Scottish Water
Always serving Scotland

Climate change

Third and fourth level

Description of module

The module looks at the causes and consequences of climate change, drought and flooding. The pupils are invited to explore the experiences of people involved in some natural disasters, and to compare the effects of these in different countries.

Main experiences and outcomes

Sciences

I can explain some of the processes which contribute to climate change and discuss the possible impact of atmospheric change on the survival of living things.
SCN 3-05b

Having selected scientific themes of topical interest, I can critically analyse the issues, and use relevant information to develop an informed argument.
SCN 4-20b

Social studies

I can identify the possible consequences of an environmental issue and make informed suggestions about ways to manage the impact.
SOC 3-08a

I can compare the social and economic differences between more and less economically-developed countries and can discuss the possibilities for reducing these differences.
SOC 3-11a

Having considered responses to a recent international crisis, I can contribute to a discussion of the effectiveness of the responses.
SOC 3-19b

I can develop my understanding of the interaction between humans and the environment by describing and assessing the impact of human activity on an area.
SOC 4-10a

I can identify threats facing the main climate zones, including climate change, and analyse how these threats impact on the way of life.
SOC 4-12a

Technologies

I enhance my learning by applying my ICT skills in different learning contexts across the curriculum.
TCH 3-04a

Throughout my learning, I can make effective use of a computer system to process and organise information.
TCH 4-04a

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Activity 1

Learning intention
- Pupils gain a broad understanding of the drivers for climate change

Success criteria
- Pupils are able to summarise the main points of the video using the sheet provided
- Pupils are able to list the main points in the climate change debate

Suggestions for teachers

1 General discussion
A general discussion about climate change is useful to establish the range of understanding present in the class. There are some high profile commentators who disagree on the causes of climate change, so a whiff of controversy might stimulate interest. Global warming can't be completely explained just by natural causes. 40% of CO2 emissions are caused by individuals, mostly from energy used in the home, driving and air travel (source: www.direct.gov.uk).

2 Video clip
Play the BBC Learning Zone video clip - about four and a half minutes long. It is at:
www.bbc.co.uk/learningzone/clips/causes-of-climate-change/1491.html
Whilst this is running, ask pupils to make notes in the form of sketches under the headings:
- Variations in the Sun's output
- Changes in the Earth's orbit
- Changes in the tilt of the Earth's axis
- Wobble of the Earth's axis
- Changes in the Earth's atmosphere

Resource sheet 1 could be distributed to pupils as a pro forma for this activity. Since the facts in the video come thick and fast, it is recommended pupils have some time after the video to tidy up their pictures, then play the video again, this time asking the pupils to note just two words (or a word and a number) beside each picture. More time after this, will make for a more satisfactory result. The sheet is a useful formative assessment tool before any further activities. (Pupils may well need the aid of a practical or virtual orrery in order to visualise the Earth's movements).

3 Reinforce messages
The messages from the video can be reinforced in a number of ways, such as:
- Pupils work in groups. A volunteer in each group talks through what they have learnt from the video, then each other member of the group adds anything they think was missing. Pupils may then tweak their own sheets ('Speak and Tweak').
- The video also comes in a version without voice over, so groups working together on a computer could practise their own voice overs to show to the rest of the class.

4 Research arguments
Because of the controversies surrounding climate change, the topic is an excellent way of investigating how individuals and organisations can hold opposing viewpoints based on different readings of scientific data. Pupils could research the arguments on both sides and evaluate their validity for themselves, perhaps writing a one page report from each viewpoint, and finishing with their own conclusion. A formal debate could be held, which would be a very good context for developing persuasive language.

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Climate change
Activity 2

Learning intentions
- Pupils understand that climate change is thought to be producing changes in weather patterns which can lead to flooding and drought
- Pupils understand some causes and effects of drought, and some ways of conserving water in this country

Success criterion
- Pupils show understanding by the quality of the 'Facebook' they produce

Suggestions for teachers

1 Introduction
There is a good introductory video on Glow: Water as a Resource: the causes and effects of water shortages. The video could be shown as it is, or given more focus by exercises such as those in activity 1.

2 Water supply
Introduce idea of security of water supply now and for future generations; water supply versus demand; average person in Scotland uses around 165 litres of water a day multiplied by population; Scottish Water provides over 1.4 billion litres of treated drinking water everyday as of 2019.

3 Resource sheets 2a and 2b
Give out resource sheets 2a and 2b, which are about drought in the UK, divided into four parts:

- What is drought?
- What is the effect on the people?
- What is the effect on wildlife?
- What can we do to help at home?
- What can we do to help in the garden?

With the pupils divided into groups of four, each pupil reads a different section, with the object in mind that at the end of the allotted time, they will have to speak for 'Just a Minute' to the rest of their group about their section.

4 Facebook
Using what they have learned, each group creates a Facebook page - information and photos - which they show to the rest of the class. This could be done as a paper exercise. Depending on school policies, teachers may want to take this a stage further and launch an actual Facebook campaign page which could encourage water efficiency and promote what we can do at home/in school to help.

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Climate change

Activity 2
continued

5 Reinforce messages

Recent droughts in the UK are a good topic for research. Using rainfall data from affected areas, graphs of various sorts could be prepared: an excellent context for learning statistics. An application such as Excel could be used to generate charts, for example:

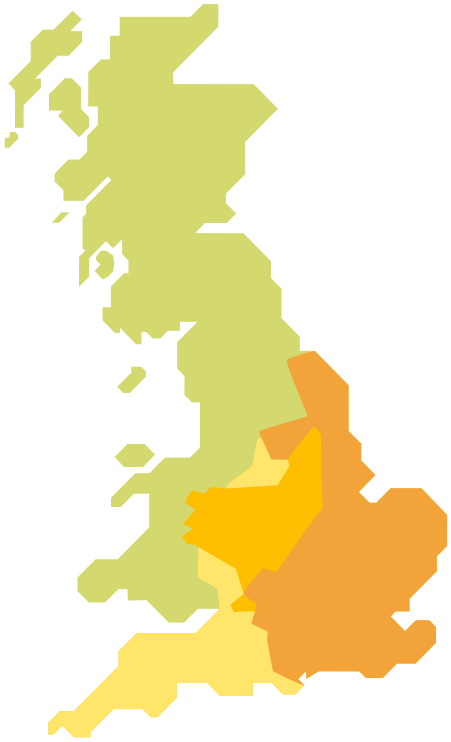
- 3D column charts comparing rainfall and temperatures in for example London and Fort William in a normal year
- The same in drought years
- Mean, mode and median monthly rainfall
- Cumulative rainfall data over a given period, such as January – July 2012 showing when hosepipe bans were imposed and removed
- Radar graphs (wind roses) showing prevailing wind directions in a normal period compared with a drought

6 Statistics

The statistics could be compared with maps of the areas where droughts were declared, and press releases from the water companies in those areas about the reasons for actions taken.

7 Reducing the school's global footprint

These activities give a useful introduction to any work on reducing the school's global footprint. They also link in with Eco Schools projects. A search on Glow using the keywords 'water' and 'footprint' and for PDF files will bring up two excellent documents: a text file on the need to conserve water, and how to set up an action plan, and a comprehensive set of recording sheets to help monitor water use in the school over the course of the project. There is also the possibility of broadening this work into surveys of water use in the pupils' homes.



Basic map showing main areas at risk from drought during March 2012

- In drought
- At high risk of drought
- At moderate risk of drought

Source: www.bbc.co.uk/

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Activity 3

Learning intention
- Pupils understand the effects of drought in other countries

Success criterion
- Pupils show understanding by the quality of their debate

Suggestions for teachers

1 General discussion

Groups of pupils research drought in other countries. Suggested:

Malawi	US
Australia	India
Egypt	Brazil
UK - Western Isles (2012)	

Each of these will have a different set of issues, in particular whether there is a physical drought (simple lack of rainfall), or economic drought (country is too poor to build the necessary infrastructure).
Pupils could structure their reports as follows:
- Where the country is located
- Reasons for the drought
- Effects of the drought
- What is being done to help/what could be done (look at renewables, water efficiency, and innovative solutions)

Each section could occupy one quadrant of an A2 sheet to make a poster promoting an innovative idea to help save water and reduce carbon emissions.

2 Class debate

A whole class debate could be carried out. The premise could be that the United Nations has decided to give a huge amount of money to help countries experiencing drought. Each group from the exercise above has to explain the problems faced by their country and make a pitch for a share of the funds.

A chairperson from each group is allowed to ask one question of one other group - otherwise it would take too long - but this could be extended. The pupils should pick up very quickly on the differences between countries, and the scale of the problems.

If each pupil is given 10 Post Its, each with a value of a million pounds, they could decide which country to give the 'money' to be sticking the Post Its to the chosen poster. Obviously, this needs to be done carefully, to avoid vote rigging! It is best if the pupils go up one group at a time, and they are not allowed to vote for their own country (it helps if each group has different coloured notes) and they are only allowed to touch their own notes. A Eurovision-type commentary could be provided by a willing volunteer. If pupils are inclined to be too excitable, the voting could be done behind a screen.

A plenary session could bring out the huge differences in the problems experienced in different countries, and the different ways in which issues are tackled.

3 Fundraising

This is an excellent jumping-off point for a fundraising activity. A search for 'Health' and 'Presentations' on Glow will bring up a very good PowerPoint which shows the extent of the problems faced in Africa, in particular. WaterAid also has resources which can be used in this way.

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Activity 4

Learning intention
- Pupils understand some of the causes and consequences of flooding

Success criterion
- Pupils show understanding by their notes taken

Suggestions for teachers

1 General discussion

To understand much of what follows, it is important to carry out an experiment to show how water soaks into the ground. Teachers (or janitors, or pupils) could dig 4 shallow holes in a grassed area, each hole about 50cm square. With the class divided into 4 groups - one group per hole – the pupils could investigate what rate of water each hole could cope with. So, the groups could pour in the following amounts, using milk containers:

Group 1 – half a litre per minute
Group 2 – 1 litre per minute
Group 3 – 5 litres per minute
Group 4 – 10 litres per minute

Depending on the soil conditions, at least one of the holes should overflow, and pupils will be able to see that soil can soak up a certain amount before that happens. This also shows how important vegetation and ground cover is to flood management. Could pupils contrast this with concrete or tarmac?

In the classroom, work out what these amounts of water would be equivalent to in terms of rainfall. For example: 1 litre would cover a square metre (10 000 square centimetres) to a depth of 1mm.

If the hole was 50cm square it would be a quarter of the area of the square metre, so the water would be four times as deep: 4mm in this example.

The other amounts can be deduced from that figure: half a litre is equivalent to 2mm per minute, 5 litres is equivalent to 20mm (a bit under an inch) and 10 litres is equivalent to 40mm.

Look at resource sheet 3 with the pupils. This is a record of rainfall in Perth in 2011, from July through to October. Pupils should be able to see that the spikes show the intensity of rainfall: how many mm per hour. The worst period had about 56mm in an hour - in total, more than any of the holes used in the experiment.

Pupils will need to know that, in the same way, drains can only carry away so much water before they become overloaded and can't cope. It's then that water begins to build up in low-lying areas. How do pupils think that water be intercepted/stored/ slowed between falling as rain and reaching the sewers? Trees, grass, ponds, roofs and gardens all have a role to play.

Pupils should also consider environmentally sustainable measures that can be taken, particularly in rural areas (at the source) to slow or store the water before it reaches settlements.

2 Flooding

The video at:
http://news.stv.tv/tayside/262828-clean-up-begins-after-summer-flash-flooding-damages-homes-and-businesses-in-perth/
is amateur footage of the flooding in Perth in July 2011, when almost 8cm fell - twice as much as in the hole experiment. The video demonstrates flash flooding and vividly illustrates the figures shown in resource sheet 3.

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Activity 4

continued

The second, at **www.youtube.com/watch?v=heWO1sQRwkQ** is an interview with Paul Hendy, who heads the Scottish Flood Forum, which is funded by the Scottish Government and works in partnership with SEPA and other relevant organisations. The Scottish Flood Forum supports and represents those affected by or at risk of flooding.

One way of ensuring that the pupils focus on the essential features of these is if each group makes out a poster sized sheet with three columns marked on it: **Causes**, **Consequences** and **What Can We Do?** They can then work together to jot down the main points about the flooding incidents. It would probably be necessary to show the second video twice: once for initial work, a period where pupils can fill in other details they remember, and a final showing to make sure all of the essential facts were recorded.

3 The human dimension

The STEM Central website also has a comprehensive section on flooding: https://education.gov.scot/improvement/learning-resources/stem-central

Teachers might like to reinforce the human dimension by dramatising aspects.
For example:

- How a family might react if they woke up at night to see the water level rising outside their house.

People often think it is a good idea to help unblock culverts etc. leading in some cases to drowning. Children often think it's 'fun' playing in flood water, which of course could be contaminated with sewage or have broken glass or live electric cables in it. There is good advice about flooding on the SEPA website: **https://www.sepa.org.uk/environment/water/flooding/**

A dramatisation could be based on a study of resource sheets 4 - 7. Pupils could produce short plays based on the known facts, perhaps structured:

Scene 1 - **Flood warnings given out by SEPA**; family prepares for the worst
Scene 2 - Midnight, and **the house starts to flood**. Family moves out to local school for help and shelter
Scene 3 - **All clear given**. Family clear up home, and think what they might do in future

4 Emergency flood kit

A short activity based on resource sheets 4 - 7 involves the pupils deciding what items should go into an emergency flood kit. The activity is described on resource sheet 8 and resource sheet 9 includes a recording sheet.

5 Flood map

Pupils could look at the SEPA flood map (**www.sepa.org.uk**) to see if their postcodes are in flood risk areas and to then check if they can receive a flood warning.

6 Long term changes

Older/more able pupils may also consider the relationship between long term climate change and the increase in flooding around the world. Long term changes in the hydrological cycle (the flow of water throughout Earth) due to higher temperatures include more evaporation, melting of ice and more intense rainfall. Many scientists say these factors contribute to more flooding.

Pupils could research and deliver presentations on what many scientists say are the links between long term climate change and flooding. Can pupils find examples of places around the world where a rise in sea levels and severe rain are increasing the risk of floods? What are the long term effects of flooding for people and farming?

Alternatively, can pupils find examples of possible positive effects of climate change, e.g. its effect on extending the growing season in some places around the world which have short seasons?

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Resource sheet 1

Causes of climate change

Variation in the Sun's output

Changes in the Earth's movement

Changes of Earth's orbit

Tilt of Earth's axis

Wobble

Changes in Earth's atmosphere

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Resource sheet 2a

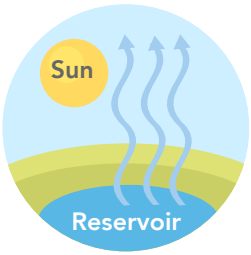
Drought

1 What is drought?

A drought is when a region gets much less rain (or precipitation) than normal for an extended amount of time. This means the region will have much less water on the surface (in rivers, streams and reservoirs) or underground than usual. Just because it rains during a drought doesn't mean the drought is over unless it rains enough!

A drought can carry on for several years but even a fairly short drought can cause a great deal of damage to wildlife, farming and the economy. Long periods of drought have triggered terrible crisis and poverty in developing countries, particularly in Africa.

All of east and the south of England - from the Severn to the Tees - was in drought in the spring of 2012. It was the worst drought in the UK for 30 years, with many areas having the driest 18 months since records began. In Scotland, there were only local shortages, but in the Western Isles only 4% of normal June rainfall was recorded; in Ross and Cromarty, also in June, only 27.8mm of rain fell - about a third of what is usually expected.



2 Why does drought happen?

The reasons for drought are complex, and we are only beginning to understand the causes. Some scientists believe it has something to do with regular fluctuations in the temperature of the Atlantic. Many scientists think the loss of Arctic sea-ice due to global warming is causing colder, drier UK winters which have led to the droughts we have experienced in recent years. Scientists from the Met office - the UK's chief weather experts - have made links between the melting sea-ice and new weather patterns across the world. Despite the colder winters, nine of the 10 hottest years on record have happened since 2001. In February 2012, the environment secretary Caroline Spelman warned farmers that drought may be "the new normal" for the UK because of climate change.

3 Can't drier areas get water from wetter areas?

Water companies are looking at ways to share water, but moving water over long distances is extremely difficult and costs a lot of money.

4 What is the effect on wildlife?

Drought is tough for many animals. Tadpoles of frogs, toads and rare species such as the great crested newt are at risk of dying if ponds dry out. Drought is also difficult for water mammals, wading birds and fish.

It is possible for official environmental agencies, such as SEPA, to remove fish from some ponds and rivers that are drying out and place them in less affected water. This is expensive, though, and takes time.

The birds most affected by drought are water birds such as lapwings, redshanks and avocets. They need wetlands to breed and to raise their chicks. The baby birds need to feed on the insects that live close to the edge of pools. If the ponds dry up then chicks will be forced to look elsewhere which puts them in danger.

Aquatic insects such as dragonflies can be hit hard. Ponds and streams may dry out before dragonflies are hatched or fully developed.

Drought is bad news for riverbank mammals such as water voles. As rivers and streams shrink the burrows of these creatures, usually safely nestled into river banks, are on show. Passing stoats and weasels, which prey on water voles and other creatures, can come in for the kill.

At the height of the drought in 2012, Helen Perkins at the Wildlife Trust said, "A wildlife tragedy is unfolding in parts of the country. After such a long period of low rainfall, some species may not recover and could be lost from some rivers and wetlands if we don't act now."

As we now know, the drought did end, with heavy rain in the summer and autumn making 2012 the second wettest year on record. Wildlife that had suffered the effects of the drought now had to endure flooding with all the problems it brings. Many scientists believe that climate change will mean wetter and more unpredictable weather in the UK. It certainly seemed so in 2012!

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Resource sheet 2b

5 What can we do to help at home?

There is plenty we can do at home and in school to use less water. It's so easy in a rich country like the UK to take water for granted, to think that water magically appears out of the tap. It's only when a hosepipe ban is announced that many of us start thinking about where water actually comes from!

It's obvious that the more that is taken from reservoirs and rivers the less there will be for wildlife. Water companies are keen for you to reduce the amount of water you use.

6 How can I save water at home?

- **Don't let taps** run while you brush your teeth or wash hands. Six liters of water are lost a minute doing that!
- If your toilet has a large or old cistern, fit it with a **water saving device**.
- **Have a shower not a bath.**
- A dripping tap can waste more than 5,500 liters of water a year so **turn taps off properly** and fix drips.
- **Don't run dishwashers and washing machines when they are only half full**; wait until there is a full load before setting them off.
- **Only boil as much water as you need**.
- **Wash vegetables in a bowl** rather than under a tap.

7 What can we do to help in the garden?

Gardens can use a lot of water. A hosepipe left on for an hour uses as much water as a family of four does in a week. On a sunny day 80% of water from sprinklers is lost to evaporation before it makes it to the plant. So you can see why water companies might issue hosepipe and sprinkler bans in affected areas.

8 Tips for conserving water in a home or school garden:

- **Don't water the lawn**. Keeping a beautiful lush green lawn going all summer requires heavy water use. Garden experts suggest either letting the lawn go brown (if you spike and feed it, the lawn will still come back next year!) or digging it over and planting a new kind of garden.
- **Plant less thirsty plants** that can cope with drought, the RSPB (Royal Society for the Protection of Birds) advises rosemary, thyme, sage and lavender. Bees and butterflies love the flowers of these plants and they require very little water.
- **Use water butts** at the base of drainpipes and elsewhere in the garden to harvest water. Some water companies offer these at a discounted price.
- **Save water from the house** in buckets. "Grey water" from baths etc, is perfectly fine for watering plants.
- **Reduce the amount of small pots and hanging baskets** in your garden. These need frequent watering.
- **Improve the soil** by digging in mulches such as garden compost of other organic matter, this helps to keep the soil moist so you don't have to use as much water.
- To **help wildlife** consider putting a pond in your garden - fill it with your harvested rainwater.
- If you haven't got space for a pond, **create a mini wetland** instead - simply by burying an old sink or bucket and let it fill up with rainwater when it does rain.

9 If we follow these tips will that be enough to solve the problem?

No. All of the above tips will help, but most experts agree this won't be enough to stop water shortages, especially in eastern and southern England. There is basically too much demand and not enough water. Experts are calling for the government and water companies to invest lots of money in new technologies that can cope with climate change and deliver water to a growing population.

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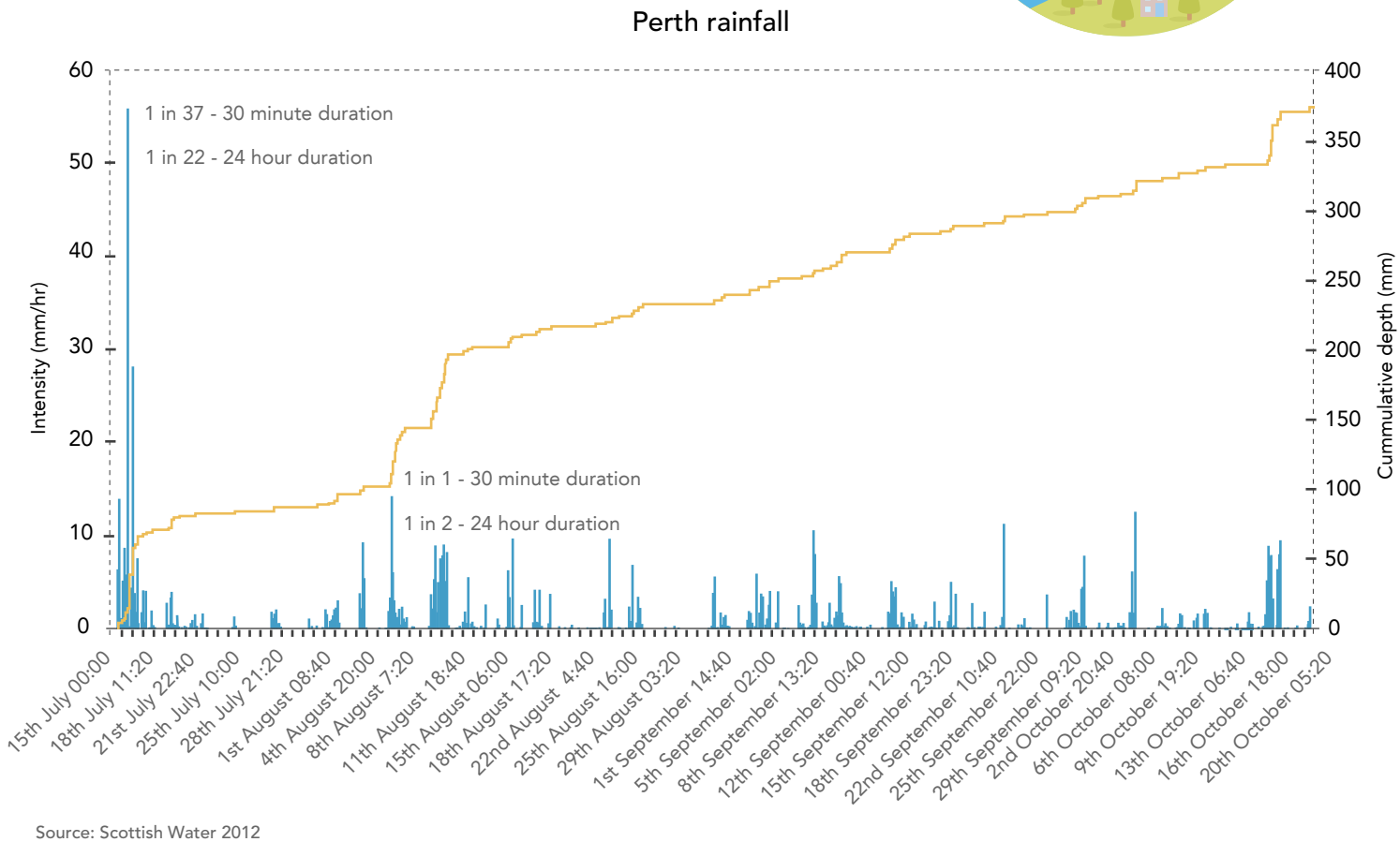
Resource sheet 3

Perth rainfall

This graph is a record of rainfall in Perth in 2011, from July through to October.



Source: Scottish Water 2012

A return period is an estimate of how likely an event is to occur in any one year. For example, events such as very large storms do not happen often but smaller events can happen once a week (especially in Scotland). The classification of a rainfall event using the return period is used as a way to explain how big an event was (how much rain fell, how quickly) and how often it is likely to occur. This is also a way that professionals, such as hydrologists and flooding specialists, use to communicate the class of a rainfall event.

So, a 1 in 10 year rainfall event will be bigger (more rare) that a 1 in 5 year rainfall event (more frequent).

You should however keep in mind that a 1 in 10 year rainfall event does not mean that it will only happen once in 10 years, it could happen twice in a week or not at all!

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Resource sheet 4

Flooding in Scotland

Flooding usually happens after a long period of heavy rain, when the ground becomes so saturated that it can't absorb any more water; then,the water simply builds up. Rivers become so full of water that they spill over their banks and flood the areas all around, especially if the land is very flat. If this happens very quickly, after torrential rain, it is called a flash flood.

The Scottish Environment Protection Agency (SEPA) provides flood alerts through its Floodline telephone service, and on its website.
https://www.sepa.org.uk/environment/water/flooding/floodline/

SEPA flood warning duty officers are on stand by 24 hours a day all year round. They never close!

SEPA flood warning duty officers use weather forecasts, rainfall data and river level data from SEPA's river monitoring network and assess each day the likelihood of flooding.

When it looks as if flooding is likely SEPA will issue a Flood Watch for the area. They will then keep looking carefully at the weather forecasts, rainfall and the river levels.

If the river levels reach an agreed height when a flood is a possibility SEPA will issue a Flood Warning for the area.

Once the danger of flooding is past they will issue an All Clear message.

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Resource sheet 5

Who does what?

A number of different organisations are involved with flooding and flood warning in Scotland.

Scottish Environment Protection Agency (SEPA), as well as issuing flood warnings, also coordinate flood risk management nationally with the Local Authorities, Scottish Water, Police, Fire Brigade and other emergency services like the Ambulance Service and Air Sea Rescue helicopters.

Local Authorities:

- Clear ditches, road gullies and other open drains.
- Manage local flood risk.
- Organise road closures.
- Provide temporary shelter for people evacuated from their homes.
- Organise the clean-up afterwards.

Police:

- Save lives.
- Rescue people.
- Help evacuate people.
- Stop people stealing from flooded houses.

Fire Brigade:

- Help pump water using fire engines.
- Help evacuate people if asked by the police.
- Help rescue people from trees and rooftops if asked.

Scottish Water:

- Clear blocked drains and sewers.
- Help clean up if sewers overflow.
- Maintain water supply.
- Repair burst pipes.
- Control water released from reservoirs.
- Help clean up afterwards.

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Resource sheet 6

Preparing for a flood

Flooding is a natural process that can happen suddenly which is why families who live in areas of Scotland that may flood should be prepared because once the flood arrives there may not be time. In a flood a family might find that they have no lighting, heating or a telephone line.

Here is a list of things that SEPA suggest that home owners should do if there is a danger of flooding.

- Put valuable items and important documents upstairs or in a high place.
- Move cars to higher ground.
- Warn neighbours in case they haven't heard the flood warning.
- Turn off gas, electricity and water supply to prevent an explosion.
- Unplug all electrical items so no one is electrocuted.
- Put plugs into sinks and weigh them down with something heavy to stop water coming up through the pipes.
- Block and seal doors, windows and airbricks with plywood, sandbags or metal
- Make emergency sandbags using old pillow cases, carrier bags or even tights filled with sand or earth.
- Prepare a family flood plan so you know where to go if you wake up and find the house is flooded.
- Make sure that there is an escape route in case water levels keep on rising.
- Move furniture away from walls, as this helps when drying your property later.
- Roll up carpets and rugs and put them upstairs.
- Leave inside doors open, or take them off and store them upstairs.
- Make up an emergency flood kit that holds a torch, battery or wind up radio, mobile phone, rubber gloves, Wellington boots, waterproof clothing, first aid kit and blankets.
- Prepare emergency food, warm clothes and other essential supplies, particularly for babies and young children.
- Put emergency food and clothes in sealed bags to keep them dry.
- Weigh down manhole covers to stop them floating away.

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Resource sheet 7

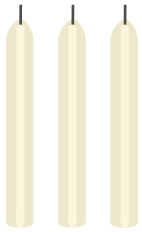
The McGregor's flood kit

John and Anne McGregor live with their three children Alexander (7), Kirsty (4) and Jamie (1) in Perthshire. They have moved to a new house in a village which is not too far from the River Tay. They have been told that if the river was ever to burst its banks then it is likely that the house will be flooded. They have been advised to prepare a flood kit - a box or case that has essential items in that will be needed if the house is flooded.

Alexander and Kirsty were asked to bring some things that they thought they might need if the house was flooded. These have been put in a pile on the living room floor together with their mum and dad's and Jamie's things. There is not enough room in the box for everything.
Can you sort through the pile and decide what should go into the box?


Books

Mobile phone


Candles


Laptop


Torch

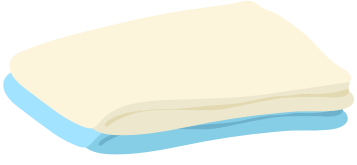

Medicine

Wellies


Waterproof clothing


Toys


Baby food


Blankets

First aid kit

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Resource sheet 8

The McGregor's flood kit - continued

What do they really need? Write your ideas in this empty box.
Say why each item is important.