

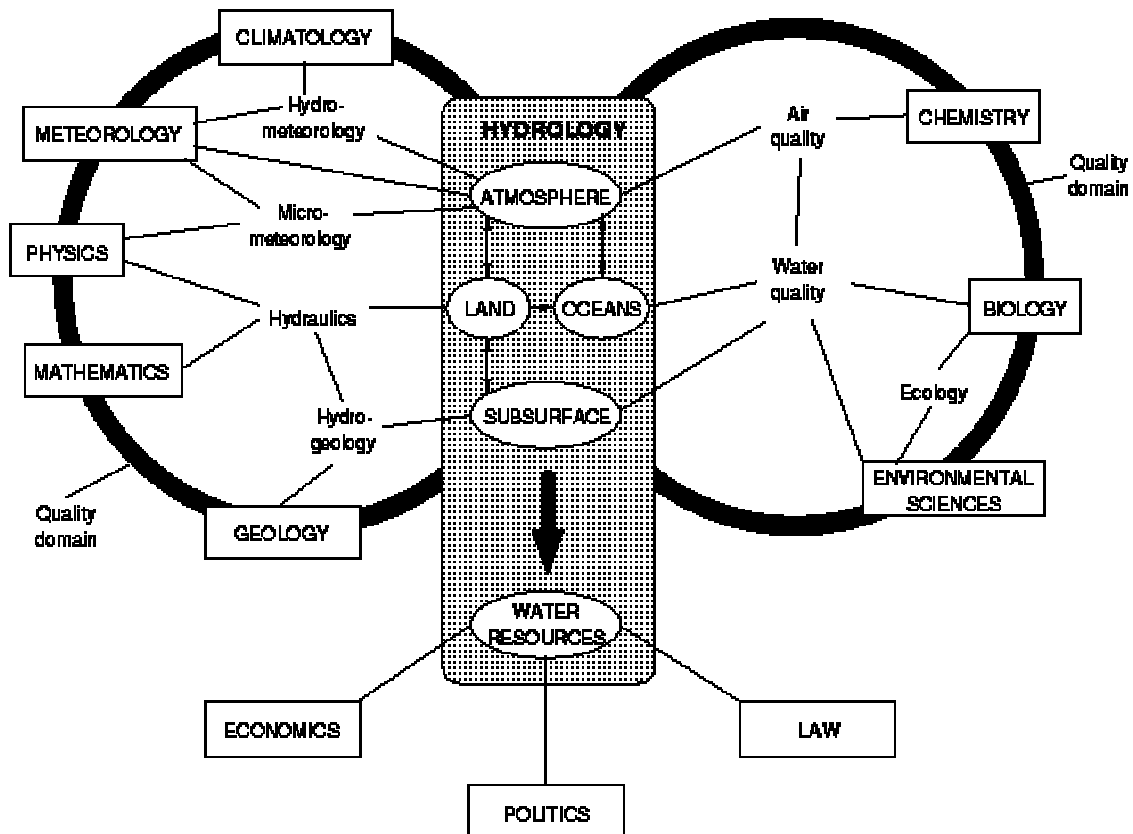
Careers in Hydrology

This information has been prepared by BHS to brief students and careers services about hydrology and to give some pointers to sources of further information. It is provided for guidance only.

What is Hydrology?

The Concise Oxford Dictionary (1990) defines hydrology as: *“The science of properties of the earth’s water, especially of its movement in relation to land.”*

Hydrology is primarily concerned with the amounts and quality of water moving and accumulating on the land surface and in the soils and rocks near the surface. It therefore encompasses water in rivers, lakes, aquifers and glaciers. Hydrology embraces a wide range of interests including scientific and engineering applications. The diagram below, based on the BHS Research Strategy *“Sustainability in a changing world: the key role of hydrology”*, illustrates the major components of hydrological science and its interactions with a broad range of disciplines.



Hydro-meteorology spans the interface between meteorology and hydrology, and professionals active in this subject may have trained in either or both disciplines. Hydro-geology addresses the science of water in the ground and has, as its name suggests, a close affinity with the geological sciences. Hydro-ecology is concerned with the aquatic habitats required for the survival of particular flora and fauna, and the changes that may occur in these conditions through human intervention.

What do Hydrologists do?

Hydrologists undertake a wide range of activities in order to monitor, manage and protect the water environment. Many activities and studies would be impossible without hydrometric data measurement, collection and archiving. Much of hydrology involves the interpretation and analysis of such data, and hydrologists frequently develop and use mathematical models to mimic the physical processes they examine. A hydrologist's activities typically include:

- **Hydrometric and water quality measurement:**
 - Maintaining monitoring networks to record river flows, water levels in rivers, lakes and groundwater; rainfall and other climate variables;
 - Taking water samples and conducting analysis for chemical properties;
 - Working with biologists and ecologists to monitor river and lake conditions.
- **Process studies:**
 - Investigating patterns of rainfall and other forms of precipitation;
 - The study of ice, snow and glaciers;
 - Modelling river flow processes including water quality, sediment movements and channel shapes;
 - Investigating water in the biosphere at all scales, including soil and water interactions.
- **Applications:**
 - The study of drought and floods, including statistical studies of drought and flood risks;
 - Modelling complex water resource and water supply systems for planning and operation;
 - Investigating the causes of flooding, and possible solutions to flooding problems;
 - Undertaking water quality and other environmental management studies;
 - Assessing water use (e.g. in agriculture and forestry);
 - Examining the impact of climate change on water resources and flooding patterns;
 - Assessing the consequences of changes in land use;
 - Developing models of hydrological processes and systems;
 - Considering environmental impacts on water bodies and the effect of engineering works to manage water (e.g. dams).

Who do Hydrologists work for?

Hydrologists work for a variety of organisations; the five main types are:

- Government - developing policies, regulating and managing the environment;
- International organisations - technology transfer, international co-operation and emergency relief;
- Consulting - providing services in civil engineering, environmental management and assessment;
- Academic and research - undertaking teaching and research into new analytical techniques;
- Utility companies and public authorities - providing water supply and sewerage services.

Hydrologist Career Profiles

The following profiles are intended to give short descriptions of the types of roles hydrologists fulfil in society, the types of organisations and companies who employ them and the range of activities and responsibilities they undertake. The descriptions are not exhaustive and should be regarded as a guide only. The information provided here is primarily aimed at undergraduates, postgraduates and those seeking a change of direction in their current career.

Water Resources Planning and Demand Forecasting

The skills of a hydrologist are highly relevant to the issue of balancing water supply and water demand. In the UK, individuals with hydrological knowledge can work for **water companies** or their environmental regulators (the **Environment Agency**, **Scottish Environment Protection Agency (SEPA)** or **Rivers Agency**) in the roles of water resource planners and demand forecasters.

As a water resources planner/demand forecaster you can become involved in establishing the yield of existing surface water and groundwater sources, assessing the effects and risks associated with the

failure of water supply systems and assessing the potential impact of climate change on water supply and demand. You may also be asked to plan and agree investigations into proposed water resources schemes and evaluate the relative costs of such schemes (e.g. as part of the Asset Management Plan (AMP) cycle). Your advice may be sought during mains distribution improvements to enhance the security of water supply and reduce leakage from treatment works and pipelines. Day to day activities may also entail producing and agreeing operational control rules for water resources (to allow for e.g. conjunctive use of sources or river regulation), supervising and monitoring the use of water resources (in accordance with their licensing and operational control rules) for water supply purposes and environmental benefits and collating/analysing information on domestic, industrial and agricultural water consumption. Periodically, you will be involved in planning, agreeing and instigating actions to be taken at the onset of, during and after a drought period.

Hydrometry

Most hydrological investigations rely on the availability of observed hydrometric data. Depending on the level at which the investigation is pitched e.g. strategic, pre-feasibility or full 'design and build' standard, the underlying data requirements and, specifically, the need for accurate records can become quite significant. As a field hydrologist you can play a direct role in the provision of high quality datasets for hydrological modelling. Typical tasks undertaken in the field by hydrologists working for or on behalf of the **Environment Agency**, **SEPA** or **Rivers Agency** include: inspection and maintenance of existing gauging structures and measuring devices for surface water, groundwater, rainfall and climatic variables; reviewing the need for (and potential locations of) new gauging structures or devices; supervising the installation of new measuring equipment; calibration of hydrometric instruments (e.g. water level recorders); and retrieval and quality control of hydrometric data. When necessary (usually during a major flood event), you may be asked to undertake current-meter gaugings to assist the development, extrapolation and verification of rating curves (stage-discharge relationships) at significant locations within a catchment. Linked to this, you may also partake in site visits during and in the aftermath of flood events to ascertain and monitor peak levels, flood extents and property damage (see also **Flood Forecasting, Flood Warning and Flood Defence**).

UK Consultancy

A UK-based consultant hydrologist, working either **independently** or for a **consultancy firm** needs to be flexible, mobile and accustomed to a diverse workload. Depending on the nature of the commission, you may be working alone or as part of a large multi-disciplinary project team, your technical input may be short or extensive and you may be called upon to work on site or on secondment to a client's office. In this respect it is important that you develop an ability to exercise clear hydrological judgement (see also **International Consultancy**), a willingness to explore different avenues in the quest for reliable data and a flare for effective communication.

In this varied role you can gain technical expertise in the following areas: low flow investigations as a precursor to ALF (Alleviation of Low Flows) schemes, habitat restoration schemes or in connection with discharge consents and water quality issues; basin level studies (e.g. Catchment Flood Management Plans) aimed at finding strategic and sustainable solutions to current flooding problems, whilst also managing the risk of potential flooding in the future; flood risk assessments for private developers or local authorities - as part of the development control process or during urban drainage/sewerage network design; and reservoir safety work, usually involving an estimation of the probable maximum flood for the subject catchment. Input into the design and construction of hydrometric gauging stations will present you with fieldwork opportunities and involve liaison with contractors, land owners and the responsible environmental agency. There is also scope for you to link hydrological modelling with hydraulic modelling (e.g. during flood risk mapping work for the **Environment Agency**) to assess the impact of design floods at key locations and to provide an indication of the spatial extent of a flood with a given probability of occurrence in any one year. Your skills may be utilised during technical and project management support to the **Environment Agency** in its role as auditor of water companies' Water Resources Plans; or in evaluating the economic, social and environmental costs and benefits of potential water resources options or flood defence schemes.

International Consultancy

For those with an interest in seeing other countries and ways of life whilst broadening their hydrological experience, overseas hydrology is an exciting opportunity. The humid tropics, arid deserts, steppes and regions snow-bound half the year have very different critical hydrological regimes. It sometimes means being prepared to go back to hydrological basics, foregoing user-friendly manuals and UK methodologies, often dealing with limited or short-term datasets and, in many cases, plunging into entirely different hydrological environments.

As an overseas hydrologist working for an **international consultancy firm** (or as an **independent consultant**) you will need to be confident, resourceful and able to tackle all aspects of hydrology - from appraising gauging stations, data quality and locally derived methodologies to defining regional characteristics and demonstrating the impact of potential water resource schemes. Usually, a significant degree of training of counterparts will be involved and here the ability to pick up local languages will be a distinct advantage. Being a local presence with a perceived expertise, you can expect to be called upon during emergencies (see also ***International Development and Emergency Relief***) – e.g. floods, droughts, crop failures or pollution spills. An open mind is essential, together with diplomacy and respect for local methods developed through experience or rules of thumb. Though such an approach may seem unscientific or far removed from ‘textbook’ methods in use in the UK, it can be important to take note of local expertise and utilise it, wherever possible, in the eventual solution to a particular issue.

As the world becomes more hydrologically aware, there is great scope for practising your hydrological skills at the high-tech end of the spectrum or at a more basic level. The former may involve developing leading-edge modelling techniques for the management of extensive river basins, whilst the latter may evoke pragmatic measures to enable communities to withstand monsoon or snow seasons, the occasional power or water supply disruption, and even the possibility of political upheaval.

International Development and Emergency Relief

As a hydrologist, you can gain experience in water engineering including such topics as: water quality sampling, designing small water distribution systems, designing rainfall harvesting schemes and siting shallow wells for local communities. Such skills are very valuable when working in developing countries or during emergency relief work. Hydrologists with these (and other) appropriate skills can make effective water supply and sanitation engineers – referred to as ‘Watsans’ by NGOs (**Non-Governmental Organisations**) – when emergency relief is required and, particularly, during longer-term development projects (see also ***International Consultancy***). Organisations such as RedR (Registered Engineers for Disaster Relief) have a number of members with hydrological backgrounds who undertake international aid assignments. For further information see the RedR website at www.redr.org

Education, Research and Development

For those hydrologists who continue in academia, opportunities exist in the form of college or university lectureships (e.g. within Civil Engineering, Geography or Earth Sciences departments) and, in the UK, as part of research teams based at specialist establishments such as the Centre for Ecology and Hydrology (CEH, Wallingford), the Meteorological Office, Flood Hazard Research Centre (FHRC) or the Tyndall Centre for Climate Change Research.

Collaborative working, both in the UK and overseas, is a key feature of the research hydrologist’s career. In choosing this route, you would be expected to share knowledge and ideas amongst your colleagues and, as appropriate, with external organisations. Your advice/opinions might be sought when key decisions need to be made (e.g. at local or national government level) or when an innovative solution to a long-standing problem needs to be found. Hydrologists employed by **educational and research establishments** often work with representatives from government departments, consultancy firms and industrial or commercial companies worldwide. They are challenged with extending the boundaries of the current level of understanding of hydrological processes and taking the lead in providing new or updated methodologies, modelling techniques and

tools with which other hydrologists should work. Most hydrologists entering this field of employment will have an appropriate postgraduate degree.

Flood Forecasting, Flood Warning and Flood Defence

The hydrological skills of, for example, **Environment Agency** flood warning officers and flood defence engineers are utilised in planning and agreeing actions to be taken at the onset, during and after a flood – these actions may feed into major incident plans managed by local authorities for key urban areas.

Hydrologists who specialise in flood forecasting often work with real-time models of river systems, linked to weather radar and/or telemetered raingauges and river gauges. Such models are often used to issue short-term flood warnings to communities in affected areas; the models can also be used operationally to determine policies for releasing water from regulating reservoirs. In these circumstances, hydrologists are responsible for monitoring hydrometric information and issuing flood warnings to the public, emergency services and businesses as the need arises. Their role requires rapid expert judgement, a sound knowledge of local hydrological regimes and an appreciation of historical trends or observed responses within a given catchment.

Flood defence engineers become involved in the 'operations' side of managing a flooding incident, in terms of acting on issued warnings and instigating mitigation measures or assisting with evacuation 'on the ground'. In this type of role, you would be expected to interact with local authorities, the public and emergency services, and perhaps provide statements to the media on the flooding situation. It may be your responsibility to co-ordinate the activities of teams working to alleviate flooding problems in disparate parts of a catchment. On a day to day basis flood defence engineers play a significant role in the implementation of improvements to flood defence assets (e.g. embankments, diversion channels and flood storage areas). They also act as a link with local flood defence committees.

In all cases, the hydrologist who plays a part in predicting or managing a flood event, is keen to learn lessons that will help to improve understanding and reactions should the situation recur. The data collected and analysed by hydrologists during and after a flood can help to improve predictive models and influence emergency planning. It can also be used to enhance public awareness of flood risk and promote self-help activities.

What education, training and qualifications do hydrologists need?

Education

There are no first degree courses in the UK in hydrology as a subject in its own right. However, hydrology is well covered as a part of programmes in civil engineering, geography, environmental science and environmental management. It also interfaces with geology, soil science and ecology degrees. Detailed training in hydrology is mostly provided at the postgraduate level.

A number of universities offer postgraduate courses in (inter-alia) hydrology and water resources subjects, usually for one year leading to a Master's degree. Most of these courses are full time, but some may be taken in modular form on a part-time basis. BHS does not maintain a list of current courses, nor does it assess or undertake accreditation of those currently available. University prospectuses and annual publications listing degree courses should be consulted for a comprehensive and up to date statement. Most public libraries and career services hold copies of reference books on university and further education courses, in some cases you may be able to examine the individual prospectuses issued by educational establishments. Alternatively, you could search for course and faculty information at a university's website or post an online request for a printed copy of their undergraduate or postgraduate to be sent to you. Most courses require a pass in mathematics at A-level, or an equivalent qualification.

For a career in hydrology, the choice of first degree is not so important, but it may be appropriate to consider whether the university or college course you choose to take is accredited by the Professional Institution to which you may subsequently apply for Membership (see also **Professional Qualifications** below). Further information should be obtained at an early stage from the educational

establishment where you intend to study. It should be noted that Membership of a Professional Institution may also have associated requirements in the form of pre-requisite A-level subjects. Again, advice should be sought at an early stage from the Professional Institution in question.

The BHS Young Members' Representative has been interviewed for a Department for Education and Skills (DfES) publication entitled "*Working in Geography*". This booklet is aimed at school-leavers seeking early advice on a career direction and its subject matter draws on the experience of others. The publication can be downloaded from www.connexions-direct.com/wigeography and includes a section on 'the hydrologist'. Alternatively, a hydrologist's occupational profile and further case studies given by recent graduates may be consulted at www.prospects.ac.uk by searching on "hydrologist" under "explore types of jobs".

Training

There is no substitute for 'on the job experience' in hydrology, gained through finding solutions to real world problems. For those embarking on a career in hydrology, the guidance of a mentor or colleague who has extensive experience in hydrological analysis and techniques (both in the UK and overseas) can be very important. The support of a wider group of skilled individuals or project/research team is also valuable and will help to consolidate your knowledge and build your confidence in exercising hydrological judgement and conveying ideas to others. Wherever possible, you should aim to learn from those around you and try to establish regular contact with a more senior hydrologist in your place of work, somebody with whom you can discuss the progress and diversity of your 'on the job' training. Joining a recognised society such as BHS, and taking part in their programme of organised events, can also be an effective way of meeting counterparts in other parts of the water industry and benefiting from the knowledge they have to impart. Such meetings often count as accredited training days towards professional qualifications.

For those seeking a change of direction in their hydrological career, the brief descriptions provided in the [Hydrologist Career Profiles](#) above should give some indication of the alternatives that are available, both in the UK and overseas. Depending on your aspirations and the extent to which you wish to specialise, you may or may not need to re-train through an academic course. In certain cases further formal qualifications will be necessary. But there may also be instances where you can broaden your skills base and gain insight into other ways of working by undertaking secondments to other areas of your company's or organisation's business, by changing departments or project/research teams, or by working from a different geographical location e.g. an international office. An understanding of basic hydrological concepts and principles, and a willingness to adapt to the issue in hand are key factors. Indeed, you may be surprised to find that you possess many transferable skills that simply need to be applied to different subject matter.

Hydrologists seeking a professional qualification (see below) will be required to prove that they have a variety of experience which meets specified criteria. During their career they must also demonstrate that they are keeping up to date by undertaking continuous professional development. This may include participation in topical meetings and seminars organised by relevant learned societies such as BHS.

Individuals who wish to progress to positions of greater responsibility in an organisation will need to develop skills in the management of project budgets and programmes and in the supervision of people. At the highest levels, hydrologists are employed in senior management positions and are required to make difficult decisions on sensitive and controversial matters. They also need to be skilled communicators in presenting scientifically complex issues to national and local politicians or in giving expert witness evidence to a public inquiry or in a court of law.

Professional Qualifications

Hydrologists who aspire to a professional qualification seek Membership of a Professional Institution which embraces their particular specialisation in hydrology. Those with appropriate engineering qualifications and who practice in an engineering environment can achieve Chartered Engineer accreditation as Members of the Institution of Civil Engineers (ICE) or through the Chartered Institution of Water and Environmental Management (CIWEM); they will normally have read Civil Engineering for

their first degree. There are three grades of professional engineer, with different minimum academic requirements: Chartered Engineer, Incorporated Engineer and Engineering Technician. Further details are available from the ICE website at www.ice.org.uk/joining

Candidates from a scientific background normally seek membership of CIWEM. CIWEM promotes a structured training programme, continuous professional development, and has instigated a Diploma in Environmental Management in partnership with a number of UK universities. In addition, many organisations and companies that employ hydrologists have developed their own CIWEM accredited structured training schemes. CIWEM's webpages www.ciwem.org.uk/education and www.ciwem.org.uk/membership provide further guidance and points of contact for initial enquiries on routes to membership. The website also hosts links to www.environmental-careers.info – these webpages focus on a publication entitled “*Environmental Careers – The Inside Guide*”. This document contains advice on job prospects related to flood defence, river engineering, water resources management, fisheries and water quality amongst other ‘hydrology-related’ disciplines.

Hydrologists who specialise in hydro-meteorology, may be eligible for admission by the Royal Meteorology Society (RMS) as Chartered Meteorologists. The RMS website www.royal-met-soc.org.uk should be consulted for up to date information.