INVESTIGATION

How Could Global Warming or a Glacial Period Affect North America?

This shaded-relief map of North America colors the land surface and seafloor according to elevation above and below the present sea level. These elevations represent possible levels to which the sea could rise or fall if the climate dramatically warms or cools and causes a change in the extent of glaciers. You will use estimates of the amount of ice that could be lost or gained to calculate how much sea level could rise or fall, and then evaluate the implications for the economy, transportation, and hazards for some major cities of North America. The scenarios presented in this investigation are extreme end members, not situations that will happen, except perhaps after thousands, millions, or even hundreds of millions of years.

Goals of This Exercise:

- Observe the shaded-relief map of North America to identify areas that are close to sea level (above it and below it).
- Use estimates of the current amounts of ice on the planet to calculate how high sea level would rise if all the ice melted.
- Use estimates of the amount of ice that was present during the last glacial maximum (20,000 years ago) to calculate how much sea level would drop if these conditions returned.
- Use your results to identify how such rises and falls in sea level would affect some major cities of North America.

Data

Listed below are data about the present surface area of the oceans and estimates for the amount of ice that (1) is present today and (2) was present when glaciers were at a maximum 20,000 years ago. Use these data to complete the calculations on the next page.

1. The present surface area of the oceans is 361,000,000 km².
2. The total amount of ice (ice sheets, ice caps, glaciers) currently present on the planet is estimated to be 32,000,000 km³.
3. During the last glacial maximum, 20,000 years ago, the amount of ice is estimated to have been 52,000,000 km³ more than is present today. Your calculations will determine how much water is used to make this additional amount of ice, and how much this would lower sea level.
4. When ice melts, the volume of water produced is about 0.9 times the volume of the ice. That is, the volume of water produced is only 90% of the volume of ice.
Procedures
Follow the steps below, entering your answers for each step in the appropriate place on the worksheet.

1. Calculate how much water would be released if all the ice on the planet melted (an extremely unlikely scenario). For this calculation the equation is: the volume of water gained = the volume of ice × 0.9 (volume water / volume ice).

2. Calculate the volume of water that would be tied up in ice if glaciers returned to the same volume as 20,000 years ago. The equation is: the volume of water lost = the volume of additional ice 20,000 years ago × 0.9 (volume water / volume ice).

3. Calculate how much sea level would rise for the water volume gained in step 1 or how much sea level would fall for the water volume lost in step 2. Ignoring many important complications, the much simplified equation is: the change in sea level = change in water volume / surface area of the oceans.

4. Examine how each city shown on this map would be affected by the two extremes. Would it be flooded, not flooded but much closer to the shoreline, or much farther from the shoreline? Discuss how such changes would affect a typical city’s transportation, vulnerability to coastal flooding, economic livelihood, and any other factors you can think of.