

Math Problem #2: Global population and atmospheric CO₂

Name: Date:

"All organisms modify their environment and humans are no exception. As the human population has grown and the power of technology has expanded, the scope and nature of this modification has changed drastically" (Vitousek et al., 1997. *Nature*. Vol. 277, p. 494-499). Figure 1 below presents two crucial dimensions of global change, displaying relative rate of increase in both human population and atmospheric concentrations of CO₂. Although there seems to be a strong relationship between these two parameters, we will determine (calculate) the extent of that relationship and assess if there is indeed some form of functionality between these two parameters.

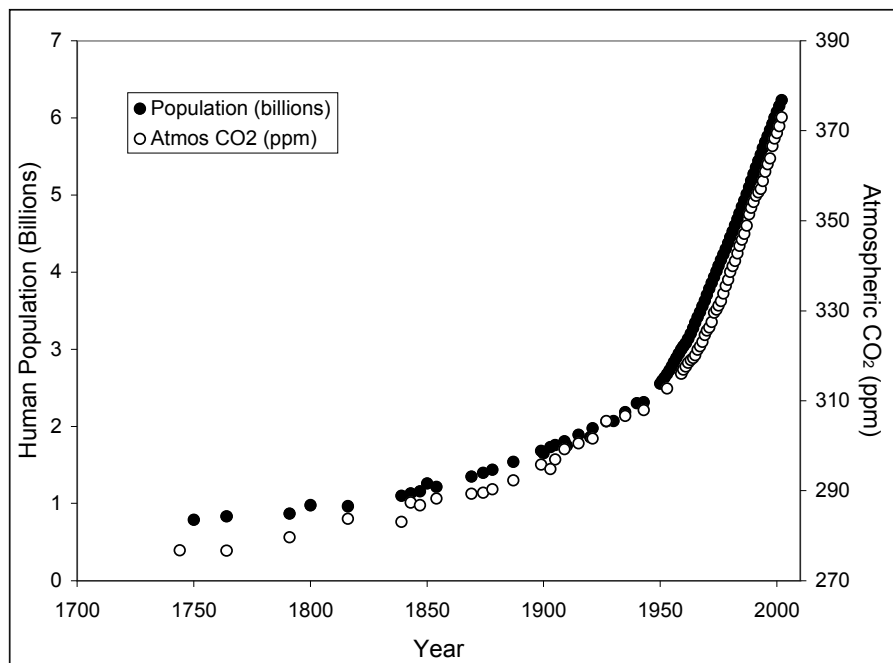


Figure 1. Two indicators of global change. Both human population levels and the concentration of CO₂ in the atmosphere have sharply increasing growth rates that are unprecedented in the history of the Earth over the timescale indicated.

- 1) Extract population and atmospheric CO₂ data from 1750 to the present using the web sites below (place these data into an Excel spreadsheet):
 - a. Population: <http://www.census.gov/ipc/www/world.html> and <http://www.census.gov/ipc/www/worldhis.html>.
 - b. CO₂: <http://cdiac.esd.ornl.gov/trends/co2/siple.htm> and <http://cdiac.esd.ornl.gov/trends/co2/sio-mlo.htm>
- 2) On the same graph (different y axis), plot human population and atmospheric CO₂ data from 1750 to the present.

3) Calculate the relationship of human population vs. CO₂ concentrations by calculating the sum of squares for x (Human population: SS_{xx}), the sum of squares for y (CO₂ concentrations: SS_{yy}), and the sum of cross-products (SS_{xy}).

4) Calculate the correlation coefficient (r).

5) Calculate then the coefficient of determination (r^2).

6) Calculate the slope of the line (m) and the intercept of on the (m) and the intercept of on the y axis? Please write the overall equation of relationship.

7) How much does population increase explain increases in atmospheric CO₂ (explain)?

8) Can you determine what the global population was when [CO₂] was 240 ppm? If yes, what was it (show your work)?

9) Can you determine what will be the atmospheric [CO₂] when the global population will reach 10×10^9 ? If yes, what will it be (show your work)?

10) Is the relationship functional (is there functional dependency between the two parameters)? If yes, is it direct or indirect? Explain.