hydrometry

the science of measuring the water cycle




THE HYDROMETRIC SURVEY OF ENGLAND AND WALES

NRA

National Rivers Authority

why is our water environment important?

Water is a vital and valuable resource which has to be looked after carefully to meet the many demands that are placed upon it.

In England and Wales, the task of managing water resources falls to the National Rivers Authority, (NRA) "Guardians of the Water Environment".

Many demands are made on our rivers:

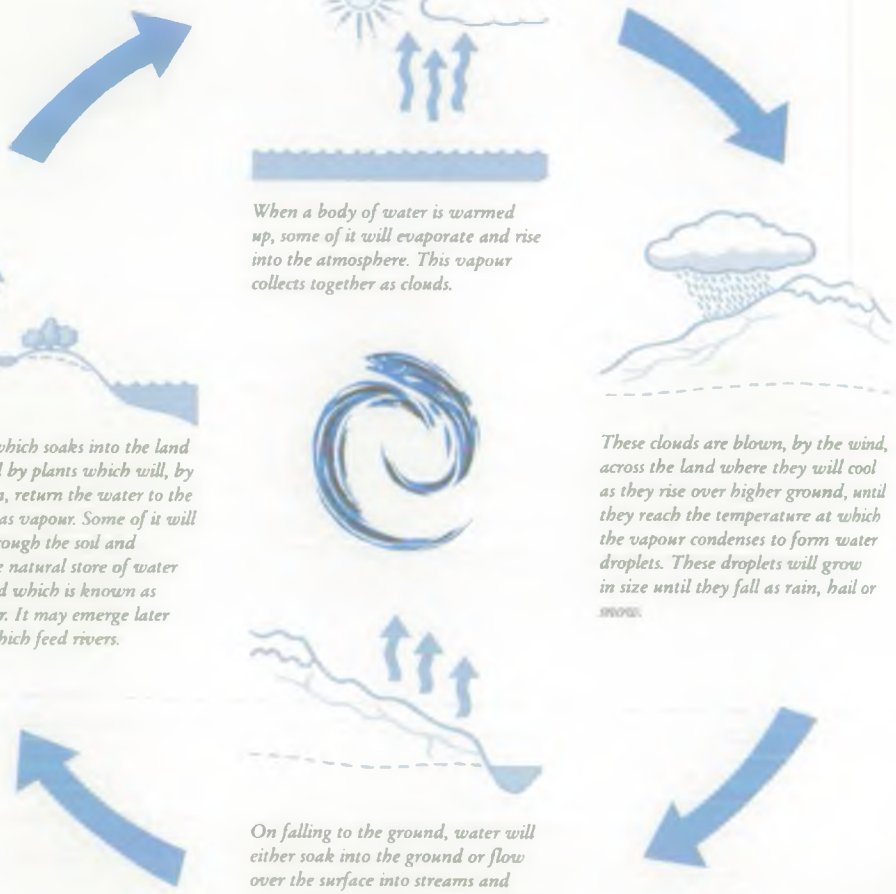
- they provide many different kinds of wildlife habitat;
- rivers, streams and water stored naturally in rocks underground are important sources of drinking water;
- many are navigable and act as highways for ships and boats;
- they provide essential water for industry and agriculture; people look to them for their scenic beauty and for recreation activities such as fishing.
- they act as a significant and complex drainage system. If we damage them we could end up with waterlogged land and the continual risk of flooding or dried up rivers;

The management and conservation of water resources is a vital part of the NRA's work. Balancing the needs of the environment and the needs of water users is a complex task. It involves the continual assessment of available resources, licensing of abstractions, issuing of consents to discharge effluent (waste), and protecting groundwater and surface water from pollution.

ENVIRONMENT AGENCY

the water cycle

In whatever form it is found, water is part of a natural system called the *water cycle* or *hydrological cycle*. It is this system we tap into when removing water for our needs in the home, industry and agriculture.



When a body of water is warmed up, some of it will evaporate and rise into the atmosphere. This vapour collects together as clouds.

These clouds are blown, by the wind, across the land where they will cool as they rise over higher ground, until they reach the temperature at which the vapour condenses to form water droplets. These droplets will grow in size until they fall as rain, hail or snow.

On falling to the ground, water will either soak into the ground or flow over the surface into streams and rivers. Some will also evaporate back into the atmosphere.

The water which soaks into the land may be used by plants which will, by transpiration, return the water to the atmosphere as vapour. Some of it will infiltrate through the soil and replenish the natural store of water underground which is known as groundwater. It may emerge later as springs which feed rivers.

The rock type, slope, vegetation and soil type of an area determine the rate of '*run-off*' – the speed at which water falling as rain eventually returns, via lakes, rivers or the earth's surface, to the oceans. Much surface water collects into river channels, but in some areas (such as limestone terrain) water may filter down through the permeable rock, a process known as *percolation*.

Rocks that hold water underground are called *aquifers*. Once inside an aquifer, underground water will flow, often very slowly and usually towards a river. This journey can take a long time, sometimes many

years. Because it can take such a long time groundwater helps to keep rivers flowing through periods of drought when little rain falls.

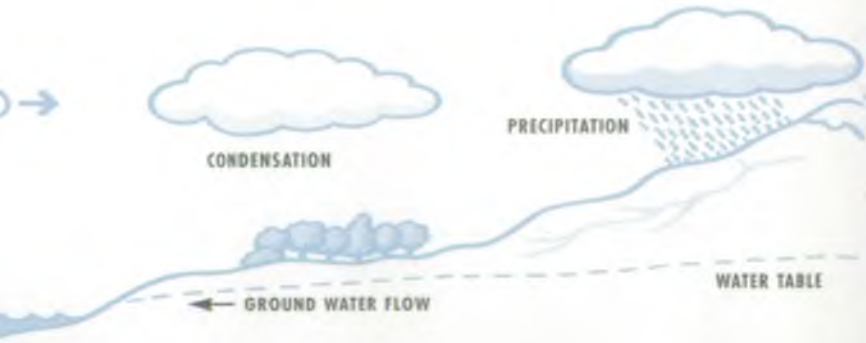
The flow of groundwater in aquifers is influenced by two things, *permeability* and *porosity*.

Porosity is a measure of the volume of water that a rock can hold between the individual grains. Those with a large proportion of open space where water can collect are described as *porous*.

Not all porous rocks permit water to flow through them easily, however.

Those that allow water to move freely have a structure which allows water to flow through the rock and are called *permeable*. Where groundwater is taken for use on a large scale, the rocks need to be both highly porous and permeable.

The direction, speed and volume of groundwater flow can be affected by fissures and faults which run through the rock. The size, abundance, alignment and degree of connection between the fissures all have an influence. These may vary in size from a fraction of a millimetre, up to many metres in some cave systems.



The Hydrometric Survey of England and Wales

Hydrometry is the science of measuring the quantity of water in the water cycle. Information is collected and managed for England and Wales by the NRA through an ongoing Hydrometric Survey.

To manage the water environment it is essential to accurately assess the amounts of water both above and below ground, at a number of points in the hydrological cycle. To do this, the NRA takes measurements of rain and snow fall, river flow, river level and ground-water levels using:

- raingauges
- river flow gauges
- groundwater borehole monitors

Each year Hydrometric Survey work of the NRA provides vital information for all aspects of the NRA's work. The uses of hydrometric data are essential to manage the water environment effectively. The data must, therefore, be accurate.

measuring the water cycle

measuring rainfall

The NRA can collect rainfall data in three ways:

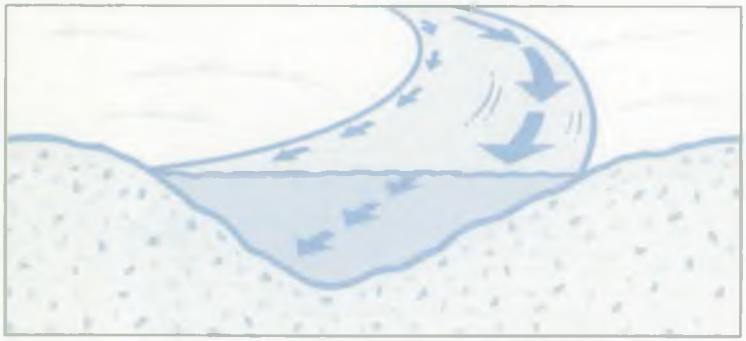
- The simplest measuring device is a storage raingauge which funnels rain into a graduated collecting vessel. These are usually read by volunteer observers who send the data to the NRA on a regular basis. A network of nearly 4000 raingauges across England and Wales provides rainfall data as daily total rainfall at each rainguage site.

- Rainfall is also measured automatically and the data is stored electronically in data loggers, many of which can be transmitted to computers using telephones or radio signals. This record gives the intensity and the duration of the rainfall.

- Rainfall can also be measured using radar. The NRA co-operates with the Meteorological Office to operate this network. Radar provides a complete coverage and shows patterns in rainfall over a wide area, which can be compared with site measurements from individual raingauges.

The rainfall data collected in these ways is used both to assess the availability of water resources and in the NRA's flood forecasting and flood alleviation work.

measuring river level and flow



*The **velocity** of water in a river usually decreases with depth and increases toward the outside of bends.*

Changes in river level are recorded on paper charts or electronically in data loggers. Information may also be sent directly to NRA offices via radio or telephone. This is known as ***telemetry***, and is needed so that data can be used quickly when monitoring potential flood events and emergencies. The level is usually recorded by a float in a vertical 'pipe' called a stilling well that is open at one end to the river.

Some rivers need to be measured continuously to enable the river to be managed properly. Sites are chosen at points on rivers where it may be necessary to control river abstractions or to measure the extent, duration and frequency of droughts and floods as well as to relate the flow from catchments to rainfall received.
This information can be used to study how rivers are affected by changes in how land is used, such as building new towns or planting forests. The sites are called gauging stations and the NRA operates in excess of 1100 of these throughout England and Wales.

At gauging stations, because the processes of erosion and deposition continually change the shape of natural rivers, it is sometimes necessary to build stable structures such as weirs. A calculation is then used to convert the level of the river accurately into flow.

At some sites, installation of such structures may not be suitable for a number of reasons; for example where rivers are too wide, where boats need to pass or where visual appearance is of concern. In these circumstances, more sophisticated methods of flow measurement are used such as ultrasonic or electromagnetic gauging stations. It is possible to calculate flows directly by accurately measuring the speed of sound in water at an ultrasonic station or by the voltage induced by water moving through an artificially created magnetic field at an electromagnetic station.

When flow needs to be measured at a location where a permanent monitoring site is not available, or where only a few flow measurements are needed, a current meter is used. The flowing river turns the blades of a propeller and the velocity at that point is measured from the rate of revolution. Flow velocity varies a great deal across the width and depth of a river, so a number of measurements are taken. Details of the river cross section are measured, and from this the flow can be calculated.

measuring groundwater

Groundwater resources are investigated and monitored by the NRA using boreholes sunk into aquifers (water bearing rocks which act as natural underground reservoirs). Although groundwater cannot be seen, it is just as important as the water in lakes and rivers because the two are very closely linked. During dry spells, the flow in rivers mostly comes from groundwater that emerges from springs.

The boreholes, which sometimes may be over 100m deep, provide information about the quantity, quality and movement of water within aquifers. Groundwater is a particularly important resource in the drier south and east of the country where the geology is particularly suitable for this sort of abstraction. The NRA records over 55,000 measurements of groundwater level each year to help manage and protect these valuable resources.

How much information does the NRA collect?

Each year the NRA Hydrometric Survey will involve:

24,400	Current meter gaugings
55,500	Groundwater level measurements
900	Recording & telemetry raingauges
1,165	River gauging stations
3,000	Voluntary daily rainfall observers

Differences in the extent and nature of rivers and aquifers in each region leads to the differences in the amounts of each type of Survey work carried out. For instance, a region that contains many heavily used aquifers will need to undertake more groundwater level measurements than one that does not.

what is this information used for?

The information gathered from our Survey work helps us to check the state of surface and underground resources throughout the year for planning how best to use water and protect the environment.

The NRA uses the information for the following purposes:

- to assess the availability of water resources;
- to manage water resources and the licensing of water abstractions;
- in flood forecasting and the design of flood defences;
- to set water quality standards for both rivers and groundwater;
- to protect and improve fisheries and further conservation;
- managing releases of water from reservoirs to maintain river flows which support abstractions and protect the environment;
- managing transfers of water between rivers for water supply;
- low flow alleviation schemes.

Hydrometric Survey information is available to the general public, though a charge may be made to cover costs. The data is extensively used by the Water Companies, Research Institutes, Schools, Colleges and Universities, the Meteorological Office, consultants and the government.

For further information please contact your regional NRA Office.

HEAD OFFICE
Rivers House
Waterside Drive
Aztec West
Almondsbury
Bristol
BS12 4UD
Tel: 01454 624 400
Fax: 01454 624 409

LONDON OFFICE
Eastbury House
30-34 Albert Embankment
London SE1 7TL
Tel: 0171 820 0101
Fax: 0171 820 1603

ANGLIAN
Kingfisher House
Goldhay Way
Orton Goldhay
Peterborough PE2 5ZR
Tel: 01733 371 811
Fax: 01733 231 840

NORTHUMBRIA & YORKSHIRE
Rivers House
21 Park Square South
Leeds LS1 2QG
Tel: 0113 244 0191
Fax: 0113 246 1889

NORTH WEST
Richard Fairclough House
Knutsford Road
Warrington WA4 1HG
Tel: 01925 653 999
Fax: 01925 415 961

Awarded for excellence

SEVERN-TRENT
Sapphire East
550 Streetsbrook Road
Solihull B91 1QT
Tel: 0121 711 2324
Fax: 0121 711 5824

THAMES
Kings Meadow House
Kings Meadow Road
Reading RG1 8DQ
Tel: 01734 535000
Fax: 01734 500388

SOUTHERN
Guildbourne House
Chatsworth Road
Worthing
West Sussex BN11 1LD
Tel: 01903 820 692
Fax: 01903 821 832

WELSH
Rivers House/Plas-yr-Afon
St Mellons Business Park
St Mellons
Cardiff CF3 0LT
Tel: 01222 770088
Fax: 01222 798555

SOUTH WESTERN
Manley House
Kestrel Way
Exeter EX2 7LQ
Tel: 01392 444 000
Fax: 01392 444 238

The NRA is committed to the principles of stewardship and sustainability. In addition to pursuing its statutory responsibilities as Guardians of the Water Environment, the NRA will aim to establish and demonstrate wise environmental practice throughout all its functions.