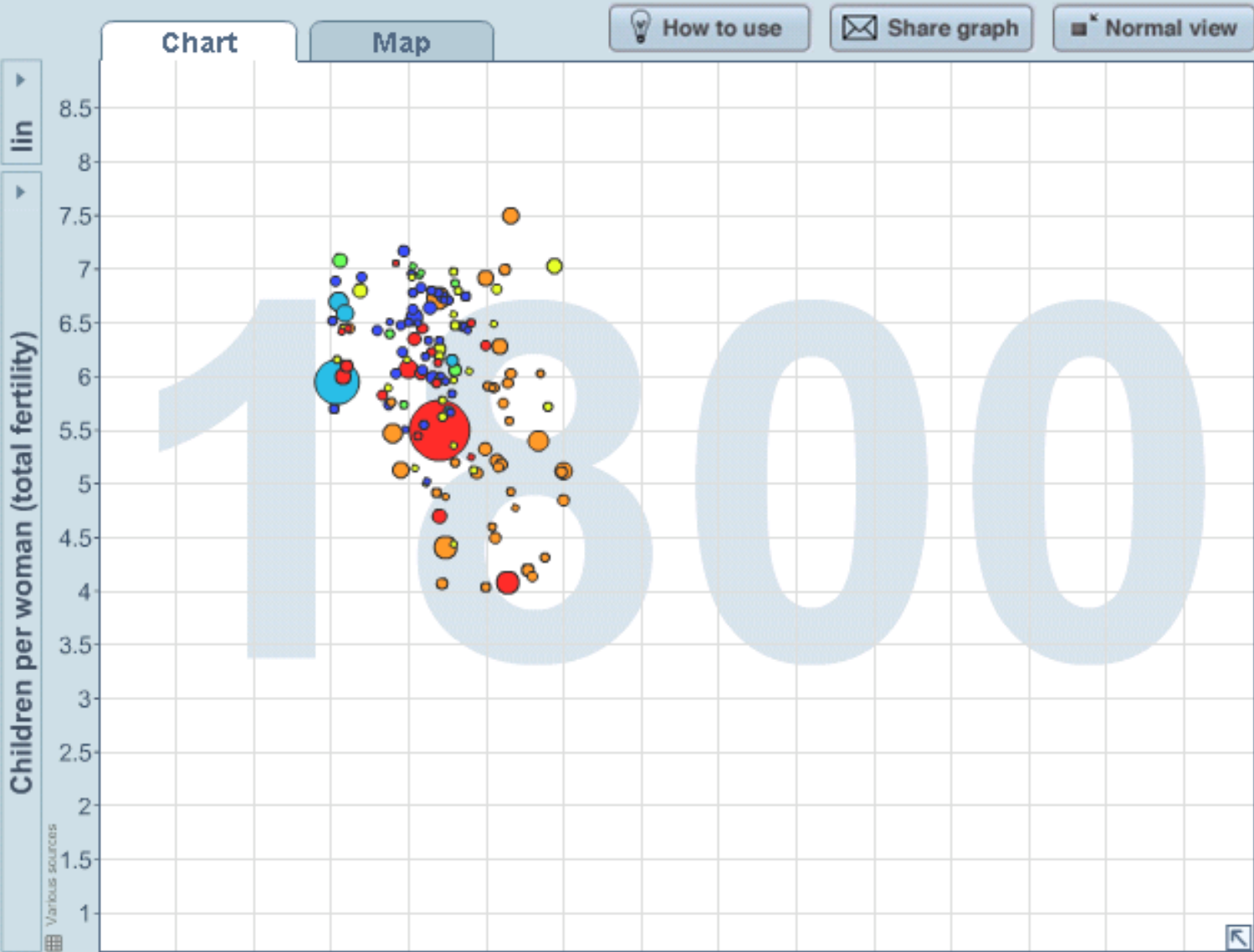
Total fertility

Total fertility is the sum of present fertility rates by age for females of ages 15-49. An estimate of the number of children a woman will give birth to during her life, assuming she will live longer than 49 years, and present fertility rates will prevail.

Approximately: **$\text{TFR} = 2 \cdot \text{NRR}$**

Mind the gap with www.gapminder.org:

<http://alturl.com/4xgwy>



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Deselect all

Size Various sources

Population, total ▾

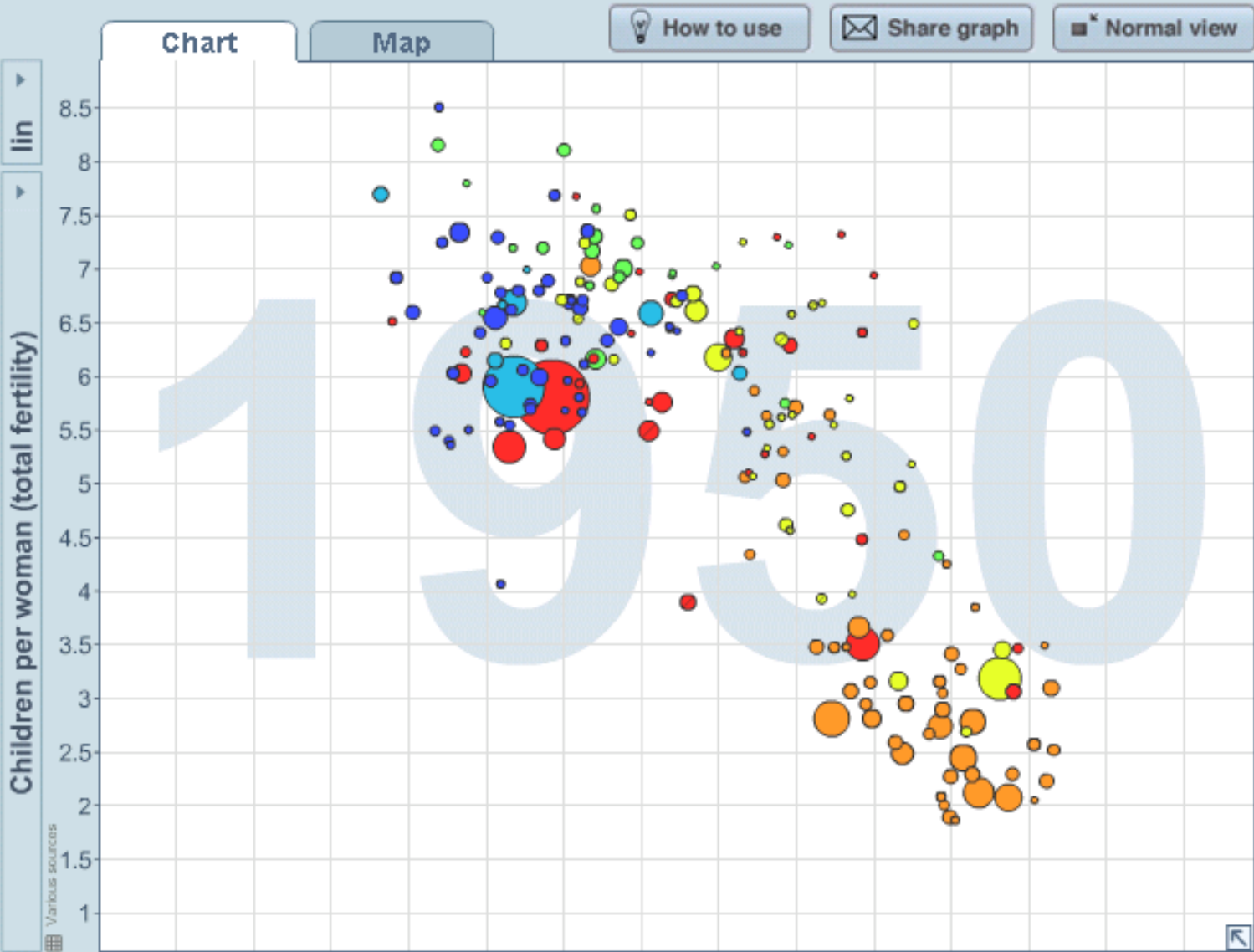
0 1.46 B

Various sources

Play ▶

1800 1820 1840 1860 1880 1900 1920 1940 1960 1980 2000

Trails



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Size Various sources

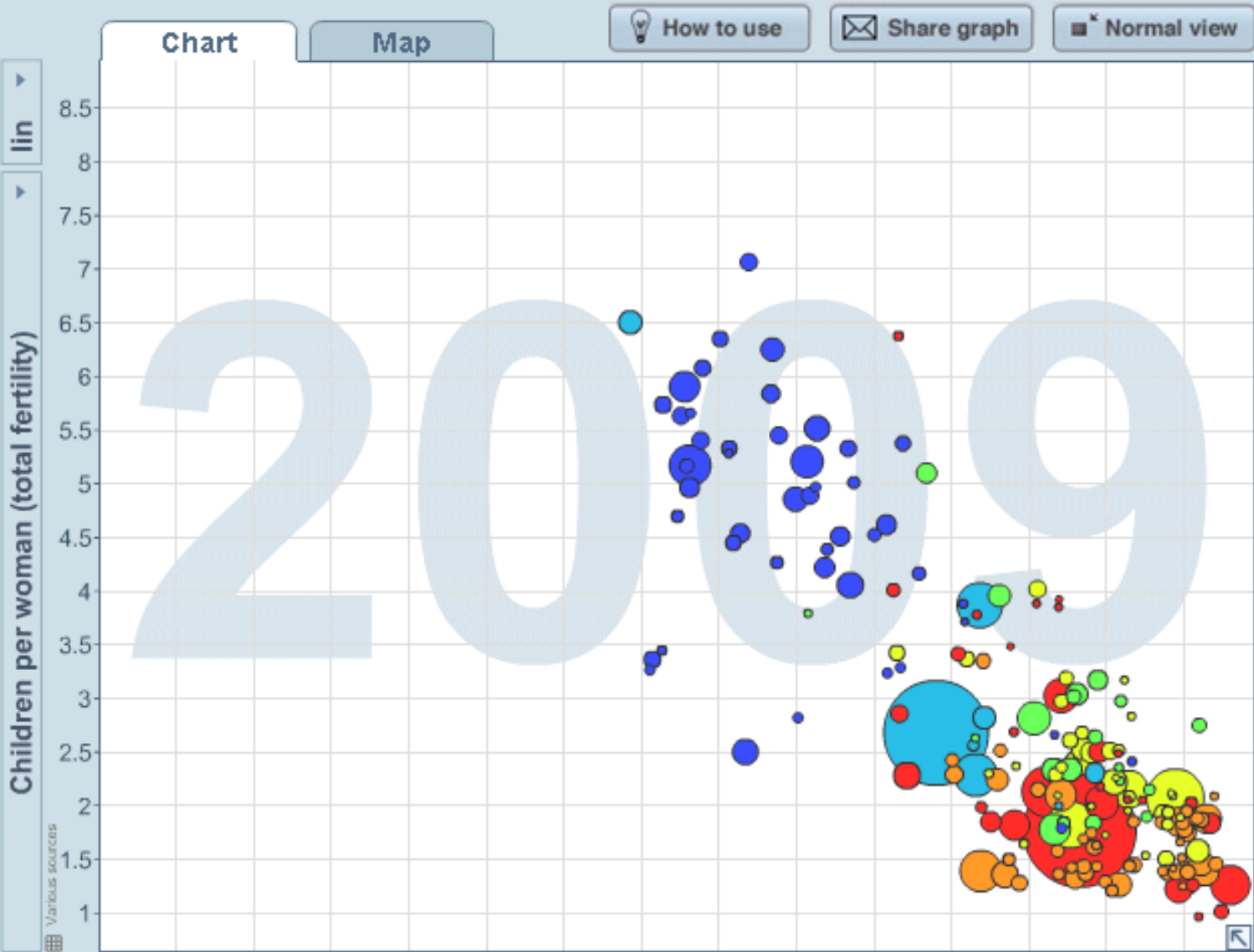
Population, total

0 1.46 B

Play

1800 1820 1840 1860 1880 1900 1920 1940 1960 1980 2000

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Population, total

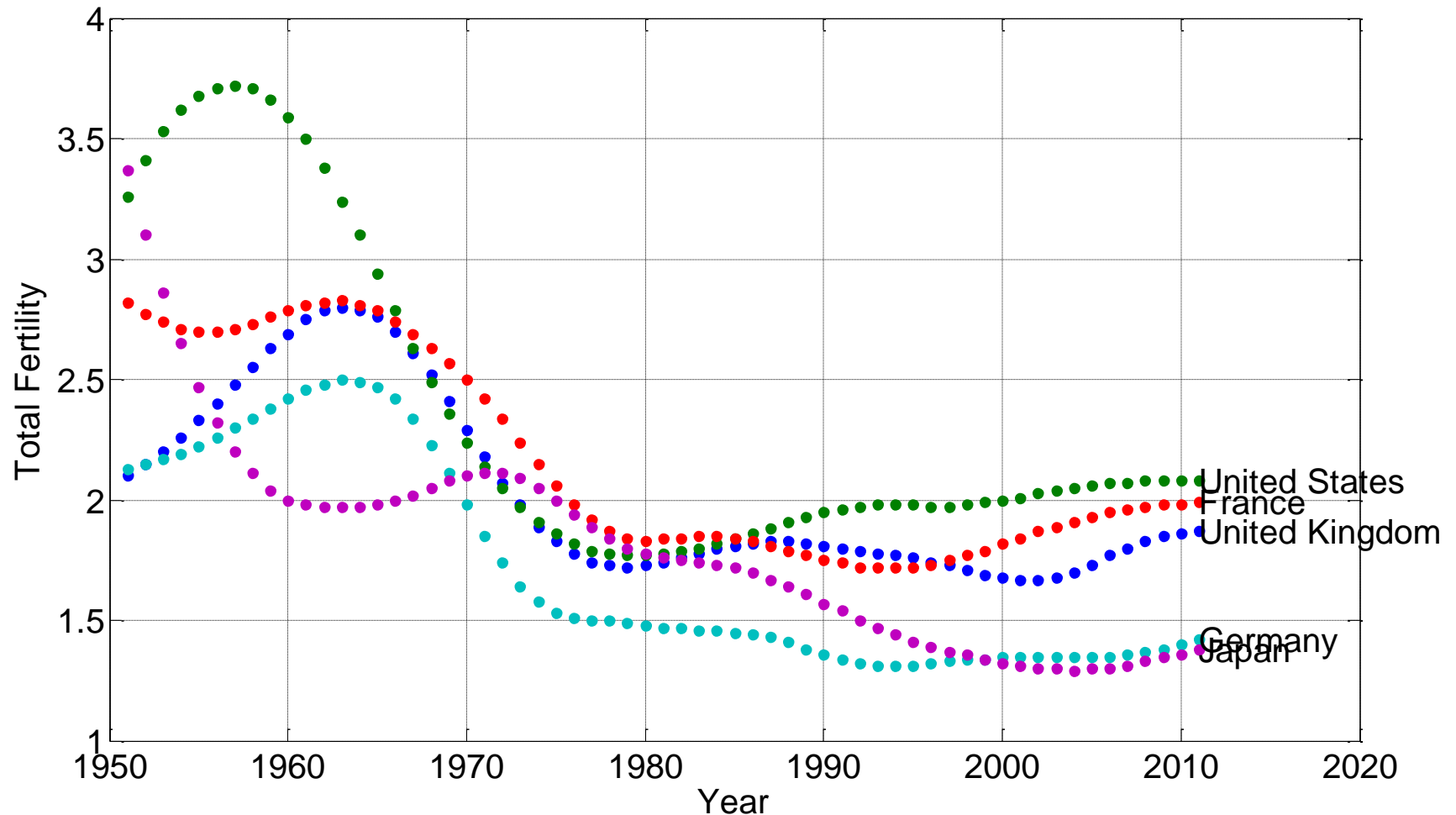
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Various sources

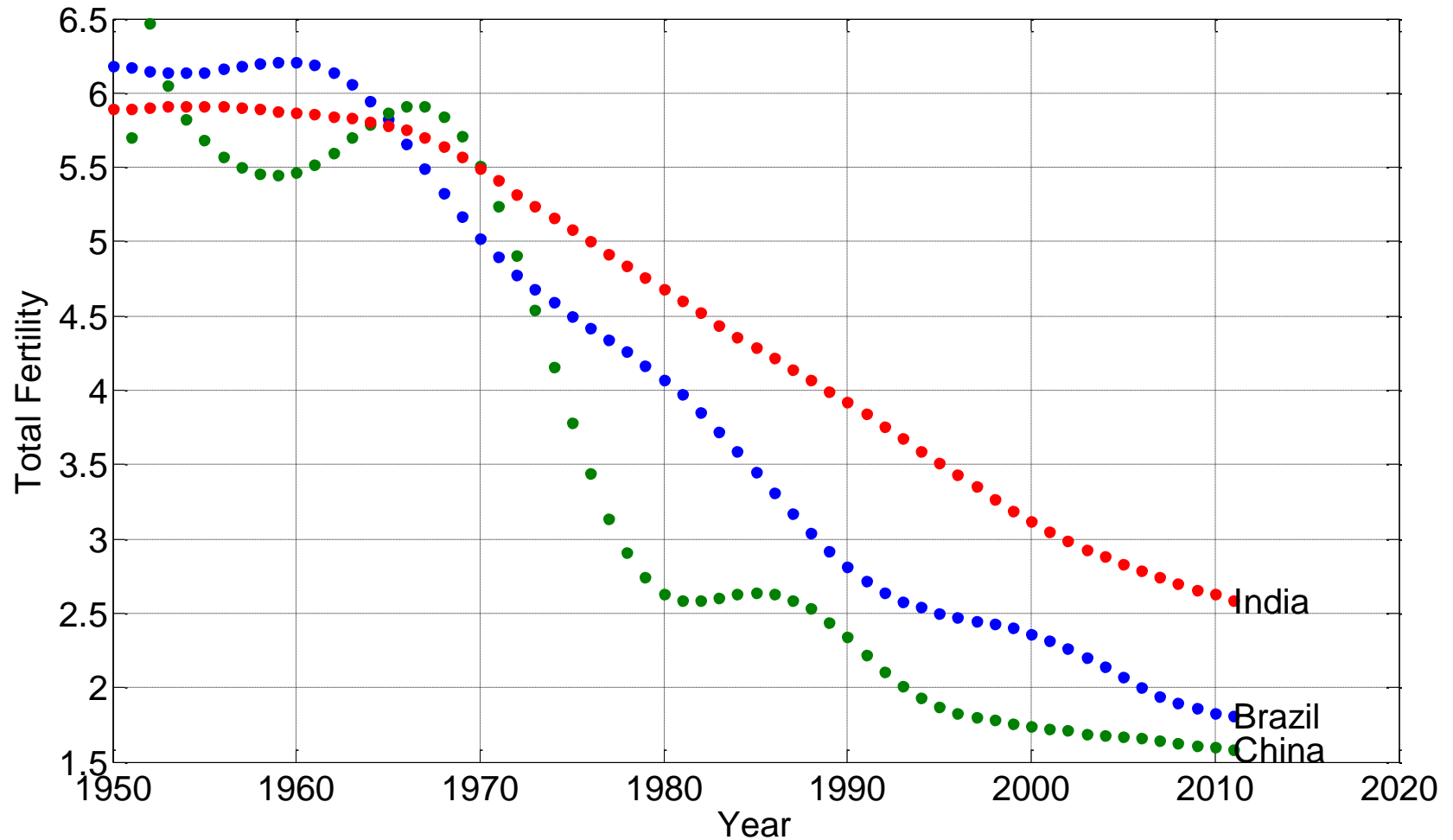
Play | **Trails**

1800 | 1820 | 1840 | 1860 | 1880 | 1900 | 1920 | 1940 | 1960 | 1980 | 2000

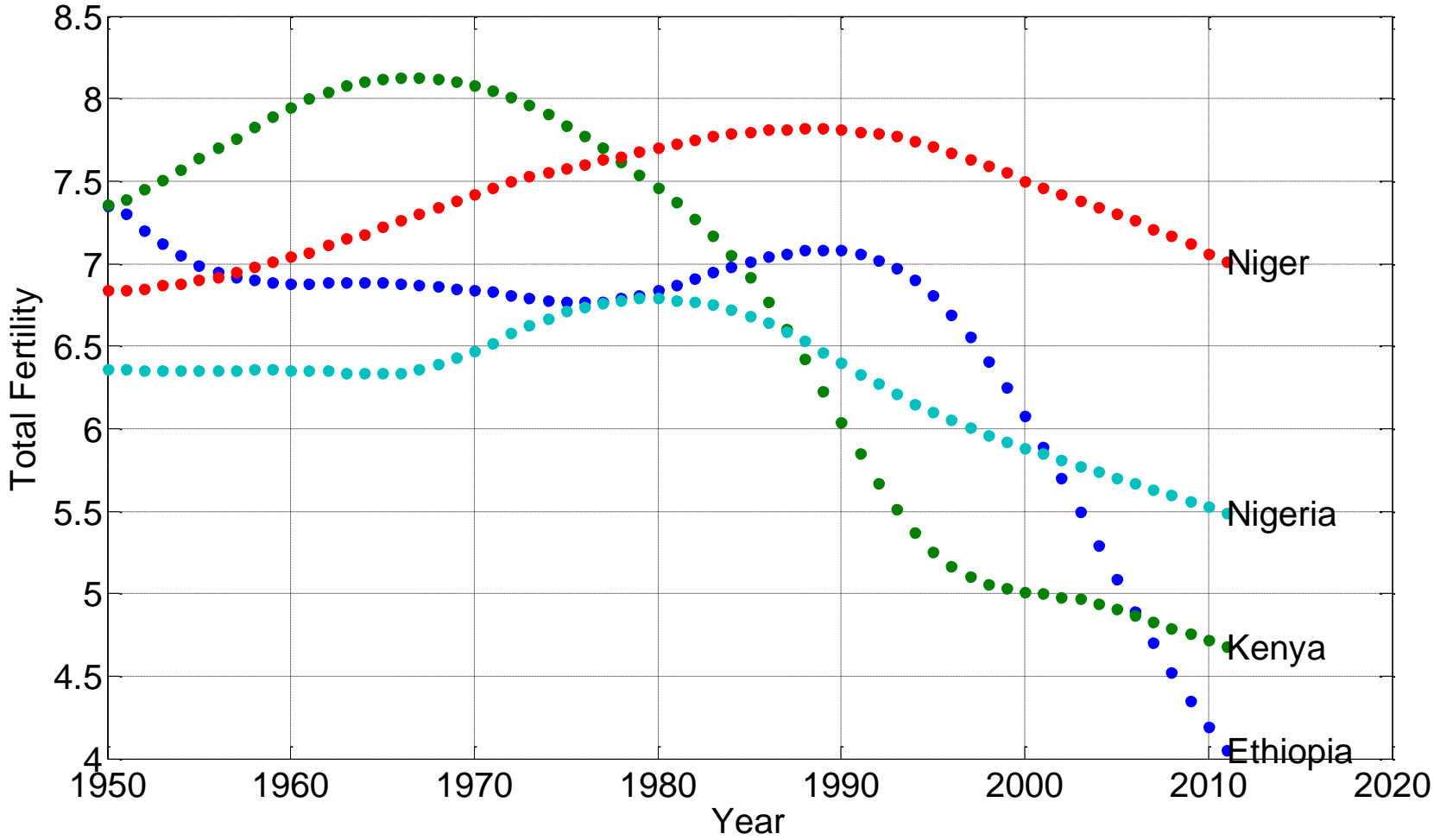
Total fertility trends – OECD examples



Total fertility trends – B(R)IC



Total fertility trends – examples from Africa



Conclusions and hypotheses on total fertility

- In many western countries total fertility is below 2, and remained stable for ~30 years.
- In many other countries total fertility declined in recent decades, and has not stabilized yet.
- Significant changes in total fertility can be fairly rapid, within a decade.

Hypothesis: a scenario of shrinking total fertility may materialize during the next 2-3 decades.

Positive aspects of shrinking global population

We presently deal with several issues that are directly related to global population size:

- Ecological footprint
- Air pollution
- Energy consumption
- Non-renewable resources

In a world with 1 billion population these issues are ten times smaller than in a world with 10 billion population.

Negative aspects of shrinking global population

- From the point of view of evolution theory: growth is the essence of success
- Contradicting common cultural perceptions and beliefs
- Could it leading to mankind extinction?
(maybe, but there is a long way to go....)

Opportunities of shrinking global population

Shrinking population may enable to “un-build” areas (Detroit). However it is not trivial:

- Planning and decision making – where to evacuate and when?
- Intermediate stages – how to manage half empty buildings and communities?
- How to fund the restoration of “nature”?

Challenges of shrinking global population

- Aging population – pension and medical systems (already in the focus of attention)
- Maintaining balance between cultures and religions.
- Winners and losers
- Operating systems with substantial fixed costs like energy and sewage (East Germany)
- 20th century data, and rules of thumb that are based on it, may be irrelevant.

Summary and conclusions

- There is a non-negligible chance that a scenario of shrinking global population will materialize within the planning horizon (20-30 years)
- This scenario presents challenges and opportunities.
- Paradigm shift may be needed in regional planning, economics, and other domains.
- Methodological preparation should start now!
(If the scenario will not materialize, it could still be fun research...)