

**Module : 'The response of glaciers to climate change' ( )**

**KS3 - Scheme of Work**

**Overview:**

**Most children will:** know that glaciers are affected by climate change and be able to explain how shrinking glaciers impact on our world. They will understand how glaciers form and where they are located.

**Some children will not have made so much progress and will:** know that glaciers are affected by climate change and be able to explain how shrinking glaciers impact on our world.

**Some children will have progressed further and will also:** be able to explain why glaciers are located in specific places. They will be able to link glacial location to vulnerability to climate change.

Learning Objectives	Cross Curricular & Other	Key Resources:
<p>To understand the definition of a glacier.</p> <p>To understand what glacier mass balance means (what inputs mass and what are the outputs).</p> <p>To understand how glaciers are affected by climate change.</p> <p>To know where glaciers are located.</p> <p>To understand the factors that influence where glaciers are located.</p>	<p>Science Geography Citizenship Literacy Numeracy ICT</p>	<p>ICT – IWB and computers Access to water in Lesson 2 - Ice to be prepared by students in Lesson 2, to be used in Lesson 3 Equipment for experiments - see SoW</p> <p><b>Overall Outcome:</b> <b>Students know that shrinking glaciers are caused by climate change and have an impact on our world.</b></p>
<p>To recognise that altitude, latitude and continentality are the factors which influence the location of glaciers.</p> <p>To understand the impact that shrinking glaciers have on the world.</p>	<p><b>Vocabulary:</b> Glacier Ablation Input Output Mass balance Avalanche Condensation Calving Evaporation Global Warming Sublimation Latitude Altitude Continentality</p>	<p><b>Assessment:</b> Melting Glaciers and their Impacts Sheet Lesson 5</p> <p><b>Unit Extension</b></p>

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Learning Objectives	Key resources	Suggested Activities	Cross-curricular & other	Outcomes	Extension(s)
<b>(1) What is a glacier?</b>					
<p>To understand the definition of a glacier.</p> <p>To understand what glacier mass balance means (what inputs mass and what are the outputs)</p> <p>To understand how glaciers are affected by climate change.</p>	<p>Computer/ internet/ projector (for teacher)</p> <p>Preferably ICT access for students (if not available see handouts 1-5).</p> <p>PPT Lesson 1 Glacier-Intro.ppt</p> <p>A3 Paper (1 sheet per group), pens – red, yellow &amp; green</p> <p>Post-it notes</p> <p>Resources –</p> <p>Lesson 1 Resource Sheet</p> <p>PPT Glaciers Slideshow</p>	<p>Bell Work – image/video of glacier on IWB. Students on post-it note to write who/what/why/when/where/how. Compare ideas in groups.</p> <p><a href="http://www.trp.dundee.ac.uk/~spitz/images/calve.gif">http://www.trp.dundee.ac.uk/~spitz/images/calve.gif</a> Also on PPT – Glacier Intro</p> <p>Explain to students what they have just seen (glacier in Spitsbergen, Norway, in 2002 calving – chunks breaking off – 1 type of ablation (which is the word used to describe any output from a glacier).</p> <p>Ask students ‘What is a glacier?’ In groups, students to create mind map of their ideas (using red pen to enable progress to be shown throughout lesson).</p> <p>If students have access to ICT: work in groups to research 1 key question from below (questions graded in ability, starting with Less Able). If no ICT access use Resource Sheet Lesson 1.</p> <p><u>What is a glacier?</u> Suggested resource: <a href="http://www.onegeology.org/extra/kids/earthprocesses/glacialice.html">www.onegeology.org/extra/kids/earthprocesses/glacialice.html</a> or see Resource Sheet Lesson 1.1 (LA) or 1.2 (HA) ‘What is a glacier?’</p> <p><u>How do glaciers increase (input) and decrease in size (output)?</u> See Resource Sheet Lesson 1.3 ‘Card sort Glacial Inputs and Outputs’</p> <p><u>How are glacier changes measured?</u> <a href="http://www.nrm-sc.usgs.gov/research/glaciers.htm">www.nrm-sc.usgs.gov/research/glaciers.htm</a> or</p>	<p>Science Geography Citizenship Literacy Numeracy ICT</p>	<p>Students understand the definition of a glacier.</p> <p>Students know how the mass of a glacier increases and decreases</p> <p>Students know that climate change can affect glaciers</p> <p>Students have produced a mind map showing progression of understanding</p>	<p>Students to search for articles in newspapers relating to glaciers.</p>

see Resource Sheet Lesson 1.4 'How do scientists measure a glacier?'

Feedback findings to rest of class.

Discuss with reference to Resource Sheet 1.3 'If global warming is occurring, as most scientists agree, how might it affect glaciers?'

Look at:

<http://www.nps.gov/olym/naturescience/interactive-glacier-glacial-mass-balance.htm>

Update mind maps in yellow pen to show progress.

Students to act as components of glaciers (*Model on PPT*) acting as snow falling, changes to ice as it compacts, increasing in density as more is added. Then show ablation (reduction of glacier) due to warmer weather, glacier calving (blocks of glaciers collapsing) and then as climate gets warmer show glacier reducing. As time allows increase glacier again etc.

*Use Glacier Intro PPT as model to show how glaciers form, increase and decrease*

Students to make final mind map additions in green.

**Note:** there is a Glacier Slide Show resource which can be played throughout the lesson, whilst students are working, or used in a plenary.

(2) Where are glaciers located?					
<p>To understand where glaciers are located.</p> <p>To understand what factors influence the location of glaciers.</p>	<p>Internet access</p> <p>PPT Lesson 2 'Where are Glaciers Located'</p> <p>P/c of world map outlines x number of groups</p> <p>Atlases</p> <p>White paper to tear up to represent glaciers</p> <p>Blutack</p> <p>Class copy of world map outline</p> <p>Resource Sheet – Lesson 2 (Resources Sheet – Quick on the Draw) contains questions and answers – cut up questions so each group only has 1 at a time</p> <p>Each student to record answers</p>	<p>Bell Work – on PPT Lesson 2 'Where are Glaciers Located' – students to locate specific countries on map.</p> <p><b>Where are glaciers located?</b></p> <p>Starter – In pairs students to identify 5 countries which they think have permanent ice from a given list (on PPT) and must justify their choices. Teacher note: the only ones that don't have glaciers from list are Brazil, UK, Tunisia and mainland Australia – but Australian and UK islands do have permanent ice (e.g. Heard Island, South Georgia, etc.).</p> <p>In groups, on World Map outline chn to mark where they think glaciers are using white paper and blutack, to show size and frequency. Must have a reason for their choices, e.g. it is very cold in Norway, etc.</p> <p>Groups to feedback to class their suggestions and mark on Class World Map outline using pieces of white paper and blutack to show size and frequency of glaciers, giving reasons for their choices.</p> <p>Main - In groups <i>Quick on the draw</i> exercise. <b>Why do some places have glaciers?</b></p> <p>Resource Sheet Lesson 2 (Quick on the Draw) contains questions and fact sheet.</p> <p>Questions colour coded Red=HA, Amber=A, Green=LA</p> <p>10 questions for groups to answer – each member must have answer for Question 1 before they get Question 2 etc.</p> <p>Competition between groups to answer the questions in the given time. Need to work together to ensure all in group have the answer</p>	<p>Science</p> <p>Geography</p> <p>Citizenship</p> <p>Literacy</p> <p>Numeracy</p> <p>ICT</p>	<p>Students understand where glaciers are located.</p> <p>Students can justify their choices.</p> <p>Students understand what factors influence the location of glaciers.</p> <p>Students understand that altitude, latitude and continentality are the factors which influence the location of glaciers across the world.</p>	

before moving on to next question.  
(3 areas to look at are latitude, altitude and  
continentality [nearness to the sea]).

Do we want to change any of our ideas of where  
glaciers are on our Class Outline? When all  
suggestions are on Class Outline look at  
[www.worldmapper.org](http://www.worldmapper.org) which resizes countries  
to correspond with data about certain areas.  
How would this affect our map? Compare Class  
Map to World Mapper map is on PPT  
showing where predominance of glaciers are, 1  
map includes Greenland and Antarctica, 1 map  
excludes them as dominate results. Compare  
Class Outline and World Mapper. Then look at  
map of actual glaciers [www.nsidc.org/glims/](http://www.nsidc.org/glims/) .  
How accurate were we? What surprises  
werethere?

Plenary – Two Stars and a Wish – What 2 things  
did we do well today? What do you wish you had  
done differently?

(3) Research of specific glaciers					
To be able to research specific glaciers	<p>Internet access preferable</p> <p>PPT Glacier Experiment Sequence</p> <p>Glacier Research Instructions (1 per group)</p> <p>Glacier Info Sheets:            West Antarctic Ice Sheet            Greenland Ice Sheet            Columbia Glacier (Alaska)            Larsen Ice Shelf            Arolla Glacier (Switzerland)            Furtwängler Glacier (Mt. Kilimanjaro, Tanzania) a tropical glacier            Baby Glacier (Axel Heiberg Island, Nunavut, Canada) a Polar Glacier</p> <p>Apparatus to set up experiment for next lesson:            2 x ice cream tubs to hold 1.5l water            2 x large margarine tubs to hold 0.5l water            1 x yoghurt pot (not curving inwards to ensure can get ice out) to hold 0.2l water            1 x ice cube tray to hold at least 8 ice cubes</p> <p>If no water access in class 5l of water</p>	<p>Explain to the class that they are going to research specific glaciers in groups so that they can give a short presentation about their glacier to the class in the next lesson. They will use their findings from this lesson to set up an experiment to find out the effect climate change might have on their type of glacier, which they will carry out in the next lesson.</p> <p>Using Glacier Experiment Sequence PPT explain that after the experiment is complete they will compare the results from all 7 types of glacier to find out which glacier is the most vulnerable.</p> <p>Split the class into 7 groups (1 for each type of glacier) and give them each a copy of Lesson 3 Glacier Research Instructions (GRI). Distribute the glaciers below to the groups for them to research – 1 per group:</p> <p>West Antarctic Ice Sheet            Greenland Ice Sheet            Columbia Glacier (Alaska)            Larsen Ice Shelf            Arolla Glacier (Switzerland)            Furtwängler Glacier (Mt. Kilimanjaro, Tanzania) a tropical glacier            Baby Glacier (Axel Heiberg Island, Nunavut, Canada) a Polar Glacier</p> <p>If there is internet access, groups <b>can</b> research their glacier, completing the GRI sheet, and giving a score for vulnerability. However, for many of these glaciers, the internet may be very complicated and may only be suitable for MA or as an extension activity.</p> <p>If there is no internet access, or for Able and Lower Ability groups, use the Info Sheets provided (1 sheet for each glacier type).</p>	<p>Science            Geography            Citizenship            Literacy            Numeracy            ICT</p>	<p>Students can use resources for research.</p> <p>Students will be able to give a presentation about a specific glacier to the class.</p>	<p>Students can justify their predictions.</p> <p>Students use internet to research glaciers.</p>

Once the groups have completed their research, and have a vulnerability score, explain that they need to set up their experiment for the next lesson.

Discuss as a class the different glaciers in the experiment and the apparatus available to 'make' their glaciers.

Decide as a class which container suits which glacier the best.

1.5l = West Antarctic Ice Sheet

1.5l = Greenland Ice Sheet

0.5l = Columbia Glacier (Alaska)

0.5l = Larsen Ice Shelf

0.2l = Arolla Glacier (Switzerland)

4 ice cubes = Furtwängler Glacier (Mt. Kilimanjaro, Tanzania)

4 ice cubes = Baby Glacier (Axel Heiberg Island, Nunavut, Canada)

Students to fill containers with correct amount of water, ready to freeze and begin experiment for next lesson.

Collect in information for presentations from students.

(4) Experiment to find out the effects of climate change on glaciers					
<p>To be able to carry out a fair test.</p> <p>To be able to carry out an experiment</p> <p>To understand what results and observations to make.</p> <p>To be able to take suitable measurements for results.</p> <p>To be able to make observations.</p> <p>To be able to record results.</p> <p>To be able to give a presentation to the class</p>	<p>Ice as above</p> <p>7 trays to put ice glaciers in which will hold the amount of water which melts</p> <p>Rulers to measure difference in 'sea level' 5l lukewarm water</p> <p>2 measuring jugs to add water to West Antarctica and Larsen Ice Shelf glaciers</p> <p>7 measuring cylinders- 1000ml</p> <p>7 funnels to assist pouring water to measure meltwater at end of experiment</p> <p>Paper and pencils to record results</p> <p>Paper towels</p> <p>2 lamps to use to provide heat for Furtwängler (Tropical Glacier) or place near/on a radiator.</p> <p>Timer to remind to check ice regularly</p> <p>For teacher use: Glacier Vulnerability Scores</p>	<p>Discuss with students what they were doing in the last lesson using Glacier Experiment Sequence PPT .</p> <p>Discuss which glaciers will need water adding, due to the proximity of their glacier to oceans.</p> <p>Teacher to prepare 7 labels for ice. <b>CHECK ice is totally frozen throughout.</b></p> <p><b>Note 2 glaciers need water adding:</b> West Antarctic Ice Sheet needs lukewarm water adding until it is <b>nearly</b> floating.</p> <p>Larsen Ice Shelf needs lukewarm water adding until it is <b>actually</b> floating.</p> <p>Ensure these 2 groups know they need to accurately measure the amount of water added.</p> <p><b>Note:</b> 1.5l = West Antarctic Ice Sheet – needs lukewarm water to almost float – note amount 1.5l = Greenland Ice Sheet – no water added 0.5l = Columbia Glacier (Alaska)- no water added 0.5l = Larsen Ice Shelf – needs lukewarm water added – note amount 0.2l = Arolla Glacier (Switzerland) –no water 4 ice cubes = Furtwängler Glacier (Mt. Kilimanjaro, Tanzania) no water, use lamps for heat – make sure spread out 4 ice cubes = Baby Glacier (Axel Heiberg Island, Nunavut, Canada) – make sure spread out</p> <p>Produce the ice glaciers and apparatus – ensure that each group has the equipment needed.</p> <p>Pupils to set up apparatus and begin experiment.</p> <p>Show the pupils the results table as a prompt to remind them of what we will be recording.</p>	<p>Science Geography Citizenship Literacy Numeracy ICT</p>	<p>Students can carry out an experiment.</p> <p>Students understand the effects of climate change on the glacier they have been investigating.</p>	

Once experiment has started, **groups to give presentations to class about their glacier from research done during last lesson.**

Check glaciers every 10 minutes.

10 minutes before the end of the lesson stop the experiment and get the students to record their findings, measuring the changes and amount of meltwater from their glaciers. Use Glacier Experiment Sequence PPT Slide 2 to remind the students of the observations needed and to record in observations column. Did anything else interesting happen? E.g. Larsen Ice Shelf may have tipped over, West Antarctic Ice Sheet develops a hinge (notch) under the ice.

Collect in results for use in the next lesson.

For teacher information see the correct results for the Vulnerability Scores.

<b>(5) Feedback – What effects does climate change have on specific glaciers? How do these changes impact on our world?</b>					
<p>To understand the effects of climate change on different glaciers.</p> <p>To be able to use results to form conclusions.</p> <p>To be able to identify which glaciers are most vulnerable to climate change.</p> <p>To understand that some glaciers are more vulnerable to climate change than others.</p> <p>To understand that smaller glaciers are the most vulnerable to climate change, but have less impact on sea level.</p>	<p>For teacher use 'Glacier Vulnerability Scores'</p> <p>Results collected from previous lesson.</p> <p>Glacier Experiment Sequence PPT</p> <p>Melting Glaciers and their Impacts Sheet – 1 per student</p> <p>Assessment Task – Graphs</p> <p>Assessment Task – Choose your own</p> <p>Graph Paper – Levels 5 and over</p> <p>Calculators – Level 5 and over</p> <p>Climate Change Students Learning Survey – 1 per student</p>	<p>Return Glacier Research info sheets to students from Lesson 4. Begin lesson by finishing off any presentations not given during last lesson.</p> <p>Return results from previous lesson to groups. Discuss what results they were collecting and ensure that they have time to compare the vulnerability scores given in Lesson 2 to their results.</p> <p>Collect in results and record on class sheet on Glacier Experiment Sequence PPT and compare.</p> <p>Discuss which glaciers are the most vulnerable. Results should show Baby/ Furtwängler as most vulnerable, followed by Columbia, Larsen, Arolla, West Antarctic and Greenland, showing that smaller glaciers are the most vulnerable. Discuss the impacts of the melting glaciers on our world.</p> <p>Give out Melting Glaciers and their Impacts Sheet. Students to choose their own activities from sheet to show their understanding of the impacts melting glaciers have on our world and lives.</p> <p>Students to complete a survey to show how their attitudes and learning have changed as a result of this series of lessons.</p>	<p>Science Geography Citizenship Literacy Numeracy ICT</p>	<p>Students understand the effects of climate change on different types of glacier.</p> <p>Students know that smaller glaciers are the most vulnerable to climate change.</p> <p>Students know that melting glaciers have an impact on our world and on our lives.</p>	<p>See Melting Glaciers and their Impacts Sheet – differentiation for Levels 3 to 7</p>