

Glacier – extended package

Guide with lesson plans

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Glaciers – extended package

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“Glaciers – extended package” is aimed at students between 16 and 19 years of age, which is to say at students in grades 1-3 of general secondary school and grades 1-4 of technical secondary school. Due to the reform of secondary education, the recommended use of the package may be extended to younger students starting their education in grades 1 of general and technical secondary schools in the academic year 2019/2020.

The package can be used during lessons following the core curriculum and is especially appropriate for classes with extended curriculum in geography.

It helps to achieve learning aims included in the Polish core curriculum, especially:

- noticing regularities in the natural environment;
- processing and presenting information taken from a variety of sources;
- suggesting solutions to problems occurring in the natural environment.

As far as the educational content is concerned, the package refers to the following points in the Polish core curriculum:

The student:

- can recognize and describe features of the natural environment;
- can interpret geographical phenomena presented in charts, tables, diagrams and models;
- can describe causal, functional and temporal relationships between selected elements of the natural, social and economic environment, as well as verify them with the use of thematic maps;
- can use examples to explain causes and effects of global climate changes on Earth;
- can explain differences in the elevation of the permanent snow line at different latitudes;
- can explain the process of glacier formation using examples from different continents;
- can indicate the limits of glaciated areas on maps and evaluate the impact of climate changes on the changes in their surface area;
- can describe the mechanism and effects of different types of erosion and accumulation, including water (river, sea, lake), glacial and aeolian.

Bearing in mind time constraints imposed by the necessity to cover the core curriculum, it is recommended to use the package during extracurricular lesson or school trips. This gives teachers more freedom in terms of the amount of time they can devote to the materials included in the package, and thus makes it possible to combine the package with other materials created as part of the ERIS project (for example, the package entitled “Meteorological measurements in the Arctic”).

Title	GLACIERS – extended package
Author	Dr. Jerzy Gizejewski Department of Polar and Marine Research Institute of Geophysics, Polish Academy of Sciences
Age of students	16-19
Stage of education	Upper secondary school (general or technical)
Subject	Geography, Physics
Overview of package content	
The inhabitants of Greenland, Iceland or Spitsbergen have glaciers within short walking distance of their homes. For people living in the Alps, reaching a glacier takes longer, sometimes many hours. For those inhabiting other areas, glaciers are remote and, as a result, exotic and fascinating. Related to global warming, the problem of glacier and ice cap melting receives a lot of media attention, which further increases people's interest in the topic. The purpose of this package is to provide an extension to the information on glaciers which is available in textbooks and to make it easier for teachers to prepare and conduct lessons on the topic. The package includes a general part (theoretical introduction) and a practical part (tasks to be completed by students). There are two multimedia presentations, which explain what glaciers are, the conditions in which they form, geographical characteristics of where they occur, and the mechanism of glacier movement. They also clarify the terms "ablation" and "accumulation", and provide information on erosion, movement and accumulation, and basic forms of glacial morphology. Moreover, the presentations discuss selected issues in more detail. These include, for example, glacier mass balance, drainage system and cryokarst, glacier movement, calving, charging, glacial and fluvioglacial erosion and accumulation forms. Both presentations have been created in PowerPoint and come with notes, which are supposed to help the teacher during the presentation stage. The presentations can be edited and adjusted to the interests of particular groups and their current level of knowledge. Both presentations are also available in the form of videos with a running commentary provided by the author of the package. The videos can be played in class. They can also be used by teachers before the lesson to help them prepare in case they prefer to discuss the topic on their own with the use of the presentation. The practical part contains tasks to be completed by the students. Each task familiarizes	

the students with measurement methods applied to various glacial processes and with ways in which the obtained data are processed and used. To complete the tasks, the students need data sets which are either included in the task or can be obtained online from publically available free databases, such as <http://eklima.met.no/>

An extra advantage of working with the package is the opportunity to familiarize students with the rules they should follow when using scientific databases available online.

Assumed educational aims

The student knows:

- where and why glaciers may form;
- what forms glaciers may take in different morphological conditions;
- what impact climate changes have on glacier development.

The student understands:

- the process of glacier formation;
- the process of glacier ablation (gradual disappearance as a result of, for example, melting) and accumulation (increasing thickness)
- the process by which snow turns into glacial ice;
- processes related to glacier movement.

The student can:

- read hypsometric maps of glaciers;
- draw a morphological cross-section of a glacier on the basis of a map;
- draw bar charts illustrating annual ablation and accumulation in particular points on a glacier on the basis of data presented in a table;
- make a diagram of changes in the annual glacier mass balance;
- determine the location of equilibrium line altitude (ELA);
- use several diagrams illustrating annual glacier mass balance to indicate the trend in mass balance changes;
- draw movement vectors of measurement points on the surface of a glacier;
- enter data onto a map of a glacier.

Package content

1. "Glaciers Part I" – presentation – extended package;
2. ["Glaciers Part I" – movie based on the presentation;](#)
3. "Glaciers Part II" – "Equilibrium line altitude" – presentation;
4. ["Glaciers Part II" – movie based on the presentation;](#)
5. ["Glaciers" – animation;](#)
6. "Cross-section of a glacier" – instruction to worksheet;
7. "Cross-section of a glacier" – worksheet;

8. Hypsometric map for use with the worksheet "Cross-section of a glacier";
9. "Glacier mass balance" - Instructions for the worksheet 2-8;
10. "Glacier mass balance_2004_2005_worksheet 2";
11. "Glacier mass balance_2005_2006_worksheet 3";
12. "Glacier mass balance_2006_2007_worksheet 4";
13. "Glacier mass balance_2007_2008_worksheet 5";
14. "Glacier mass balance_2008_2009_worksheet 6";
15. "Glacier mass balance_2009_2010_worksheet 7";
16. "Glacier mass balance_2010_2011_worksheet 8";
17. "Balance and temperature_worksheet 9";
18. "Glaciers" – test – extended package;
19. "Glaciers" – test – answer key – extended package;
20. Guide with lesson plans.

Supplementary materials

- Blij de H.J., Muller O. 1996. Physical Geography of the Global Environment. John Willey & Sons, Inc. pp. 469-489.
- www.hornsund.igf.edu.pl/en/
- <http://www.kbp.pan.pl>
- Link to online quiz:
<https://play.kahoot.it/#/?quizId=00d53a44-e39a-4ad1-8ea8-7e87195fa8f6>

Lesson 1

Subject: Drawing a morphological cross-section of a glacier

Lesson plan for “Glaciers – extended package”

Necessary materials and equipment:

- multimedia projector, computer, loudspeakers;
- video about Polish Polar Station Hornsund:
[https://www.youtube.com/watch?v= GsjVfofRKE](https://www.youtube.com/watch?v=GsjVfofRKE)
- physical map of Europe or the world;
- world atlas;
- package materials (no. 1, 2, 6, 7, 8)

Lesson aims:

General and specific aims as specified in “Glaciers – extended package”

Methodological suggestions:

- expository methods: lecture, talk;
- demonstration methods: presentation, video;
- activation methods: brainstorming, thumbs;
- practical methods: worksheets

Lesson procedure:

1. Start of the lesson, organisational activities, checking the register.
2. Introduction of the topic. Students watch a video showing the daily life of scientists at the Polish Polar Station Hornsund on Spitsbergen:
[https://www.youtube.com/watch?v= GsjVfofRKE](https://www.youtube.com/watch?v=GsjVfofRKE).
3. The teacher points out the location of the station on a map (southern part of Spitsbergen in the Svalbard Archipelago). The teacher asks the group: How does the location of the station influence the life of the scientists and the running of the station?

The fact that the station lies beyond the polar circle means that for several months a year the scientists must work in conditions of polar night. In summer, on the other hand, the Sun does not set for several weeks, a phenomenon known as the polar day. Other consequences of high latitude include low air temperature, snow cover which persists for much of the year and close proximity to glaciers. The severity of the climate is diminished by the sea and the passing sea current, as a result of which the winters are not that cold. The biggest problem for the scientists working in the area is high winds which often occur in the open.

4. The teacher uses the multimedia presentation “Glaciers Part I” to discuss phenomena related to glaciation. The presentation includes a theoretical introduction as well as guidelines which the students will require in order to correctly complete their task. Slide no. 17 shows the correct answer to the task. The presentation can be modified depending on the needs of the group. An alternative is to use the video “Glaciers Part I” – movie based on presentation (no. 2), in which the presentation comes with a running commentary provided by the author of the package. Throughout the duration of the video, the teacher should monitor to ensure that everything is clear and provide additional explanations whenever necessary. The video must be stopped at the right moment in order to give the group some time to complete the task in the worksheet.
5. The next stage is to complete the tasks in the worksheet. The teacher distributes the materials: worksheet “Cross-section of a glacier”, hypsometric map for use with the worksheet and “Cross section of a glacier” – Instruction to worksheet. The students familiarize themselves with the instructions and draw a morphological cross-section of a glacier. The teacher monitors and provides support whenever necessary.
6. Finally, the students present their work and share impressions regarding the task and its level of challenge.

Lesson 2

Subject: ELA – Equilibrium line altitude

Lesson plan for “Glaciers – extended package”

Necessary materials and equipment:

- multimedia projector, computer, loudspeakers;
- completed worksheet from Lesson 1 (Morphological cross-section of a glacier);
- stationery (ruler, pencil);
- physical map of Europe or the world;
- world atlas;
- package materials (no. 3, 4, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18)

Lesson aims:

General and specific aims as specified in “Glaciers – extended package”

Methodological suggestions:

- expository methods: lecture, talk;
- demonstration methods: presentation, video;
- activation methods: brainstorming, thumbs;
- practical methods: worksheets

Lesson procedure:

1. Start of the lesson, organisational activities, checking the register.
2. Review of the material introduced in the previous lesson. A completed worksheet from the previous lesson (Morphological cross-section of a glacier) is needed to complete the tasks included in this lesson. Students recall the meaning of the terms “accumulation”, “ablation”, “permanent snow line”.
3. Students watch the video based on the multimedia presentation “Glaciers Part 2 – Equilibrium line altitude” (no. 4). The teacher monitors to ensure that everything is clear, providing additional explanations whenever necessary. As an alternative, the teacher may use the presentation “Glaciers Part II – Equilibrium line altitude”.
4. Here starts the practical part of the lesson. The students calculate the net mass balance of a glacier for a selected period. The students use task instruction sheets which contain tables with accumulation and ablation data.

Attention: Glacier net balance is calculated from the beginning of the accumulation period (autumn), which is why in the worksheet 2004/2005 the students must use accumulation data from 2004/2005 and ablation data from 2005.

5. The teacher divides the group into teams of seven. Each team receives a set of materials, which includes “Glacier mass balance” worksheets (no. 10-16) and “Glacier

mass balance” - instructions. The students should also have completed worksheets from the previous lesson (Morphological cross-section of a glacier).

6. The teacher clarifies the task with the use of the worksheet instructions. Each team member draws a single worksheet out of the available seven (“Glacier mass balance” no. 10-16) and calculates glacier mass balance for the period specified in the worksheet. Once all worksheets have been completed, each team will have annual mass balance sheets from the year 2004/2005 till the year 2010/2011.
7. The students compare task results within their groups and work together to complete the worksheet “Balance and temperature” – worksheet 9, which involves comparing the equilibrium line altitude in particular years (from worksheets 2-8) and entering data on the average annual air temperature. Having completed the exercise, the students decide if there is a link between the equilibrium line altitude and the average annual air temperature.
8. Summary and test. The teacher distributes test papers “Glaciers” – test, whose aim is to check the extent to which the lesson aims have been met. A possible alternative is to do the quiz in an interactive way with the help of kahoot.it. Follow the link to access the quiz:

<https://play.kahoot.it/#/?quizId=00d53a44-e39a-4ad1-8ea8-7e87195fa8f6>