A Study of Human Population Growth

Stuart A. Umpleby

The George Washington University

Washington, DC
Heinz von Foerster
Origin of Heinz’s interest

• Heinz responded to a request for proposals for a mathematical model of white blood corpuscle populations
• He decided to do also a study of a communicating population
The graph shows the relationship between historical time and apparent doubling time in years. The x-axis represents historical time, with labels from 0 AD to 2000 AD. The y-axis represents the apparent doubling time in years, ranging from 0 to 1400. The graph includes a straight line indicating the trend.
The Doomsday Study

• Study a communicating population
• Gather data, eliminate redundancy
• Plot on semi-log paper to reveal a rising or falling growth rate
• Convert the growth rate to doubling time
• Extrapolating the falling doubling time indicated an infinite growth rate early in the 21st century
The Doomsday Equation

\[ N = \frac{1.79 \times 10^{11}}{(2026.87 - t)^{0.99}} \]
POGO . . . by Walt Kelly

WHAT ABOUT THAT NEWSPAPER WHAT THE HAM SANDWICHES WAS WRAPPED IN?

IT HAD A FASCINATIN' STORY IN IT.

NAMELY, NAMELY, A SCIENTIST GOT IT ALL FIGURED OUT THE WORLD'S COMIN' TO A END.

WHEN? IN NOVEMBER . . . FRIDAY 13, 2026.

FRIDAY THIRTEEN? DON'T TELL CHURCHY! HE'LL SAY IF IT DOES HAPPEN IT'LL BE A SIGN OF BAD LUCK.
DID THIS HERE SCIENTIST ACTUALLY SAY THE WORLD WOULD END ON NOV. 13, A FRIDAY, IN 2026?

YEP

HOW?

POPULATION! WE'LL HAVE SO MANY PEOPLE WE'LL BE SQUEEZE TO DEATH.

DOES THAT MEAN THAT TOO MANY PEOPLE IS BAD FOR HUMANITY?

OR TOO MUCH HUMANITY IS BAD FOR PEOPLE?

'CORDIN' TO HIS FIGURES IT'LL BE ABOUT SIX BILLION OF ONE AND HALF A DOZEN BILLION OF THE OTHER.
SO THE WORLD'S GONNA END ON FRIDAY 13, NOVEMBER, 2026!

YEP... THIS SCIENTIST SAY WE IS GONNA HAVE SO MANY PEOPLE THERE WOHN'T BE ROOM.

AN' HE GOT THE FIGURES TO PROVE IT?

NOTHIN' ELSE BUT! HE CLAIM THERE AIN'T NO TWO WAYS... THE WORLD IS GONNA END!

I KNOWED THERE WAS A CATCH TO ALL THIS.

WITH ANY KIND OF LUCK YOU WOHN'T BE ALIVE TO SEE IT.

FRIDAY THIRTEEN, NOVEMBER, TWENTY TWENTY-SIX, HUH?

BEFORE OR AFTER LUNCH?
Criticism from demographers

Robertson, Bond, and Cronkite expressed concern that the equation “may be taken too seriously” and claimed that it is “obvious that such a theory has no relation to reality and is of no value whatever in predicting future populations.”
Criticism from demographers 2

• Shinbrot wrote that the article “would be too ridiculous to comment on if it were not such an outstanding example of the inadmissible use of mathematics to prop up a manifestly absurd conclusion.”

• Von Foerster, *et al.*, replied that in the scientific community “support of a hypothesis is gained through compatibility with experimental observation rather than by arguments about what should be the case or what should not be the case.”
Singularities as warnings

• Von Foerster, et al., explained that “singularities” occur quite commonly in nature (e.g., air pressure at Mach 1, voltage breakdown in gaseous conduction, temperature and magnetic susceptibility).

• Such expressions (when a parameter increases rapidly beyond all bounds) indicate instability and warn of a breakdown in the system’s structure.
..... If we apply “Coale’s Law” of the inverse relationship of population density with growth rate and technological knowhow -- as suggested in his letter -- to the development of the human population as a whole over the last couple of millennia, we arrive at the peculiar conclusion that either Stone Age man was a technological wizard who carefully removed his technological achievements so as not to upset his inferior progeny, or that -- if he was at the level at which most of us believe he was -- our population dwindled from once astronomical size to the mere three billions of today (Von Foerster, et al., 1961, June, p.1932).
Two very different interpretations of trends

Population
Growth
Rate

Von Foerster
Coale
Technical Knowhow
Sources of data

• Demographers use estimates of future fertility and mortality in making forecasts
• Cohort analysis, used by demographers, involves summing up estimates of future events
• Von Foerster, *et al.*, extrapolated data from the past
On predictions

• Demographers base forecasts on fertility and mortality (first derivative)
• Von Foerster, *et al.*, pointed to coalitions and noted that two people jointly can do things that the two independently are never able to achieve (second derivative)
• Higher derivatives produce better forecasts
Table 1

Low, Medium, and High World Population Projections (in billions) for A.D.2000, made by the U.N. in four different years and derived from the Doomsday Equation (Von Forester, et al., 1962)

<table>
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<tr>
<td>Low</td>
<td>3.20</td>
<td>5.00</td>
<td>4.88</td>
<td>6.20</td>
<td>6.91</td>
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<tr>
<td>Medium</td>
<td>4.88</td>
<td>5.70</td>
<td>6.20</td>
<td>7.00</td>
<td>7.40</td>
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<tr>
<td>High</td>
<td>6.90</td>
<td>7.00</td>
<td>6.44</td>
<td>7.40</td>
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Post hoc population growth

- Von Foerster showed in 1962 that estimates of world population in future years converge toward the doomsday estimate as the date in question approaches.
- Umpleby showed in 1989 that estimates of world population in a specific year, such as 1975, continue to rise after the date in question has passed.
Table-2

Estimates of human population in billions as a function of time

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<td>1950</td>
<td>2.406*</td>
<td>2.517</td>
<td>2.501</td>
<td>2.504</td>
<td>2.516</td>
<td>2.515</td>
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<td>1955</td>
<td>2.731</td>
<td>2.722</td>
<td>2.746</td>
<td>2.751</td>
<td>2.751</td>
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<tr>
<td>1960</td>
<td>2.731</td>
<td>2.988*</td>
<td>2.986</td>
<td>3.014</td>
<td>3.019</td>
<td>3.019</td>
<td>2.792</td>
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<tr>
<td>1990</td>
<td>5.188</td>
<td>5.280</td>
<td>5.248</td>
<td>5.246</td>
<td>5.292</td>
<td>5.033</td>
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<td>1995</td>
<td>5.648</td>
<td>5.763</td>
<td>5.769</td>
<td>5.678</td>
<td>5.766</td>
<td>5.814</td>
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</tr>
</tbody>
</table>

- Changes in population are a function of fertility and mortality
- Population has increased because deaths have declined faster than births
- Development leads to declining pop. growth rates

- Fertility and mortality are influenced by communication
- The rate of growth has increased because the size of the coalition has increased
- World population has increased as devel. has increased
Demographers vs. Nat’l. Sci. 2

- Human beings, like other species, are limited by their envir.
- An infinite pop. and infinite growth rates are absurd and imposs.
- Est. of pop. should be based on est. of future fertility and mortality rates
- Human beings are unique in their ability to enlarge their envir.
- Singularities in rel. btw variables are common and warn of instability
- Est. for future dates should be based on computed rates of ch.
World Population 0 A.D. to 2000 A.D.
Conclusions

- Demographers and natural scientists have different ways of making projections.
- Other scientists assume demographers are operating like natural scientists.
- Doomsday Equation estimates were too low for ½ of its lifetime, 33 years and too high for ½ of his lifetime, 33 years.
Contact information

Stuart Umpleby
Department of Management
The George Washington University
Washington, DC 20052

umpleby@gwu.edu
www.gwu.edu/~umpleby