Hydrological Summary

for the United Kingdom

December 2009

General

December was a cold and unsettled month with wintry conditions predominating after the first ten days; snowfall was substantial – in eastern regions and on high ground particularly. This Arctic episode, which extended well into January, resulted in extensive and sustained transport disruption with major impacts on many communities. The low frequency of Atlantic frontal systems contributed to December precipitation totals being mostly below average but many rivers were in spate early in the month and flood alerts were both common and widespread. Thereafter recessions became established, heralding particularly low flows around month end. Nonetheless, the abundant late autumn and early winter replenishment ensured that December reservoir stocks were generally very healthy. There was some local drawdown to moderate flood risk (e.g. at Clywedog) but, entering 2010, most major reservoirs were close to capacity; there were a few exceptions in eastern England (stocks in Rutland reservoir were below the early January average). Despite the seasonally late onset of groundwater recharge in 2009, groundwater levels were generally above the December average and notably high in some areas. The water resources outlook for 2010 is therefore very encouraging but the considerable (albeit spatially very variable) snowpack storage implies a moderately enhanced flood risk – particularly in the event of a rapid thaw.

Rainfall

A succession of active frontal systems which dominated weather patterns in the late autumn continued into December but from the 2nd week, with high pressure established to the north of the British Isles, northerly or north-easterly winds brought very cold conditions with accompanying snow episodes across much of the country. On the 18th, accumulations of up to 20cm were reported (e.g. on the North York Moors) as bands of snow moved in from the North Sea. Further significant falls were reported later in the month; in Scotland fresh snow on a consolidated snowpack increased the risk of avalanches (one on Ben Nevis on the 30th caused two fatalities). The limited Atlantic influence on weather patterns is reflected in the December precipitation totals (the high proportion of snowfall implies that these are likely to be underestimates). The UK rainfall total was a little below the December average with meagre totals characterising much of central and western Scotland; Northern Ireland was relatively dry also. Conversely, totals exceeded the average, commonly by appreciable margins, across much of eastern Britain (reaching 200% in a few parts of Kent). Notwithstanding a preponderance of relatively dry months, provisional 2009 rainfall totals are close to, or above, average in all regions. Initial data suggest that the UK registered its 11th wettest year in a series from 1914 – but six of the wetter years cluster into the post-1997 period (within this timespan Scotland has been exceptionally wet).

River flows

Most rivers registered a wide flow range in December with high flows early on – more than 100 flood alerts were in operation on the 1st across England & Wales – followed by sustained recessions but with moderate spates in southern Britain around month-end; snowmelt being a contributory factor in most cases. With catchments saturated and many rivers already flowing close to bankfull, modest floodplain inundations were common but the rapid passage of most low pressure systems helped moderate storm rainfall totals and, as a consequence, the risk of severe flooding. Following notably high flows around the 8th, weather patterns became more settled and recessions became widely established – heralding notably low runoff rates particularly where frozen conditions gripped the headwaters. In western Scotland, flows in the Luss fell below previous end-of-year minima; flows were also depressed in parts of Northern Ireland. However, with considerable snowpack storage (10-30cm across many upland areas), milder conditions (accompanied by rain in some areas) triggered further spates around the 30th. December runoff totals were boosted by the lagged impact of the late November rainfall (and increasing baseflows in permeable catchments) but exhibited wide spatial variations. Monthly totals generally exceeded the average, and were among the highest on record in some southern catchments (e.g. the Dorset Frome) and the Yorkshire Derwent. However, limited precipitation combined with frozen catchments resulted in low runoff totals in some regions (e.g. western Scotland and Northern Ireland) – the Carron and Lagan both recorded their 3rd lowest December runoff in series of 31 and 38 years respectively. Nonetheless, 2009 annual runoff totals for the great majority of index rivers also exceeded the long term average; a few including the Nith eclipsed previous annual maxima.

Groundwater

Across the outcrop areas of most major aquifers December precipitation totals were above average and, with soil moisture deficits generally eliminated, heavy groundwater recharge would normally be expected. However, infiltration rates will have been significantly reduced by frozen ground conditions over the latter half of the month. In part due to access problems, the December levels for a few index boreholes are unavailable and, for the others, the reporting dates vary considerably – this can be particularly important when groundwater levels are changing relatively rapidly. Nonetheless, on a countrywide basis groundwater resources are clearly healthy – a reflection of the exceptional late autumn recharge. This, together with some early December infiltration, triggered a 15 metre rise in groundwater levels at Tilshead (in the western Chalk outcrop). Levels across the Chalk are generally within, or above, the normal early winter range but relatively low in some eastern areas where, for some index boreholes (e.g. Washpit Farm), the seasonal recovery is still awaited. Above average levels also characterise most index wells in the Limestone and Permo-Triassic sandstones aquifers with notably high levels at several locations – including Skirwith which benefited from the extreme November rainfall across Cumbria.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

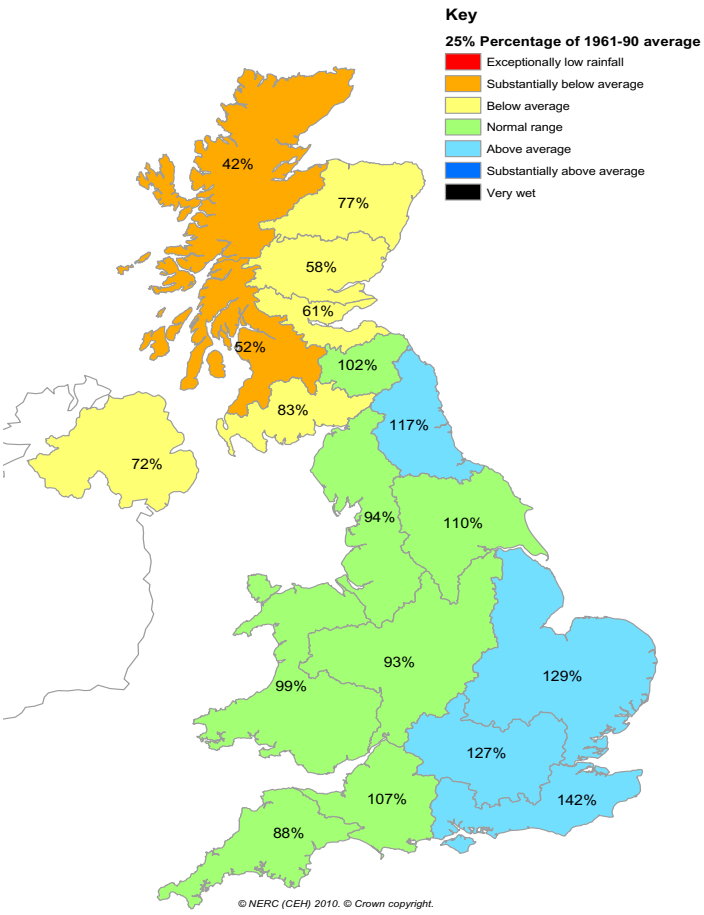
Area	Rainfall	Dec 2009	Oct 09 - Dec 09		Aug 09 - Dec 09		Mar 09 - Dec 09		Jan 09 - Dec 09	
England & Wales	**mm**	**102**	**374**		**473**		**824**		**968**	
	%	**107**	**137**	**5-15**	**110**	**2-5**	**110**	**2-5**	**107**	**2-5**
North West	mm	**118**	508		707		1196		1357	
	%	**94**	134	10-20	117	5-10	117	10-20	112	5-10
Northumbrian	mm	**96**	367		494		872		993	
	%	**117**	149	30-40	123	5-10	121	10-20	115	5-10
Severn Trent	mm	**73**	268		340		675		779	
	%	**93**	124	2-5	97	2-5	105	2-5	101	2-5
Yorkshire	mm	**91**	347		439		778		888	
	%	**110**	145	10-20	114	2-5	112	2-5	106	2-5
Anglian	mm	**72**	213		269		488		590	
	%	**129**	129	5-10	99	2-5	95	2-5	98	2-5
Thames	mm	**91**	287		363		604		735	
	%	**127**	143	5-10	113	2-5	103	2-5	105	2-5
Southern	mm	**117**	396		457		680		848	
	%	**142**	159	10-20	122	2-5	105	2-5	108	2-5
Wessex	mm	**102**	386		467		773		936	
	%	**107**	148	5-15	116	2-5	111	2-5	110	2-5
South West	mm	**124**	478		581		1067		1307	
	%	**88**	124	2-5	103	2-5	112	2-5	110	2-5
Welsh	mm	**155**	593		736		1258		1453	
	%	**99**	135	5-10	111	2-5	114	5-10	108	2-5
Scotland	**mm**	**88**	**517**		**845**		**1415**		**1666**	
	%	**56**	**109**	**2-5**	**115**	**5-15**	**117**	**35-50**	**113**	**10-20**
Highland	mm	**82**	545		932		1592		1904	
	%	**42**	94	2-5	106	2-5	111	10-20	109	5-10
North East	mm	**76**	405		608		1039		1204	
	%	**77**	133	10-20	125	10-20	121	30-40	117	20-30
Tay	mm	**78**	498		777		1306		1521	
	%	**58**	126	5-10	126	10-20	125	30-50	118	10-20
Forth	mm	**69**	396		652		1107		1267	
	%	**61**	113	2-5	116	5-10	117	10-20	111	5-10
Tweed	mm	**99**	396		613		1009		1166	
	%	**102**	136	10-20	129	10-20	121	15-25	116	10-20
Solway	mm	**124**	587		950		1529		1772	
	%	**83**	129	5-15	132	30-40	129	>100	123	40-60
Clyde	mm	**97**	619		1044		1720		2000	
	%	**52**	109	2-5	117	5-15	120	25-40	114	10-20
Northern Ireland	**mm**	**79**	**398**		**597**		**1063**		**1236**	
	%	**72**	**120**	**5-10**	**113**	**2-5**	**118**	**10-20**	**112**	**5-10**

% = percentage of 1961-90 average *RP = Return period*

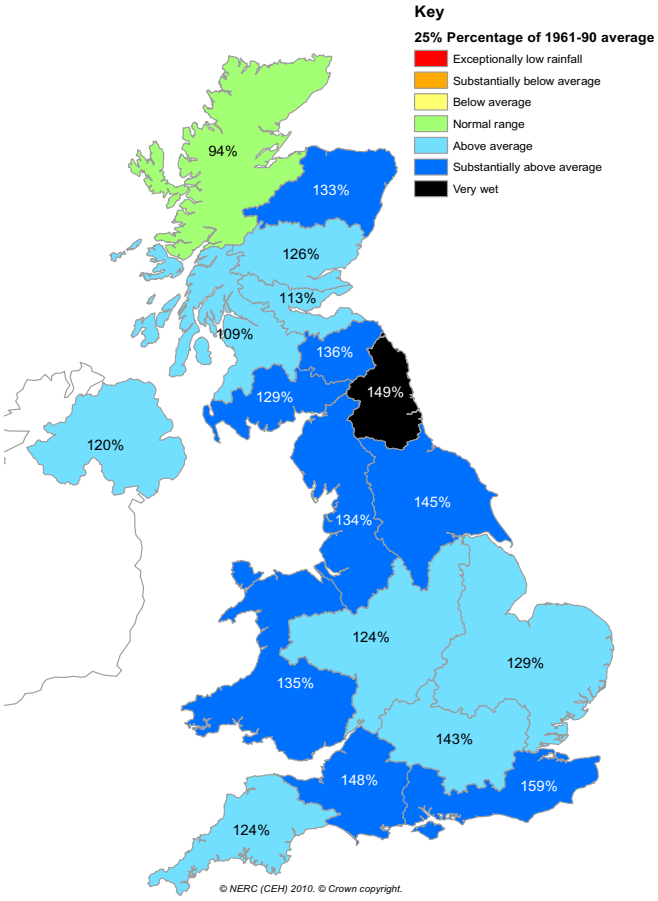
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and derived following the method described in: Tabony, R. C. 1977, *The variability of long duration rainfall over Great Britain*. Met Office Scientific Paper no. 37. The estimates reflect climatic variability since 1913 and assume a stable climate. The timespans featured do not purport to represent the critical periods for any particular water resource management zone. For hydrological or water resources assessments of drought severity, river flows and/or groundwater levels normally provide a better guide than return periods based on regional rainfall totals.
All monthly rainfall totals since June 2009 are provisional.

Rainfall . . . Rainfall . . .

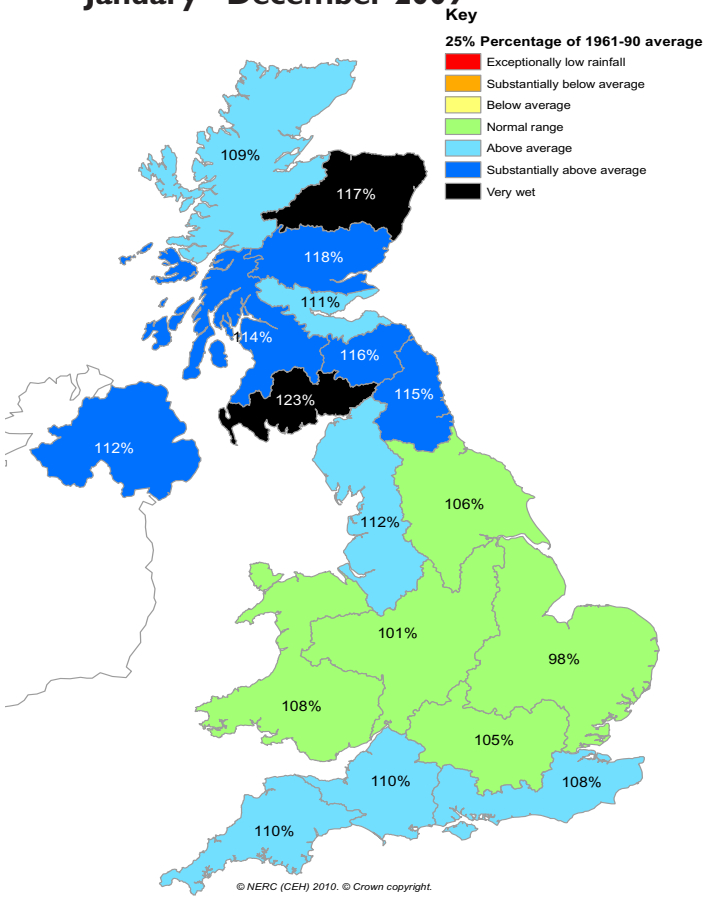
December 2009



October - December 2009



January - December 2009



Met Office Winter 2009/10 forecast

Forecast for Winter 2009/10:
Issued 30 December 2009

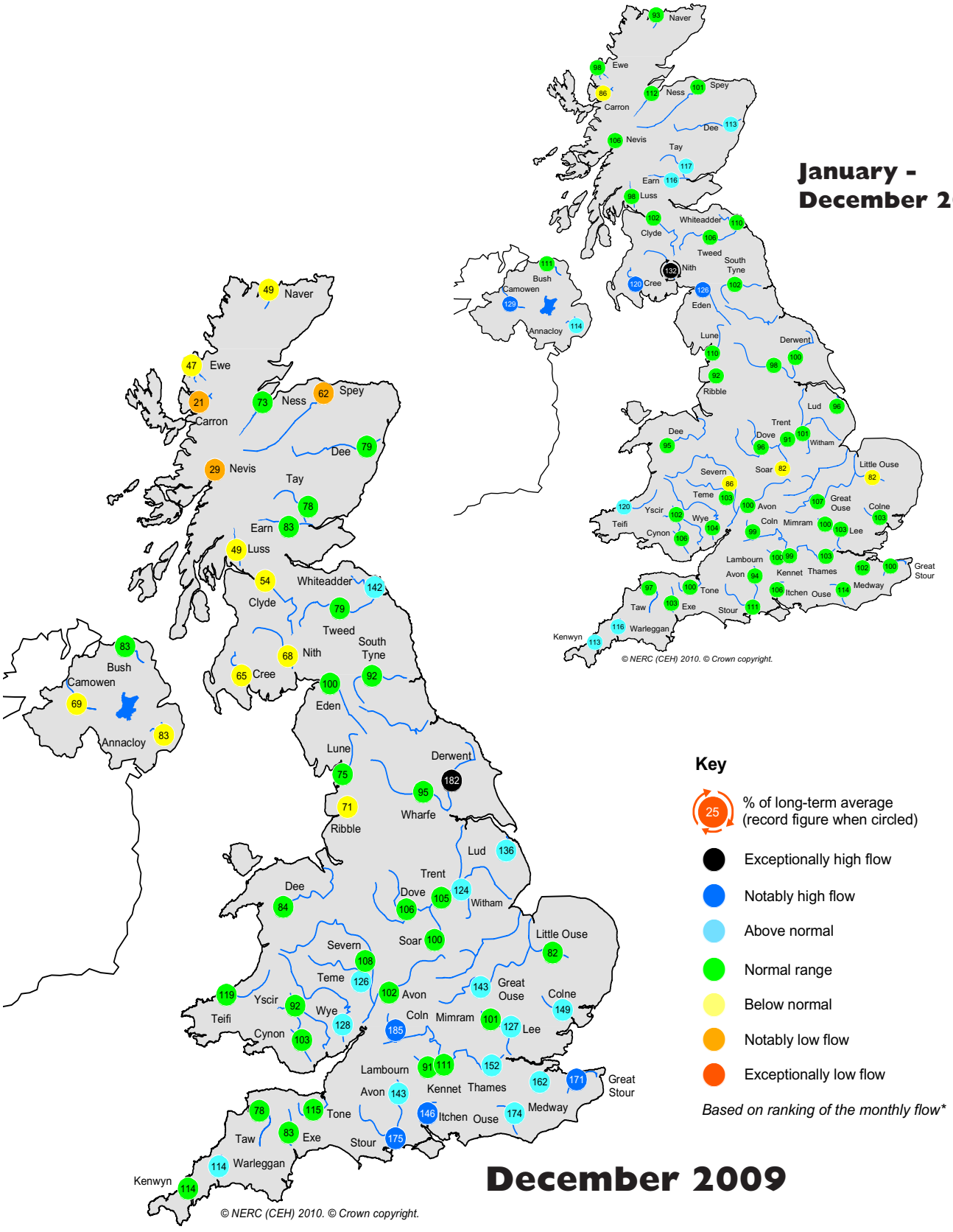
Temperature
For the rest of winter, over northern Europe including the UK, the chance of colder conditions is now 45%; there is a 30% chance of average and a 25% chance of milder conditions.

Rainfall
For the rest of winter, for northern Europe including the UK, there are near-equal chances for each of the three categories. There is a 30% chance of a drier winter, a 35% chance of an average winter and a 35% chance of a wetter winter.

Updates and reviews of the forecast
A monthly appraisal of the winter will start in early February 2010.

For further details please visit:
http://www.metoffice.gov.uk/weather/seasonal/2009/winter/

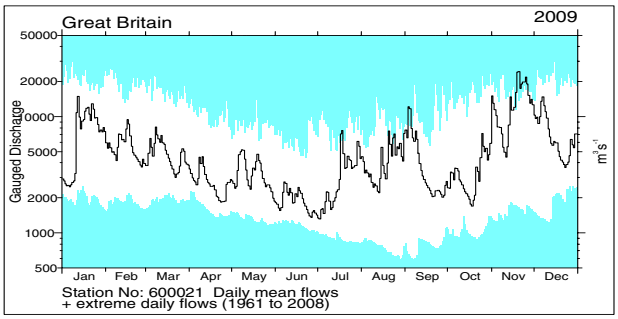
River flow . . . River flow . . .

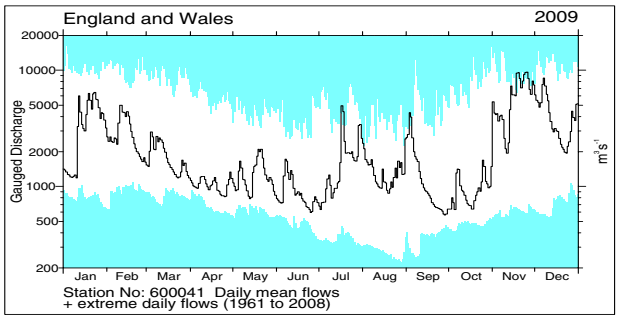


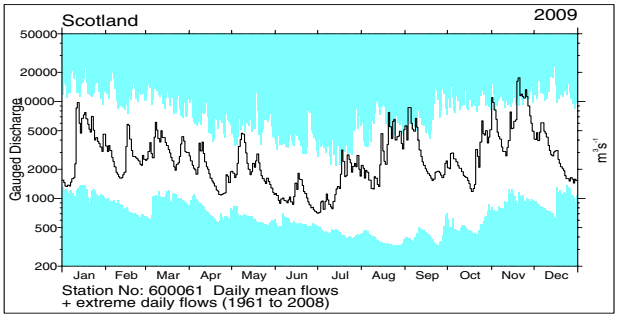
River flows

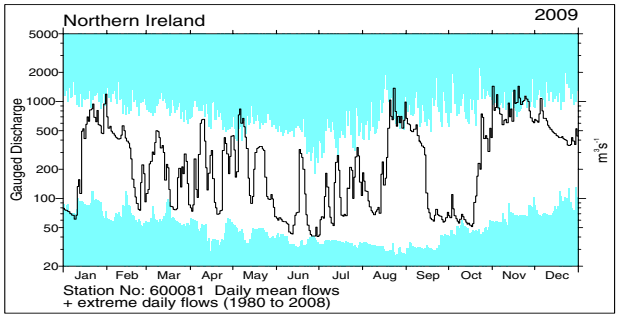
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the period of record on which these percentages are based varies from station to station. Percentages may be omitted where flows are under review.

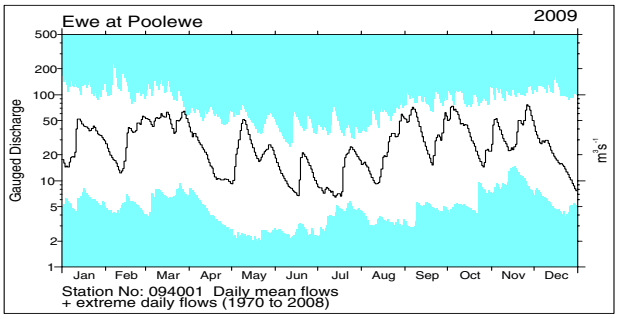
River flow . . . River flow . . .

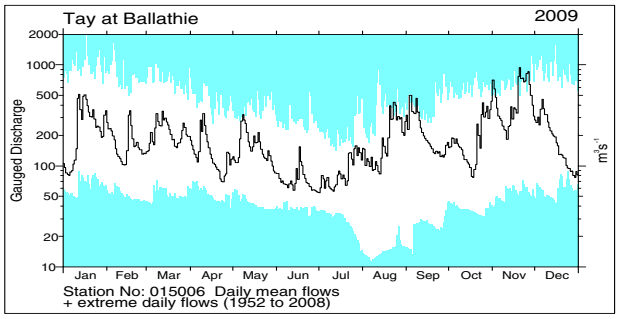


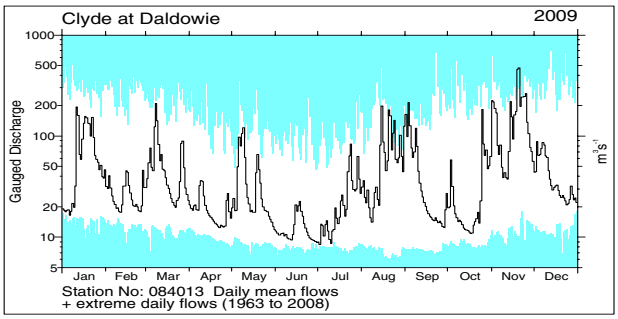


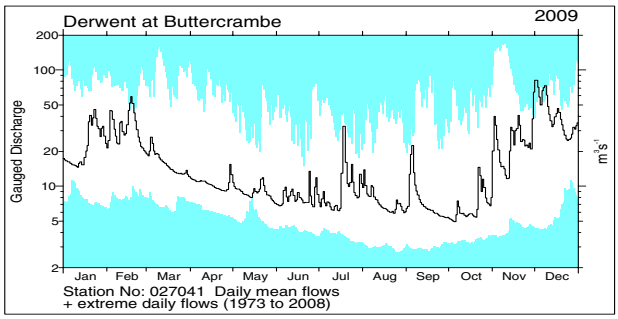


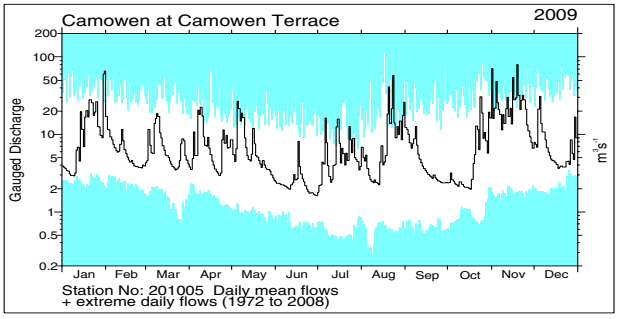


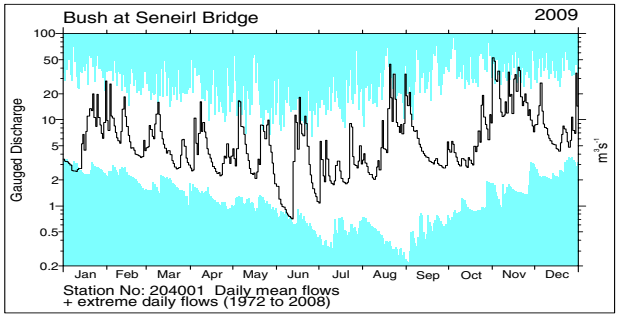








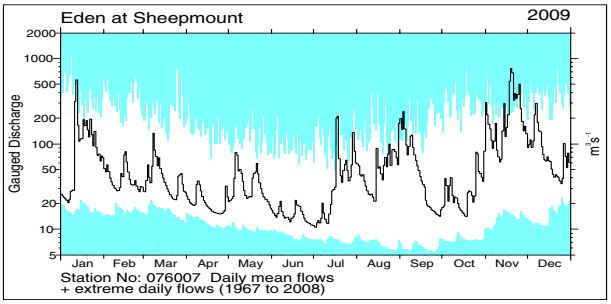


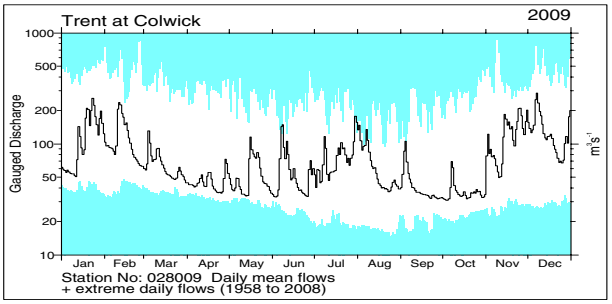


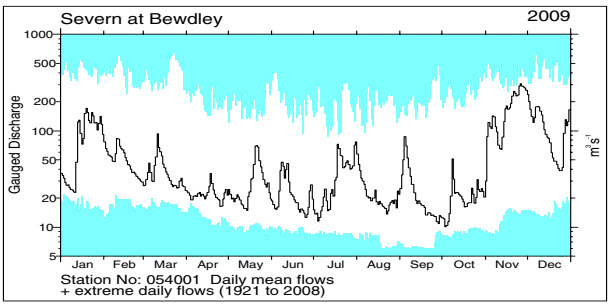
River flow hydrographs

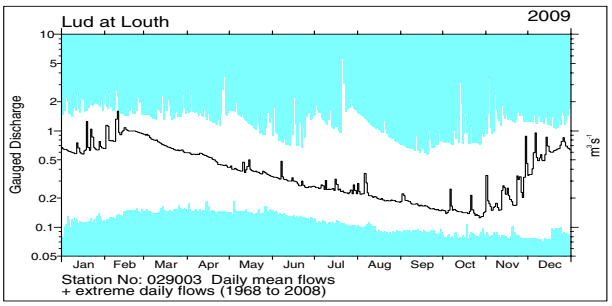
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to January 2009 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

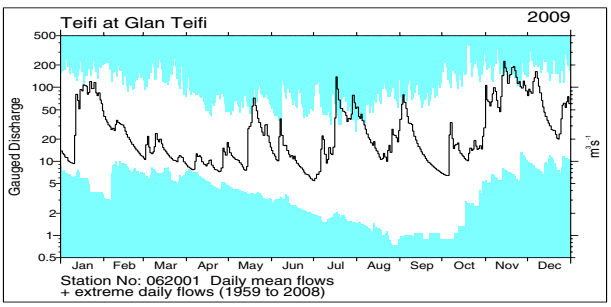
River flow . . . River flow . . .

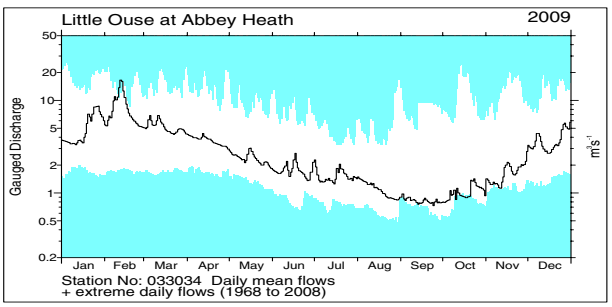


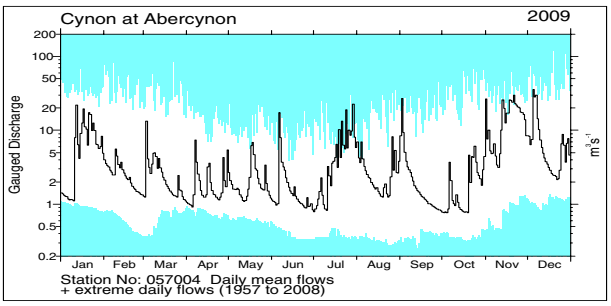


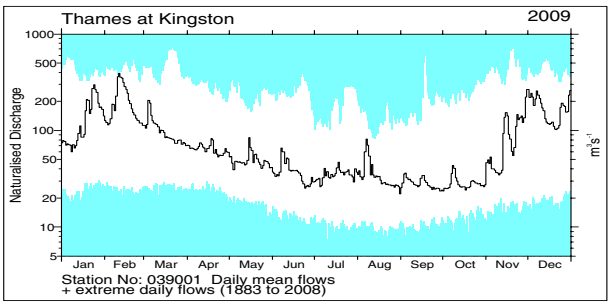


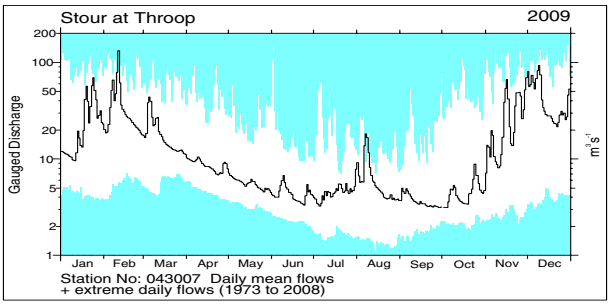


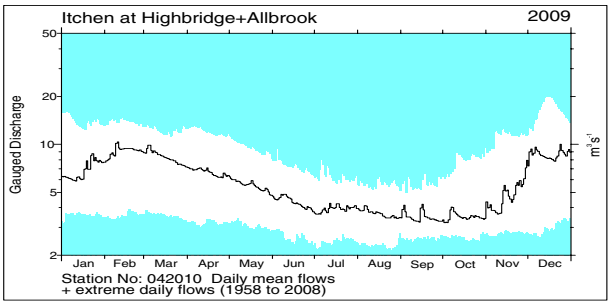












Notable runoff accumulations (a) October - December 2009, (b) August - December 2009,

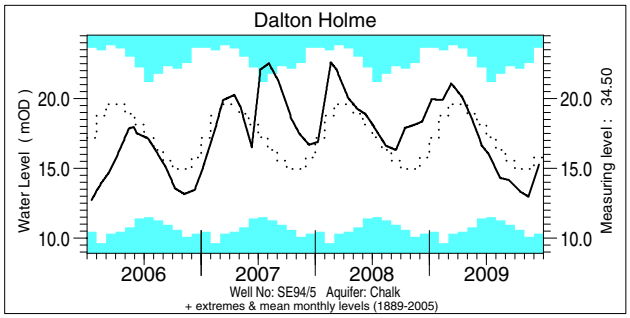
	River	%lta	Rank
a)	Wharfe	140	51/55
	Mole	170	32/35
	Otter	137	44/48
	Wye	151	69/74
	Teifi	138	49/51
	Lune	131	44/49
	Carron	65	5/31

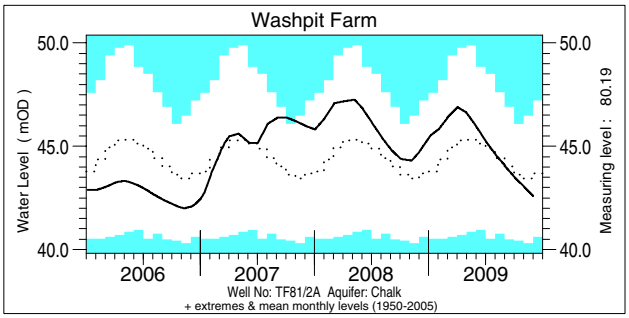
	River	%lta	Rank
b)	Dee (Park)	141	34/37
	Tay	144	53/57
	Forth	136	26/29
	Tweed (Boleside)	142	47/49
	Tyne (Bywell)	147	48/51
	Dover Beck	169	31/34
	Mole	153	32/35
	Lymington	155	43/47

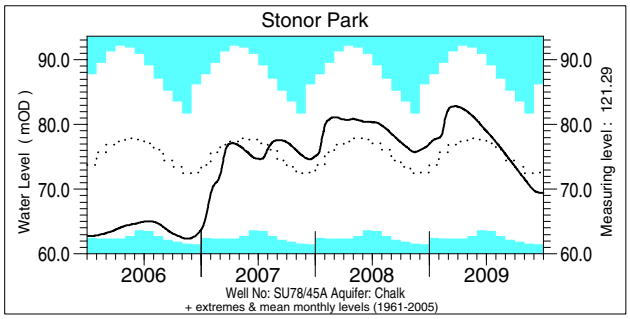
	River	%lta	Rank
b)	Eden	166	41/42
	Nith	153	52/52
	Cree	136	42/46
	Clyde (Blariston)	138	47/50
	Camowen	148	37/37
	Mourne	141	28/28

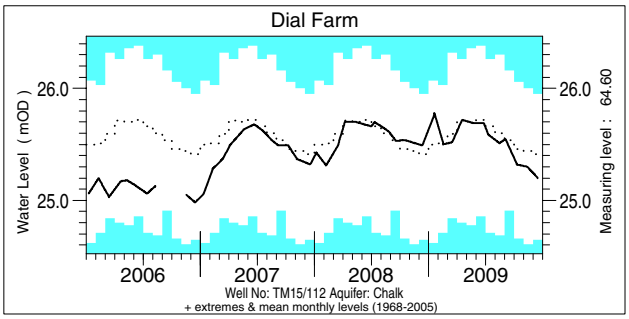
lta = long term average
Rank 1 = lowest on record

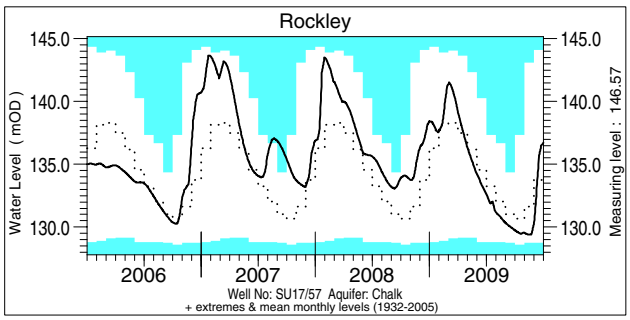
Groundwater . . . Groundwater

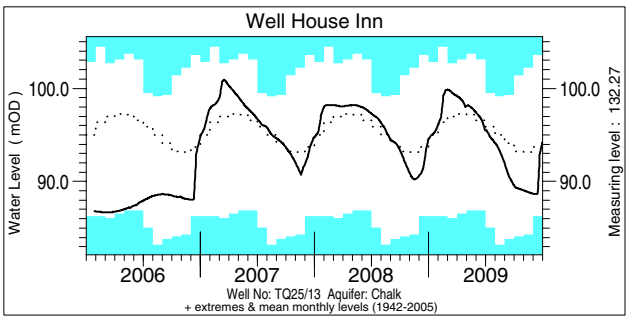


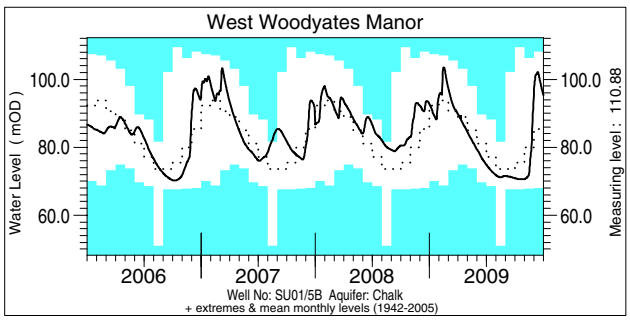


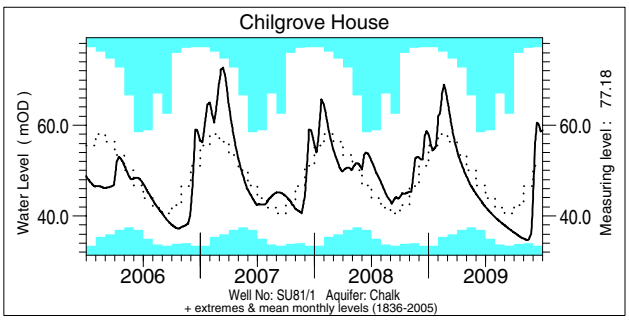


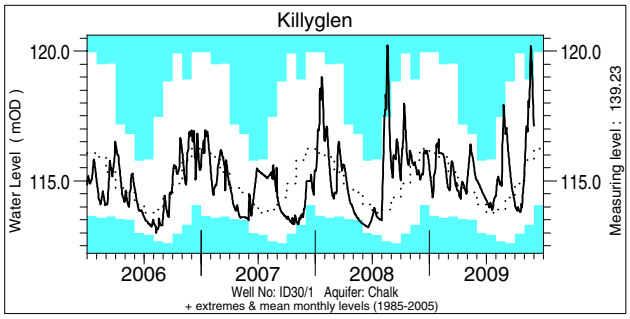


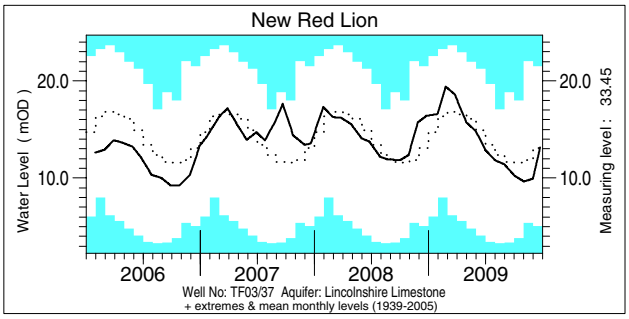






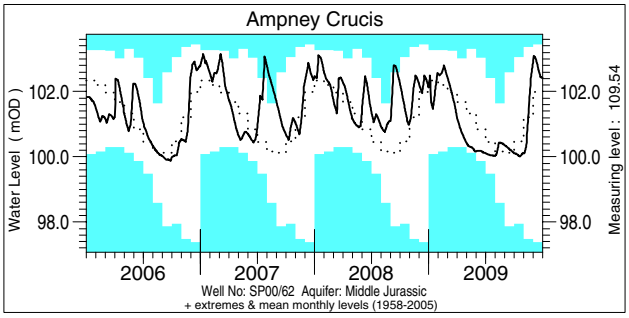


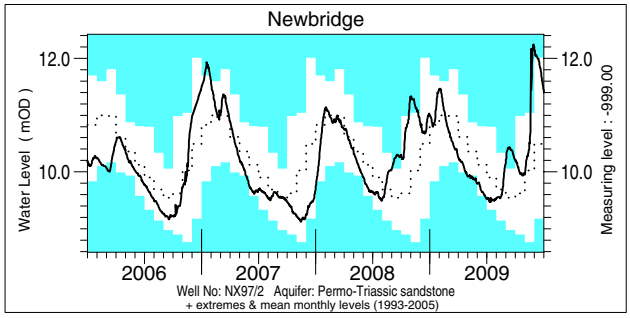


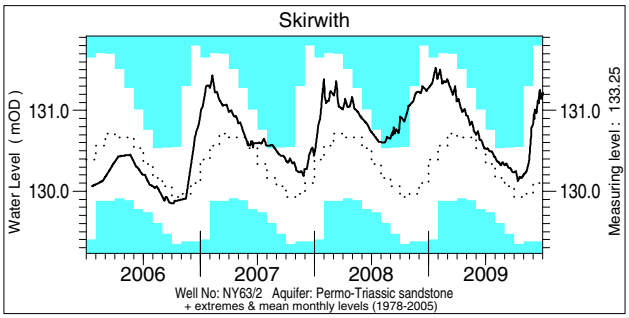


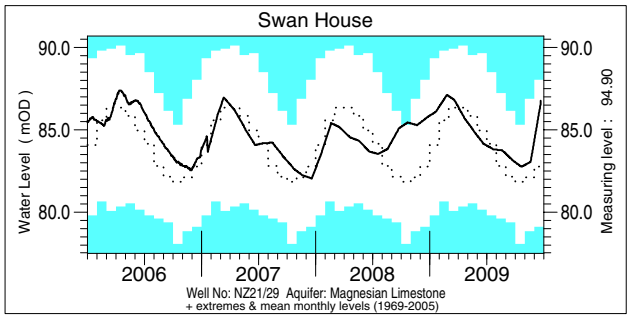
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly mean and the highest and lowest levels recorded for each month are displayed in a similar style to the river flow hydrographs. Note that most groundwater levels are not measured continuously – the latest recorded levels are listed overleaf.

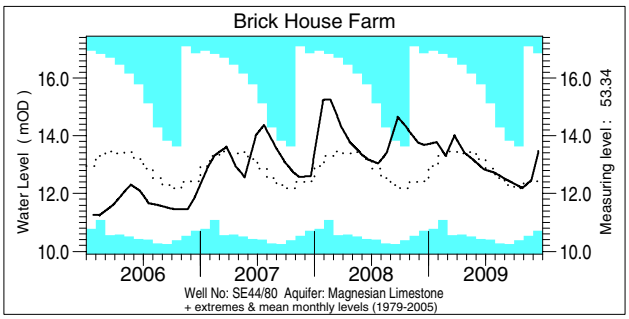
Groundwater . . . Groundwater

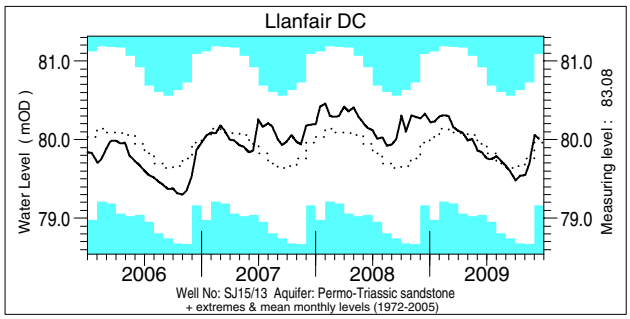


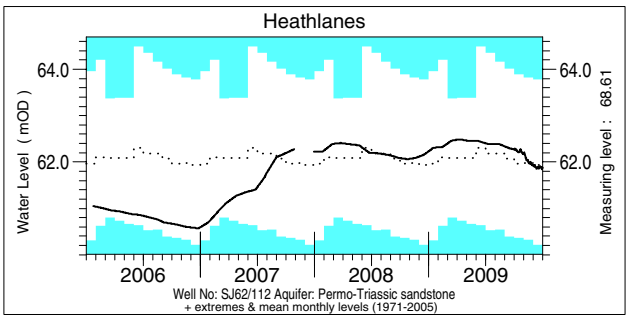


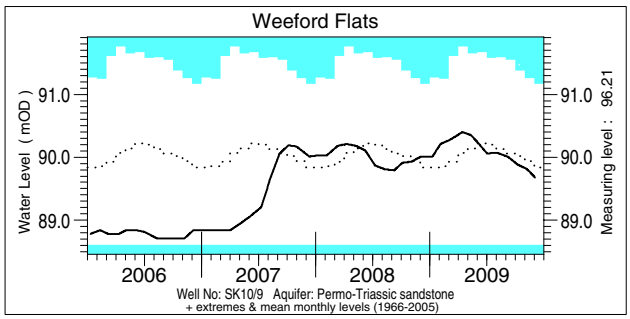


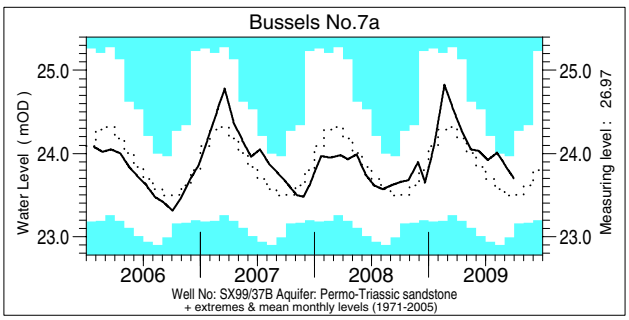


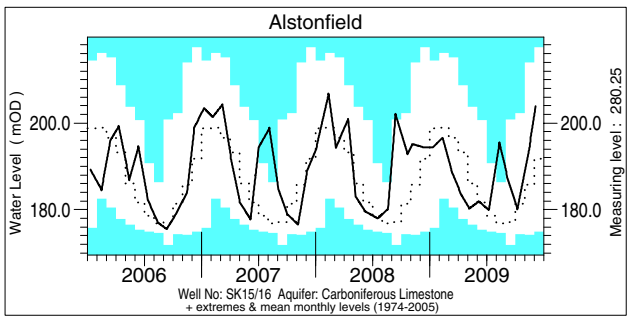








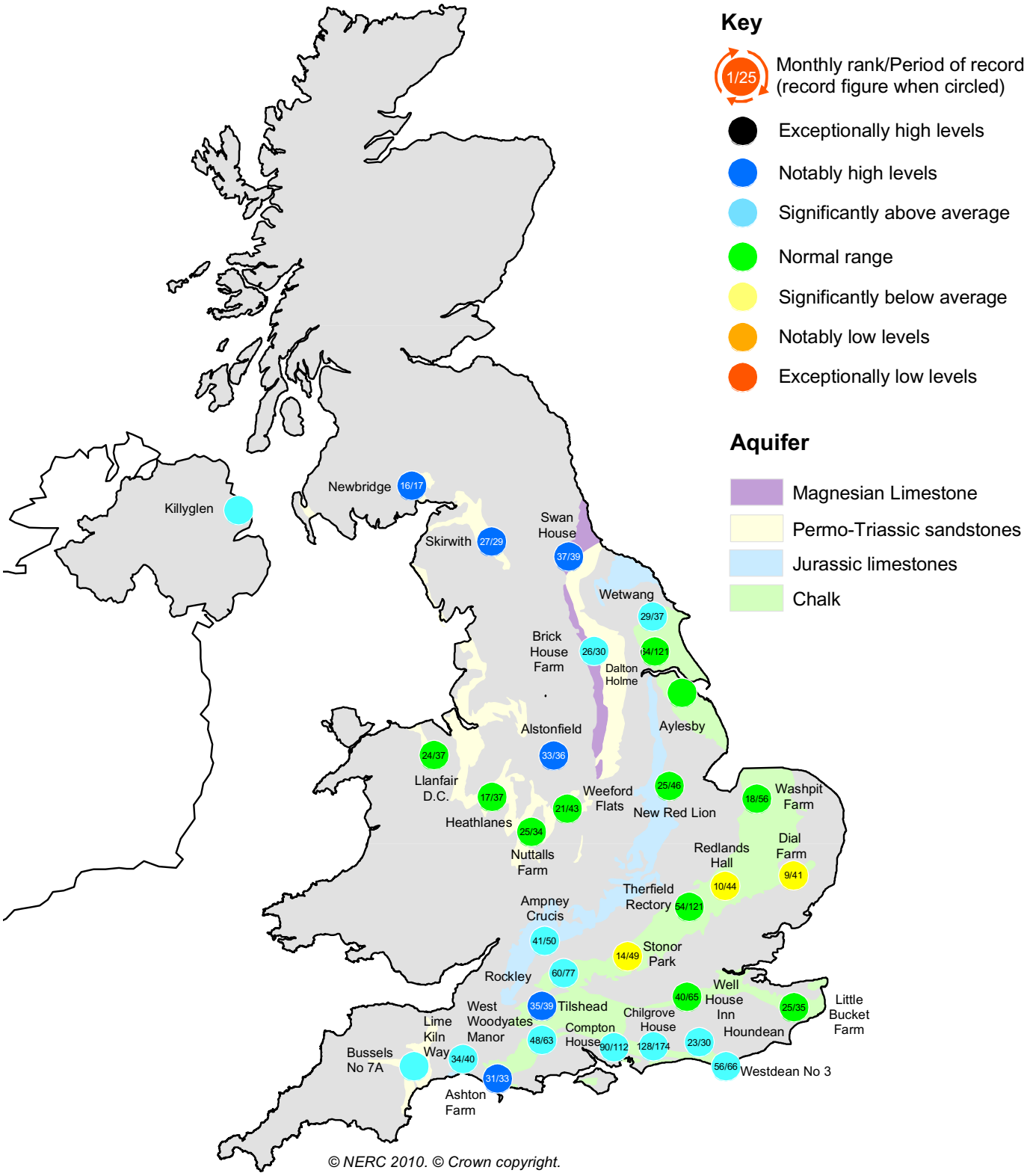




Groundwater levels December 2009 / January 2010

Borehole	Level	Date	Dec. av.	Borehole	Level	Date	Dec. av.	Borehole	Level	Date	Dec. av.
Dalton Holme	15.29	16/12	15.59	Chilgrove House	58.90	31/12	51.91	Brick House Farm	13.48	17/12	12.45
Washpit Farm	42.67	04/01	43.43	Killyglen (NI)	117.12	30/11	116.12	Llanfair DC	80.01	15/12	79.89
Stonor Park	69.97	05/01	72.46	New Red Lion	13.18	22/12	13.04	Heathlanes	61.88	31/12	61.89
Dial Farm	25.20	15/12	25.40	Ampney Crucis	102.62	05/01	102.00	Weeford Flats	89.68	02/12	89.65
Rockley	136.84	05/01	133.91	Newbridge	11.37	01/01	10.48	Bussels No.7a	24.21	25/11	23.83
Well House Inn	94.69	04/01	93.60	Skirwith	131.20	01/01	130.29	Alstonfield	203.95	04/12	192.74
West Woodyates	95.20	31/12	87.03	Swan House	86.76	21/12	83.10	*Levels in metres above Ordnance Datum*			

Groundwater . . .Groundwater



Groundwater levels - December 2009

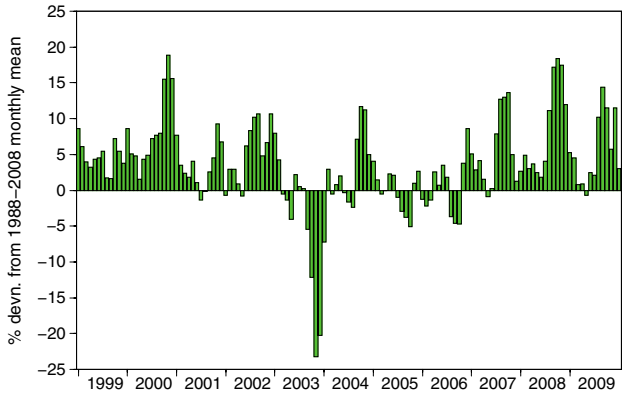
The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods of record. Rankings may be omitted where they are considered misleading.

Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.

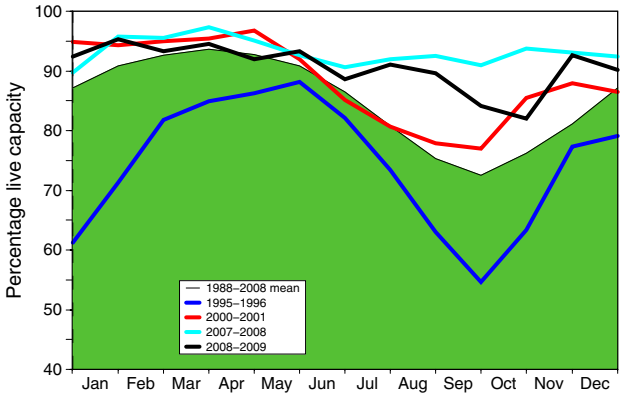
ii. Yew Tree Farm levels are now received quarterly.

Reservoirs . . . Reservoirs . . .

Guide to the variation in overall reservoir stocks for England and Wales



Comparison between overall reservoir stocks for England and Wales in recent years



These plots are based on the England and Wales figures listed below.

Percentage live capacity of selected reservoirs at start of month

Area	Reservoir		Capacity (Ml)	2009 Nov	Dec	2010 Jan	Jan Anom.	Min Jan	Year* of min	2009 Jan	Diff 10-09
North West	N Command Zone	•	124929	90	99	**90**	4	51	1996	92	-2
	Vyrnwy		55146	72	99	**90**	-1	35	1996	90	0
Northumbrian	Teesdale	•	87936	92	98	**87**	-1	41	1996	83	4
	Kielder		(199175)	(88)	(97)	**(87)**	-4	70	1990	90	-3
Severn Trent	Clywedog		44922	79	98	**79**	-5	54	1996	83	-4
	Derwent Valley	•	39525	67	100	**92**	3	10	1996	99	-7
Yorkshire	Washburn	•	22035	77	93	**96**	13	23	1996	94	2
	Bradford supply	•	41407	74	100	**98**	9	22	1996	99	-1
Anglian	Grafham		(55490)	(81)	(84)	**(85)**	1	57	1998	92	-7
	Rutland		(116580)	(69)	(70)	**(75)**	-7	60	1991	90	-15
Thames	London	•	196628	80	94	**96**	11	60	1991	96	0
	Farmoor	•	13822	85	81	**86**	-5	71	1991	96	-10
Southern	Bewl		28170	45	54	**86**	14	34	2006	80	6
	Ardingly		4685	55	72	**97**	13	41	2004	100	-3
Wessex	Clatworthy		5364	72	100	**100**	9	54	2004	100	0
	Bristol WW	•	(38666)	(57)	(80)	**(100)**	23	40	1991	96	4
South West	Colliford		28540	95	100	**94**	18	46	1996	98	-4
	Roadford		34500	86	98	**99**	22	23	1996	96	3
	Wimbleball		21320	81	100	**100**	17	46	1996	100	0
	Stithians		4967	75	91	**100**	25	33	2002	95	5
Welsh	Celyn and Brenig	•	131155	85	95	**92**	0	54	1996	94	-2
	Brianne		62140	95	100	**96**	-1	76	1996	92	4
	Big Five	•	69762	89	91	**89**	0	67	1996	92	-3
	Elan Valley	•	99106	93	100	**100**	4	56	1996	97	3
Scotland(E)	Edinburgh/Mid Lothian	•	97639	92	100	**99**	10	60	1999	97	2
	East Lothian	•	10206	97	99	**100**	5	48	1990	99	1
Scotland(W)	Loch Katrine	•	111363	93	100	**89**	0	75	2008	98	-9
	Daer		22412	93	98	**99**	2	83	1996	99	0
	Loch Thom	•	11840	95	96	**96**	0	80	2008	96	0
Northern Ireland	Total+	•	56920	96	99	**96**	12	61	2002	90	6
	Silent Valley	•	20634	95	99	**92**	11	39	2002	91	1

() figures in parentheses relate to gross storage • denotes reservoir groups +excludes Lough Neagh *last occurrence

Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2008 period except for West of Scotland and Northern Ireland where data commence in the mid-1990's. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.
The London total has been revised to 196628 Ml as of November 2009.

Location map . . . Location map

National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme (NHMP)[#] is undertaken jointly by the Centre for Ecology & Hydrology (CEH) and the British Geological Survey (BGS). Financial support for the production of the monthly Hydrological Summaries is provided by the Department for Environment, Food and Rural Affairs (Defra), the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA), the Rivers Agency (RA) in Northern Ireland, and the Office of Water Services (OFWAT).

Data Sources

River flow and groundwater level data are provided by the Environment Agency, the Environment Agency Wales, the Scottish Environment Protection Agency and, for Northern Ireland, the Rivers Agency and the Northern Ireland Environment Agency. In all cases the data are subject to revision following validation (flood and drought data in particular may be subject to significant revision). Reservoir level information is provided by the Water Service Companies, the EA, Scottish Water and Northern Ireland Water.

The National River Flow Archive (maintained by CEH) and the National Groundwater Level Archive (maintained by BGS) provide the historical perspective within which to examine contemporary hydrological conditions.

Rainfall

Most rainfall data are provided by the Met Office (see opposite). To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA and SEPA. Following the discontinuation of the Met Office's CARP system in July 1998, the areal rainfall figures have been derived using several procedures, including initial estimates based on MORECS[*]. Recent figures have been produced by the Met Office, National Climate Information Centre (NCIC), using a technique similar to CARP. A significant number of additional monthly raingauge totals are provided by the EA and SEPA to help derive the contemporary regional rainfalls. Revised monthly national and regional rainfall totals for the post-1960 period (together with revised 1961-90 averages) were made available by the Met Office in 2004; these have been adopted by the NHMP. As with all regional figures based on limited raingauge networks the monthly tables and accumulations (and the return periods associated with them) should be regarded as a guide only.
The monthly rainfall figures are provided by the Met Office (National Climate Information Centre) and are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

[*]MORECS is the generic name for the Met Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain.
[#] Instigated in 1988

NATURAL ENVIRONMENT RESEARCH COUNCIL

For further details please contact:

The Met Office
FitzRoy Road
Exeter
Devon
EX1 3PB

Tel.: 0870 900 0100 Fax: 0870 900 5050
E-mail: enquiries@metoffice.com

The National Hydrological Monitoring Programme depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged.

Subscription

Subscription to the Hydrological Summaries costs £48 per year. Orders should be addressed to:

Hydrological Summaries
Centre for Ecology & Hydrology
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB

Tel.: 01491 838800
Fax: 01491 692424
E-mail: nrfa@ceh.ac.uk

Selected text and maps are available on the WWW at
http://www.ceh.ac.uk/data/nrfa/index.html
Navigate via Water Watch

01/10