Royal Geographical Society with IBG

Glacial Environments

Geography Teaching Today

Lesson 1: Where in the world is the ice? (approx. 40 mins – or 2 x 40 mins if all suggested online resources are used)

<table>
<tr><th>Key concepts</th><th>Range and content</th><th>Key questions and ideas</th><th>Teaching and learning activities</th><th>Resources</th></tr>
<tr>
<td>Place – understanding the physical characteristics of real places.

Space – knowing where places are located and how and why they are changing.

Scale – appreciating different scales and making links between them.

Physical processes – explaining how physical processes shape places and landscapes.</td>
<td>Variety of scales, both spatial and temporal.

The location of places and environments.

Different parts of the world in their wider settings and contexts.

Physical geography, physical processes and natural landscapes.</td>
<td rowspan="3">Pupils should learn:

• How ice is spread across the world, how this has changed over time and the different types of glacier that exist today.

Learning outcomes:

• Identify how ice cover is distributed across the world and become spatially aware of (i) which regions have the most ice and which have the least, (ii) the different sizes of glacier that exist.
• Learn about how ice is made and moves forwards; and learn under what conditions a glacier will advance or retreat.
• Appreciate that the physical world is highly dynamic and that physical processes are often changing (sometimes over very long time-scales).</td>
<td rowspan="3">STARTER:
Where is all the ice?
Students watch the introductory PowerPoint ‘Where is the ice?’ to explore ice cover and learn facts. Classroom atlases can also be used.

What does the ice sound like?
The sound of moving ice can be played while the PowerPoint is shown.

MAIN ACTIVITY:
Types of glaciers
The main activity is structured around three key questions or facts, with a range of downloadable resources available to support teaching.

1. What kinds of glaciers are there and how do they change over time?
Students use the ‘Types of glaciers’ Word document.
2. How do glaciers change size over time?
Students consult the online interactive activity.
3. What is an Ice Age, what causes it and how was the UK affected by the last Ice Age?
A ‘call my bluff’ style activity is used to study the causes of Ice Ages. Students draw the maximum extent of the Pleistocene ice sheet in the UK on a map (using ‘Ice Ages’ Word document).

See teacher notes for further details.

PLENARY:
Ice Age history
Students are told that the UK and France were joined together 18,000 years ago and consider what has happened since then to separate the countries.</td>
<td>Interactive:
How glaciers work

Downloads:
Where is the ice? (PPT)
Types of glaciers (Word)
Ice Ages (Word)

Links:
The sounds of cold environments are heard at: www.antarctica2000.net/sounds/other.html

Online information about the distribution of the ice can be found at:
SwissEduc website
Nsidc.org website (for use with Google Earth)

The story of how ice forms is also told at:
http://nsdic.org/glaciers/story/

Interactive exercise on seasonal changes in sea-ice cover at: www.discoveringantarctica.org.uk/multimedia/flash/3_seasonal_change.html</td>
</tr>
<tr><th>Key processes</th><th>Curriculum opportunities</th><th>Notes</th></tr>
<tr>
<td>Geographical enquiry – ask geographical questions, solve problems and analyse evidence.</td>
<td>Explore real and relevant contemporary contexts.

Examine geographical issues in the news.</td>
<td>Gifted and talented
geographers might want to know more about the scientific explanations for past climate change (e.g. Milankovitch curves).</td>
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</table>

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Lesson 2: Why are our glaciers shrinking? (approx. 40 mins)

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<tr><th>Key concepts</th><th>Range and content</th><th>Key question and ideas</th><th>Teaching and learning activities</th><th>Resources</th></tr>
<tr>
<td>Place – understanding the physical characteristics of real places.

Physical processes – explaining how physical processes shape places and landscapes.

Human processes – understanding how activities in the human worlds lead to change in places and landscapes.

Environmental interaction and sustainable development – understanding that the physical and human dimensions of the environment are interrelated and influence environmental change.</td>
<td>Physical geography, physical processes and natural landscapes.

Human geography and human processes.

Interactions between people and their environments, including the causes and consequences of these interactions.

Different parts of the world in their wider settings and contexts.</td>
<td rowspan="3">Pupils should learn:

• That the world's glaciers are in retreat as a result of climate change.

Learning outcomes:

• Understand that the world's glacial environments are changing.
• Identify climate change as the cause of melting and appreciate the role that human processes are now known to be playing.
• Appreciate that small contributions can be made by each of us as citizens to help protect the world's glaciers, by attempting to reduce our own carbon footprint.</td>
<td rowspan="3">STARTER:
Who is the iceman, why was he murdered, and why was his body found after 5000 years?
Students are introduced to the 'iceman', found in an Austrian snowfield in 1991 and speculate as to who he was, the cause of his death, and why his body was exposed after so long.

MAIN ACTIVITY:
Who killed the iceman?
The class read through a case study of the iceman and find out what happened to him, concluding that his body was revealed due to the melting of the ice.

What's happening to the world's ice?
Students use online resources to chart the decline of the world's ice and draw a sketch map showing the retreat of the Columbia glacier.

How does ice tell us the secret of why it is melting?
Students learn about ice cores and plot the CO_2 content of ice cores from 1800 to 2008.

PLENARY:
Do your bit today!
The plenary 'Help save the ice' PowerPoint presentation gives students a reminder of how they can live more sustainably and help save the world's ice.</td>
<td>Downloads:
Iceman Murder Mystery (Word)
Ice cores (Word)
Help save the ice (PPT)

Images:
National Geographic website
SwissEduc website

Video:
Play the film An Inconvenient Truth, Scene 07: Glaciers recede (2:00) (also note Scene 08, which shows ice core analysis).

Links:
Useful websites for a global warming recap:
Your Climate Your Life
BBC Newsround</td>
</tr>
<tr><th>Key processes</th><th>Curriculum opportunities</th><th>Notes</th></tr>
<tr>
<td>Geographical enquiry – ask geographical questions, solve problems and analyse evidence.

Graphicacy and visual literacy – construct maps and plans at a variety of scales.</td>
<td>Explore real and relevant contemporary contexts.

Examine geographical issues in the news.

Use varied resources.

Participate in informed responsible action in relation to geographical issues.</td>
<td>Gifted and talented
geographers might know that there is sometimes debate surrounding facts about climate change. However, they may struggle to find a better explanation for the retreat of ice than that described in this lesson.</td>
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Lesson 3: Living with glaciers (approx. 40 mins)

Key concepts	Range and content	Key question and ideas	Teaching and learning activities	Resources
Place – *developing 'geographical imaginations' of places.* **Space –** *understanding the interactions between places and the networks created by flows of people.* **Interdependence –** *exploring the social, economic and environmental connections between places.* **Physical processes –** *understanding how events in the physical and human worlds lead to change in places and landscapes.* **Environmental interaction –** *understanding that the physical and human dimensions of the environment are interrelated*	A variety of scales from personal and local to continental and global. Different parts of the world in their wider settings and contexts. Physical geography, physical processes and natural landscapes. Human geography, built and managed environments and human processes. Interactions between people and their environments, including how to place for and manage for future impact.	**Pupils should learn:** • That glaciers can bring opportunities and challenges for people that live close by or visit them as tourists. **Learning outcomes:** • Learn about different ways in which societies rely upon glaciers. • Appreciate the importance of glacial meltwater in supplying drinking water to a very large number of the world's poorer people – and appreciate the problems and conflicts that could arise if this interaction is threatened as supplied begin to dwindle. • Identify the diverse role that the physical landscape plays in people's lives, creating hazards in addition to varied benefits.	**STARTER:** *What is the difference between a hazard and a resource?* These two important concepts are introduced through the 'Hazards and resources' PowerPoint, discussing whether various geographical features can be considered hazards or resources. **MAIN ACTIVITY:** *How have people and ecosystems adapted to a hazardous life in glacial conditions?* Students learn about different ways in which societies have adapted to life in extreme environments. The 'Living with glaciers' PowerPoint and 'Glacial hazards and resources' Word document are used to explore housing, clothing, hunting and industry and the opportunities that glaciers bring. *Why are ski resorts under threat?* Students use the 'Melting mountains' Word document to study the importance of skiing industries to Alpine economies, and the threats that climate change bring to this, and complete an activity based on 'rebranding' the Alps. **PLENARY:** *Why are they wrapping the Gurschen glacier in plastic?* The lesson ends with a look at the Gurschen glacier, which has been wrapped in half-inch thick PVC to prevent it from melting.	**Downloads:** Hazards and resources (PPT) Living with glaciers (PPT) Glacial hazards and resources (Word) Melting mountains (Word) **Links:** Additional downloads that show glacial hazards and resources are available on the SwissEduc website. An interactive and animated display of glacial hazards (including overflowing lakes) can be found on the NOVA Science website. A report on rock-falls and the collapse of the Matterhorn is available on the Observer website. A report on the Gurshen glacier is available on the Geography in the News website. **Printed resources:** Atlases and maps
Key processes	**Curriculum opportunities**			**Notes**
Geographical enquiry – *ask geographical questions, solve problems and make decisions, analyse and evaluate evidence.*	*Explore real and relevant contemporary contexts.* *Examine geographical issues in the news.* *Investigate important issues of relevance globally.*			Gifted and talented geographers might want to explore the hazard-resource dualism in more detail, as it is an area for reflective thinking. What role do population migrations (including tourism) play in helping to turn potential hazards into disasters?

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Lesson 4: What landforms of erosion will disappearing ice reveal? (minimum 40 mins – can be extended if desired)

Key concepts	Range and content	Key question and ideas	Teaching and learning activities	Resources
Place – *understanding the physical characteristics of real places.* **Space** – *knowing where landscapes are locate, why they are there and how they are changing.* **Physical processes** – *understanding how events in the physical world can lead to changes in places and landscapes.*	Physical geography, physical processes and natural landscapes. The location of places and environments. Key aspects of the UK, including its changing physical geography. Interactions between people and their environments.	**Pupils should learn:** • What erosional landforms are revealed in upland areas when ice melts – and the role that ice played in creating them. **Learning outcomes:** • Appreciate that some places in the world are home to unique landforms that give them a special character that is not found elsewhere. • Identify the role of physical processes in producing these characteristic landforms. • Learn that the exposure of these special landforms is on-going, with some revealed at the end of the last ice age and others only becoming uncovered in recent years as ice has started to melt again.	**STARTER:** *What is the difference between weathering and erosion?* Students can either group together images of weathering and erosion (see image links) or study the 'Erosion and weathering' Word document. **MAIN ACTIVITY:** *How does ice erosion work?* The 'Erosion and weathering' Word document also explains how ice erosion and other forms of physical erosion work. Students can also complete the activity on this sheet. *What are the main landforms of glacial erosion?* Students watch the 'Glacial landforms' PowerPoint presentation which shows some of the key landforms of glacial erosion. They then complete the 'Glacier card sort' to consolidate their learning. **PLENARY:** *Where did the roche moutonnée get its name?* In the 'Roche moutonnee' PowerPoint presentation, students are asked to consider four questions about this type of glacial landforms before the answers are given.	**Downloads:** Erosion and weathering (Word) Glacial landforms (PPT) Glacier card sort (Word) Roche moutonnée (PPT) **Images:** Online images showing erosional landforms (especially corries) revealed by melting ice are available on the SwissEduc website: www.swisseduc.ch/glaciers/morteratsch/comparison/bernina-summit-en.html and www.swisseduc.ch/glaciers/earth_icy_planet/glaciers02-en.html?id=10 **Links:** Teachers can research erosion landforms and processes as preparation for the lesson in M Ritter's 'The Physical Environment'. **Video:** To see ice moving (and the 'sandpaper' effect of abrasion), watch this You Tube video.
Key processes	**Curriculum opportunities**			**Notes**
Geographical enquiry – *ask geographical questions, solve problems and apply geographical skills to create new interpretations of place and space.*	*Investigate important issues of relevance to the UK and globally.* *Opportunity to undertake fieldwork investigations on this topic.*			**Gifted and talented** geographers may want to know more about the process of glacial plucking. This involves pressure melting of ice at the base of a glacier and subsequent re-freezing around disintegrating bedrock. It is a more advanced scientific concept and need not be taught at this level unless students require further stretch and challenge.

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Lesson 5: How will melting glaciers affect people living in the UK? (approx. 40 mins)

<table>
<tr><th>Key concepts</th><th>Range and content</th><th>Key question and ideas</th><th>Teaching and learning activities</th><th>Resources</th></tr>
<tr>
<td>Space – knowing how and why places and landscapes are changing and the implications for people.

Scale – appreciating different scales from local to national to global.

Physical processes – understanding how physical processes can lead to change in places, landscapes and societies.

Interdependence – exploring the social, economic and environmental connections between places.

Environmental interaction – understanding the interrelationships between physical and human dimensions of the environment.</td>
<td>A variety of scales from personal and local to national and global.

Key aspects of the UK, including its changing human and physical geography and current issues.

Physical geography, physical processes and natural landscapes.

Human geography, built and managed environments and human processes.

Interactions between people and their environments, including how to plan for and manage future impact.</td>
<td rowspan="3">Pupils should learn:

• That because physical geography connects different places together, what happens to glaciers in far-off places can still impact on people living in the UK.

Learning outcomes:

• Recognise that in an interconnected world, we may all suffer impacts caused by melting ice elsewhere.

• Learn about some of the diverse and different ways in which settlements may be affected by sea-level rises.

• Identify problems associated with protection (costs might outweigh benefits for sparsely populated areas).</td>
<td rowspan="3">STARTER:
What happens to sea levels when glaciers melt and water runs into the sea?
Students discuss how high they think sea-level could rise if different bodies of ice were to melt (recap – lesson 1 ‘Where is the earth’s ice).

MAIN ACTIVITY:
How will our place be affected by sea-level rise?
Students consider how rising sea-levels could impact on their home town. The Word document ‘How will melting ice affect our place?’ provides guidance for the completion of this task, and a table to complete. Following this, students can complete the ‘Our place’ poster.

PLENARY:
How will sea-level rise in other places impact on life in our place?
By way of a class discussion, encourage students to consider the concepts of interdependency and interconnectedness. For example, what products may no longer be available due to flooding in the places where those products are made or grown? What might the impacts on tourism be? How about migration?</td>
<td rowspan="2">Downloads:
How will melting ice affect our place? (Word)
Our place (Word)

Links:
Online information about UK flood risks:
• To see the 70-80m upper limit impact on the UK as a whole, visit: http://merkel.zoneo.net/Topo/Applet/
• More projections at: http://flood.firetree.net/
• The Environment Agency website has existing flood risk maps (enter your school postcode where indicated) which can be taken as a starting point for investigating sea-level rise impacts.</td>
</tr>
<tr><th>Key processes</th><th>Curriculum opportunities</th></tr>
<tr>
<td>Geographical enquiry – ask geographical questions, collect data and record data, solve problems.

Graphicacy and visual literacy – use geographical data including maps at a range of scales.</td>
<td>Build on personal experiences of geography.

Use varied resources, including maps.

Investigate important issues of relevance to the UK.</td>
</tr>
<tr><td colspan="3"></td><td colspan="2">Notes</td></tr>
<tr><td colspan="3"></td><td colspan="2">Gifted and talented
geographers might want to explore the additional sea-level rise factor of thermal expansion. Again, this is a more advanced area of science and is not required knowledge for the age group.</td></tr>
</table>

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Lesson 6: How will melting glaciers affect people living in other countries? (approx. 40 mins)

<table>
<tr><th>Key concepts</th><th>Range and content</th><th>Key question and ideas</th><th>Teaching and learning activities</th><th>Resources</th></tr>
<tr><td>Place – developing ‘geographical imaginations’ of places.

Space – knowing how places and landscapes are changing and the implications for people.

Scale – appreciating different scales including international and global.

Interdependence – understanding the significance of independence in change at all scales.

Environmental interaction – understanding influences on environmental and climate change.</td><td>The location of places and environments.

Different parts of the world, including regions and countries in different states of development.

Interactions between people and their environments, including causes and consequences of interactions and how to plan for and manage future impacts.</td><td rowspan="3">Pupils should learn:

• That the risks associated with glacial melting and sea-level rise are not evenly distributed around the world.

• That some of the world’s poorest people are also the most vulnerable to flooding.

Learning outcomes:

• Identify some places which are especially vulnerable to sea-level rise and think about who lives there.

• Learn how some of the poorest people in the world are likely to be affected by sea-level rises.

• Question whether the only solution will be mass migrations of a kind never seen before, thereby developing students’ geographical imaginations.

• Recognise that richer countries may have to bear some responsibility for all of this, thus posing questions for citizenship.</td><td rowspan="3">STARTER:
Where in the world will the greatest impact of climate change and melting glaciers be felt?
The ‘4As’ PPT encourages students to decide which of four places they think will be most affected by climate change and melting glaciers.

MAIN ACTIVITY:
What is the global threat of glaciers melting and who is most at risk?
The PowerPoint presentations ‘The global threat’ and ‘Global pressure points’ can be used to set up a class discussion about flooding vulnerability, migration and flood prevention.

Students can then work in groups to prepare a 5 minute TV documentary on the threat of sea level rise and how we can act to reduce it or prepare for it.

PLENARY:
End of unit quiz
A series of questions take students back through the content of the entire scheme of work.</td><td rowspan="2">Downloads:
4As (PPT)
The global threat (PPT)
Global pressure points (PPT)
End of unit quiz (PPT)

Video:
Extract to pay from the film ‘An Inconvenient Truth’: Scene 21: Sea-level rise (4:00)

Links:
Other useful online sources showing the impacts of sea-level change:
Discovering Antarctica website
US AIT website
Australia AIT website

Printed resources:
The book of the film is called ‘An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About it” (Rodale Press 2006) ISBN-10: 1594865671</td></tr>
<tr><th>Key processes</th><th>Curriculum opportunities</th></tr>
<tr><td>Geographical enquiry – ask geographical questions, solve problems and think creatively about geographical issues.

Geographical communication – communicate knowledge and understanding using geographical vocabulary in both speech and writing.</td><td>Explore real and relevant contemporary contexts.

Participate in informed responsible action.

Make links between geography and other subjects, including citizenship.

Investigate important global issues.</td><td>Notes

Gifted and talented geographers might want to think more critically about the time-scale for sea-level changes. Younger children may imaging future sea-level risk in catastrophic term (like the 2004 Asian tsunami), with the sea suddenly overwhelming communities. The reality may be less dramatic and extreme-scenario changes will take many decades or centuries. In some places, a gradual creep of water inland will result in the less dramatic scenario of managed retreat and abandonment of high-risk property and land.</td></tr>
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