What is groundwater?

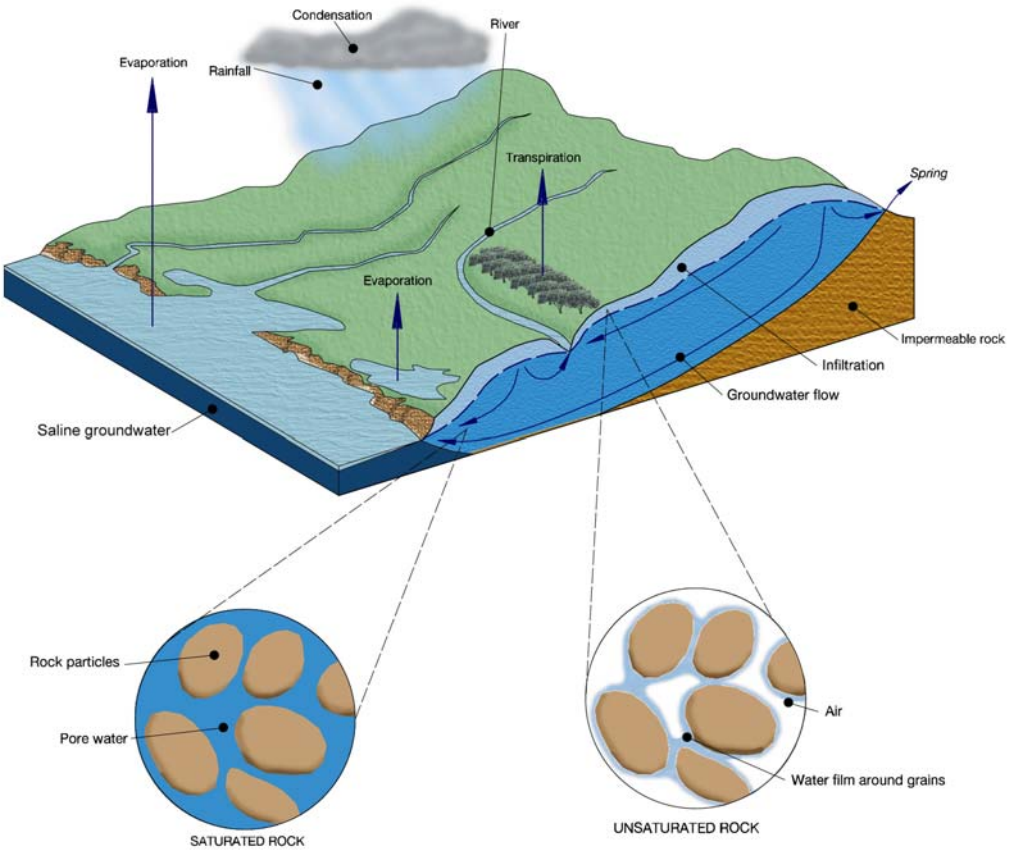
When a hole is dug in permeable rocks, at a particular depth water begins to flow in. The surface of the water that accumulates in the hole is the water table and the water in the ground below the water table is groundwater.

The variations in the shape of the water table reflect the topography in a subdued form. The water table is near the ground in valleys, actually intersecting the ground surface where rivers, lakes and marshes occur, but it is at much greater depths below hills.

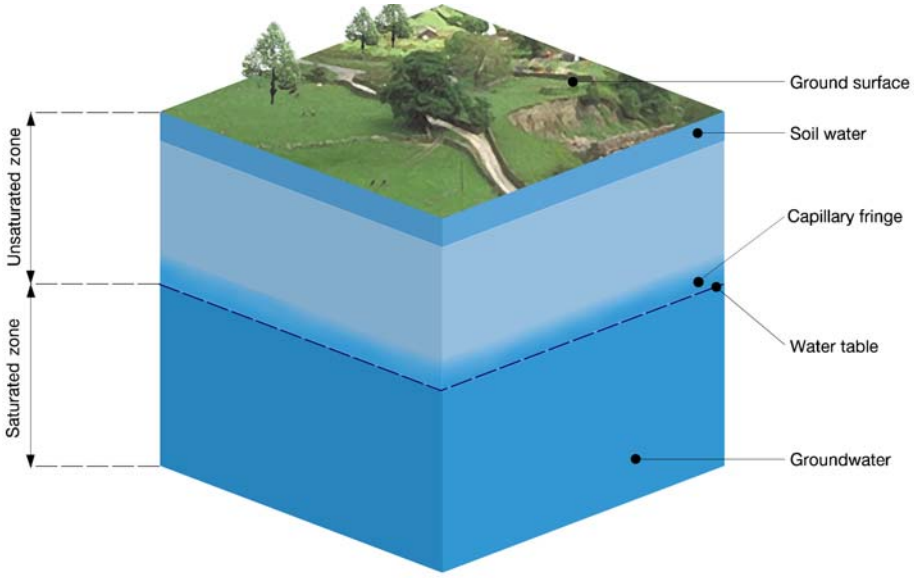
The pore spaces of rocks are saturated with water below the water table and groundwater is said to occur in the saturated zone. Immediately above the water table, water is drawn up into pore spaces by capillary forces into a thin zone called the capillary fringe. Rocks above the water table, including the capillary fringe, form the unsaturated zone; although they do contain water they are generally not completely saturated, and the water cannot be abstracted.

Groundwater comes from rain. The average annual rainfall over the UK is about 1100 millimetres, ranging from more than 2500 millimetres over highland Britain to less than 600 millimetres on the lowlands of eastern England. A significant part, almost 500 millimetres in lowland areas, evaporates, mainly in the summer. The remainder is available to infiltrate permeable rocks although where the rocks have low permeability or where they are overlain by layers of relatively impermeable clay, part will flow over the ground as surface runoff. Water infiltrates the ground mainly in the winter and slowly moves down through the unsaturated zone, eventually reaching the water table and becoming groundwater.

After temporary storage in the ground, groundwater drains from springs and seepages into streams and rivers. Maximum discharges occur at the end of the winter when groundwater levels are high following the seasonal infiltration. They steadily decline throughout the summer into

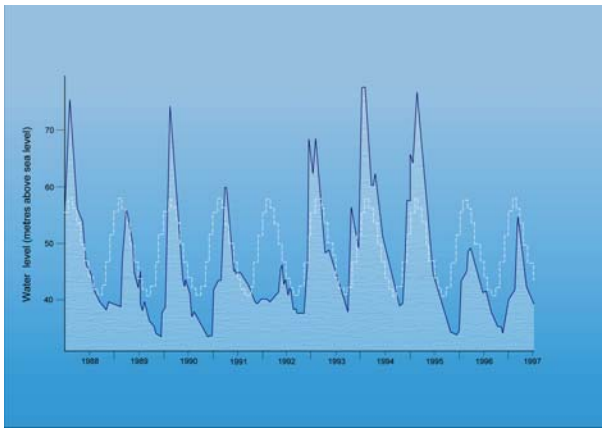


Groundwater in the hydrological cycle. Part of the rainfall returns to the atmosphere through evaporation and transpiration by vegetation, and part flows over the ground. The remainder infiltrates aquifers and replenishes groundwater storage. Groundwater flows through aquifers to outlets in rivers, at springs and in the sea. Springs occur where the water table intersects the ground surface, as in valleys and along coastlines, and where water overflows from an aquifer where it overlies a less permeable rock.



Profile of subsurface water. The thickness of the soil layer is up to about 1 metre. Below hills the unsaturated zone can be tens of metres thick. The grain size of the rocks controls the thickness of the capillary fringe. In fine-grained rocks it can be over 10 metres while in coarse sandstones no more than several centimetres. The saturated zone can be hundreds of metres thick although most groundwater flows in the upper 200 to 300 metres.

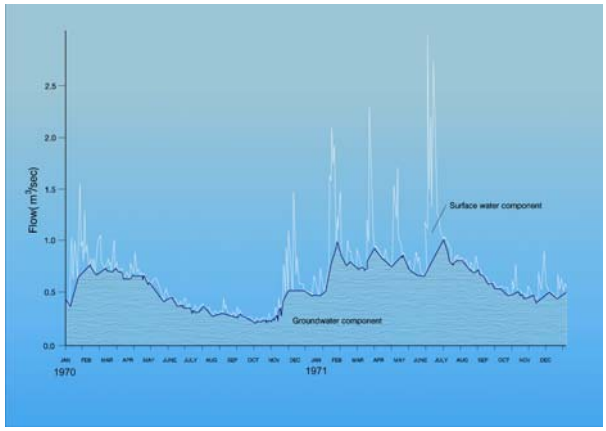
the autumn. The contribution that groundwater makes to the flow of rivers is called base flow and it is responsible for maintaining the flow of rivers during extended periods of dry weather, when surface runoff virtually ceases.



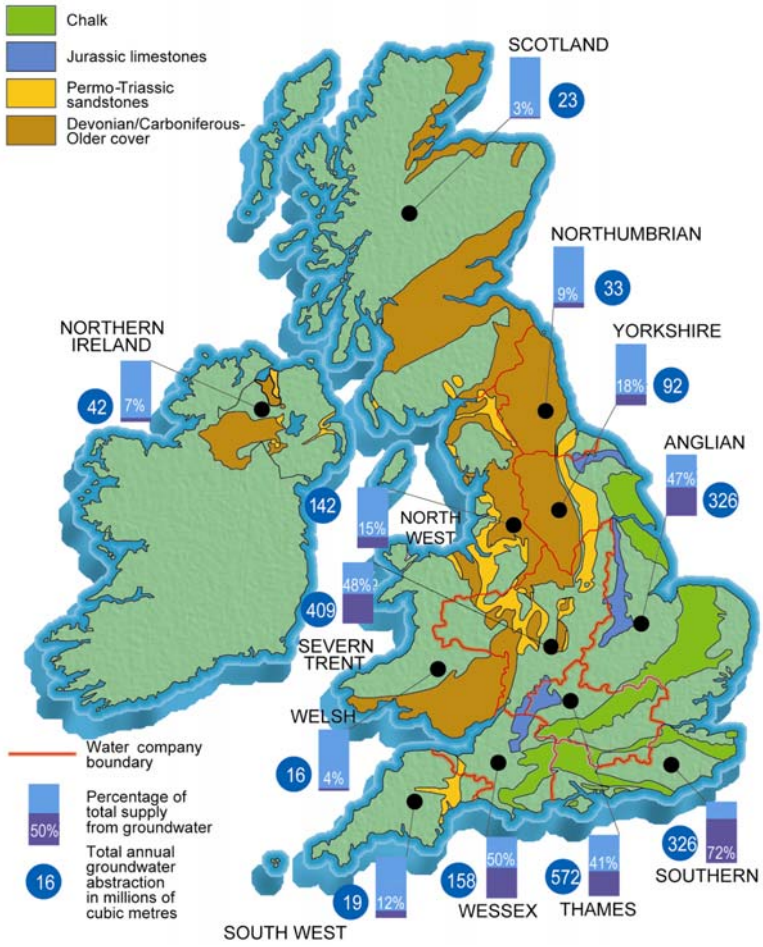
A hydrograph of the groundwater level in the Chalk measured in a well at Chilgrove in the South Downs. The water level has been measured in this well since 1836, probably the longest continuous record in the world. Over the entire period of the record the range is about 43 metres. The illustration includes two periods of low infiltration (1988–92 and 1995–97). In contrast, the high infiltration, and the consequent high water levels in the winter of 1993–94, increased the spring discharge from the Chalk, causing major flooding in Chichester. The broken line shows the mean monthly groundwater level.

Groundwater provides about one-third of public water supplies in England and Wales, 7% in Northern Ireland and 3% in Scotland. The regional differences reflect the distribution of aquifers and the more favourable conditions for the development of surface water resources in both Northern Ireland and Scotland.

The total abstraction of groundwater in the UK, including that used by industry and agriculture, is some 2400 million m^3/year. About 85% is pumped from the two main aquifers — the Chalk and the Permo-Triassic sandstones which provide 60% and 25% respectively. Over 70% of the total



A hydrograph of the River Pang in Berkshire showing the groundwater component. The river drains a Chalk catchment partly covered by clay. Groundwater discharging from the Chalk provides almost the entire flow in dry periods.



The use of groundwater. Most groundwater is abstracted in central, eastern and south-eastern England. (N.B. the water company boundaries are not up-to-date).

public supply in south-east England is derived from groundwater, while in the Severn and Trent basins, eastern England, the Thames Valley and the Wessex region the figure is between 40 and 50%. Industry and agriculture rely on groundwater in many areas and, of course, it is still the source of supply for numerous rural communities.

The Environment Agency controls the abstraction of groundwater in England and Wales by issuing licences which are required for all major sources of water supply. A licence is not required in Scotland or Northern Ireland, or in England and Wales if the water is used for domestic purposes.

Groundwater is relatively cheap to develop and it is generally of a very high quality. However, the cost can increase significantly if there is a need to ameliorate any undesirable impact of its development on river flows and wetlands, or provide complex water treatment to remove contaminants.

The Crocodile Spring at Compton Abdale in the Cotswold Hills. The water issues from the Great Oolite Limestone and flows into the River Coln, a tributary of the Thames. The spring has never been known to fail.