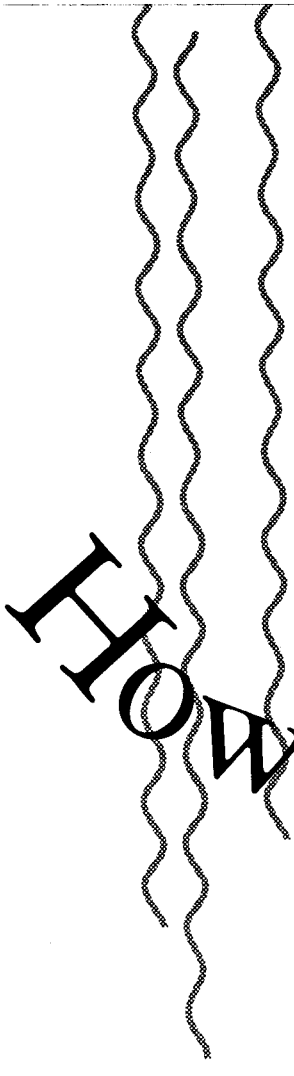

How Things Are

A Science Tool-Kit for the Mind

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The Uniqueness of Present Human Population Growth

Joel E. Cohen

Two numbers summarize the present size and growth of Earth's human population. The total number of people on Earth is approximately 5.5 billion. The increase in the number of people on Earth from last year to this is around 92 million. Using these two numbers alone, I show you that the present growth of population could not have occurred over long periods of the past and cannot continue long. The human species is passing through a brief, transient peak of global population growth that has no precedent and probably will be unique in all of human history.

To derive such a grand conclusion requires only elementary arithmetic, the two numbers (5.5 billion people, an annual increase of some 92 million) and—of course—one or two innocent assumptions. The arithmetic involved will be familiar if you understand compound interest.

I begin with the past. To extrapolate to the past without any additional data requires some assumption about how the

population changed in earlier years. As always in making assumptions, various choices are possible.

One possible assumption is that the recent increase in population of 92 million also occurred in each prior year. If this assumption were true, the population two years ago would be this year's population minus twice 92 million, or (5.5 − 2 × 0.092) billion = 5.3 billion. Given this assumption, Earth's population must have been nearly zero between 59 and 60 years ago, because 59.1 years × 92 million per year = 5,496 million or very nearly 5.5 billion people. This is an absurd conclusion. Earth's population was nowhere near zero around 1930, and surely the 1930s were no Garden of Eden. If the population had been near zero in 1930, it could not possibly have increased by 92 million in one year. Adam and Eve were fertile but not, according to the best available account, *that* fertile. Conclusion: The absolute change in numbers, 92 million, from last year to this is much greater than the absolute increases that must have occurred over most of human history.

A second possible assumption is that the same *relative* growth rate of population from last year to this occurred in each prior year. By definition, this year's relative growth rate is the change in population from last year to this, divided by last year's population. So the increase of 92 million divided by last year's population of roughly 5.4 billion works out to a relative growth rate of 1.7 percent per year. If the relative growth rate of population had been the same throughout the past, then Adam and Eve must have lived less than 1,300 years ago, because a population starting from two people and increasing by 1.7 percent per year for 1,290 years would grow to more than 5.5 billion people.

Even Archbishop James Ussher, primate of all Ireland, who calculated that God created the universe in 4004 B.C.,

would agree that human history is much longer than 1,290 years and, therefore, would have had to concede that the present relative growth rate could not have been sustained for most of human history. (Ussher determined the moment of creation to be October 23 at noon. The Oxford divine and Hebraist John Lightfoot revised Ussher's calculations and concluded that creation occurred on October 26 at 9 A.M., the date and time which are quoted in many texts. I wish to avoid taking sides in the controversy over whether the creation occurred October 23 at noon or October 26 at 9 A.M.)

Firm conclusion: The current increase of Earth's human population, in either absolute or relative terms, vastly exceeds the average increases that occurred over most of human history.

As a further confirmation that the present relative growth rate of population could not have been sustained for most of human history, let's play just one more arithmetic game before we turn to the future. The last ice age ended roughly 12,000 years before the present (actually, at different times in different places). Archaeological evidence confirms that there were substantial human populations on all the continents except Antarctica. If there had been only one person 12,000 years ago, and that population had grown (parthenogenetically, at first) at an average rate of 1.7 percent per year, then Earth's current population would be approximately 7,100,000,000,000,000,000,000,000,000,000,000,000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000,000,000,000,000,000,000, or 7.1×10^{87} people. This is more than 10^{78} times as many people as Earth currently has. If the average weight per person were 50 kilograms (about 110 pounds), the mass of people would be about 6×10^{64} times the mass of Earth (which is a mere 6×10^{24} kilograms), and Earth would have left its current orbit long ago.

I must confess that no one knows either the exact present population of Earth or its exact rate of increase. How sensitive are these conclusions to errors in the two numbers on which the calculations are based? Would it make much difference if the actual population of Earth this year were 5.0 billion or 6.0 billion? Would it make much difference if the relative growth rate were 1.4 percent per year or 2.0 percent per year? (I know of no professional demographer who suggests that the current population size or growth rate lie outside these ranges.) The answer, in every case, is the same. Even if the current data are not exactly correct, the human population's current absolute growth rate (in numbers per year) and the current relative growth rate (in percent per year) could not have been sustained over most of history.

Human demographic history differed from the hypothetical models of constant absolute growth or constant relative growth in at least two important ways. First, population growth differed from one place to another. While Babylonian and Hittite cities were rising in what are now called Iraq and Anatolia (Asian Turkey), what is now Europe probably saw no comparable demographic growth, and parts of South America may have been still unpeopled.

Second, population growth varied over time: now faster, now slower, sometimes even negative. It has been conjectured that the first real surge in human population growth occurred before 100,000 B.C., when people discovered how to use and make tools. Archaeological and historical evidence shows that a surge occurred from 8000 B.C. to 4000 B.C., when people discovered or invented agriculture and cities, and again in the eighteenth century, when people discovered science and industry and major food crops were exchanged between the New World and the Old. Between these periods of rapid rise were much longer periods of very slow growth

or occasional falls (as in the fourteenth century, when the Black Death struck).

By far the largest surge in human history started shortly after World War II and still continues. According to the best estimates, the human population increased from somewhere between two million and twenty million 12,000 years ago to about 5.5 billion today. The relative growth rate of global population accelerated so strikingly in recent centuries that roughly 90 percent of the increase in human numbers during the last twelve millennia occurred since A.D. 1650, in less than 350 years. Until as recently as 1965, human numbers have grown like the money in a bank account with an erratically rising interest rate.

Now let's look into the future. I confidently assert that the average growth rate of the human population for the next four centuries cannot equal its present growth rate. Why? Because if the present growth rate of 1.7 percent per year persists for four hundred years (plus or minus ten), the population will increase at least a thousandfold, from 5.5 billion now to 5.5 trillion people.

The total surface area of Earth, including oceans, lakes, streams, icecaps, swamps, volcanoes, forests, highways, reservoirs, and football fields, is 510 million square kilometers. With a population of 5.5 trillion, each person would be allotted a square area less than 10 meters on a side. This area is perhaps commodious as a jail cell, but it is incapable of supporting a person with the food, water, clothing, fuel, and physical and psychological amenities that distinguish people from ants or bacteria. No optimist, if that is the right word, has suggested that Earth could support 5.5 trillion people.

The present growth rate of 1.7 percent per year is an average over some quickly growing regions (like Africa and southern Asia) and some slowly growing regions (like Eu-

rope, Japan, and northern America). In detailed projections published in 1992, the United Nations considered what would happen if each region of the world maintained its 1990 levels of fertility and gradually reduced its death rate. Naturally, the faster-growing regions will grow faster than the slowly growing regions. Therefore, the faster-growing regions will become a larger and larger fraction of the global population pie, and the average growth rate of the global population will increase. At first, the U.N.'s hypothetical population doubles within forty years. Within 150 years, it passes 600 billion, and by 2150, it exceeds 694 billion people.

The U.N. commented dryly: "To many, these data would show very clearly that it is impossible for world fertility levels to remain at current levels for a long time in the future, particularly under assumptions of continuing mortality improvement."

Many people, I among them, think that upper limits like 600 billion people, let alone 5.5 trillion, far exceed what humans and Earth would ever tolerate. I give you simple arguments with very large limits not to suggest that the limits I mentioned are anywhere near the actual limits, but to illustrate that even with extremely large limits, the amount of time remaining to the human population to bring its numerical (not spiritual, cultural, or economic) growth to a halt is not extremely long. In the next few to tens of decades, a drastic though not necessarily abrupt decline in the global population growth rate is inevitable.

The global population growth rate can fall from its present value of 1.7 percent per year to zero or below only by some combination of a decline in birth rates and a rise in death rates in those largely poor areas of the world with currently high fertility. (Forget extraterrestrial emigration. To achieve

a reduction in the present global population growth rate from 1.7 percent to 1.6 percent would require the departure of 0.001 × 5.5 billion or 5.5 million astronauts in the first year and more every year after that. The cost of exporting that many people would bankrupt the remaining Earthlings and would still leave a population that doubled every 46 years. Demographically speaking, space is not the place.)

People face a choice: lower birth rates or higher death rates. Which would you prefer?

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This essay is based on a book entitled *How Many People Can the Earth Support?,* to be published in 1995 by W. W. Norton and Company, New York.