GOLD LEVEL

CREST AWARDS

Resource pack

Hydrology

Water solutions in a changing climate

COLLECTION

IN PARTNERSHIP WITH

BRITISH SCIENCE ASSOCIATION

Hydro-JULES
Next generation land-surface and hydrological predictions

UK Centre for Ecology & Hydrology

UKRI Natural Environment Research Council

Contents

How to run CREST using these activities

Preparation

Ready to get going with CREST? Enter your student(s) Award by signing up for a CREST Account here: crestawards.org/sign-in

Create a new Gold Award project with the name(s) of the student(s) and the title of their project. If you don't have all the details, you can fill these in later.

Run the project

We have some super handy profile forms for your students to use when running a CREST Award. You can download these when you create your CREST account by following the link above. Encourage your students to use the workbook or profile to plan and carry out their project, keeping a record of all their amazing progress. Make sure you consider safety and risks!

Reflection

Once your students have completed their CREST project, don't let that be the end of their learning. They should now fill in any remaining sections of their profile form. This is a chance for them to reflect on all the interesting things they've learnt and the invaluable skills they have used.

Enter your project for a CREST Gold Award

Hard work deserves a reward! Celebrate and certify your student's achievements by entering their project for a CREST Gold Award. Simply:

Log in to your CREST account at crestawards.org/sign-in

Select the project and upload a profile form per student and other project evidence, to be assessed by our trained assessors online. Check the participating students have met each of the criteria. Finally, complete the delivery and payment details to order your snazzy certificates. Congratulations on completing CREST Gold!

What next?

Don't keep all the fun to yourselves. Encourage others to take part in CREST projects and share the wonder of science. For free ideas on how to get started, see crestawards.org.

Entering your project without a teacher or facilitator? No problem! You can enter your work yourself by following this link: crestawards.org/sign-in

Looking for some support?

Find a mentor by contacting your local STEM Ambassador hub: https://www.stem.org.uk/stem-ambassadors/local-stem-ambassador-hubs

Background

Hydro-JULES
Next generation land-surface and hydrological predictions

UK Centre for Ecology & Hydrology (UKCEH)

The UK Centre for Ecology & Hydrology is an independent, not-for-profit research institute, carrying out excellent environmental science across water, land and air.

The UKCEH has a long history of investigating, monitoring and modelling environmental change. Its focus is on mitigating and building resilience to climate change, preventing and reducing pollution, and creating sustainable ecosystems.

The UKCEH's research extends from molecular biology to global climate modelling. It carries out fieldwork across the world, and its work helps to underpin environmental policies, commercial innovation and conservation action all around the world.

The UKCEH, the British Geological Survey and the National Centre for Atmospheric Science are working jointly on a project funded by the Natural Environment Research Council (NERC) named Hydro-JULES. Its aim is to deliver an open-source, three-dimensional model of the terrestrial water cycle to provide next generation land-surface and hydrological predictions.

The science and societal issues addressed by Hydro-JULES are the basis for the development of these CREST resources.

Humans depend on nature. Humans are changing nature.

Water constantly cycles across our Earth. As our planet's atmosphere warms due to greenhouse gases, climate change is affecting, and will continue to affect, the distribution of water across the world.

Some areas are projected to get wetter, others will become much drier. Rainfall impacts soil saturation and can cause rises in streams and rivers. Lack of rain stresses vegetation and water reserves.

Climate change is not just a future problem; it's already affecting global patterns of drought and flooding. The frequency and magnitude of floods and droughts are increasing, and will continue to increase. This has a wide-ranging impact, from local weather to where crops can grow.

Droughts can be disruptive and dangerous for agriculture, water supplies, fisheries, infrastructure, and public health. Flood risk to people, buildings and businesses is predicted to rise in coming years, with a significant impact on global health, safety and the economy. Climate change and land degradation threaten our ability to produce sufficient and nutritious food supplies for a growing global population.

The combination of climate change with a growing population, land-use change and economic development will create greater pressure on water resources in future. These are complex and intertwined issues, and it is vital that we identify environmentally-sustainable solutions that meet the increasing, and often competing, demands of users in different sectors, including public water supply, agriculture and food, commerce and industry, and energy.

Instructions for teachers

The topic

The topics of climate change, drought and flooding are great for getting your students thinking about the future.

What do they imagine the world will look like in 10, 20 or 50 years' time? What challenges will we face in managing climate change, protecting against flooding and continuing to produce food through droughts?

This pack contains project ideas to suit a range of interests, enabling students to investigate a range of issues around climate change, drought and flooding in a real-life context, and to explore innovative ideas and solutions for the future.

Project outcomes

Your students could design and make a new product, carry out a practical investigation, do a research project or create a communication campaign for their target audience.

Encourage them to consider the impact of their project on people's lives now and in the future.

Students should record their work in a final project report or presentation.

Supporting students to complete their project

Each project should involve approximately 70 hours of student work from start to finish. The project should be led by the students. As a teacher or mentor your role is to:

- Act as a sounding board for students' ideas and nurture the students' work.
- Check your students' project plans before they begin the next stage.
- Help students see mistakes and setbacks as an opportunity for positive learning and lateral thinking (leading to creativity).
- Where relevant, support students to access professionals or experts who could support them.
- Provide access to the Internet, library books and magazines.
- Help students to complete their project and record their findings.
- Encourage them to reflect on their own performance and learning.
- Use the tips on page 22 to help students complete their CREST Gold project report.

Health and safety

Students should be encouraged to make their own risk assessment before they carry out any activity, including surveys. They can use the CLEAPSS student safety sheets to help them science.cleapss.org.uk/Resources/Student-Safety-Sheets.

They should write out their project plan, identifying the risks involved in each stage and the control measures and precautions they will take.

In all circumstances this must be checked by a competent person.

Students using specialised equipment should be supervised at all times. Students may want to set up unorthodox experiments and you may need to seek specialist advice. Contact CLEAPSS directly at cleapss.org.uk for advice if you are unsure. Teachers in Scotland should refer to SSERC at www.sserc.org.uk.

- Unless stated, no external links have been checked by CLEAPSS.
- Safety checked but not trialled by CLEAPSS.

In this pack

This collection of resources contains nine different project ideas that can each be used to gain a CREST Gold Award. Each project has a Teacher Guide, which outlines the project from a teacher's perspective, and then a student brief, which can be given to the student when they are ready to do the project. Check out the CREST resource library for more support on running a CREST project if you need to as well.

Teacher guide

Virtual water

Climate change and food supply

RESEARCH PROJECT

Hydro-JULES

More water is consumed in producing food than in any other economic or social activity. Many countries regularly import food from other countries. Importing food from other countries enables us to have cheaper food, and to have foods that do not grow where we live, or that are out of season. However, when that food is imported, in a sense the water used to grow that food is also imported – this is known as virtual water.

For example, 1kg of rice takes 2497 litres of water to grow. If a country imports rice, it is saving the water that would have been needed to grow the rice. But the flip side is that the country exporting that rice is also exporting that water, meaning that water is not available for local vegetation (nature), or to grow crops that are eaten domestically.

By importing food, we export the environmental and social risks associated with water shortages, such as drought, famine, access to clean water for drinking and sanitation, and so on. And what's more, in the UK much of our food comes from countries like Spain, Morocco and Egypt, where there are already frequent water shortages. By importing food, and by extension water, we are exacerbating those risks.

In this project, students will investigate how much virtual water is in our food, and explore the impact of increasing imports during droughts in the UK on water stress in food exporting countries.

Prompts

- How might the concept of virtual water and data surrounding virtual water imports/exports be useful to decision-makers?
- Are all sources of water of equal value?
- If a country stopped exporting food, what impact would that have in terms of water supply for the exporting country? Could that water be used for other things? How much of it?
- How would you go about calculating how much water can be sustainably exported?

Student brief

Virtual water

Climate change and food supply

(Physics, economics, data, computing, water)

RESEARCH PROJECT

Hydro-JULES

Have you ever wondered how much water is in our food and where it comes from?

In the UK, much of our food comes from countries like Spain, Morocco and Egypt, where there are already frequent water shortages. By importing food, we export these environmental and social risks to other countries.

Imagine you work at the Department for Business, Energy and Industrial Strategy. You need to investigate how much virtual water is in our imported food, and explore the impact of increasing imports during droughts in the UK on water stress in food exporting countries.

Getting started

Start by looking into the concept of virtual water and how it is calculated. See if you can find out how much virtual water we import and export from the UK every year. Where does this water come from? What would be the consequence if this water was coming from domestic water reserves?

Things to think about

- How might the concept of virtual water and data surrounding virtual water imports/exports be useful to decision-makers?
- Are all sources of water of equal value?
- How would you go about calculating how much water can be sustainably exported?

Useful resources

- Virtual water trade https://waterfootprint.org/en/water-footprint/national-water-footprint/virtual-water-trade/
- Future changes in the trading of virtual water https://www.nature.com/articles/s41467-020-17400-4
- UK Water Footprint: the impact of the UK's food and fibre consumption on global water resources https://waterfootprint.org/media/downloads/Orr_and_Chapagain_2008_UK_waterfootprint-vol1.pdf
- UK's 'virtual water' reliance leaves international footprint https://www.raeng.org.uk/news/news-releases/2010/April/uks-virtual-water-reliance-leaves-footprint
- Virtual Water: Tackling the Threat to Our Planet's Most Precious Resource https://www.bloomsbury.com/us/virtual-water-9781845119843/

Teacher guide

SMART watering

Climate change and food supply

DESIGN & MAKE PROJECT

Hydro-JULES

Conventional irrigation controllers operate according to pre-programmed timers. However, more and more farmers are turning to smart irrigation controllers which can monitor weather, soil conditions, evaporation and plant water use to automatically adjust watering to suit real-time conditions.

In this project students will design, make and test their own smart irrigation controller which automatically adjusts watering based on at least one condition.

Prompts

- How does the farmer know when to water their crops? How do you know when a plant needs watering?
- What variables might affect whether a plant needs water?
- What is the optimal amount of water for a plant? Does it vary from species to species? Does it change based on other environmental factors?
- What are the potential wider benefits of SMART irrigation? Encourage students to think beyond the farmer in the brief. Students could calculate how much water a farmer might save through SMART irrigation, and then use that to estimate how much water could potentially be saved across the UK if all farmers adopted it.

Student brief

SMART watering

Climate change and food supply

(Engineering, biology, plants, water)

DESIGN & MAKE PROJECT

Hydro-JULES

Have you ever wondered when your plants really need watering?

Imagine you are a farmer. Every year one of your biggest expenses is water. You would like to find out what the optimal amount of water is for the different crops you grow.

You also spend a lot of time watering crops. You would like to have an irrigation system that can not only be controlled remotely, but that automatically waters your crops when they need watering.

Design and make a prototype SMART irrigation system that adjusts watering based on at least one condition.

Getting started

Think about what variables affect whether or not a plant needs watering. You might need to do some research or conduct an experiment to find out how much water a particular crop needs.

Start by reading up on different SMART irrigation systems and how they work. Maybe you can interview a local farmer about what technology they use on their farm.

Things to think about

- How does the farmer know when to water their crops?
- How do you know when a plant needs watering?
- What is the optimal amount of water for a plant?
- Does the amount of water a plant needs vary from species to species?
- Are there any environmental conditions which might affect how much water a plant needs?

Useful resources

- UKCEH Environmental Information Platform https://eip.ceh.ac.uk/
- Arduino Plant Watering System https://www.instructables.com/Arduino-Plant-Watering-System/
- What Is Smart Irrigation https://www.gardeningknowhow.com/garden-how-to/watering/what-is-smart-irrigation.htm
- Crop Water Needs http://www.fao.org/3/s2022e/s2022e02.htm
- Irrigation Best Practice: Water Management for Field Vegetable Crops, A Guide for Vegetable Growers https://www.ukia.org/docs/booklets/water%20management%20for%20field%20vegetable%20crops.pdf

Health and safety

To avoid any accidents, make sure you stick to the following health and safety guidelines before getting started:

- Find out if any of the materials, equipment or methods are hazardous using http://science.cleapss.org.uk/Resources/Student-Safety-Sheets/
- Decide what you need to do to reduce any risks, such as wearing appropriate personal protective equipment.
- Make sure there is plenty of space to work.
- Clear up slip or trip hazards promptly.
- Make sure your teacher agrees with your plan and risk assessment.

Teacher guide

Growing with greywater

Climate change and food supply

PRACTICAL PROJECT

Hydro-JULES

Greywater is wastewater – typically water from sinks, showers, tubs, and washing machines (but not toilets).

Greywater is non potable, which means it is unsafe to drink. But in some places greywater is reused for other things, for example toilet flushing or crop irrigation. Reusing greywater helps reduce demand for fresh clean water, and relieves pressure on wastewater treatment systems.

Although water quality affects a plant's health, there are many plants that are able to grow even when they are given water that is polluted or that has some salt content.

Greywater may contain traces of dirt, food, grease, hair, soap, and cleaning products. So how safe is soapy water on plants, especially if we are eating those plants?

Understanding what types of fluids plants can use can help scientists learn more about how to meet the needs of plants as well as people in times of drought.

In this project, students will design and conduct an experiment to investigate the potential for using greywater on crops. As well as measuring how well the plants grow, they will need to consider how to determine whether the crops would be safe to eat.

Prompts

- How much data do you need to collect to make your conclusions statistically significant? Encourage students to think about how many plants they will grow and to think about growing control plants.
- How will you measure your greywater? Is all greywater the same? It is recommended that students intentionally make their own greywater so that they know exactly what is inside it and can control and replicate it, and avoid any dangerous substances.
- What tests will you perform to find out if food produced from plants watered with greywater is safe to drink?

Student brief

Growing with greywater

Climate change and food supply

(Biology, plants, water)

PRACTICAL PROJECT

Hydro-JULES

Have you ever wondered if we can use greywater on crops?

Imagine you are a farmer. One of your biggest expenses is water. You know that everyday there is a lot of almost clean water going down the sink in the local area! You are also concerned about the future impacts of climate change, and know that in the future you are likely to experience more drought and water shortages in your area. You want to find out if your crops would still grow well if they were watered with greywater, and if they would be safe for people to eat. Design and conduct a series of experiments to find out.

Getting started

There are two parts to your project – finding out if plants can grow with greywater, and finding out if they are safe to eat if they have been watered with greywater.

Start by planning out your first experiment – think about how long you have and which plants you can grow within that time. What will you compare your plant grown with greywater to?

Is all greywater the same? It is recommended that you make your own greywater so that you can know and control exactly what is inside it, and replicate it for the purposes of your experiment. Start with some warm tap water and add small amounts of things found in greywater, e.g. washing up liquid and small amounts of food and drink. You could try different brands and concentrations of washing up liquids.

Things to think about

- What tests will you perform to find out if food produced from plants watered with greywater is safe to eat?
- Do your results apply to all crops? Or would you need to perform these tests on every type of plant?
- How many plants will you grow to have a good sample size?

Useful resources

- Application of domestic greywater for irrigating agricultural products: A brief study https://www.sciencedirect.com/science/article/pii/S2352484719311862
- Greywater recycling https://farmerhealth.org.au/2014/03/21/greywater-recycling
- Effects of greywater irrigation on plant growth, water and soil properties https://www.researchgate.net/publication/236871967_Effects_of_greywater_irrigation_on_plant_growth_water_use_and_soil_properties
- Watering gardens with greywater – plants that like greywater https://www.gwig.org/watering-gardens-with-greywater-plants-that-like-greywater

Health and safety

To avoid any accidents, make sure you stick to the following health and safety guidelines before getting started:

- Wear eye protection.
- Decide what you need to do to reduce any risks, such as wearing appropriate personal protective equipment.
- Make sure you do not go over the recommended user concentrations for ANY products you are adding to the greywater – refer to the instructions on the bottle for these.
- Do not use any meat or dairy products or any food which is either beyond its use before date or is obviously mouldy, smelly or unfit to eat. Ideal items to test would be; cooking oil, pasta, rice, bread, grains, crisps, nuts, biscuits, fruit or vegetables. These should be in small pieces, but do not mash them up.
- Avoid using dishwasher/washing machine tablets or liquids due to their potential corrosive contents.
- Filter off the greywater and place the filtered remains in non-recycling waste.
- Do NOT store or keep any greywater for future use – it should be made up and used straight away. Excess greywater should be poured down the drain with lots of water and you must wash your hands afterwards.
- Do NOT taste or eat/drink any of the items used.
- Do NOT be tempted to use actual greywater, as this will likely contain many unknown items.
- Do NOT drink the water or eat any plants grown with greywater – these may not be safe to consume.
- Find out if any of the materials, equipment or methods are hazardous using http://science.cleapss.org.uk/Resources/Student-Safety-Sheets/ to assess the risks. (Think about what could go wrong and how serious it might be.)
- Make sure there is plenty of space to work.
- Clear up slip or trip hazards promptly.
- Make sure your teacher agrees with your plan and risk assessment.

Teacher guide

Hydro-illogical

Drought

RESEARCH PROJECT

Hydro-JULES

Droughts are not the same as aridity and water scarcity. A lack of understanding of the differences between water scarcity, aridity and drought often causes confusion between scientists and decision-makers responsible for drought management.

Drought is difficult to define – it is the absence of something. Unlike other weather events like thunderstorms, it is not obvious when a drought begins and when it ends. The effects of a drought may not be evident until weeks or months later.

Aridity is usually defined in terms of low-average precipitation (rainfall) and available water. It is a permanent climatic feature of a region. Drought, on the other hand, is a temporary feature, occurring when precipitation falls appreciably below the 'normal' level over a period of time, leading to a shortage of water.

But what is 'normal' precipitation and how do we define that? And what about places that have seasonal aridity? To confuse matters further, there can be other factors that cause or exacerbate dry conditions – not just precipitation, but also land overuse and overpopulation, for example.

To help with this, some scientists use different terms to refer to different kinds of droughts – meteorological, hydrological, agricultural and socioeconomic.

In this project, students will research the scientific definition(s) of drought and use historical data to develop a definition of 'normal precipitation' and a definition of 'drought' specific to their local area.

Prompts

- Why might it be important to be able to define drought? Encourage students to think about the wider purpose of their project, and the role of measurement in informing decision-making.
- What factors might influence how severe the impacts of a drought are? Encourage students to think about how changes to the physical environment (such as urbanisation) might affect what constitutes a drought in their area.
- In a changing climate, after how long is a drought no longer a drought, but rather aridity? Weeks? Months? Years? How many years?

Student brief

Hydro-illogical

Drought

(Physics, computing, data analysis, probability, drought, climate change)

RESEARCH PROJECT

Hydro-JULES

Have you ever wondered when a drought is not a drought?

Imagine you work for the local council. You are responsible for creating a drought management plan for the area. In order to decide what actions need to be taken and when, you need to come up with a scientific definition for what would constitute a drought in your area. Using historical records to help, develop a definition of drought for where you live.

Getting started

Start by researching different definitions of drought. You might like to find out if there is already a drought management plan for your area and how that defines drought. In order to define drought, you need a baseline for the average or 'normal' rainfall in your area to compare to. Look at historical records from the MET Office and UK Water Resources Portal.

Things to think about

- What is 'normal' precipitation for your area? How is that defined?
- How many years of records do you need to look at when finding the average?
- How do you account for variation? Do you look at each day/week/month/season?
- What other factors might cause or exacerbate dry conditions? Think about land use, population increase, water reservoirs, etc.

Useful resources

- Historic Droughts project
  https://historicdroughts.ceh.ac.uk/
- UK Water Resources Portal
  https://www.ceh.ac.uk/news-and-media/ecology-and-hydrology-faq/where-do-i-find-uk-rainfall-data
  https://eip.ceh.ac.uk/rainfall
  https://eip.ceh.ac.uk/hydrology/water-resources/
- Drought
  https://www.nationalgeographic.org/encyclopedia/drought/
- What Is a Drought?
  https://www.livescience.com/21469-drought-definition.html
- Drought Definition: A Hydrological Perspective
  https://link.springer.com/chapter/10.1007/978-94-015-9472-1_3
- Historic data (Met Office)
  https://www.metoffice.gov.uk/research/climate/maps-and-data/historic-station-data
  https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-temperature-rainfall-and-sunshine-time-series
  https://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Rainfall/date/UK.txt
- Drought vs. Aridity
  https://www.ncdc.noaa.gov/monitoring-references/dyk/drought-aridity

Teacher guide

Turning air into water

Drought

DESIGN & MAKE PROJECT

Hydro-JULES

In many parts of the world, droughts and an increasingly dry, arid climate have led to water scarcity and this in turn can lead to food scarcity. But even where there is no obvious source of water, water vapour, from water evaporating from bodies of water or transpiration from plants, is in the environment.

At night the air cools and it cannot hold as much water vapour, so water condenses on exposed objects like grass and leaves and on man-made objects like cars. Dew occurs when the water vapour condenses faster than it evaporates.

Humans have collected dew for hundreds of years in dew traps, shallow holes lined with material that funnels the droplets to the centre. In many places, people continue to use low-tech solutions to collect this moisture from the air to help farmers grow food and to act as a source of clean drinking water. With water becoming an increasingly precious resource, more and more versions of dew traps are emerging as people study how to make these more efficient.

In this project, students will investigate how people in arid regions can collect water, and they will design, make and test their own dew traps.

Prompts

- What is the definition of ‘dew point’?
- Find examples of plants that collect water from dew. What characteristics do these plants have that enable them to harvest dew? Encourage students to use these in their designs.
- What alternative materials could you explore to try and improve the efficiency of your dew trap?
- If you change the shape of your dew trap will that affect the amount of water it collects? How does the diameter and/or surface area of the dew trap affect the amount of water collected?
- Where will you put your dew trap? How might the location affect the efficiency of the trap?
- Is the amount of moisture in the air likely to change with climate change? Students might like to do some research on how this is predicted to change in different areas. How might this affect the efficiency of your product?

Student brief

Turning air into water

Drought

(Engineering, water, drought, climate change)

DESIGN & MAKE PROJECT

Hydro-JULES

Have you ever wondered if we can capture and use water vapour?

Imagine you are a farmer in an arid area. You currently spend a lot of money on water in order to grow your crops, and sometimes your crops do not grow well because they do not have enough water. You have heard about dew traps and want to investigate if you could incorporate dew traps on your farm to help decrease the amount you need to spend on water.

Find examples of plants that collect water from dew. What characteristics do these plants have that enable them to harvest dew? Is there a way you could integrate some of these features in your design?

Getting started

Start by researching different types of dew traps – both traditional and more modern techniques. Find out how they work and use these ideas to inform and influence your own designs.

Have a look at the UKCEH CHESS app to find out potential evapotranspiration in different parts of the UK: https://eip.ceh.ac.uk/apps/chess/

Things to think about

- What materials will you use? Why?
- How will you test out the efficiency of your dew trap? How many times will you test it?
- How does the shape and size of your dew trap affect how much water is collected?
- How does the amount of sunlight the trap receives affect the amount of water it collects? If you place the trap in a shady location, will it still collect water?
- Try making dew traps out of different materials and using slightly different designs. Can you improve the efficiency of your dew trap?
- How many of your dew traps would you need to have enough water for one day?

Useful resources

- Dew-harvesting 'web' conjures water out of thin air https://newscientist.com/article/dn12923-dew-harvesting-web-conjures-water-out-of-thin-air/
- Review of sustainable methods for atmospheric water harvesting https://academic.oup.com/ijlct/article/15/2/253/5718410
- A review: dew water collection from radiative passive collectors to recent developments of active collectors https://link.springer.com/article/10.1007/s40899-015-0038-z
- The Fog Collectors: Harvesting Water From Thin Air https://blogs.ei.columbia.edu/2011/03/07/the-fog-collectors-harvesting-water-from-thin-air/

Health and safety

To avoid any accidents, make sure you stick to the following health and safety guidelines before getting started:

- Do not drink the water you collect from your dew trap – it may not be safe to consume.
- Find out if any of the materials, equipment or methods are hazardous using http://science.cleapss.org.uk/Resources/Student-Safety-Sheets/ to assess the risks. (Think about what could go wrong and how serious it might be.)
- Decide what you need to do to reduce any risks (such as wearing personal protective equipment, knowing how to deal with emergencies and so on).
- Make sure there is plenty of space to work.
- Clear up slip or trip hazards promptly.
- Make sure your teacher agrees with your plan and risk assessment.

Teacher guide

Measuring moisture

Drought

PRACTICAL PROJECT

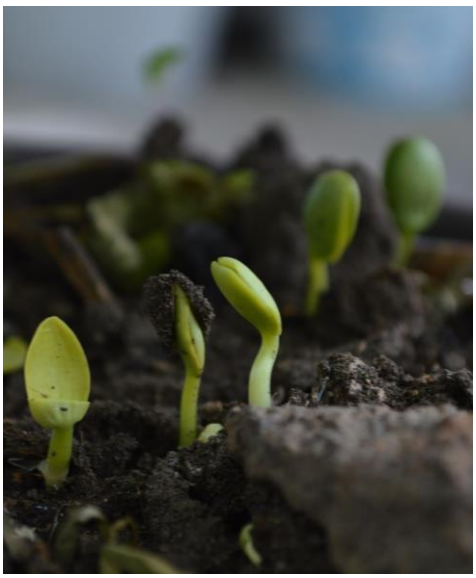
Hydro-JULES

Drought is sometimes described as an imbalance between precipitation and evaporation over a long period of time.

Climatologists use many different indicators to monitor when drought begins and ends, and also how severe a drought is.

Temperature and amount of rainfall are the most obvious indicators, but other important indicators include water levels in bodies of water, moisture in the soil and snow in the mountains.

In this project, students will design and conduct an experiment to measure the moisture level in soil over a period of time, investigate the relationship between soil moisture and drought, and analyse the data they have collected in light of this.



Prompts

- What else will you need to measure? The sensor alone will only provide data about the soil moisture. You will need to compare this to other data. For example, if it rains a lot the soil moisture will most likely increase, so you will need to compare your sensor data to the weather over the same period of time. Encourage students to think about weather conditions, soil types, vegetation cover, etc., and how these might affect their data, or affect how they interpret their data.
- Students might like to explore how the Internet of Things could be utilised to analyse relationships between different sources of data.
- What do your results tell you? Encourage students to think about the wider purpose of their project and how their research could be taken further.
- Aside from predicting drought, what could data about soil moisture be used for? Encourage students to think about the potential ways in which farmers and local/regional water authorities might be able to use the data.

Student brief

Measuring moisture

Drought

(Physics, computing, data, drought, climate change)

PRACTICAL PROJECT

Hydro-JULES

Have you ever wondered what we can learn from studying soil moisture?

Imagine you work for an organisation that conducts drought research. You are concerned about the pattern of more intense and longer-lasting droughts in some regions, and how this will evolve in the future.

Your organisation already collects data about temperature and rainfall. Now you want to start monitoring soil moisture across the area, to see if there are any patterns that could be used to predict periods of drought or water scarcity with greater accuracy.

Getting started

Start by researching soil moisture sensors – find out about how they work. Have a look at some of the UKCEH Water Resources Portal data at https://eip.ceh.ac.uk/hydrology/water-resources/. Bear in mind that the results from your monitor alone will only tell you about variance in soil moisture in that location, and think about what other types of data would be helpful to compare your data to. Do some reading about the relationship between soil moisture levels and drought to help guide you, and think about what patterns you might be looking for.

Things to think about

- How many different locations will you collect data from?
- What soil moisture sensor will you use?
- How long will you take measurements for?
- How often will you take measurements?
- How will you present your findings?

Useful resources

- Effects of soil characteristics on moisture evaporation https://researchgate.net/publication/324109178_Effects_of_soil_characteristics_on_moisture_evaporation
- Soil Moisture https://www.drought.gov/drought/data-maps-tools/soil-moisture
- Climate Change and Drought: the Soil Moisture Perspective https://link.springer.com/article/10.1007/s40641-018-0095-0
- Increase in severe and extreme soil moisture droughts https://www.medecc.org/increase-in-severe-and-extreme-soil-moisture-droughts-article/
- Guide to soil moisture sensors: Why use them and the options https://www.fwi.co.uk/machinery/technology/guide-to-soil-moisture-sensors-why-use-them-and-the-options
- Soil moisture sensor https://en.wikipedia.org/wiki/Soil_moisture_sensor
- Drought Resistance and Soil Moisture https://www.jstor.org/stable/1928954?seq=1

Health and safety

To avoid any accidents, make sure you stick to the following health and safety guidelines before getting started:

- Find out if any of the materials, equipment or methods are hazardous using http://science.cleapss.org.uk/Resources/Student-Safety-Sheets/ to assess the risks. (Think about what could go wrong and how serious it might be).
- Decide what you need to do to reduce any risks (such as wearing personal protective equipment, knowing how to deal with emergencies and so on).
- Make sure there is plenty of space to work.
- Clear up slip or trip hazards promptly.
- Make sure your teacher agrees with your plan and risk assessment.

Teacher guide

Information inundation

Flooding

COMMUNICATION PROJECT

Hydro-JULES

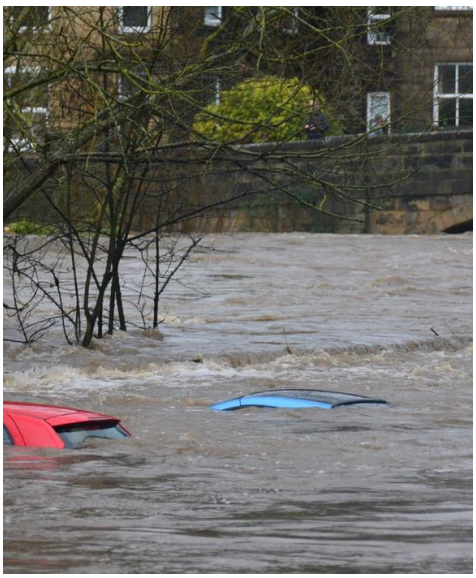
In the UK, floods are managed by catchment, and a local area may contain a number of catchments. In recent years flood management strategies in many catchments are placing an increasing responsibility on at-risk communities themselves, in terms of understanding the risks and taking protective action.

As a result, communication about flood risk is more and more important in terms of developing flood resilience. However, a lot of research suggests that current communication approaches about flood risk have not resulted in the intended increase in awareness, or behavioural change.

In this project, students will consider and evaluate different flood risk communication approaches and, based on their analysis, develop their own flood management communications plan for their local catchment.

Prompts

- Too much information can lead to a communication overload. Encourage your students to be selective in what their key messages are.
- Should the response to a flood always be the same? How does the recommended behaviour vary? Encourage students to research the recommended behaviours specific to the likely risks in their catchment and to base their communication strategy on those.
- Is your catchment low or high risk? How will that affect your messaging? How do the catchments either side of yours affect what happens in your local area?
- How will you evaluate your campaign? Encourage your students to think about how they will measure if their campaign is successful. Students should think about this early on in the planning process.



Student brief

Information inundation

Flooding

(Geography, flooding, climate change, environment)

COMMUNICATION PROJECT

Hydro-JULES

Have you ever wondered what to do if there is a flood?

Imagine you work for the local council. Your area is at high flood risk. You have been asked to design a communications campaign to inform local residents about how to react if there is a flood, keeping safe in a flood, and how to protect their home from floods.

Getting started

Start by researching the information you might like to include in your campaign, e.g. what to do and what not to do in a flood, how to get help and how to protect your home.

Next, you will need to think about how to deliver your message. Remember to think about:

- What's the goal of the campaign?
- Who is your target audience? Are certain demographics more likely to be uninformed about flooding and how to stay safe?
- Messaging, tone and design. How will you present your ideas so that your audience takes notice?
- How are you going to reach your audience? What media will you use so that people see your campaign?

Things to think about

- What type of flooding is your catchment at risk of? Is it at high risk or low risk? How might these factors affect your approach? Make sure you are only including information that is relevant to your audience.
- What content will you include/exclude? You might like to rank the information you find in order of importance.
- How will you test out your campaign to know if it would be effective? Think about doing a before and after survey or interview with a group of people to see if your campaign works.

Useful resources

- UKCEH Flood and drought impacts https://www.ceh.ac.uk/our-science/science-challenges/flood-and-drought-impacts
- Flooding Communications Toolkit (Public Health England) https://www.nottinghamshire.police.uk/sites/default/files/Flooding%20-%20Communications%20Toolkit%20FINAL.pdf
- How to communicate during flood emergencies https://www.floodmanagement.info/how-to-communicate-during-flood-emergencies/
- How to plan ahead for flooding https://check-for-flooding.service.gov.uk/plan-ahead-for-flooding
- What to do in a flood https://check-for-flooding.service.gov.uk/what-to-do-in-a-flood
- How to recover after a flood https://check-for-flooding.service.gov.uk/recovering-after-a-flood

Teacher guide

Building flood barriers

Flooding

DESIGN & MAKE PROJECT

Hydro-JULES

A flood barrier is a type of floodgate – a gate that can be adjusted to control water flow, which is designed to prevent flooding of the area behind the barrier.

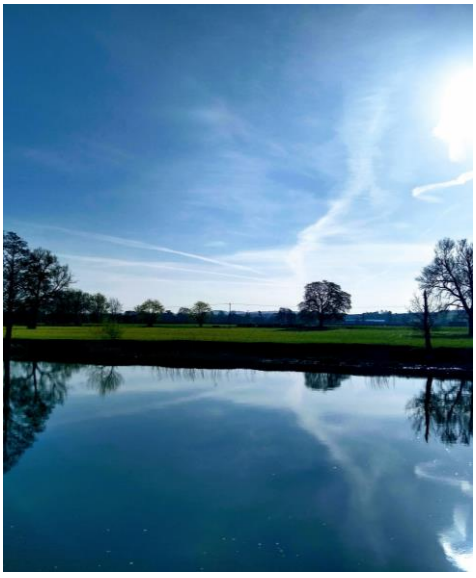
Flood barriers can be large scale, aimed at preventing flooding of whole areas, or smaller to prevent flooding of individual buildings, for example.

Large scale flood barriers work in different ways. Some redirect flood water somewhere where it can be absorbed, some redirect the water further downstream in a river, and some are seawalls to prevent coastal flooding.

In this project students, will focus on flood defence walls. They will research, design and make and test their own model flood barrier, exploring which materials provide the best performance.

Prompts

- How will you test your flood defence wall? Encourage students to think about how their model will survive under different amounts of water pressure, and over long periods of time.
- Could your barrier withstand an extreme weather event? How easy will it be to maintain?
- Encourage students to think about how they could use natural flood defences as well as man-made structures. Often, flood defences employ a combination of both.



Student brief

Building flood barriers

Flooding

(Engineering, materials, flooding, climate change, environment)

DESIGN & MAKE PROJECT

Hydro-JULES

Have you ever wondered how to stop a flood?

Imagine you work for the local council. In recent years, a local river has flooded several times, often causing a lot of property damage as well as damaging the local environment.

You are worried about flooding and erosion going forward. You are interested in the example of Boscastle, and flood defence wall built there following severe flooding.

Investigate different materials and designs and make your own model flood defence wall that prevents flooding.

Getting started

Start by testing out different types of material. How do they fare under water pressure? Once you have decided on a material you will need to think about design and construction – what shape will your flood defence wall be?

Things to think about

- Where will the water go after it hits the wall?
- How high will you need to make it to ensure that water does not flow over the barrier?
- What shape will your wall be?
- What are some of the impacts of the wall on the local environment? How will your design account for these?
- Can you think of any ways to work with natural processes to help prevent floods? What are the advantages and disadvantages of nature-based solutions to flooding?

Useful resources

- Boscastle Floods https://www.metoffice.gov.uk/weather/learn-about/weather/case-studies/boscastle
- What's the best way to prevent flooding? https://www.bbc.com/news/uk-25929644
- Flood Management Scheme – Boscastle https://www.internetgeography.net/topics/flood-management-scheme-boscastle/
- Catchment Based Approach https://catchmentbasedapproach.org/

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- Make sure there is plenty of space to work.
- Clear up slip or trip hazards promptly.
- Make sure your teacher agrees with your plan and risk assessment.

TOP TIPS

For completing a Gold project

1. Understand the problem

Do your research! Make sure you plan your time effectively and find out as much as you can about climate change, drought and flooding before you start. And make sure you are clear about the problem you need to solve. If you are developing you own project idea, discuss your ideas with your teacher or mentor before you start your project.

2. Plan your approach

Draw or write a plan showing how you will approach the problem, the tasks you will complete, the resources you'll need and how long you will spend on each task. Ask your teacher or mentor for feedback on your plan.

3. Watch out!

Identify any risks to health and safety or ethical concerns you think there will be. Decide how you will limit or overcome these risks. Show your risk assessment to your teacher.

4. Research

Find a professional mentor:

https://www.stem.org.uk/stem-ambassadors/local-stem-ambassador-hubs

Find out more by doing some research using the suggested links on the project page.

Research relevant news articles, blog posts and other media sources.

5. Use your research to improve your plan and generate ideas

Use your research to help you come up with a possible solution or to select the best experiments to use in your practical work.

6. Finalise your idea and carry out practical work

Carry out any practical work including experiments, surveys, designing and making activities. When testing your ideas, make sure you make it a fair test and record all your results clearly. You could also use photos and a diary to record your project activities.

7. Concluding your project

What have you found out by doing your project?

Did you come across any problems? How did you overcome them?

What is the impact of your project for other people? How could it be developed further?

Has it changed how you feel about climate change, drought or flooding?

8. Choose the best way to communicate it

Tell others about what you did. You could use a written report, a digital presentation, a blog or a poster display. Make sure you include each stage from planning through to the conclusion.

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