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DRY: the diary of a water superhero – a teacher's guide

Introduction

This activity pack and associated book are the product of evidence-based research in the UK which focussed on how people use water, their understanding of drought and water saving practices. It has been designed to support the delivery of the National Curriculum in Key Stage 2 and has links to aspects of geography, science and citizenship, connecting the local and global scale through the theme of climate change.

Climate change is an issue that educators and young people are all familiar with, through media coverage. Unfortunately, the doom and gloom stories that litter the headlines and get into our classrooms can often leave learners feeling, at best, upset and uncertain, at worst, disengaged and disempowered. Educator researcher David Hicks (2016) notes that instead of this, our classrooms need to offer spaces for young people to reflect on how they feel about the situation, as well as opportunities to identify ways they can be involved in the solution and begin to take action, no matter how small the steps are. Based on this premise, we present a young person's journey through a year of learning ups and downs. We bring focus to the problems associated with drought in the UK, as well as many actions that young people and communities can take to change their water practices. We hope you and the young people in your classrooms find this engaging, empowering and enabling.

Written by a cross disciplinary team of academics and educational specialists, all activities have been tested in schools.

If you would like to comment on your use of the resources or have further questions, please **contact us**[1] or **tweet, using the hashtag: #DRYPrimarybook**

Drought Risk and You

About Drought
Maximising the impact of UK research on drought & water scarcity

UKRI Natural Environment Research Council

UWE Bristol University of the West of England

[1] **DRY@uwe.ac.uk**

How to use the DRY Primary Book and the Teacher's Guide

There are lots of different ways you may wish to use the storybook – *DRY: The Diary of a Water Super Hero*. You may decide to read the whole story to your class or dip in and out of it. You may just use the book to develop visual literacy skills, through inference and deduction of the illustrations (there is a *"what to look for"* guide below). You may choose to use one or more of the eight core activities associated with the book, develop subject specific vocabulary through using the glossary, or go even further and embed the linked learning ideas. These give more ideas for class activities and ways to develop a broader curriculum, when learning about water.

Other resources to draw on

In addition, NERC Drought and Water Scarcity programme, which funded this book as part of its knowledge exchange programme, has other resources that you can draw on. The DRY Story Bank is a searchable database of stories from seven UK river catchments (the Cornish Fowey, the Bristol Frome, the Welsh Ebbw, the Berkshire Pang, Bevills Leam in the Fenlands, the Sheffield Don and the Fife Eden) about different people's perceptions of drought and wider water behaviours[2]. The DRY (Drought Risk and You) project also produced some learning resources for children (e.g. on hidden water). These can also be found on the DRY Utility website[3].

In addition, there is the opportunity to link to a Primer Resource[4] that tackles the issue of water efficiency campaigns in public sector organizations, such as schools. Chapter 4 of the Primer Resource provides summaries of encouraging studies of water efficiency campaigns in different parts of the world. Chapter 4 also sets out 9 building blocks for developing your own water efficiency campaign. This provides an opportunity to discuss with pupils what each of these nine building blocks could mean, in the context of your own school. The Primer includes a visual for a water efficiency campaign in a school that is based on the motto 'water that is good for us is good for our plants, too', in order to promote grey water recycling of water used in the school for its plants and grass areas.

[2] https://dryutility.info/story-bank/

[3] https://dryutility.info

[4] https://aboutdrought.info/drought-research/publications/briefing-notes/

What to look for

a guide to asking questions about the DRY: the diary of a water superhero's illustrations

This guide picks out questions you may want to pose to your class to get them to take a really good look at each of the images and think about what is going on in the illustrations.

September

What is an "Indian Summer"?

How can you tell that it has not rained for a while? Look at the colour of the plants and what the birds are saying.

How is water being used in the illustration? Look at the types of business on the High Street and the adverts for ice lollies.

Why might it be hard for the birds to find food? Is it because their prey has died or has moved because of the weather?

Why do you not hear the word **drought** *very often*? Is it because it is associated with other countries and distant places? Is it because people in the UK might panic? Is it because water companies will feel they have failed if people use the word? Is it because people in the UK think it is too wet for a **drought**?

October

What is the difference between the way Grandpa is looking after his **allotment** and the way his neighbour does? Grandpa uses mulch on his beds, collects rainwater in a water butt and uses watering cans. The neighbour uses a hose.

How is water being stored on the **allotment**?

Where might the fox and other wildlife get their water from?

How are trees being affected by the **drought**?

How does the report on the radio talk about the dry weather?

Why have they got a bottle of water with them? Think about how important it is to keep hydrated.

November

Where does the water that comes out of the tap come from?

How could you save water in the kitchen? Put a lid on the saucepan, fix the dripping tap and only put on the washing machine with a full load.

How could you save water in the bathroom? Only flush the brown down (!) and take short showers rather than baths.

December

How might we reduce the amount of water we use for food? Eat less meat and chocolate! Activity 2, 3 and 4 support this aspect of water use.

Remember that the body needs to be hydrated so reducing the amount you drink is not a healthy option. It is also important to remember to wash hands as usual, as this is a good way to stop the spread of germs and illness.

The **water footprint** for nuts is very high. If we are supposed to eat less meat, what vegetable protein could we use with a smaller water footprint? Pulses? Peanuts?

Will a misshapen vegetable – sometimes known as 'ugly' vegetables, like the snowman shaped potatoes – taste any different to regular shaped vegetables? What shape do people expect their fruit and vegetables in the shops to look like? What are the implications of this for farmers and supermarkets? Misshapen vegetables are used for animal feed or thrown away, rather than used for people's food.

January

Why are there puddles where she is walking? Dried out earth goes very hard and water often cannot penetrate it. This means water puddles.

The water cannot get through to the worms because the pavement that is made from tarmac is preventing it being absorbed. Due to this, water is not able to go into the soil and be stored.

Why are the cracks in the ground bigger (known as **desiccation cracks**) than before? Is it because it's been dry for so long?

February

Why do we need water to stay healthy? Take a look at how much water is in your brain!

Why do people think dry weather is better than rain? Think about the problems that reduced rain can lead to.

How can there be a drought when it has rained?

Her T-shirt and phone contain **'hidden' water**. What else might have **'hidden' water** in it?

Look at the maps on the back wall – what is the relationship between rainfall and temperature? Is this likely to change in the future? Think about how climate change may impact on this. Scientists predict warmer, wetter winters; hotter, drier summers; and more extreme weather events for the UK, which will lead to more flooding and drought.

March

What changes have Grandad and his granddaughter made to the **allotment**? How has **water storage** increased? (Look at the water butt).

How has the granddaughter helped the wildlife already? Look for the hedgehog.

April

Why are the water levels so low?

Why might the fish die? Some fish (like salmon and eels) need higher flows in the river to migrate and get over barriers in the river. In addition to this, these fish cannot tolerate polluted water.

Why have the pollution levels gone up? If there is less water, the pollutants have a higher concentration.

Why is Callum having to stay in the shade? How else do we need to stay safe in hot weather?

May

Why is there a brick in the cistern of the toilet? Think about how it displaces water so that less is required for every flush.

What is **grey water**? Look for the water butt that the girl will fill her watering can from.

How has the wildlife been helped? Look for the bird's water bath.

Would a timer in the shower help you have shorter showers?

Why should we fill the kettle only with what we use? Think about how this reduces evaporation. It also reduces the need to drain the kettle of unused water each time. How might this also save energy?

Why is using a washing up bowl better than filling the sink?

Look at the plant – notice that there is no longer a watering can. Instead there are water storing gel granules in the soil. These biodegradable substances can absorbs 400 times their own weight in water and then release this at the rate required by the plant. This can reduce watering by 75%. How would this help with **drought**? Do you think the gel granules could be used outside?

June

Why does the neighbour water plants in the evening? Think about how it might help to reduce the amount of water that would otherwise evaporate in the hotter parts of the day.

Why is Grandad planting **Yacon**? It is a drought resistant crop. **Yacon** means "water root" in Inca language.

Why have beet and artichokes been planted? Can learners find out about similar perennial plants that are more **drought resistant** than annuals?

Why is it important to have ponds and leave water out for wildlife? Think about how this supports food chains and also how it allows for water to be stored.

Why does Grandad think that **mulching** is so important? Remember, mulch is able to retain more water in the soil and adds organic matter. This means it is more fertile and does not need to be watered as often. Mulching also protects the structure of the soil.

How does the report on the radio talk about the dry weather? Is it different to how the dry weather was being reported earlier in the book?

What have the people living in the flats added to their window sills? Why might they do this?

How has water storage increased? There is an extra water butt and the granddaughter is digging a pond.

Why has the granddaughter switched from a plastic, single use water bottle to a reusable one? Think about the hidden water in products and the problems with plastic waste.

Why is the granddaughter wearing long sleeved tops even in the summer? Think about how we need to stay safe in the sun and what we can do to protect our skin from harmful UV rays.

July

Think about what the people are saying:

Why do some people not have access to water?

Why do we have to drink water to keep healthy?

Do you think you could reduce your own water use? What are the different ways you use water? There is the direct use of it, through taps, flushing toilets, doing washing etc. and there are the hidden ways, through the foods we eat and the stuff we buy. What are the relative amounts of water saved in these activities e.g. switching off a tap, compared to running a washing machine less often?

August

What ideas would you add to this picture?

What water saving practices can you spot in the final illustration that were not already suggested in the book? Can you see the increased water storage? In addition to the water butts and pond in the **allotment**, the house with the red door has **water harvesting** and there is a **reed bed**. The reed bed stores water and also filters out some of the pollutants, cleaning the water, before it runs off into the river.

Will more get done to save water and change our water behaviours if people work together? What benefits and difficulties are there when you try and work with a group?

Glossary

Allotment: a small piece of ground near a town or city that can be rented to grow fruit, vegetables or flowers in.

Biodiversity: the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.

Blue water: surface water (rivers and lakes) and groundwater that are drawn upon when agriculture needs more water.

Conservation: preventing the wasteful use of a resource.

Dehydrate: to remove water from something.

Desiccation cracks: the cracks, in the ground, that are formed when soil becomes very dry.

Drought: a deficit of water from what is usually expected. Its impacts can be described in four different ways or stages:

1. lack of rainfall (**meteorological drought**);
2. dry soils with little or no water for plants (**agricultural drought**);
3. low water or no water in rivers (**hydrological drought**);
4. and finally, in the worst droughts, limited or no water coming out of the taps (**water supply drought**).

Embedded water: the 'hidden' water necessary for production of items, including fruit, vegetables and clothing.

Fertiliser: nutrients added to soil to grow plants. These can be both natural and chemical based.

Filtration: the process of cleaning water, by removing particles, so that water is safe to drink.

Flash flood: a sudden, heavy rainfall that produces a rush of water. Usually, this cannot be absorbed fully into the ground.

Green water: rainwater that's been stored in the upper soil as moisture (this is most of the water used in agriculture).

Grey water: water that has been recycled, for example from the washing up bowl.

Groundwater: the water that is stored under the ground's surface.

Hidden water: see 'embedded water'.

Hydroelectric power: electricity created by harnessing the power of the movement of water that drives turbines.

Indian Summer: period of unusually dry, warm weather.

Pesticides: chemicals applied to plants to kill insects that may damage them.

Pipeline: the physical infrastructure that transports water from one place to another (usually underground).

Reed beds: water-loving plants that digest sewage, cleaning the water of bacteria, fungi and algae.

Reservoir: a natural or artificial place where water is stored.

Supply chain: a channel of distribution, starting with the supplier of the raw materials and ending with the consumer.

Surface runoff: excess rainwater or storm water that collects on the surface of the ground in large amounts. Also known as 'overland flow'.

Sustainable drainage systems ('SuDS): 'SuDS' promote and/or mimic natural water management processes such as retention, infiltration, percolation and evaporation to enable surface runoff (from the ground or roofs) to be held where it falls and, in some cases, reusing it. SuDS can be constructed from natural or manmade materials (e.g. vegetation in lower places – swales – or infiltration basins; concrete blocks with joints between them in permeable paving). Natural, vegetated SuDS provide additional benefits over manmade ones, such as being better for wildlife and biodiversity and providing green and blue spaces to enjoy.

Sustainability: actions that are not harmful to the environment or deplete natural resources.

Virtual water: see 'embedded water'.

Water content: the amount of water that is found in food.

Water footprint: the individual's use of water and its impact on the environment.

Water harvesting: the collection of grey water in, for example, water butts.

Yacon: a drought resistant vegetable.

Activity 1: Busting water myths

Learning Objective: To challenge misconceptions of drought through critical thinking.

Below are statements that refer to common misconceptions and water myths. Give young people a selection of them to think about and discuss:

- **Water is free**
- **Water is available everywhere**
- **There is no shortage of water**
- **Water comes from the tap**
- **Everyone has access to clean water**
- **Turning the tap off when you clean your teeth doesn't save water**
- **It always rains in the UK**
- **The UK never has a drought**
- **You only get a drought in the summer**
- **You cannot get a drought in the winter**
- **Drought is something that only happens in hot countries**
- **If it rains, a drought will end**
- **Melting polar ice caps means we will have more water to drink**
- **Wildlife can always find something to drink**
- **You can save water by drinking less**
- **If we do not have any rain, it's great!**
- **Rain is bad!**
- **Climate change is a good thing**

Ask young people to organise into true/false/not sure statements.

Discuss.

Remember, there are no simple answers here. Below are some useful links to help guide your discussion.

- **Water is free:** We have to pay for the water that comes through our taps as it has to be cleaned and pumped to our homes. The average cost per UK household, per year, is £415[5].

- **Water is available everywhere:** Even in the UK, some areas are not linked to the main pipelines and rely on groundwater, e.g. water being pumped up from a local well. If we have long periods without consistent rain then everyone's water supply is at risk.

- **There is no shortage of water:** even in the UK, there can be a shortage of water. Back in 1976 there was a long drought and people had to queue for water from standpipes in the street! While it has not been as bad as that since, we still get hosepipe bans. Farmers more regularly have to deal with drought as they are first to be affected by lack of rainfall and dry soils when they are growing their crops or rearing livestock.

[5] https://www.lovemoney.com/news/20775/what-does-average-water-bill-uk-cost

- **Water comes from the tap:** yes, but where does it come from before that? Think about the water cycle! The water in your tap is just one part of this cycle. The sources of tap water will vary with where you live in the UK – sometimes reservoirs (storing surface water) and sometimes aquifers (storing groundwater).

- **Everyone has access to clean water:** in the UK, our treatment plants work to clean our water, adding chemicals to the supply to kill bacteria. Where local sources of water are used then the water may go through similar treatment or be passed through a UV light, where bacteria are killed. However, there are over 1 billion people[6] in the developing world who don't have access to clean water.

- **Turning the tap off when you clean your teeth doesn't save water:** yes it does. You are recommended to clean your teeth for 3 minutes, twice a day. If you only have the tap on to wet your brush, and then clean your brush at the end, you could save 12 litres of water[7]. That's more than some people have access to in a week.

- **It always rains in the UK:** no, it doesn't, though some areas are more likely to get more rain than others. In fact, the west of the UK tends to get more, due to the prevailing winds off the Atlantic[8].

- **The UK never has a drought:** yes, we do[9]! In 2010 there were low reservoirs and hosepipe bans, in the NW of England, that affected 6 million people. In 2011, rivers and groundwater became so low that farmers found it difficult to grow crops and keep their animals healthy.

- **You only get a drought in the summer:** hot summers add to potential drought situations but these are made worse if there has been low rainfall over the year. This is because reservoirs and groundwater stores are not refilled over winter, ready for the next summer.

- **You cannot get a drought in the winter:** while more unusual in the UK, we do have them. For example in 2011[10]. This can happen after a dry summer and autumn.

- **Drought is something that only happens in hot countries:** The UK can be vulnerable to both heat waves and drought.

- **If it rains, a drought will end:** not necessarily. A little rain does not do much good as it does not have time to soak into the ground and raise the levels of groundwater, 'the water table'. If we have flash flooding, the water doesn't have time to seep into the ground and just washes, very quickly, off the land.

- **Melting polar ice caps means we will have more water to drink:** ice caps melt into the sea. We cannot drink sea water and to desalinate water for drinking is very expensive and uses lots of energy.

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6 https://thewaterproject.org/water-scarcity

7 https://www.savewatersavemoney.co.uk/water-efficiency-tips-advice/view/105/turn-off-the-tap,-it%27s-as-simple-as-that!.html

8 https://www.metoffice.gov.uk/weather/learn-about/weather/types-of-weather/rain/how-much-does-it-rain-in-the-uk

9 https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather-events

10 https://www.telegraph.co.uk/news/earth/earthnews/8892385/Winter-drought-could-mean-hosepipe-bans-next-year.html

- **Wildlife can always find something to drink:** not so! If there is no water on the surface then lots of wildlife struggle to survive. That is why it's important to top up bird baths and leave saucers of water out for animals. However, you need to take care that wildlife doesn't drown – water butts should be covered and ponds have a shallow area that animals can climb out of should they fall in[11].

- **You can save water by drinking less:** NO! It is essential that our bodies are hydrated, in order to stay healthy.

- **If we don't have any rain, it's great!** It may be lovely to have warm, dry weather, but prolonged periods without rainfall can have terrible consequences for people, plants and animals. Any water in the soil will still be evaporating into the air or being transpired by plants.

- **Rain is bad!** Is it? Think about what we need rain for and how important it is for life on this planet.

Linked Activities

1. **Encourage secondary research about water.**
   Use search terms: water myths, save water.

Use the information learners have found to make posters and leaflets to communicate the facts about some of the common misunderstandings, or make an advert using ICT. For example, Falmouth University students have produced adverts to try and change young people's water behaviours[12].

2. **Think about how water is a global issue and has been identified in the United Nation's Sustainable Development Goals[13], which are an agreed blueprint to achieve a better and more sustainable future for all by 2030.**

Introduce these 17 goals (see page 13) that have been agreed and ask learners to be 'President of the World' – in which order will they sort out the problems? This card sorting activity allows for lots of discussion and develops an understanding.

[11] https://www.telegraph.co.uk/gardening/gardeningadvice/9160460/How-to-help-wildlife-in-the-drought.html
[12] http://aboutdrought.info/water-saving-media-campaign-entries-are-a-splash-hit
[13] https://sustainabledevelopment.un.org/?menu=1300

United Nation's Sustainable Development Goals

No poverty	**No hunger**	**Good health**
Quality education	**Gender equality**	**Clean water**
Renewable energy	**Good jobs and economic growth**	**Innovation and infrastructure**
Reduced inequalities	**Sustainable cities and communities**	**Responsible consumption**
Climate action	**Life below water**	**Life on land**
Peace and justice	**Partnership for the goals**	

Some resources for young people about the UN Sustainable Development Goals[14]

[14] https://www.un.org/sustainabledevelopment/student-resources

Activity 2: Hidden water content

Learning Objective: To understand that the production of different foods require different amounts of water.[15]

If we are to support young people in making sense of how water is used and recognise how our choices can support a reduction in water use, we need to look more closely at the water that is required to make the things we buy.

In the story, December sees our protagonist receiving water goggles for Christmas and being able to see the hidden, virtual, or embedded water, which is required to grow the food, transport the food and process it. This can be a difficult concept for young people to understand and the following two activities support enquiry into the concept, starting with water content of food and then looking at the water needed for processing and transportation.

Product	Amount of water in 100g (g)	Product	Amount of water in 100g (g)	Product	Amount of water in 100g (g)
Cornflakes	3	Custard	75	Doughnut	26
Slice of bread	39	Chocolate biscuit	2	Pancake	43
Cooked pasta	72	Cheese and tomato pizza	51	Cooked rice	70
Fish fingers	56	Apple	65	Avocado	69
White grapes	76	Pear	69	Raspberries	83
Baked beans	74	Carrots	90	Lettuce	96
Mushrooms	92	Potato	81	Cucumber	96
Yam	66	Sweet corn	65	Parsnips	83
Turkey	65	Sausage	48	Hamburger	51

Source: http://apjcn.nhri.org.tw/server/info/books-phds/books/foodfacts/html/data/data2b.html

Provide the group with the list of food above.

Can they predict which of the food has the highest water content? Why do they think this?

Compare their predictions with the data and discuss.

[15] https://dryutility.info/resources/

Linked activities

Use the data to create pie charts for comparison of water content.

Set up a fair test to investigate the water content of fruit and vegetables yourself.
Before starting, discuss or review the states of matter and ask young people to consider why cooking foods will make them lighter. Explain the conversion of water inside fruits and vegetables to water vapour at room temperature, and at increased rates with the application of heat.

1. Weigh each fruit and vegetable separately and note its weight. For some fruits (such as a watermelon), weighing a serving size of the fruit will be more appropriate.
2. Cut the produce up into thin slices and put it into the oven for 20–40 minutes at a low heat such as 120 degrees Celsius. You may have to dehydrate each item separately. Just make sure that you dehydrate all of the pieces of a fruit together.
3. Weigh the dehydrated produce.
4. Calculate what percentage of the fruit or vegetable is water by subtracting the dehydrated weight from the hydrated weight, dividing this value by the entire weight of the fruit and multiplying by 100.

Activity 3: Hidden water in the supply chain

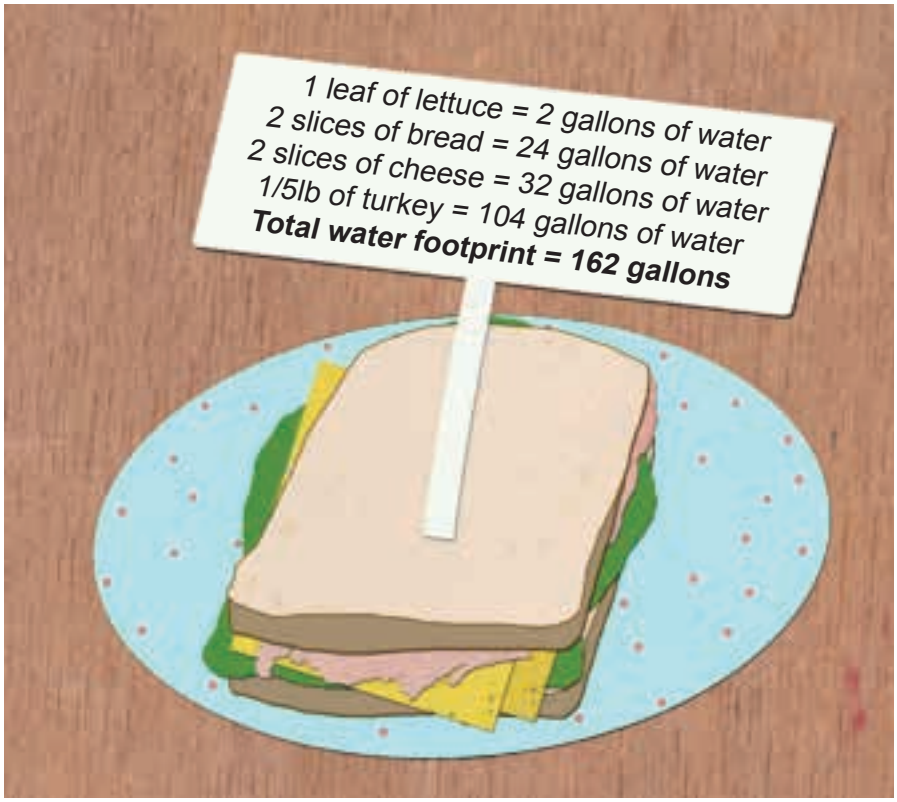
Learning Objective: To understand that the production of different foods require different amounts of water.

The water **content** of food is only part of the water story. Young people should be encouraged to think about how much water goes into the production, manufacturing and transportation of the food they eat – the **embedded** water, also known as the **water footprint** or **virtual water**. This water is hidden and can be a difficult concept for young people to understand.

Watch the UNESCO animation[16] about the water footprint.
Discuss the animation – what is surprising? Clarify any new concepts such as what **groundwater, blue, grey** and **green water** is.

Now ask children to look at the image below of the water footprint of a turkey sandwich.

Two gallons of water may not sound like much, but work on conversions in maths and you can contextualise what a gallon looks like (4.5 litres). You might want to fill a litre bottle as a demonstration or have filled jugs of water to show 4.5 litres. Seeing this visually is really important. You could time how long it takes to fill a litre and then work out how long it would take to fill 729 litre bottles (the equivalent to 162 gallons needed for the sandwich). This is a really powerful way of communicating the vast amount of water required in recognisable terms.



[16] https://www.youtube.com/watch?v=b1f-G6v3voA

Using Post-it Notes, ask the children (in groups) to tell the story of the different parts of the sandwich and how it got into the kitchen – the story of the **supply chain**. It is useful to model this first. For example:

For the bread, you would have crop fields (these will need water to grow, as well as water for their liquid fertiliser and pesticides), harvested by combine harvesters / tractors (that need water to run) and taken to factories (which will need water to keep the machines cool). The grain would be ground to a flour, bagged up and taken to a bread-making factory. Here it would be mixed with yeast, water and a bit of salt and oil to make bread. It would be wrapped up and then sent to a shop, perhaps via a warehouse.

Ask where water would be needed for each part of the process (everywhere is the answer, as blue, green and grey water are required through the processes).

Linked activities

In Grandad's **allotment**, he starts to grow more **drought resistant** crops towards the end of the book. Have a look at the labels. Discuss how drought may affect what we can eat in the future and what food will be difficult to source.

Search for drought resistant plants, using the Royal Horticultural Society's website[17]. Some drought resistant fruit and veg include: Swiss chard, sweet potato, artichokes, aubergine, okra, peppers and green striped cashew squash.

Find out more about these crops and, if possible, grow some.

[17] https://www.rhs.org.uk/advice/profile?PID=397

Activity 4

Learning Objective: To understand that the production of different foods require different amounts of water.

To be able to identify how a balanced, healthy and tasty meal can have different water footprints.

To begin to demonstrate an understanding that food choice and water practice are connected.

Plan a meal based on the water footprint of food. Can young people create a tasty meal with a high water footprint? Who can plan the tastiest meal with the lowest water content? In discussion, consider whether this has to be healthy.

Food	Water content
8oz steak	4050 litres
1 apple	70 litres
Margarita pizza	1485 litres
Hamburger	2835 litres
1 tomato	13 litres
1 potato	25 litres
1 cup of tea	35 litres
1 slice of bread	40 litres
1 glass of apple juice	190 litres
1 glass of milk	200 litres
1 orange	50 litres
1 egg	135 litres
1 slice of bread with cheese	90 litres
1 bag of crisps	185 litres
1 burger	2400 litres

It might be interesting to note that an average vegetarian diet is 600 gallons a day – 40% less than a meat-eaters diet, due to the high water content needed to provide animals with their grain food.[18, 19]

[18] http://www.greeneatz.com/1/post/2014/03/foods-water-footprint.html
[19] http://www.eniscuola.net/wp-content/uploads/2014/10/water_footprint_food.jpg

Activity 5

Learning Objectives: To begin to recognise that water is a limited resource in a larger system.

To begin to think about ways of saving water through changing water practices.

Young people may not be aware how water is distributed; falling on mountains, collecting in and taken from reservoirs, pumped to cleaning stations and then pumped to homes. Look at a diagram explaining the process.[20]

Take the group outside (or to a space where water spillage will not be a problem). Split the class into groups of seven. Each person has a cup labelled with what part they play in the water system and should stand in the correct order.

Reservoir	Pipe	Home and garden	Pipe	School	Pipe	Arable farm (crops)

Explain that the water in the reservoir needs to be transported through the pipes and that everyone needs enough for all of their needs. However, water can only go through each part of the system once. So water can only move from the reservoir to the first pipe once, from the pipe to the home once etc. If enough is not put through the pipe then the needs of others further down the system will be compromised.

This activity highlights how we need to share the limited resource we have, and think about what we want to use it for.

To make it more challenging, the activity can be repeated. This time though there has been a lack of rain over the last few months. The reservoir is only half filled (to resemble drought) but the needs of the school, homes and farms remain the same. Sharing the water is more difficult now as discussion about what is really important at each place takes place. Young people should be encouraged to think of ways of saving water so that the water in the pipes can be used for essential activities.

Examples of water saving practices might include:

Saving washing up water to water the plants.

Having a 3 minute shower only when needed.

Turning the tap off while cleaning teeth (this can save up to 18 litres / 4 gallons every minute).

Making sure the washing machine is only used when it is full.

Scrapping plates rather than rinsing them before putting them into the dishwasher.

Checking for dripping taps and getting them fixed (1 drip every second adds up to 23 litres/ 5 gallons a day).

Washing fruit and vegetables in a bowl, not under a running tap.

[20] https://cycles.thameswater.co.uk/Accessible/The-water-treatment-process

It is essential that young people are reminded that reducing the amount of water they drink is not a way of saving water. Drinking plenty of water is crucial to stay healthy. Also hand washing and good hygiene is a good way to stop the spread of germs and illness.

To expand the activity and introduce the concept of alternative/decentralised water supply systems, have other children with cups join in to represent rainwater harvesting or grey water reuse systems that replace the need for piped water at different points. For example, at the home, a water butt can be added to water the garden, wash cars or other outdoor uses. At the school, a larger rainwater harvesting system can be added to flush toilets. At a farm, harvested rainwater can be cleaned and used to irrigate crops or to provide water for animals (e.g. chickens in egg production[21]). In a large hotel an onsite grey water system can reuse water used to wash towels and bed linen to flush toilets and water the outside areas. This also shows that not all the water we use should or has to come from a centralised piped supply system. There are lots of international examples that can be found through internet research, using the key terms here and in the glossary. This will also broaden children's perspective on water and how it is used beyond the UK.

Reservoir	Pipe	Home and garden	Pipe	School	Pipe	Arable farm (crops)	Pipe	Hotel
		Rainwater harvesting		Rainwater harvesting		Rainwater harvesting		Grey water reuse

Linked Activities

Sometimes, the storage of water for human use is controversial. One example is the forcible abandonment of Tryweryn Valley and intentional flooding of this Welsh valley to make the Llyn Celyn reservoir to supply water to Liverpool, in the 1960s.

Encourage debate in class, asking questions such as: Is it right that reservoirs be made far away from the area to which the water is to be used? Should we change the landscape to ensure a water supply? How can water be collected for use more locally? Should we share water resources, whatever the cost? Even today, graffiti protest messages can still be seen calling for people to 'Cofiwch Dryweryn' (remember Tryweryn) and, in 2018, after prolonged periods of little rain, the remains of the village were, once again, visible.

Search terms: Tryweryn 50 years on

[21] https://www.youtube.com/watch?v=R8NR4bOS95g

Activity 6

Learning Objectives: To empathise with other people in different stages of drought and begin to understand the importance of changing water practices to reduce water use.

To identify good water practices and consider how they could be incorporated into everyday life.

Providing opportunities for young people to act out different water practices, in different circumstances, can encourage them to explore their ideas and feelings surrounding the topic and provides a space to consider possible solutions. The four levels of drought are given to explore (from **meteorological** to **water supply** drought).

Young people should work in groups of 4–6. Each group should be given a scenario that they are asked to interpret. Initially, this should be to show what it is like trying to live with the water they have and then consider the same scenario but introduce water saving solutions – showing how changing water practices can help to save water. Creating a freeze frame that actors have to explain or a short piece of drama can work well here.

Scenario 1: Meteorological Drought
It has not rained for over 4 weeks. There are desiccation cracks at the park and the grass is starting to turn yellow. The local stream is a bit lower than usual. Ice creams are selling well. Gardens need to be watered.

Scenario 2: Agricultural Drought
It has not rained enough to provide the farmer's crops with enough water to grow. The crops are beginning to die. If this continues then there will be very little to harvest and the farmer is worried, not only about how much money he will lose, but also about what people will eat.

Scenario 3: Hydrological Drought
The lakes and rivers are now very low due to persistent low levels of rainfall and high temperatures. Fish are dying. Wildlife is finding it increasingly difficult to find water.

Scenario 4: Water Supply Drought
The low level of rainfall has now led to severe restrictions on the use of water in homes. Less water can be abstracted from rivers and groundwater sources to fill water supply reservoirs. Residents are having to queue for water which is being distributed from lorries at the end of each street. **Hydroelectric power** stations are no longer able to work due to low water levels and the government is having to source more energy from less sustainable sources, such as coal and gas power stations. There are strict energy conservation measures in place.

Once again, it is essential that young people are reminded that reducing the amount of water they drink is not a way of saving water. Drinking plenty of water is crucial to stay healthy, even when the supply for other activities is limited.

Other sources of information:
The Centre for Alternative Technology[22]

[22] https://www.cat.org.uk/info-resources/free-information-service

Activity 7

Learning Objective: To reflect on ways of saving water through changing water practices and how these can be communicated to others.

Having read the book and considered how water practices could be changed in order to support a more sustainable use of it, challenge young people to consider what actions the class (or school) can take to minimise water use at school and in the local area. Creating an action plan can be useful – but make it realistic otherwise enthusiasm and engagement can quickly fade.

Action	Who's involved	When will it be done by?	How will we know if it's been successful?
For example: **Check all the taps to make sure none are dripping**	Year 5 and the site manager	By 1st Feb	All taps will be checked again on the 15th Feb and no taps will be dripping
Make leaflets for parents about how to save water	Year 6	Parent's evening when they will be given out	All the leaflets will be taken at parents evening
Have an assembly about water saving	School Council to invite local water company to speak to school	School Council to make enquiries by next meeting	School will have assembly about water saving
Have a water saving poster competition that will be sent out to the local schools, scouts, guides, churches and other community groups	Head teacher and school council to launch it Local Water Board to supply prizes	1st March	Lots of entries in the competition and prizes to give away
Create a water saving advert in ICT	Miss Williams to upload these to our school website and put them on twitter	Summer term	Shared in assembly and put on school website

Activity 8

Learning Objectives: To become familiar with Surface Runoff and Sustainable Drainage Systems ('SuDS').

To understand the differences between traditional and environmentally friendly ways of managing surface runoff.

In the illustration for August, you will see that a reed bed has been created to store and clean water. A reed bed is a type of water treatment system, which can be part of a wetland feature, which is a type of 'Sustainable Drainage System' ('SuDS').

Sustainable drainage is a way of thinking about water management that means surface runoff does not have to be piped underground and stored in concrete structures. However, where that is still required, the water can be reused nearby instead of being transported through sewers to wastewater treatment plants that may already be dealing with a lot of sewage from people's toilets, showers and baths. Sustainable drainage systems are about storing and using surface runoff, as close to where it falls as possible, so it does not become a problem downstream. SuDS involve thinking about water in terms of quantity, quality, **biodiversity** and amenity. This video, by CIRIA, provides an accessible introduction to ideas about Sustainable Drainage:

Ever wondered where the rain goes?
Sustainable drainage animation: https://www.youtube.com/watch?v=LMq6FYiF1mo

The video illustrates the following SuDS features:

- Wetlands
- Permeable Paving
- Swales
- Wet basins/ponds
- Dry basins
- Tree pits
- Rain gardens
- Green roofs
- Bio-retention areas
- Rills and channels
- Underground storage (also known as 'rainwater harvesting', which uses tanks to store roof runoff that can then be used in buildings).

All of these features can be constructed in new developments (where nothing was built previously) or 'retrofitted' to existing developments (where houses, streets, etc. already exist). 'Retrofitting' is a challenge, however, as the land available or connections between the different features may be more difficult to find or make. To familiarise the young people with the above SuDS features, how they work and why they are different to traditional piped urban drainage systems, several activities can be undertaken:

i. **Mimicking traditional and sustainable drainage systems.**
Take the group outside (or to a space where water/sand/soil/gravel spillage will not be a problem). Each person holds a cup/receptacle, with a hole in it at the bottom, over a capture tray. Each receptacle contains either:

- Nothing; sand; soil; gravel; plant & soil – sustainable drainage surface mimics.
- Nothing; a lump of rock/concrete (whatever is available to the teacher) – traditional surface drainage mimics.

The young people pour water into each receptacle and record the time it takes for the water to travel through each material and out of the bottom (dripping down to the capture tray) or how long the water pools on top of the material. This introduces the concept of a 'flow rate', which engineers use to design a lot of water-related devices and infrastructure and hydrologists use to monitor the health of rivers and other water bodies.

ii. **Playing 'Sustainable Drainage System' Top Trumps** (provided in Appendix One with instructions). Explore what the features are and how the different features perform different functions, to greater or lesser extents, using the cards. The game familiarises the young people with each SuDS feature and the functions they demonstrate. Once the young people are familiar with the SuDsTT cards, get them to think about how each feature could lead to different outcomes for water quantity, quality, biodiversity and amenity. For example, a rain garden scores better for 'Storage', 'Look' and 'Enjoyable' than a small rainwater harvesting system – but the small rainwater harvesting system scores better than the rain garden for 'Water re-use' – which might be more important in which part of the urban water system? Could roof runoff storage and use be better for a house, school or other building, if that building has a high water consumption?

iii. **Doing a 'surface runoff treasure hunt'** around the school. Take a walk around the school and talk about where puddles form, where the downpipes are, where drains do or do not work, where flooding sometimes happens and other surface runoff related items. Back in the classroom, get the young people to use a paper or digital map of their school grounds to mark up where these features are. Think about where the biggest puddles are and whether one of the SuDS features listed above and in the SuDsTT (see item (i)) could be useful for the school.

iv. **Co-creating a school rain garden, rain planter or rainwater harvesting design** using the map, the list of features and the young people's imaginations! Use A3 paper for a free drawing exercise and then A3 posters, exploring additional features that the group might want to consider. Get them to vote on their preferred options, using stickers in circles on the A3 posters (see example below).

- What colours should the plants be?
- How should the plants affect our senses? (4 circles for – sight, touch, smell, taste)

Can the group design and make a model of their new building as part of a Design and Technology project?

This gets the young people thinking out how people and wildlife and their needs should be involved in the design of SuDS too, not just how they function and perform.

What colours should the plants be?

Do different plants need more or less water?

v. **Reading and reflecting on other books** about sustainable water management and sustainable drainage systems and engineering, such as the Frankie the Flamingo book series[23]. Frankie introduces these concepts but at KS1, through the use of a series of worksheets and workshops. At KS2, young people could reflect on these and design harder worksheets for their classmates, teachers, parents/guardians or other adults to try out. Frankie resources are available from the ech2o website[24].

[23] https://www.stem.org.uk/resources/elibrary/resource/438042/frankie-flamingo-ks1

[24] http://www.ech2o.co.uk/frankie-the-flamingo

Appendix 1 – Sustainable Drainage Top Trumps (SuDsTT)

Brief instructions and a video on how to play Top Trumps are available on the Top Trumps website[25].

- To start the game, shuffle and deal all the cards face down. Each player holds their cards so that they can see the top card only.
- The player to the dealer's left starts by reading out a category from the top card (e.g. height, value 5). The other players then read out the same category from their cards. The one with the best or highest value wins, and that player collects all the top cards, including their own, and moves them to the bottom of their pile. It is then their turn again to choose a category from the next card.
- If two or more cards share the top value or data is not available for that particular subject then all the cards are placed in the middle and the same player chooses again from the next card. The winner of the hand takes the cards in the middle as well.
- The person with all the cards at the end is the winner.

As there are only 12 SuDsTT cards, groups of 2–4 children enable the game to work best, so print several copies and divide the class or ask the group to form teams. The game familiarises the groups with each SuDS feature and the functions they demonstrate. Once young people are familiar with the SuDsTT cards, get them to think about how each feature leads to different outcomes. For example, a rain garden scores better for 'Storage', 'Look' and 'Enjoyable' than a small rainwater harvesting system – but the small rainwater harvesting system scores better than the rain garden for 'Water re-use'.

[25] http://www.toptrumps.com/how-to-play-top-trumps

Raingarden

We can capture rainwater in a dip in the ground where plants and flowers grow. The water is stored in soil, sand, gravel & used by plants. It is slowed down and infiltrates (trickles down) into the ground and evaporates.

Storage	2	Cleans Water	3
Space	2	Upkeep	3
Wildlife	2	Water Re-Use	3
Look	3	Enjoyable	3

Green Wall

Did you know walls can be alive? Plants can grow on them, and the soil they live in captures water and the plants then use it for growth. Water is stored and evaporated. So we call them living walls or vertical gardens.

Storage	3	Cleans Water	1
Space	3	Upkeep	3
Wildlife	3	Water Re-Use	1
Look	3	Enjoyable	3

Rainwater harvesting: large

Water that falls onto our roof for example can be stored in tanks. It can then be reused — for example, to flush toilets! It can also be emptied and used automatically, using a "smart" system.

Storage	2	Cleans Water	3
Space	2	Upkeep	3
Wildlife	0	Water Re-Use	3
Look	1	Enjoyable	0

Rainwater harvesting: small

Rain that falls on our roofs can be stored to use in the garden or for washing cars. Like large rainwater harvesting systems, water butts can be "smart" too, allowing water to trickle slowly into the ground (the white pipe on the right).

Storage	2	Cleans Water	3
Space	2	Upkeep	3
Wildlife	0	Water Re-Use	3
Look	1	Enjoyable	0

Permeable Paving

In this special kind of paving, gaps in the material let water filter through. We can still use the surface for other things (like parking), but water is held there and infiltrates (trickles through).

Storage	2	Cleans Water	3
Space	2	Upkeep	1
Wildlife	0	Water Re-Use	0
Look	1	Enjoyable	0

Wetland

Wetlands are natural habitats, but they can also be built in cities to help store and clean water. Wetlands have shallow ponds and marshy areas in them, and always have some wet areas covered in plants, where they can hold water back and release it slowly when it gets dry!

Storage	1	Cleans Water	3
Space	0	Upkeep	2
Wildlife	3	Water Re-Use	0
Look	3	Enjoyable	3

Raingarden Planter

Planters can catch water from a downpipe coming off the roof. They slow it down before it reaches sewers and even reduce the amount of water going into the drain — it is used by plants in the planter!

Storage	0	Cleans Water	2
Space	3	Upkeep	3
Wildlife	2	Water Re-Use	1
Look	2	Enjoyable	3

Trees and Tree Pits

Trees in cities need water too — so they can be really useful in soaking up water from streets. They also capture rain falling in their leaves. Tree pits store water for a while, and trees are home to many animals.

Storage	1	Cleans Water	2
Space	3	Upkeep	2
Wildlife	2	Water Re-Use	1
Look	3	Enjoyable	3

Retention & Detention Ponds

Did you know ponds work hard? As well as holding water & releasing it slowly, retention ponds clean the water and support lots of plants at their edges. Detention ponds lead a double life – used as playing fields when dry, then storing loads of water when a storm hits. Good work!

Storage	3	Cleans Water	3
Space	3	Upkeep	3
Wildlife	2	Water Re-Use	3
Look	3	Enjoyable	3

Green Roof

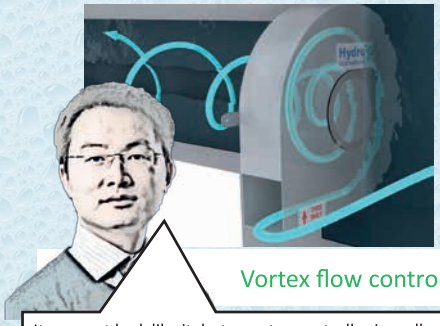
Yes, roofs can be green. Using different materials & plants on a roof is a great way to hold water where it falls. It's then used by the plants, evapotranspirated or drains to a planter, pond or pipe.

Storage	2	Cleans Water	3
Space	3	Upkeep	3
Wildlife	2	Water Re-Use	2
Look	3	Enjoyable	3

Swale

They may just look like long strips of grass, but swales collect & hold water from the surfaces that surround them. They come in all shapes & sizes & some may have pebbles or stones in. They also clean water, and work like green pipes leading water to different places!

Storage	2	Cleans Water	3
Space	2	Upkeep	3
Wildlife	2	Water Re-Use	3
Look	3	Enjoyable	3



Vortex flow controller

It may not look like it, but a vortex controller is really important for the pipes leading into & out of ponds, swales & other sustainable drainage features. Water swirls around inside, trapping air, which helps to slow the flow of water — very complicated, but very clever!

Storage	1	Cleans Water	3
Space	1	Upkeep	3
Wildlife	3	Water Re-Use	3
Look	1	Enjoyable	3

The SuDsTT were developed with funding from the Royal Academy of Engineering's Ingenious programme, through a project called 'Westcountry Women Working With Water' (5W), which was a partnership between the University of the West of England, Bristol (led by Dr Sarah Ward), the Westcountry Rivers Trust, the University of Exeter and a local company called Over the Air Analytics. The 5W team worked with two schools in Taunton to co-design and create SuDS in their schools – the people shown on the SuDsTT cards are some of the 5W team members.

For more information on the project please refer to the Westcountry Rivers Trust website[26] and their associated 'SpongeSomerset' project website[27], which has case studies on the rain garden work with the schools.

[26] https://wrt.org.uk/women-working-with-water-on-iwd2019

[27] http://somerset-sponge.org/latest-news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