Name_____

Changing Planet: Melting Glaciers

Background

Glaciers are either one of two types: a continental glacier (also called an ice sheet) such as those that occur on Antarctica or Greenland, or an alpine or valley glacier found in mountain valleys. Alpine glaciers occur all over the world, yet require specific climate conditions to survive. This usually includes a location that has high snowfall in the winter and cool temperatures in the summer to prevent snow from melting.

If a glacier is to form in a given location, snow must accumulate over time, turn to ice, and begin to flow under the pressure caused by its own weight and gravity. Glacial retreat on the other hand occurs as a result of sublimation (transition of ice to vapor), snow evaporation (evaporation of liquid water in the snow), strong scouring winds, and ice melt. The process of a glacier getting smaller is called *ablation*. Over the past 60 to 100 years, almost all glaciers worldwide have been getting smaller and in most cases there is strong evidence that current glacier retreat is due to Earth's warming climate. This is most evident for alpine glaciers in the Arctic, and for alpine glaciers at high elevations in tropical latitudes, such as those found on top of Kilimanjaro in Tanzania. (See Figure 1)

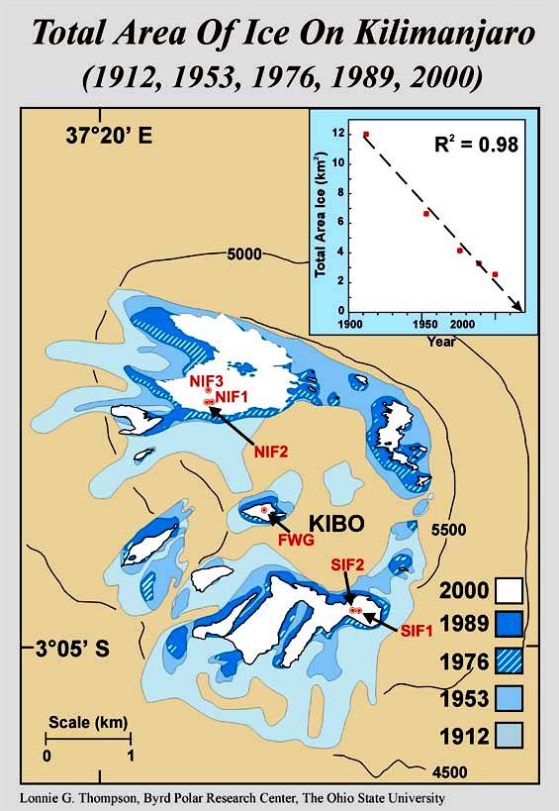

Figure 1: Courtesy: National Science Foundation

Materials

Repeat photos of Alaskan alpine glaciers
Google Earth
NSIDC Google Earth Glaciers and Climate Change kml file
Ruler

Part 1

1. With your partner(s), look carefully at each photo and note the year each was taken and the any interesting features each may possess.
2. Match the photos of the same glacier, and after you have done that compare your matches with those of the other teams around you.
3. Once your teacher has confirmed you have the correct pairs, fill in the Data Table 1 with observations of the changes over the timeframe of each pair of photos.
4. Use Google Earth to find the latitude and longitude of each of the glaciers. Open Google Earth and change degrees, minutes and seconds to decimal degrees by clicking on "Tools," then "Options," and then change "show lat and long" to "decimal degrees" if it is not already in that format. To find each of the glaciers, turn on the NSIDC Glaciers and Climate Change kml file and then put the name of the glacier in the "Fly to" box, and click enter. It will take you to the glacier for a more recent view and may even provide you with additional photos. While the NSIDC file is open, take time to observe additional pairs of photos of Alaskan alpine glaciers.

Data Table 1

Glacier Name Latitude and Longitude	**# of years between photographs**	**What is the same in the photos?** *(List multiple observations)*	**What is different in the photos?** *(List multiple observations)*
Name: Latitude: Longitude:			
Name: Latitude: Longitude:			
Name: Latitude: Longitude:			
Name: Latitude: Longitude:			

Name: Latitude: Longitude:			
Name: Latitude: Longitude:			
Name: Latitude: Longitude:			
Name: Latitude: Longitude:			

Questions for Part 1

1. What stayed the same in the photos?

   What changed in the photos?

2. Do all the glaciers in this sample follow the same pattern of retreat? Explain.

Part 2

Alpine glaciers around the world are retreating, and the Gangotri Glacier in the Himalaya Mountains is another good example of this occurrence. In this section you will measure the distance of glacial retreat from one timeframe to the next. Use the scale at the bottom of the image to estimate the distance of retreat. Fill in Data Table 2 with your responses.

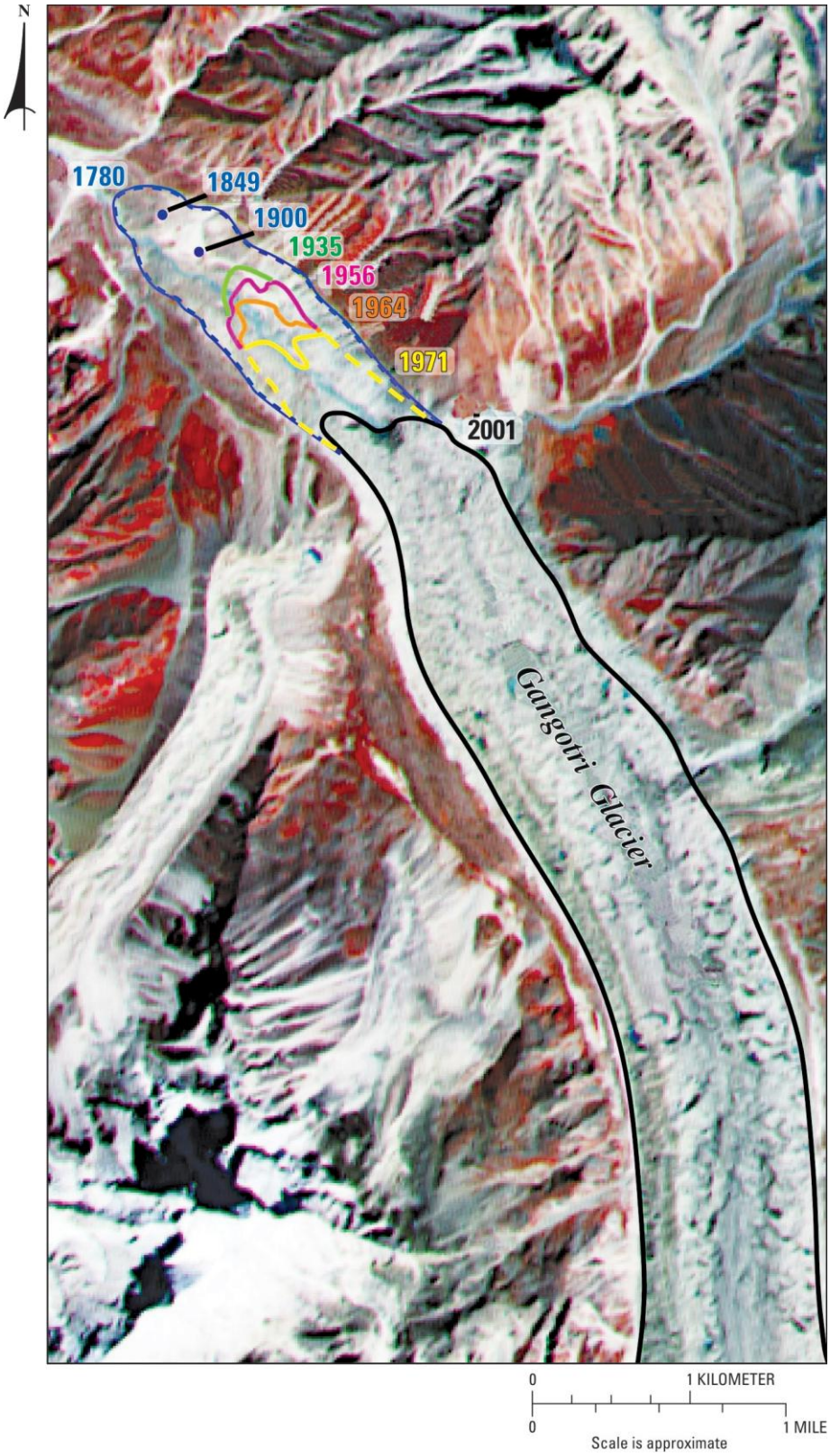

Figure 2: Sept 9, 2001 ASTER image showing the position of the terminus of Gangotri Glacier, India, between 1780 and 2001. Image from Jesse Allen of NASA's Earth Observatory. Courtesy of the U.S. Land Processes Distributed Active Archive Center (Acquired from: http://gallery.usgs.gov/photos/08_25_2010_s85Are1QPl_08_25_2010_4)

Data Table 2

Timeframe	Total # of years in timeframe	Approximate distance of retreat during the timeframe (kilometers)	Average Annual distance of retreat during the timeframe (km/yr)
1780-1849			
1849-1900			
1900-1935			
1935-1956			
1956-1964			
1964-1971			
1971-2001			

Questions

1. Use Google Earth to locate this glacier. Latitude: _____ Longitude: _____

2. What is the average annual distance of retreat for the entire timeframe? *(Show your work)*

   _____km/yr

3. Is the rate of retreat constant for the time period of 1780-2001? _____
   How did you decide this?

   If the rate was not constant, approximately when was the rate slow? _____

   When was the rate fast? _____

4. What do these rates of retreat indicate about climatic conditions over the period of record?

5. Based on the rate you calculated in question 1, in what year will Gangotri Glacier be off the photo? *(Show your work)*

Conclusion

1. Do all the glaciers in this investigation follow the same pattern of retreat? Explain.

2. Does latitude play a role in the retreat of these glaciers? Explain.

3. What climate conditions encourage glacier growth and glacier retreat?

4. What might account for glacier retreat today?

5. In this investigation you made inferences from observations of retreating alpine glaciers at different latitudes. What additional data is needed to investigate the causes of glacial retreat?

Application *(Use additional paper if needed)*

1. As glaciers get smaller, how might this affect the Earth?

2. Are humans affected by melting glaciers? Explain.

3. What are the risks and benefits of melting glaciers to human populations?