Water Quality

Introduction

Water Quality

Water is one of the most essential resources on Earth, supporting life in countless ways. From sustaining aquatic ecosystems to providing drinking water, its quality directly impacts humans, wildlife and the environment.

Clean, healthy water is vital for maintaining biodiversity, supporting agriculture, enabling industry, and providing recreational opportunities. However, water quality is increasingly threatened by pollution, climate change, and human activities.

Water quality refers to the physical, chemical, and biological characteristics of water that determine its suitability for various uses. Factors such as pH, temperature, clarity, and the presence of nutrients or contaminants play a crucial role. For example, turbidity, or the cloudiness of water, can impact aquatic ecosystems by blocking light needed for photosynthesis, affecting plant growth and reducing oxygen levels. High turbidity, caused by sediment runoff, algae growth, or pollution, can also harm fish by clogging their gills and degrading their habitats. Monitoring turbidity is vital for understanding and improving water quality.

The characteristics of water also vary by region, such as differences in soft and hard water. Soft water, with low calcium and magnesium levels, is more effective for cleaning and kinder to pipes but may lack minerals beneficial for health. Hard water, rich in minerals, supports dietary needs but can lead to limescale buildup in appliances and pipes, increasing maintenance costs. These variations highlight the importance of understanding water quality's impact on daily life and ecosystems.

Aquatic ecosystems, including rivers, lakes, and coastal waters, depend on good water quality to sustain life. These environments provide habitats for a wide range of plants and animals and benefit humans by supporting fisheries, protecting coastlines, and filtering pollutants. However, threats such as pollution, overuse of resources, and physical damage to habitats put these vital systems at risk.

Conserving and monitoring water quality is vital for ensuring clean water and healthy ecosystems, enabling them to continue filtering nutrients and bacteria, absorbing carbon dioxide, and providing food and shelter for countless species. By understanding and addressing these challenges, we can protect these ecosystems for future generations.

Further research keywords

Turbidity, pH levels, sediment runoff, hard water, soft water, nutrients, nitrates, phosphates, algal blooms, ecosystem health, aquatic habitats, biodiversity, pollution, conservation, filtration, water clarity, photosynthesis, light penetration, overfishing, coastal development, limescale, erosion control, wetland preservation, waterborne contaminants, ecosystem services, water monitoring, freshwater ecosystems, marine ecosystems, sustainable water management.

30 mins

How We Use Water

Equipment required

- Print out or share the photos on sheet R_WQ_1 (1-2), one per class/group
- Large whiteboard for discussion notes
- Scissors
- Markers and sticky notes
- Internet enabled devices and internet access

To complete the activity

1. Begin by discussing with learners the different ways water is used everyday. Ask learners to come up with examples, e.g. cooking, drinking, bathing, power generation, or for wildlife. Write their ideas on the whiteboard under two headings: "Uses of Water" and "Sources of Water" (e.g. rivers, lakes, groundwater, reservoirs).

2. Divide the class into groups. Distribute the photos and category labels from sheet R_WQ_1 to each group. Ask each group to sort the images into appropriate categories, discussing why each image fits a category.

3. Provide an opportunity for each group to present their sorted categories and explain their reasoning. Discuss overlaps or ambiguous cases (e.g., watering a garden might be household or agricultural).

4. Using sticky notes, ask learners to brainstorm and add ideas about how water can be saved or better managed in different categories.

Personal/ Household use

Drinking, cooking, bathing/cleaning.

Industrial/ Commercial use

Car wash, energy production (power plant), cooling systems.

Agricultural use

Irrigation of crops, livestock, aquaculture (fish farming).

Recreational use

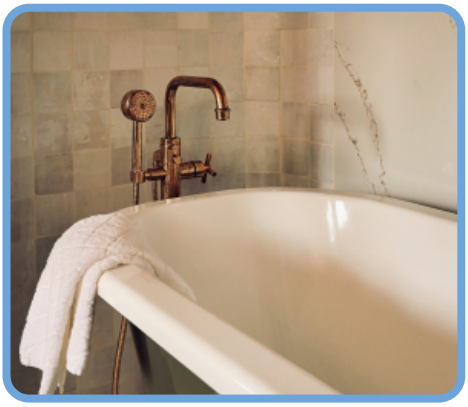
Swimming pool, fishing, water parks

Community use

Firefighting, water fountains, street cleaning

Environmental/ Wildlife use

River, lake and wetlands.

















60 mins

Water Quality Detectives

Equipment required

- Print out the 'Water Quality Detectives' worksheet, one per pair
- Pencils or pens
- Internet enabled devices and internet access

To complete the activity

1. Begin by asking learners:
   - "What do we mean by water quality?"
   - "Why is water quality important for people, animals, and plants?"

2. Share the Dŵr Cymru video 'How we clean your waste water' – www.tiramor.cymru/waterquality (Resource 1). After watching, consider:
   - What makes water safe to drink?
   - What factors could affect water quality before it reaches this stage?

3. In pairs, ask learners to consider:
   - Characteristics of good quality water (e.g. clear, safe to drink).
   - Signs of poor quality water (e.g. cloudy, bad smell, harmful substances).

4. Challenge pairs to list as many factors as they can that affect water quality. Encourage them to think about both natural factors (e.g., sediment runoff, algae growth) and human activities (e.g. pollution, industrial waste).

5. Provide each pair with a copy of the 'Water Quality Detectives' worksheet.

6. Encourage learners to use the internet to research factors that can impact water quality.

7. Support learners to create a mind map titled "How We Can Improve Water Quality." Guide learners to start with "Improve Water Quality" in the centre of the mind map. Next, ask learners to add branches for different areas where action can be taken, such as:
   - At Home (e.g. reducing water waste, avoiding harmful chemicals).
   - In the Community (e.g. organising clean-up events, raising awareness).
   - In Nature (e.g. planting trees near water sources, protecting wetlands).
   - In Industry (e.g. improving waste disposal practices, adopting water-saving technologies).

8. For each branch, encourage learners to add specifications to improve water quality.

9. As a closing task, ask learners to reflect on what they've learnt by writing or sharing one action they can take to improve water quality and why it is important.

Answer Key

Water Quality Detectives

FACTOR	IMPACT ON WATER QUALITY	POSSIBLE SOLUTION
Sediment from soil erosion	Makes water cloudy, reducing sunlight for aquatic plants and clogging fish gills.	Plant trees or use barriers to prevent soil erosion near water bodies.
Fertilisers from farms	Causes nutrient overload in water, leading to algae blooms (eutrophication) that deplete oxygen for aquatic life.	Use organic fertilisers and create buffer zones with vegetation near water sources.
Industrial waste	Releases harmful chemicals into water, poisoning aquatic ecosystems and making water unsafe for drinking.	Reduce nutrient pollution (fertilisers) and monitor water quality regularly.
Oil spills	Coats the surface of water, blocking oxygen exchange and harming birds, fish, and marine life.	Use booms and skimmers to clean spills, and improve safety measures for oil transport.
Plastic litter	Pollutes water, harming animals that ingest it or get entangled, and leaches microplastics into ecosystems.	Ban single-use plastics and organise community clean-ups near water bodies.
Sewage discharge	Adds harmful bacteria and pathogens to water, making it unsafe for human and animal use.	Improve wastewater treatment works and avoid dumping untreated sewage into water.
Stormwater runoff	Washes pollutants like oil, chemicals, and rubbish from roads into water sources.	Build permeable pavements and stormwater management systems, such as rain gardens.

Water Quality Detectives

What impact can the following factors have on water quality?

Factor	Impact on water quality
Sediment from soil erosion	
Fertilisers from farms	
Industrial waste	
Algae growth	
Oil spills	
Plastic litter	
Sewage discharge	
Stormwater runoff	

TASK!

Create a mind map titled
"How We Can Improve Water Quality."

Start with "Improve Water Quality" in the centre of your mind map, then add branches for different areas where action can be taken (e.g. "At Home," "In the Community," "In Nature," and "In Industry"). For each branch, add specific actions to improve water quality.
Use the internet to research creative and practical solutions.

Reflect

Which action do you think is the easiest to do? Why?

Which action would have the biggest impact on improving water quality?

What action can you take to improve water quality? Why is this important?

Over 80% of Wales' waters are classed as good or high quality, helping protect local wildlife.

60 mins

Exploring Water Turbidity

Equipment required (per group)

- Print out or share the 'Water Turbidity' worksheet (2 pages) digitally
- Large clear container (e.g., jar or large glass)
- 3 teaspoons of soil
- Teaspoon
- Torch
- 2 pieces of black paper (enough to surround the container)
- Pencil
- Scissors
- Tape (e.g., Sellotape)
- Plain white paper
- App: "Light Meter LM-3000" or similar (optional)
- Timer (stopwatch, timer app or clock)
- Internet enabled device and internet access (to watch the instructional videos)

To complete the activity

1. Begin with a brief discussion about water turbidity and its impact on ecosystems.

2. Divide learners into small groups (2-4 per group). Ensure each group has the necessary equipment, including jars, soil, black paper, torches, and optional light meters or apps.

3. Guide learners through preparation. You may wish to demonstrate how to cutout the circles from the black paper and attach the paper to the jar.

4. Encourage learners to test the visibility through the jar with clear water before adding soil.

5. Support groups to follow the instructions provided in the' Water Turbidity' Worksheet, recording their results on their worksheet.

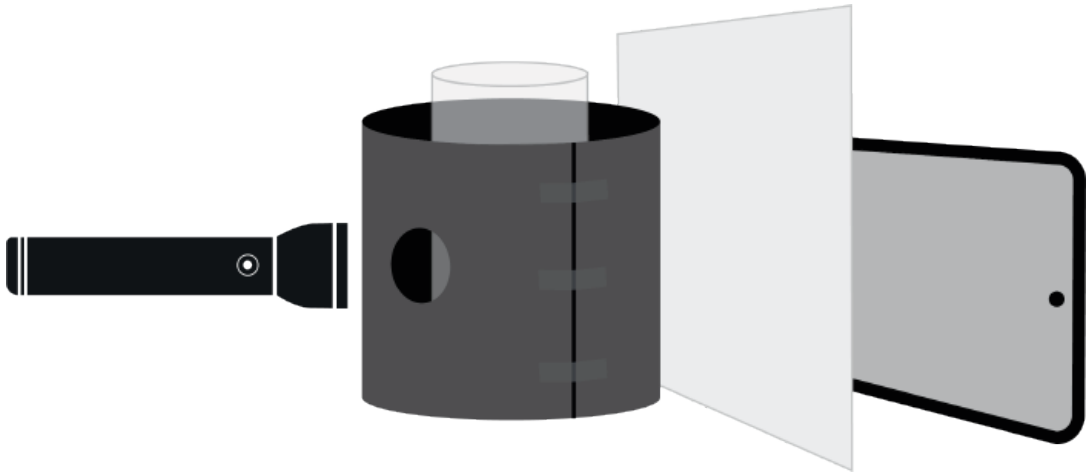
6. After the experiment, invite groups to share their completed worksheets and observations with the class.

7. Guide learners to answer key questions from the worksheet, such as: "What is the relationship between trapped light and turbidity?"

Water Turbidity

Many factors are monitored when looking at water quality e.g. pH level, temperature, salinity, oxygen level, nitrates and phosphates.

We measure turbidity we measure the amount of light that is scattered when light is shined through a water sample. The cloudier the water, the less light is passed through the sample. Water with a high measurement of turbidity can have a significant impact on how aquatic plants and organisms survive due to the lack of light. It can also choke fish gills.



Instructions

1. **Prepare the light aperture**
   A. Take one piece of black paper and draw a circle in the centre using a torch as a template.
   B. Cut out the circle and trim the paper to fit neatly around one side of the jar.
   C. Use this piece as a template to create a second identical black paper.

2. **Attatch the paper to the jar**
   A. Tape the two pieces of black paper around the jar so that the cut-out circles face each other on opposite sides.
   B. Ensure you can see through one circle and out the other. Adjust the paper if necessary, by trimming or repositioning.

3. **Build a diffuser (optional)**
   A. A diffuser evenly scatters incoming light for precise readings. If you're using a light meter app.
   Share the video 'How to Build a Diffuser' – www.tiramor.cymru/waterquality (Resource 2)
   B. To understand how the light metre app works, watch the video 'Getting Started with the Light Meter LM-3000' – www.tiramor.cymru/waterquality (Resource 3)

4. **Begin observations**
   A. Fill the jar with clear tap water and lightly seal the lid.
   B. Draw a picture on white paper and observe it through both circles, to see how water clarity affects visibility.
   C. Record your observations of the water's clarity in the table provided.

5. **Measure and record**
   A. Hold your device close to one circle so the camera or sensor is aligned.
   B. Shine the torch through the opposite circle to measure the amount of trapped light using the app, or visually assess the turbidity if the app isn't available.
   C. Record your results in the table.

Exploring Water Turbidity

6. Add soil and repeat

A. Add 1 teaspoon of soil to the jar, mix well, and wait for 1 minute to allow sediment to settle.
B. Observe the water through the circles, measure trapped light, and assess the turbidity level.
C. Record your findings.
D. Repeat the process by adding an additional teaspoon of soil each time, for a total of 3 teaspoons and 4 observations.

7. Complete the table

For each sample (clear water, water with 1, 2, and 3 teaspoons of soil), record:

A. Look: Describe the colour, clarity, and presence of sediment.
B. Trapped Light: Measure the lux (if using a light meter).
C. Turbidity: Categorise as High, Medium, or Low.

Samples	Look e.g., colour, clear/cloudy, sediment/no sediment	Trapped light (lux)	Turbidity (High/Medium/Low)
Water			
Water + 1 spoonful of soil			
Water + 2 spoonful of soil			
Water + 3 spoonful of soil			

8. Draw a Conclusion

Analyse your results and answer the following question:
What is the relationship between trapped light and the turbidity of the water?

Additional Exploration
Optional

Experiment with other liquids, such as seawater, soapy water, or water mixed with oil. Compare your findings to those from the soil experiment.

High turbidity in rivers can block up to 80% of sunlight, starving aquatic plants of oxygen production and endangering entire ecosystems.

30 mins

The Science of Hard and Soft Water

Equipment required (per group)

- Print out of the 'Hard Water vs Soft Water: The ultimate Test!' worksheet, (3 pages) 1 per group
- 2 identical empty containers with lids (no more than 300cm^3, e.g. water bottles or glass jars)
- Epsom salt (approximately 10 tablespoons)
- 1 teaspoon of soapy liquid (e.g. shower gel or handwashing soap; avoid dishwashing soap)
- Measuring jug or cylinder
- Tablespoon
- Teaspoon
- Plain white paper for notes or reflections
- Timer

To complete the activity

1. Begin with a discussion about the differences between hard and soft water. Explain how hard water contains minerals like calcium and magnesium, while soft water has lower mineral content, affecting how soap forms lather.

2. Organise learners into small groups (2–4 learners per group) and ensure each group has the necessary equipment.

3. Support learners to follow the steps in the worksheet to create"Hard Water"and "Soft Water," observe differences, and record their results. Encourage them to consider how the minerals in hard water affect foam production.

4. Encourage learners to record their findings for each container, including:
   - Look: Describe clarity, colour, or presence of sediment.
   - Foam Production: Note differences in lather formation between hard and soft water.

5. Facilitate a discussion using the reflection questions in the worksheet:
   - What differences did you notice between hard and soft water?
   - How do the minerals in hard water affect foam production?

6. Discuss the concept of a fair trial and identify which factors were kept constant.

7. Invite learners to research and discuss the pros and cons of living in areas with hard or soft water. Ask them to share their preferences and justify their reasons.

Hard Water vs Soft Water
The Ultimate Test!

Have you ever been on holiday or travelled to a different area and noticed that the water tastes different? This is because there are two main types of water: soft water and hard water.

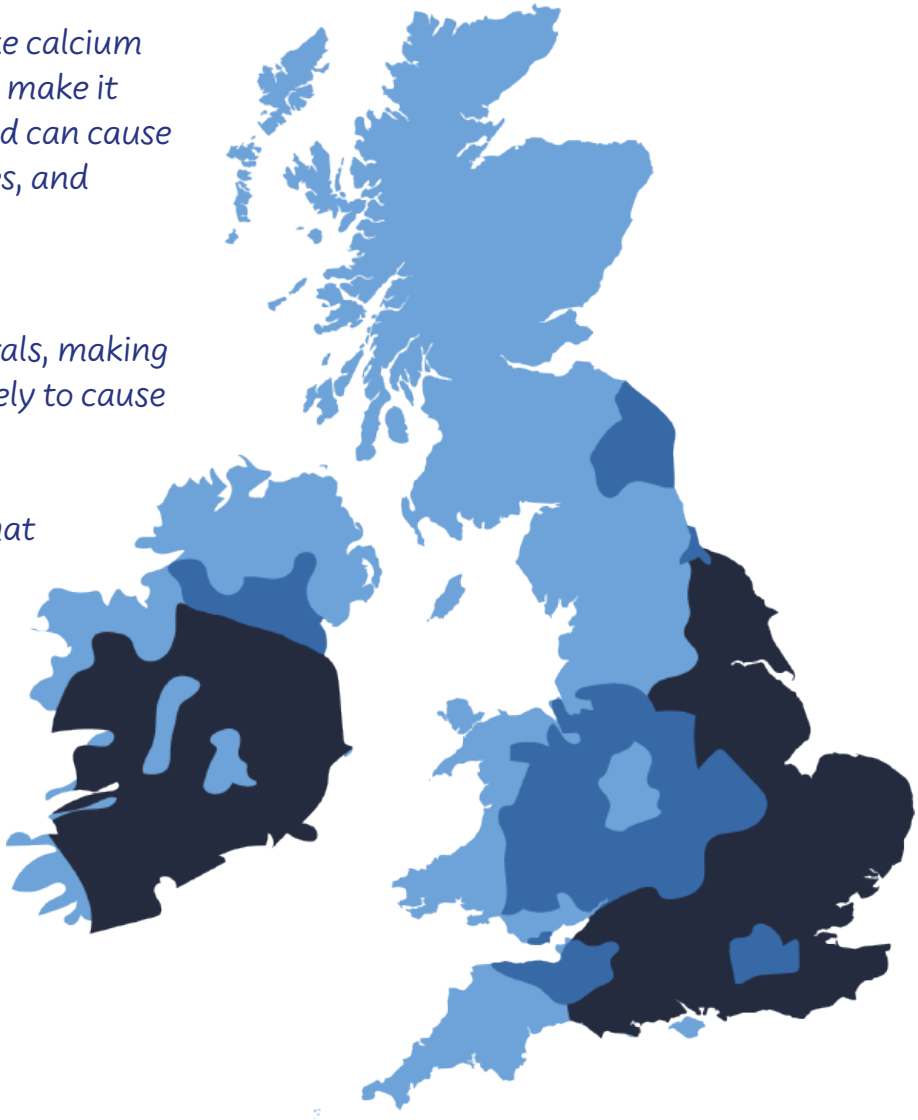
What is Hard Water?

Hard water contains minerals like calcium and magnesium. These minerals make it harder for soap to form foam and can cause limescale buildup in kettles, pipes, and washing machines.

What is Soft Water?

Soft water contains fewer minerals, making it better for cleaning and less likely to cause limescale buildup.

However, it may lack minerals that improve water's taste.



Hard to very hard
Above 250ppm as calcium carbonate equivalent

Medium to hard
150 - 250ppm as calcium carbonate equivalent

Soft to moderately soft
0 - 150ppm as calcium carbonate equivalent

Hard Water vs Soft Water

The Ultimate Test!

You will need

- 2 identical empty containers with lids (no more than 300cm^3, e.g. water bottles or glass jars)
- Epsom salt (approximately 10 tablespoons)
- 1 teaspoon of soapy liquid (e.g. shower gel or handwashing soap; avoid dishwashing soap)
- Measuring jug or cylinder
- Tablespoon
- Teaspoon
- Plain white paper for notes or reflections
- Timer

To complete the activity

1. Label the two containers as 'Hard Water' and 'Soft Water'.

2. Use a measuring cylinder or jug to measure 100cm^3 of water and pour it into the 'Hard Water' container.

3. Add 2 tablespoons of Epsom salt to the container, close the lid, and shake until the salt dissolves. Repeat this process, adding 2 tablespoons at a time and shaking after each addition, until no more salt can dissolve. You will know this has happened when a solid layer of undissolved salt forms at the bottom of the container. This may require up to 10 tablespoons. This container now represents hard water, which contains minerals such as calcium and magnesium, just like real hard water.

4. Add 1 teaspoon of soapy liquid (e.g. hand soap or shower gel) to the 'Hard Water' container. Close the lid and shake the container for 10 seconds.

5. Use a measuring cylinder or jug to measure 100cm^3 of water and pour it into the 'Soft Water' container.

6. Add 1 teaspoon of soapy liquid to the 'Soft Water' container. Close the lid and shake it for 10 seconds.

7. Observe both containers carefully. Compare the clarity, foam production, and any differences between the two types of water.

Record your observations below

Container	Clarity (clear/cloudy)	Foam production (none/some/lots)
Hard water		
Soft water		

Hard Water Vs Soft Water

The Ultimate Test!

Reflect on the experiment by answering the following questions:

What differences did you notice between hard and soft water?

How does the presence of minerals in hard water affect foam production?

In this experiment, only one factor (variable) was changed: the type of water (hard vs soft). All other factors were kept constant. Can you list all the factors that were kept the same to ensure a fair trial?

Additional Task

- Research the pros and cons of living in areas with hard or soft water.
- What kind of water do you prefer? Why?
- Find out where your area falls on the UK hard/soft water map.

Hard water can cause limescale buildup that costs the UK millions in maintenance every year!

Notes