Earth's population is still growing quickly. Even with a relatively modest growth rate of only 3%, the base population of 7.5 billion means that there are an additional 225 million people annually.

It is important to note that none of these numbers take into account the mortality rate of these countries. This lab could have been improved by incorporating this additional data to each sample set. As an example, this would have allowed us to see a more complete picture of how quickly Iceland's population would be shrinking by every year.

Data for this lab was originally presented in different units (billions, millions, thousands, etc.). To help ease the comparison of population data, all units were standardized in millions of people.

Conclusions

The change in population varies directly as a function of the rate and base population. A combination of the two was responsible for large changes observable year to year. In cases where r was big but N was small (as in Iceland), there were negligible population changes. When the opposite was true however (as was the case with China), even only 2% growth can impart a large change in population. This principle applies to both cases of exponential growth (positive rate) and exponential decay (negative rate).

If the human population model were to continue to follow an exponential growth curve, it is not hard to imagine why we would have a growing population problem on our hands. In just two decades, the Earth's population would be up to a staggering 15 billion people. The consequences of unchecked growth no doubt will be devastating to the planet in terms of the resources required to feed a growing population. Perhaps armed with this information, better education worldwide can start to limit this growth through the widespread introduction of contraceptives and other means of population control.

Data

			Year 1		Year 2		Doubling time	
Country	**Pop.**	**Rate**	**Change**	**Total**	**Change**	**Total**	**Time**	**Total**
India	1400M	+7%	98M	1498M	104.86M	1602.86M	10 y	2800M
China	1400M	+2%	28M	1428M	29.96M	1457.96M	35 y	2800M
China	1400M	-2%	-28M	1372M	-29.96M	1342.04M	35 y	2800M
Iceland	0.3M	+7%	0.021M	0.321M	0.02247M	0.34347M	10 y	0.6M
Iceland	0.3M	+2%	0.006M	0.306M	0.00612M	0.31212M	35 y	0.6M
Iceland	0.3M	0%	0	<0.3M	0	<<0.3M	∞	0.6M
U.S.	320M	3%	9.6M	329.6M	9.888M	339.488M	23.3 y	640M
Earth	7500M	3%	225M	7725M	231.75M	7956.75M	23.3 y	15000M

Observations

India and China, whose populations all started at 1.4 billion people, rapidly diverged after just two years. India at a 7% rate of growth ended up at 1.6 billion people, followed by China at a 2% rate of growth with 1.46 billion people. China at a 2% rate of decay finished with 1.34 billion people, approximately 60 million people less than the initial count.

By comparison, Iceland's population, already tiny in the beginning, experienced almost no change even with the same growth rate. Between different growth rates of 7% and 2% is a difference of only 0.03 million people, even after two years. Unsurprisingly, the model for Iceland with a 0% growth rate showed no increase in population.

The U.S. showed moderate growth, gaining some 19.5 million people over two years. The world population, with the same growth rate as the U.S., ended up with almost half a billion more people in the same period of time.

Doubling time for population was entirely dependent on the rate of growth. India and Iceland both reached twice their base populations in 10 years at 7% growth, as did China and Iceland in 35 years at 2% growth. Increasing the growth to 3% cut the time, down to only 23.3 years. Of course, Iceland at no growth will never experience any population increase, much less double.

Analysis

Base population as well as the growth rate can have a large impact on the final population even after just one or two years. This can be seen clearly in the differences between China and India, even though both started with the same population. Similarly, growth rates by themselves are meaningless without initial population, as was the case with Iceland and India.

Iceland at a 0% growth rate experienced a steady decrease in population because of mortality in an aging population. To keep a stable population requires a positive growth rate, no matter how small.

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AP Environmental Science
Period B
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Population Lab

Title

The effect of base population and growth rate on final population over a number of years.

Background

The growth of human population on Earth currently follows an exponential model. Assuming that Earth has an infinite amount of resources to sustain growth, the Earth's population is predicted to sharply rise in just a short period of time. In this lab, sample data for the base population of India, China, Iceland, the U.S., and the Earth will be used in conjunction with varying rates of growth to predict the final population in two years. As an exponential model of growth will be used, the formula used to determine final population will be $dN/dt = rN$, where r is the growth rate in percent and N is the base population.

Purpose

To find how base population and growth rates affect final population over a number of years, and to see how differences in base population can have huge impacts on final population even with the same growth rate.

Materials

Sample country population data, sample growth rates, calculator.

Procedures

For each set of population data and growth rate, the change in population after a year was calculated. This was done by multiplying the growth rate with the base population. The product is the resulting change in population after a year, and was added to the initial population to determine the population after one year. To determine the population after two years, the same procedure was repeated, only with the population after one year substituted as the new base population. This was done with all eight sets of population samples to complete the table.

Doubling time was calculated using the rule of 70, where 70 divided by the rate in percent equals the approximate time to double the initial. Again, this was done for all eight sets of population samples.