Groundwater
“Out of sight, out of mind?”
Let’s explore the water table!

UK Groundwater Forum
Contents

1. The World’s water & groundwater basics
2. Groundwater in the environment
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The World’s Water

Freshwater = 2.5% of all water: 35,000,000 billion m$^3$

Groundwater = 30% of freshwater: 10,500,000 billion m$^3$

Groundwater = 96% of available freshwater

Groundwater: The World’s most extracted raw material
600-700 billion m$^3$/year

Source: WMAF 2006, based on data from Shiklomanov and Roda 2003
The Water Cycle

Aquifer
An underground geological formation that transmits & contains appreciable quantities of groundwater

http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf048.jpg
Why Use Groundwater?

- Often occurs where there are few rivers & streams
- Responds slowly to changes in rainfall & stays available in summer & droughts when rivers & streams have dried up
- Groundwater quality is often very good & doesn’t need as much treatment as river water to make it safe to drink
- Can be found close to towns & so doesn’t require the large costs often needed for capturing, treating and piping river water
- Groundwater doesn’t require expensive reservoirs to store water in before it is used; aquifers are the underground reservoirs of groundwater
What does a hydrogeologist do? #1

Rachel Bell, Hydrogeologist, British Geological Survey

At BGS I work on a wide variety of projects relating to groundwater, including fieldwork collecting samples, gauging streams and springs, or visiting sites with groundwater contamination problems. My work sends me all over the world, with trips to Africa and Nepal. I also spend time analysing the data I’ve collected and looking at how that can improve our understanding of the sub-surface.
Principal Aquifers of the World

% Drinking Water: Groundwater

- Denmark & Austria: 100%
- Italy: 90%
- India: 85%
- Germany & Poland: 70%
- Bulgaria & Greece: 60%
- Australia: 60%
- USA: 20%

WHYMAP & Margat 2008

Principal UK Aquifers & Groundwater Use

Principal UK aquifers:
- Cretaceous Chalk
- Jurassic Limestones
- Permo-Triassic Sandstones

Groundwater provides ~35% of water supply
Regionally variable:
- 3% in Scotland
- 72% in South East England

Recent peak groundwater abstraction 2.3 billion m³ in 2003

http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf005.jpg
Uses of Groundwater

1. Drinking & domestic use
2. Farming, e.g. irrigation, cattle watering, fish farming
3. Construction, e.g. concrete, cement
4. Food & drinks manufacturing
5. Heating & cooling buildings
6. Industry, e.g. hydrocarbons, fracking
7. Mining, e.g. minerals processing
Groundwater in the Environment

1. Where can we see groundwater?
2. The ups & downs of groundwater
3. Why do rivers flow when it’s not raining?
4. The emergence of groundwater: a natural hazard
5. Life underground
Unconfined & Confined Aquifers

Confined aquifer
Permeable rock units overlain by less permeable layers

http://cehsciencenews.blogspot.co.uk/2013/10/hydrometric-data-long-view.html

http://www.ahwelldrilling.ca/well-drilling/artesian-wells/

http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf011.jpg
The Ups & Downs of Groundwater

Future of forecasting from www.hydoutuk.net
Groundwater as River Baseflow

River Pang – this is groundwater

Where’s the groundwater gone?

http://www.thetimes.co.uk/tto/weather/article3618227.ece
Groundwater Flooding – The Other Extreme


River Pang

http://www.bgs.ac.uk/research/groundwater/flooding/groundwaterHomesFAQ.htm
Life Underground

Groundwater can contain distinctive animals adapted to live in the dark. These are stygobites, but how important are they?
How to get at Groundwater

1. Abstraction boreholes
2. Wells with adits
3. Groundwater abstraction & rivers
Borehole Construction & Operation

Drilling

Pump Installation

Headworks

Aquifer

Confining Layer

GSB well chamber

Concrete

Overburden

Grout seal

Inert silica gravel/sand pack

Well casing

Well screen

Rising main

Submersible pump

Abstraction capability = 15,000 m³/day

http://findingwater.co.uk/wp-content/uploads/morgan_wellillus.jpg

Thames Water, 2012
Abstraction Wells

Borehole with Adits
(Yield dramatically improves with construction of horizontal adits – several vertical fissures are intercepted)

http://www.gstowplc.com/adits_survey.html

Thames Water, 2012
What does a hydrogeologist do? #2

Simon Starling, Groundwater Resource Analyst, Thames Water

My role is to help protect Thames Water’s public water supply groundwater sources; this ensures that groundwater abstraction is not affected by things such as pollution incidents, farming activities and local housing developments. I have a good balance of work on-site and in the office, and there are always new things to learn and understand working within the UK’s largest water company.
Groundwater Abstraction & Rivers

Abstraction borehole

Importance of river bed

Low permeability sediment

After [http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf023.jpg](http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf023.jpg)
Groundwater Contamination & Protection

1. Contamination hazards
2. Groundwater vulnerability
3. Groundwater and shale gas
Groundwater Contamination Hazards

- Numerous sources of contamination
- Urban & rural
- Groundwater & water supply sources at risk
- Source-Pathway-Receptor

[Image: http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf033.jpg]
Groundwater Vulnerability

Geology & hydrogeology can provide natural protection

• Contaminants move slowly through unsaturated zone
• Groundwater moves faster through aquifers with fractures
• Clays have low permeability

http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf034.jpg
Groundwater and Shale Gas

Hazards & Risk

- Additional water demands
- Pollution from gas, fracking fluid & contaminated water
What does a hydrogeologist do? #3

*Lucy Snape, Technical Officer, Environment Agency*

As a Technical Officer I provide technical support and guidance to internal and external customers on groundwater protection and land contamination issues on a daily basis. I am also involved in determining abstraction licence applications, including analysis and interpretation of pumping tests and groundwater level monitoring.
A career as a hydrogeologist

Water companies – in some areas of the UK, groundwater provides a major component of the water supplied. Many water companies employ groundwater specialists.


Consultants – work for private and government clients in the UK and overseas, including environmental impact, landfills, mine dewatering, water supply.

Universities – several universities undertake specialist teaching and research in groundwater, employing lecturers and researchers.

Contractors – drill boreholes, construct roads, tunnels, airports, and employ hydrogeologists as specialists to design & supervise groundwater works.
How to become a hydrogeologist......

• Hydrogeologists often come from a wide variety of backgrounds – geology, environmental science, engineering, mathematics & many others.

• The usual route after an undergraduate degree is to obtain a 1 year MSc in a relevant subject, such as hydrogeology, water management, environmental geology.

• Others may choose to do a PhD/EngD in hydrogeology, which can take 3-4 years and are funded by research councils, universities & industry.
Groundwater

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Check out the UK Groundwater Forum web site www.groundwateruk.org

Follow us on Twitter @UKGWForum

Contact us
UK Groundwater Forum Secretariat
Maclean Building
Wallingford
Oxfordshire OX10 8BB
Email: contact@groundwateruk.org