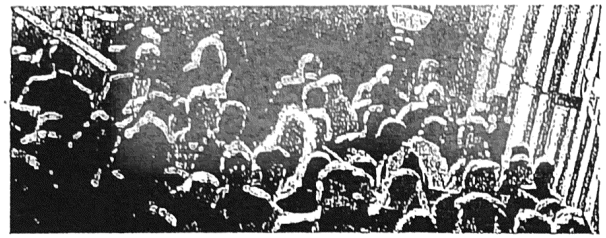
INVESTIGATION 19



World Population Growth

Quantitative

PURPOSE

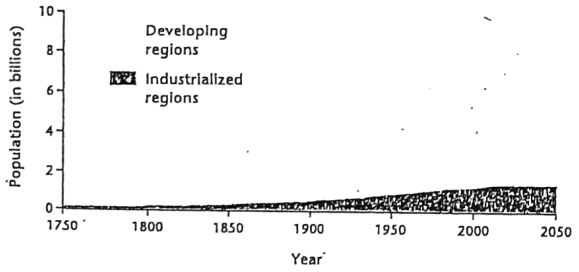
- Graph and mathematically analyze the rates of human population growth through history
- Project human populations into the future based on generalizations from various data sources for modern times

INTRODUCTION

There is a close connection between the human population of the Earth and many of the problems we currently face as a global society. Issues such as resource depletion, energy consumption, global food supplies, drinking water reserves, soil erosion, water and air pollution, global climate patterns, and many others are directly related to the growing number of people living on our planet.

Fig. 19-1

This long-range population projection, from United Nations sources, focuses on divergent trends between industrialized and less-developed nations.



As seen in Fig. 19-1, since about 1950 differing population trends between the developing and industrialized regions of the world have further complicated the situation. In this exercise you will examine human growth trends closely and draw conclusions about population numbers—and problems—in the coming generations.

Materials

- graphing paper
- Internet access

Optional:

- Excel software

PART I: Historical Overview and Analysis

Procedure

Step 1 Carefully plot the data given in chart form below. These are good estimates of world populations at various times since the beginning of human civilization.

Year	Population
8000 BC	4 million
4000 BC	7 million
500 BC	100 million
AD 500	200 million
AD 1000	250 million
AD 1500	400 million
AD 1700	600 million
AD 1900	1.6 billion
AD 1950	2.5 billion
AD 1980	4.5 billion
AD 2000	6.1 billion

Step 2 Plot years along the x-axis and label this axis Time. Start at 8000 BC, letting each inch equal 1000 years. *Attention:* Set your scales carefully; the data points are *not* uniformly spaced.

Step 3 Label and plot the population, in billions, along the *y*-axis. If you are using graph paper ruled in inches, let each inch equal 1 billion people. Each tenth of an inch then equals 100 million people. *Lab Hint:* Data for the earliest years will be difficult to plot exactly to this scale. If available, metric ruled graph paper is easier to use.

Step 4 Draw a smooth line that *best* connects all the data points.

Step 5 If taking advantage of Excel, use Chart Wizard to plot the data as a scatterplot.

- Plot a regression line by clicking on your graph, then going to the Chart menu and selecting Add Trendline.
- Look at your graph to determine what type of Trendline or regression you need and select it.
- Use Options for displaying the equation for the Trendline and R-squared value, which is a reliability measure.

Exercises

1. Examine the shape of the plotted line on your graph.
   a. What type of mathematical relationship exists between human population and time?

   b. Label the regions of the graph that represent the Lag Phase, Exponential Phase, and Stabilization Phase.
   c. Define what is meant by the terms *"J" curve* and *"S" curve*.

2. Analyze the patterns of growth after 2000.
   a. Predict the world's population in the year 2050 and plot it.
   b. If you used Excel, let the program give you the population and plot it for you.
   c. Explain why this value may be realistic. Also give a reason why it may not be.

   d. Describe how three environmental problems we now face would change if your predicted value came true.

3. Estimate as best you can the doubling time for the population after each period:
   a. 8000 BC _____ ? 500 BC _____ ? 1700 _____ ?
      1900 _____ ? 1950 _____ ? 1980 _____ ? 2000 _____ ?
   b. What is the pattern of doubling times?

   c. Using the "Rule of 70," calculate the rate of population growth for each of the above intervals. **Show your calculations.**

Exercises

   d. Graph the doubling times over time.
   e. Use your graph of doubling times to predict the rate of growth and the population in the year 2050.

PART II: Modern Trend Analysis and Projections

1. Observe this graph of past and projected population growth.

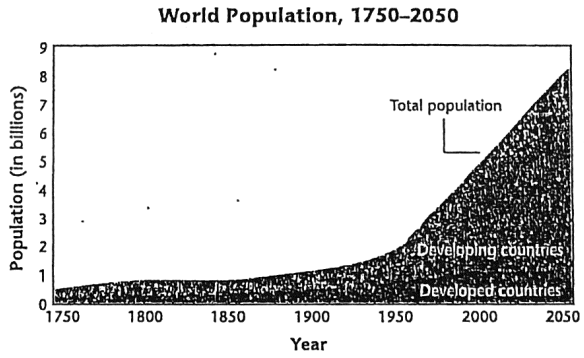


Fig. 19-2 Graph Based on Data from the World Bank

   a. What was the approximate population of the world in 2000?

   b. What percent of Earth's people lived in developed countries then?

   c. What is the World Bank prediction for world population in 2050?

   d. What percent of the world's people will live in developing countries in 2050? What increase is that in the number of people living in developing countries since 2000?

c. The population of the developed world is projected to stabilize just after 2000. Give three reasons why stabilization is not expected in the developing world.

2. Plot the Total Midyear Population data of the U.S. Census Bureau over the period 1950–2050, accessing this site:
http://www.census.gov/ipc/www/idb/worldpopinfo.php

a. How are the World Bank and U.S. Census graphs the same? Different?

b. Why do they seem to disagree?

3. Determine the trends in doubling time for the World Bank and Census Bureau graphs.

a. What population can be expected for 2250, based on World Bank data?

b. What projection do you get from the U.S. Census data for the year 2250?

c. Refer to the United Nations graph at the start of this exercise (Fig. 19-1). How do you project the world population for 2250 using that source?

d. Give three possible explanations why these projections differ.

Exercises

4. Look at the graph you made from the data in PART I.

a. Suppose you used those data to make projections like those for Question 2. Explain what problems you would have.

b. How could you change the scale to allow for a clearer projection?

5a. In general, what do the three graphs imply about the growth of human populations?

b. Taking into account their differences, what do the graphs all imply about future population growth?

c. Outline three steps that could be taken to change these growth trends in the developing world.

Exercises