Lesson Plan: Teaching Glaciology, Glaciers and Glacial Retreat, and the Cryosphere-Climate Relationship

As a **high school** or **undergraduate Geography** or **Earth Sciences** teacher, you can use this set of computer-based tools to help you in teaching about **glaciers**, **the cryosphere**, and related topics such as **the impact of temperature and precipitation on glacial mass**, **glacial budgets**, and **glacial advance and retreat**.

This lesson plan helps students learn about glaciers, and the factors that affect the movement and size of glaciers. The activity will also enable students to understand the possible impacts of climate change on glaciers and the climate-cryosphere link.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in Earth Science or Geography.

Use this lesson plan to help your students find answers to:

- *What climatic and environmental factors affect the size and motion of glaciers?*
- *How has an increase in global temperatures led to the shrinking of some glaciers?*
- *What is the relationship between climate and the cryosphere?*
- *How do glaciers provide evidence of climate change?*

About the Lesson Plan

Grade Level	High school, Undergraduate
Discipline	Geography, Earth Sciences

Topic(s) in Discipline	Glaciers, Cryosphere
Climate Topic	Climate and the Cryosphere
Location	Global (region-specific activities also provided)
Access	Online
Language(s)	English (Visualization tool available in several languages)
Approximate Time Required	minimum 120 min (can vary)

1 Contents

1. Reading (20-30 min)	A reading that introduces the topic of glaciers and their formation. https://nsidc.org/cryosphere/glaciers/questions/what.html https://nsidc.org/cryosphere/glaciers/questions/formed.html https://nsidc.org/cryosphere/glaciers/questions/components.html
2. Visualization and associated activity (~30 min)	An interactive visualization and associated activity to visualize the shrinking and growing of a glacier as a result of changes in snowfall and temperature. Interactive Visualization: https://phet.colorado.edu/en/simulation/legacy/glaciers

Associated Activity:

https://phet.colorado.edu/en/contributions/view/4484?

3. **Classroom/Laboratory Activity (minimum 1 hr, can vary)**

A classroom/laboratory activity that uses Google Earth imagery and analysis of historical data to predict the complete melting of a glacier.

https://serc.carleton.edu/quantskills/activities/glacial_retreat.html

4. **Suggested questions/assignments for learning evaluation**

- *What climatic and environmental factors affect the size and motion of glaciers?*
- *How has an increase in global temperatures led to the shrinking of some glaciers?*
- *What is the relationship between climate and the cryosphere?*
- *How do glaciers provide evidence of climate change?*

2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1. **Introduce the topic through an online reading**

- Introduce the topic of glaciers and their formation.
- Use the following resources as the primary or supplementary reading material to teach your students about glaciers, their formation, and the components of a glacier:

https://nsidc.org/cryosphere/glaciers/questions/what.html
https://nsidc.org/cryosphere/glaciers/questions/formed.html
https://nsidc.org/cryosphere/glaciers/questions/components.html

This content is provided by the National Snow and Ice Data Center (NSIDC).

2. Explore the topic further through an interactive visualization and associated activity

Now, conduct an activity using an interactive visualization tool to help your students learn about the effects of changes in snowfall and temperature on glaciers.

- Download PhET's interactive visualization tool, "Glaciers", from https://phet.colorado.edu/en/simulation/legacy/glaciers.
- Download the associated activity, "Investigating Glaciers" developed by John Judkins (Rio Rancho High School), from https://phet.colorado.edu/en/contributions/view/4484?.
- Conduct the activity and discuss how glaciers are affected by changes in temperature and snowfall.
- Discuss how temperature changes caused by climate change may impact glaciers globally.
- Discuss how the study of glaciers can help in drawing inferences about the Earth's changing climate.

3. Conduct a classroom/laboratory activity

Next, help your students investigate the melting of glaciers through a classroom/laboratory activity, "When will there no longer be glaciers in Glacier National Park" from SERC Carleton, developed by Carol Ormand, Wittenberg University.

In this activity, students will analyze and interpret historical data for the Grinnell Glacier to predict when the glacier might completely melt.

- Download the teaching material and activity files from https://serc.carleton.edu/quantskills/activities/glacial_retreat.html.
- Conduct the exercises described in Part I – Part V of the teaching material (student handout).

4. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- *What climatic and environmental factors affect the size and motion of glaciers?*

- *How has an increase in global temperatures led to the shrinking of some glaciers?*
- *What is the relationship between climate and the cryosphere?*
- *How do glaciers provide evidence of climate change?*

3 Learning Outcomes

The activities in this lesson plan will enable students to:

- describe glaciers and their formation
- discuss the factors affecting the shrinking and growing of a glacier
- determine how climate change-related temperature variations may impact glaciers

4 Additional Resources

If you or your students would like to explore the topic further, these additional resources will be useful.

1. **Video, Visualization** — Future of Glaciers – The Module

   https://imaginary.org/program/future-of-glaciers-the-module

2. **Reading** — Global Glacier Changes: facts and figures

	http://www.grid.unep.ch/glaciers/
3. Mobile App	wgms Glacier App https://wgms.ch/glacierapp/

5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided.
We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

1. Reading, "All About Glaciers"	National Snow and Ice Data Center (NSIDC)
2. Visualization Tool, "Glaciers" **and** **Associated Activity, "Investigating Glaciers"**	PhET Interactive Simulations at the University of Colorado Boulder and John Judkins (Rio Rancho High School)
3. Classroom/Laboratory Activity, "When will there no longer be glaciers in Glacier National Park?"	From SERC Carleton, developed by Carol Ormand, Wittenberg University

4. Additional Resources	Guillaume Jouvet, Chantal Landry, Antonia Mey, available on IMAGINARY's website; United Nations Environment Programme; World Glacier Monitoring Service (WGMS) and the University of Zurich