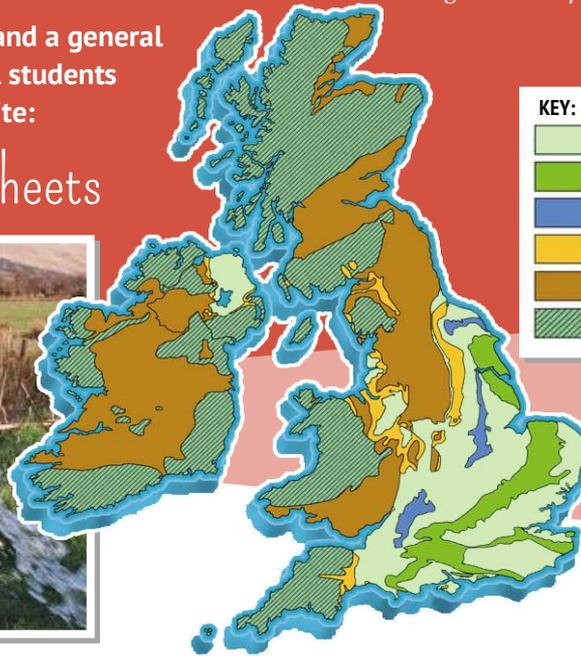


GROUNDWATER

This factsheet was written for teachers and a general audience. A factsheet for primary school students aged 9-11 is also available on the website:

www.geolsoc.org.uk/factsheets



KEY:	
	Younger rocks (poor aquifers)
	Carboniferous Chalk (good aquifer)
	Jurassic limestones (good aquifer)
	Permo-Triassic sandstones (good aquifer)
	Older Devonian & Carboniferous limestone & sandstone (less important aquifers)
	Older Impermeable bedrock (poor aquifer)

Image left: An artesian borehole. Groundwater flows naturally out of the aquifer below as it is under pressure (BGS © NERC)

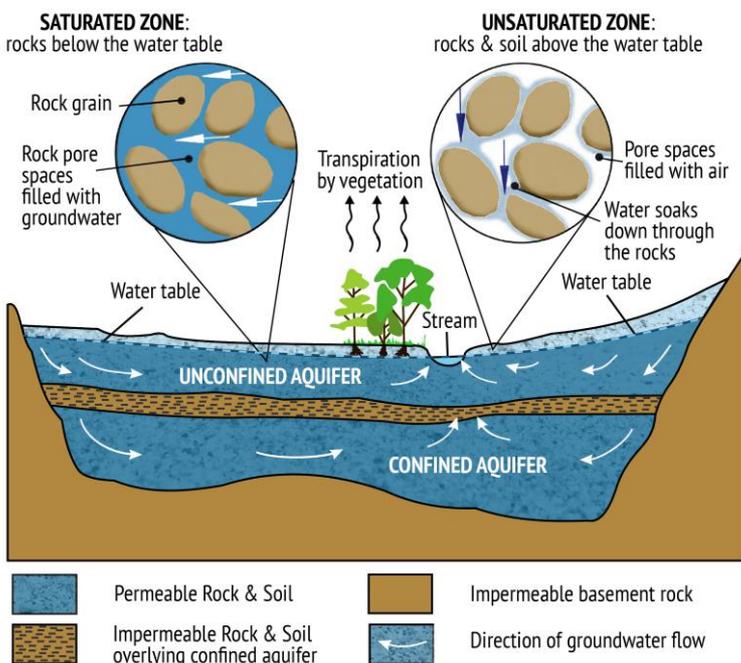
Image right: Map of UK aquifers and rock type (modified from map © UK Groundwater Forum: www.groundwateruk.org)

Maintaining a supply of drinking water to every tap in the United Kingdom is a huge challenge. Water hidden underground, or groundwater, is vital to this process in many regions of the UK, but can also cause flooding.

After rainwater falls it filters down beneath the surface through soil and into the rocks beneath. If these rocks contain pore spaces and fractures, they act like a sponge and water collects in them below the **water table** as groundwater. This water is in the **saturated zone**. From there it moves through the rocks (often very slowly) until it resurfaces as a spring or flows into rivers, lakes or the sea.

Cross section view of an aquifer

(Modified from diagrams © UK Groundwater Forum and USGS / Wikimedia Commons)



Aquifers and UK water

Rocks containing groundwater that can be usefully extracted are called **aquifers**. A good aquifer needs cracks and gaps to store water (known as **porosity**), which must also be connected so water can pass through (known as **permeability**). Some rock types, such as **sandstone**, **limestone** and **chalk**, often have high porosity and high permeability so make good aquifers. Other rock types, such as **granite**, usually have low porosity and low permeability so make poor aquifers.

An aquifer is described as **confined** if it has an overlying **impermeable** rock layer through which water cannot pass, or **unconfined** if the layer above is permeable.

Groundwater is a vital source of drinking water in many parts of the UK and around the world. The locations of the main UK aquifers, shown in the map above, determine the source of drinking water. About 35% of all public water supplies in England and Wales come from groundwater.

- In areas with good aquifers, such as much of South East England, groundwater is the main public water supply.
- In other areas, the aquifers are smaller and used less. For example, around 7% of public water supply in Scotland and Northern Ireland comes from groundwater. These areas have plentiful **surface water** in rivers, lakes and reservoirs.

DID YOU KNOW?

The average person in the UK uses about 3,400 litres of water every day (about 10 large fish tanks). Some of this is 'direct use' such as drinking or washing, but most is 'hidden use' in things like food production or manufacturing goods we use. Growing a single apple takes around 70 litres of water. Producing a glass of milk takes 200 litres!



GROUNDWATER

www.geolsoc.org.uk/factsheets

Groundwater Flooding: why do areas away from rivers flood?

In very wet weather, rivers rise and overflow their banks, causing **surface flooding**. However, areas far from a river can also flood when the water table rises above the surface causing **groundwater flooding**. This most commonly occurs after heavy rain adds more water than usual to the aquifers, but can be made worse by changes in groundwater use. Water soaks into the ground slowly, so groundwater flooding can come as a surprise, some time after the rainfall that caused it. Surface floodwater drains away quickly but groundwater may take much longer.



Groundwater flooding in Oxfordshire (BGS © NERC 2007)

Types of groundwater flooding

Clearwater flooding Extended periods of wet weather cause the water table in an area to rise. When the water table in an unconfined aquifer rises above the surface, groundwater flooding occurs.

Flooding related to rising rivers Small areas of sediments, often connected to rivers, can act as aquifers. After heavy rainfall, river levels rise and the connected groundwater rises to the surface quickly. This causes flooding away from the river.

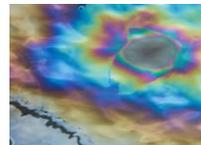
Changes in groundwater use In parts of the UK the water table level depends on how much groundwater is used. When industrial activity decreases dramatically and less water is used, the water table can rise quickly. This flooding is therefore unrelated to recent rainfall.

Groundwater contamination

Groundwater is less easily contaminated than surface water. Natural contamination can occur but pollution is mostly caused by human activities. Some pollutants are harmful to living things (including humans) and cleaning up pollution can be extremely costly, both financially and in terms of energy use.

The table below shows some of the types of groundwater pollution caused by human activities.

How do pollutants get into groundwater?	Effects of pollution
Pesticides, fertilisers & agricultural waste Chemicals added to farmland to kill pests or fertilise the soil, as well as animal waste, are washed into water courses and aquifers after rainfall.	Pesticides can cause serious problems including cancer. Fertilisers and animal waste in surface waters can trigger processes leading to low oxygen (eutrophication) which kills fish.
Landfill sites used to bury rubbish Landfills must have impermeable liners. If these leak then liquid from rotting waste (leachate) can seep into groundwater.	Leachate can be acidic and may contain hydrocarbons, heavy metals, and other toxic substances harmful to humans.
Oil-based products Underground storage tanks (such as those at petrol stations) may rupture and release their contents into groundwater.	Many oil-based chemicals can cause cancer in humans.



Groundwater around the world

Most of the liquid fresh water on Earth is groundwater (some fresh water is frozen in the polar ice caps). It can be a very convenient source of water because:

- Aquifers have enormous storage capacity – more than any man-made reservoir
- Groundwater is less easily contaminated than surface water, so is generally safer.
- It can be extracted close to areas of population with minimal infrastructure.

Many parts of the world rely on groundwater for their water supply, particularly areas without much surface water. In desert regions, storing water in surface reservoirs is not practical as they evaporate quickly. Many cities worldwide depend on groundwater. In 1998, **Mexico City** used 3.2 billion litres of groundwater a day, enough to fill six of the world's largest oil tankers!

Over-reliance on groundwater can be a problem when not enough is replaced by rainfall, leading to **groundwater drought**. Some countries are reducing their use of groundwater. One example is **Saudi Arabia** where about half of public water is supplied by removing salt from seawater (**desalination**).



Desalination Plant, United Arab Emirates
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