Hydrological Summary

for the United Kingdom

June 2007

General

Provisional data suggest that the June rainfall exceeded the previous maximum (in a series from 1914) by a wide margin across a large swathe of the Midlands and northern England – where, in Yorkshire, the highest rainfall on record for any month was recorded. This triggered flooding on a scale that has no close modern parallel for the summer period (June-Aug). Exceptionally intense storm events caused severe flash flooding in many areas and, as catchments became saturated, significant floodplain inundations were reported for several major river basins. A number of fatalities were attributed to the flooding, emergency services were widely deployed and transport disruption was severe, widespread and sustained. The cost of the flooding to insurers has been estimated at £1.5 billion. Many new maximum June river flows were established and some rivers in North East and Midlands registered period-of-record maximum flows for any month. Monthly runoff totals were outstanding across northern England and the Midlands. The extreme rainfall, together with below average evaporation losses and moderate water demand ensure that, notwithstanding drawdown for flood alleviation purposes, overall reservoir stocks for England and Wales are well above the early July average. The sustained late spring and early summer rainfall across most major aquifer outcrop areas has provided a seasonally late pulse of recharge, although given the time taken for the aquifers to respond, most groundwater levels are currently in the normal range. Correspondingly, the water resources outlook is very healthy, but the remarkably wet June has underlined the UK's vulnerability to extreme rainfall events, particularly where they coincide with concentrations of population.

Rainfall

Following a dry start to June, an unusually southerly position of the polar jet stream and the stagnation of several low pressure systems over central Britain contributed to a remarkably wet month punctuated by convective storms of notable intensity. Torrential local downpours occurred throughout the month (20mm in 15 minutes in Bangor, Northern Ireland on the 12th; 50mm in an hour in Manston, Kent on the 19th). 24-hr rainfall totals exceeding the monthly average are not especially rare in summer but their frequency and spatial extent this year were remarkable. Some localities in northern England reported exceptional 24-hr totals on both the 15/16th and 24/25th – when Winestead (E of Hull) registered 120 mm (return period >200 yrs), of which 100 mm (a sixth of the annual rainfall) fell in 12 hours. June was remarkably dry in the Shetlands (the second driest June since 1930 was recorded at Lerwick) but to the south, many June maxima were eclipsed. Sheffield reported its highest monthly rainfall total in a 125-yr series. New maximum June totals were established for several regions (including Midlands, North West, Northern Ireland); for Yorkshire, the monthly total for June (212mm) was the highest for any month in a series from 1914. Rainfall for all regions exceeded the June average and the provisional UK total considerably exceeds the previous maxima. Furthermore, the combined May/June period was exceptionally wet – the wettest recorded (since 1914) for all regions in E&W. Notwithstanding an arid April, rainfall totals for the year thus far are above average in all regions – the Jan-Jun rainfall was second highest since 1900 in the E&W record and the third highest for Scotland. Similarly, 12-month totals are above average in all regions, and exceptionally so in most Scottish regions and central and eastern parts of England.

River Flows

Seasonal river flow recessions are normally well established by June but this year witnessed a remarkable distribution and frequency of flood events – flash floods occurred in small steep catchments and urban areas as drainage capacities were overwhelmed. By late on the 25th >270 flood alerts (with >15 Severe Flood Warnings) were in operation throughout England and Wales. Many low-lying localities had to be evacuated and disruption to road and rail transport was extensive and sustained. The worst affected areas were in Northern England (particularly urban areas in South Yorkshire and Humberside) and the Midlands, although flood damage was reported from areas as far apart as County Tyrone, Gloucestershire and Norfolk. Structural damage to property and bridges was common – near Rotherham, hundreds of people were evacuated after concerns that the Ulley dam may burst. With catchments saturated during the final week, flood risk extended across many major basins. Notable summer floodplain inundations caused widespread damage to crops and required the removal of livestock to higher ground. Record June maximum flows were established in 12 out of the 75 index stations returning high flow data; this included some major rivers such as the Severn, Trent and the Dee in north Wales. Period-of-record maxima (for any month) were established on the 28-year long Annacloy record and the 39 year record for the Lud (although a 1920 event was substantially higher), and the Teme also approached its long-term maximum. Provisional data reveal that period-of-record maximum flows were recorded in a number of catchments in South Yorkshire (including the Rother, the Dearne and the Don, where the event eclipsed the 2000 peak flow) and Upper Trent area north of Nottingham. Notably high June runoff totals were registered from Cornwall to NE Scotland, with many index gauging stations in the North East and Midlands establishing new maximum June runoff totals. Correspondingly, total outflow from England and Wales exceeded the previous maximum by a very wide margin. Remarkably, the risk of further flooding remained high in many areas entering July.

Groundwater

It is generally rare for soil moisture deficits (SMDs) in early July to be lower than in early May, but such seasonally-contrary circumstances were common this year. SMDs were typically well below the monthly average, and were eliminated or close to zero over a significant proportion of the major aquifers during the latter half of June. Continuing wet conditions resulted in some late recharge: provisional estimates suggest that June recharge, whilst still modest relative to magnitudes seen in late winter, was well above the monthly average in some parts of Thames region. However, the impact of much of the June infiltration may not be evident until well into July. The majority of the June hydrographs show a continuation of the seasonal recession – although there is evidence of the decline slowing in some boreholes. There is variation in the response of the major aquifers: in a few cases hydrographs show a recovery (e.g. in the responsive Killyglen borehole and also in Brick House Farm) but these may be a localised response. It should be noted that observations predate the late June rainfall in some areas where the most significant rainfall occurred (e.g. in Humberside, where the Wetwang and Dalton Holme boreholes are located). Overall, June levels were within the normal range in most index wells, although below average levels were recorded at some sites in the west of the Chalk aquifer and in the slowly-responding Sherwood sandstones, where the low levels reflect the influence of previous dry winters. Early July SMDs suggest that given normal autumn rainfall patterns we may expect a relatively early onset of 2007/08 recharge.

Centre for Ecology & Hydrology
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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Area	Rainfall	Jun 2007	May 07-Jun 07	RP	Jan 07-Jun 07	RP	Oct 06-Jun 07	RP	Jul 06-Jun 07	RP
England	**mm**	**144**	**255**		**540**		**898**		**1106**	
& Wales	%	**227**	**201**	**>100**	**130**	**10-20**	**130**	**30-40**	**122**	**15-25**
North West	mm	**184**	273		627		1154		1431	
	%	**225**	173	35-50	120	5-10	128	20-30	118	5-15
Northumbrian	mm	**162**	234		497		792		991	
	%	**260**	188	70-100	125	5-15	123	10-20	114	5-10
Severn Trent	mm	**155**	264		504		781		985	
	%	**260**	221	>100	139	30-40	135	30-50	128	30-40
Yorkshire	mm	**212**	289		521		803		1041	
	%	**342**	235	>100	134	15-25	128	15-25	125	20-30
Anglian	mm	**120**	234		405		590		789	
	%	**231**	232	>100	143	30-50	132	30-40	131	30-50
Thames	mm	**92**	213		439		721		913	
	%	**168**	192	50-80	133	10-20	136	30-40	130	30-40
Southern	mm	**98**	197		446		771		932	
	%	**179**	181	35-50	124	5-10	127	10-20	119	5-15
Wessex	mm	**116**	241		522		889		1065	
	%	**201**	202	80-120	131	10-20	135	30-40	125	10-20
South West	mm	**136**	294		706		1187		1357	
	%	**195**	205	>100	127	5-15	126	10-20	114	5-10
Welsh	mm	**169**	299		763		1375		1604	
	%	**209**	180	50-80	127	5-15	132	30-40	119	10-20
Scotland	**mm**	**112**	**247**		**812**		**1511**		**1827**	
	%	**130**	**144**	**20-30**	**127**	**20-30**	**136**	**>100**	**124**	**50-80**
Highland	mm	**80**	264		1023		1901		2242	
	%	**81**	137	10-20	136	40-60	142	>100	129	>100
North East	mm	**118**	235		549		949		1164	
	%	**171**	165	30-40	118	5-10	123	15-25	113	5-10
Tay	mm	**152**	261		748		1385		1676	
	%	**199**	160	20-35	127	10-20	141	>100	130	40-60
Forth	mm	**122**	214		610		1176		1450	
	%	**170**	144	10-20	120	5-10	137	>100	127	30-50
Tweed	mm	**134**	229		533		938		1208	
	%	**198**	162	20-35	117	5-10	126	15-25	120	10-20
Solway	mm	**182**	289		764		1434		1763	
	%	**215**	167	30-50	122	5-15	133	40-60	123	20-30
Clyde	mm	**127**	259		912		1770		2184	
	%	**131**	134	5-10	122	5-15	135	80-120	125	30-50
Northern	**mm**	**155**	**288**		**562**		**956**		**1252**	
Ireland	%	**211**	**156**	**15-25**	**112**	**2-5**	**115**	**5-10**	**114**	**5-10**

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

Important note: Figures in the above table may be quoted provided that their source is acknowledged. See page 12. Where appropriate, specific reference must be made to the uncertainties associated with the return period estimates. Generally, the return period estimates are based on tables provided by the Met Office* but those for Northern Ireland are based on the estimates for north-west England. The estimates relate to the specified region and span of months only (RPs may be an order of magnitude less if n-month periods beginning in any month are considered), they reflect rainfall variability over the period 1911-70 only, and assume a stable climate. (For further details see Tabony, R. C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37). The timespans featured do not purport to represent the critical periods for any particular water resource management zone and, normally, for hydrological or water resources assessments of drought severity, river flows and groundwater levels provide a better guide than return periods based on rainfall totals. *In some cases ranking positions of accumulated rainfalls are also considered.

All monthly rainfall totals since December 2006 are provisional.

Rainfall . . . Rainfall . . .

Key

00% Percentage of 1961-90 average

Very wet

Substantially above average

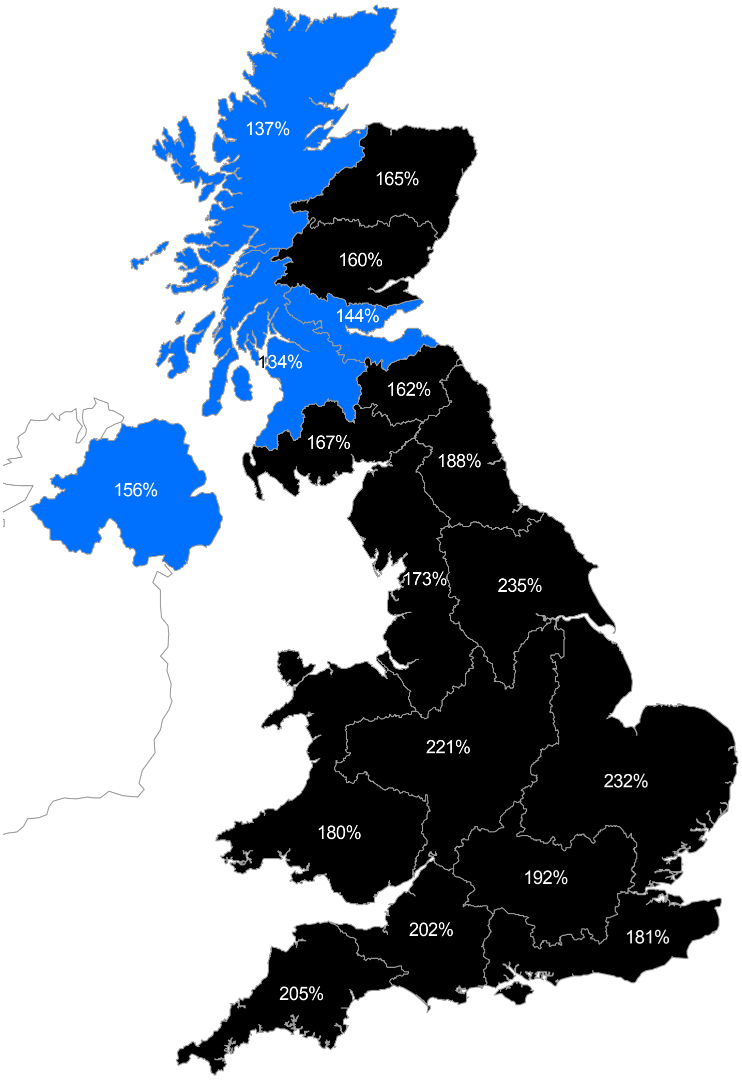
Above average

Normal range

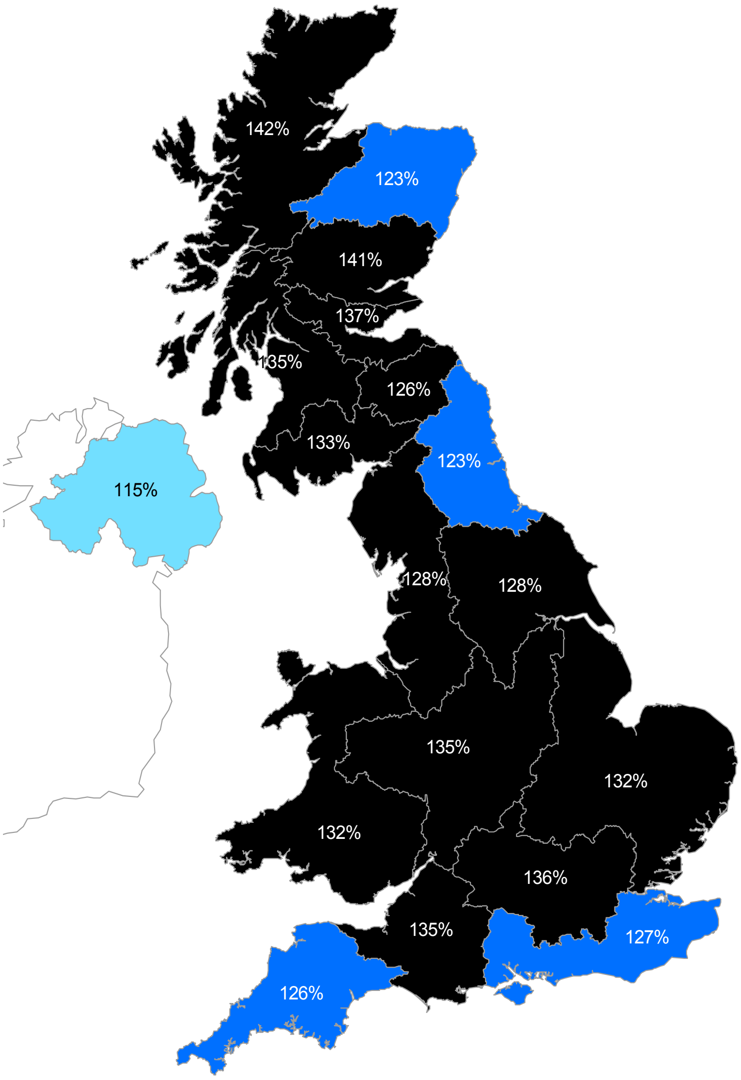
Below average

Substantially below average

Exceptionally low rainfall



May 2007 - June 2007



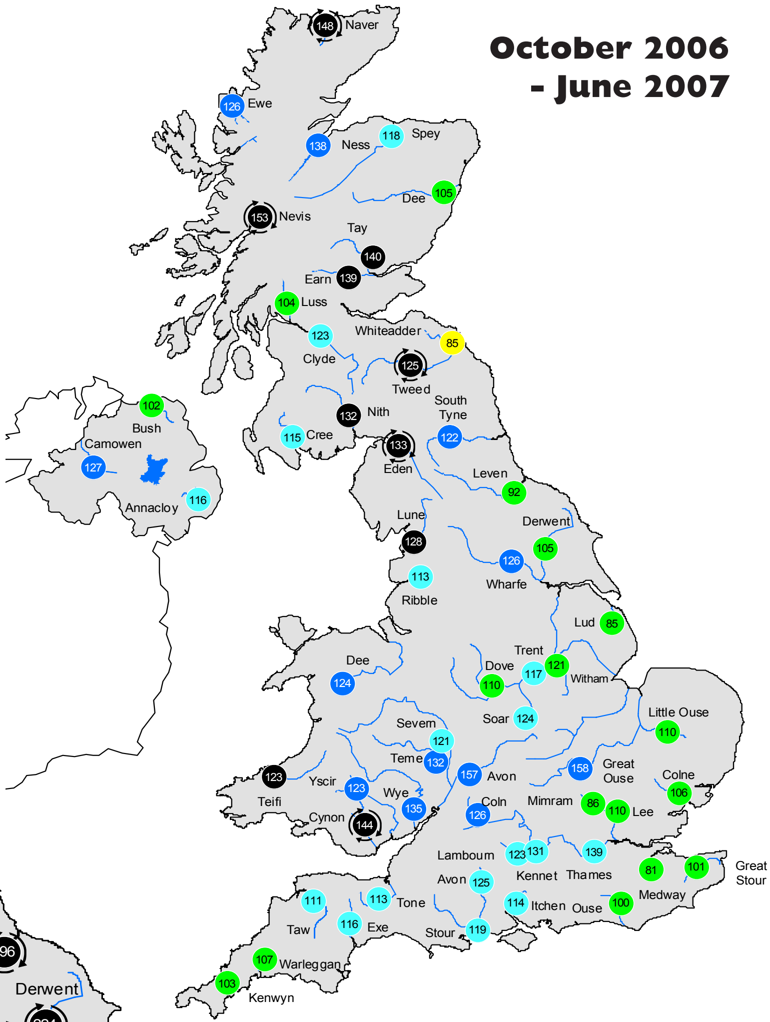
October 2006 - June 2007

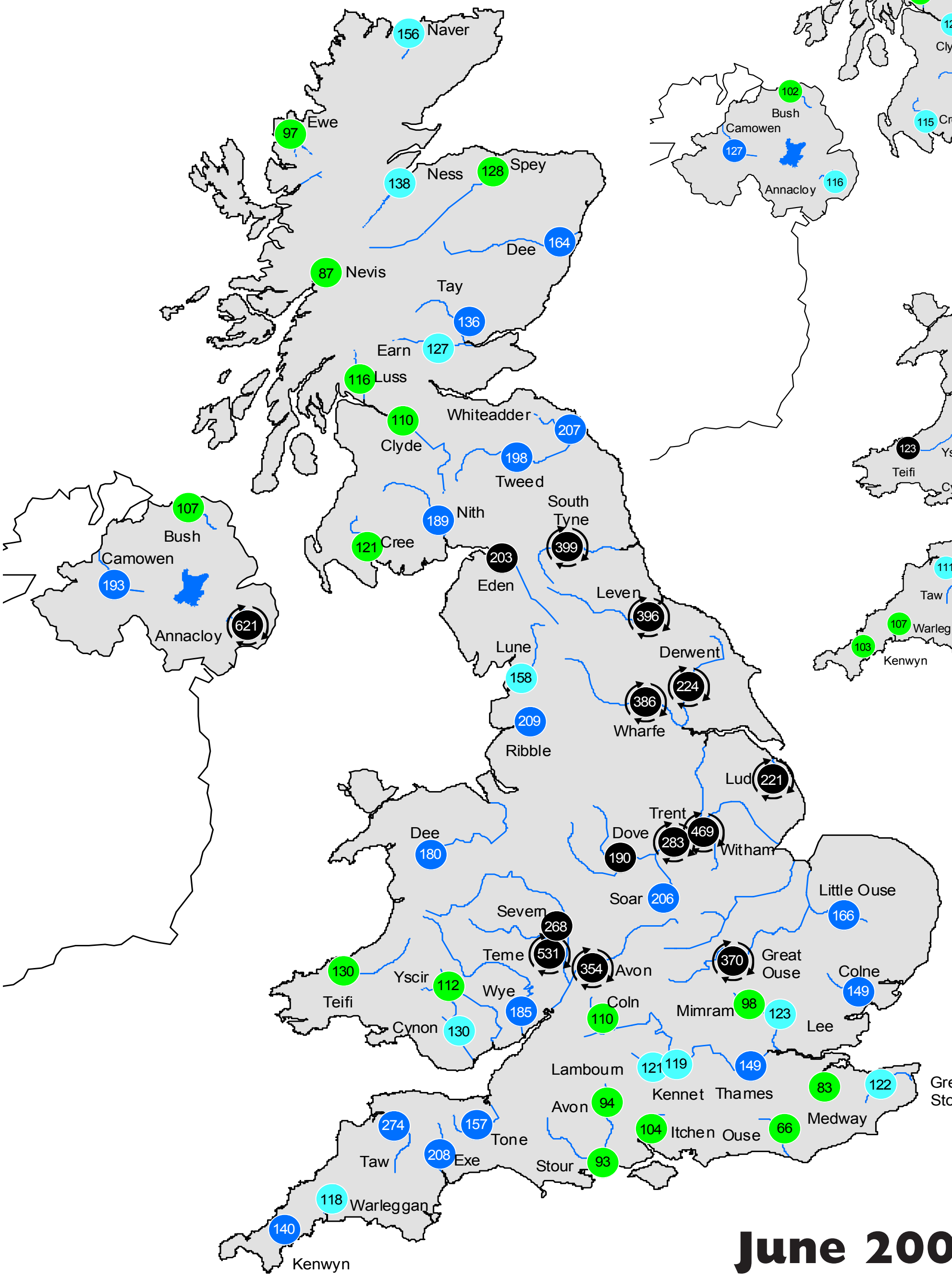
Rainfall accumulation map

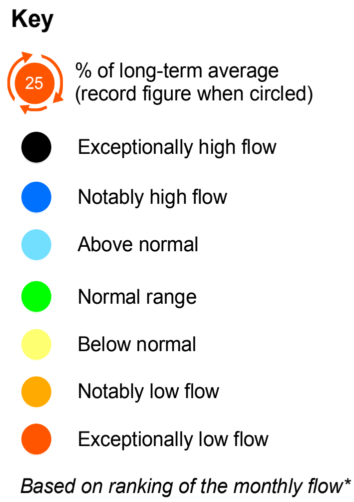
The recent two months were the wettest May-June in the England and Wales rainfall record from 1766, the UK and GB likewise exceeded their shorter records – from 1900 & 1869 – by a wide margin. In the 9-month time-frame Scotland exceeded the previous maximum; five of the six wettest Oct-Jun periods have been recorded since 1998. EW experienced its 2nd wettest Oct-Jun period in its 242-yr record (after 2001) and UK and GB rainfall exceeded previous records for the same accumulation.

River flow . . . River flow . . .

October 2006 – June 2007





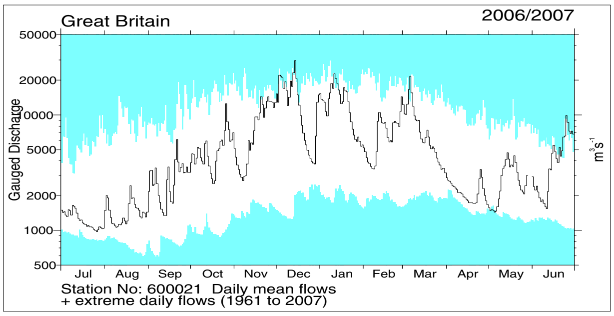


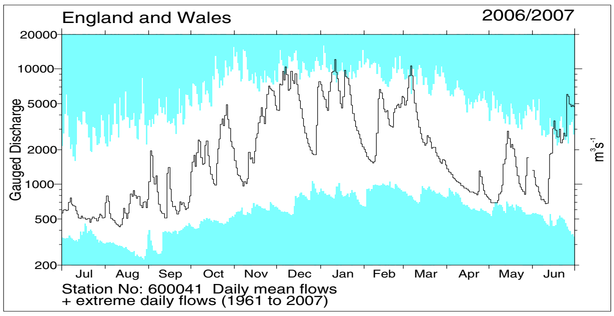
June 2007

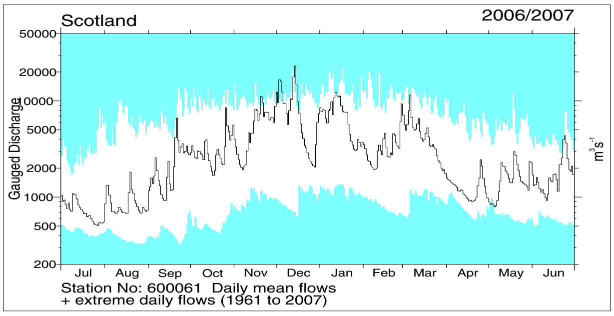
River flows

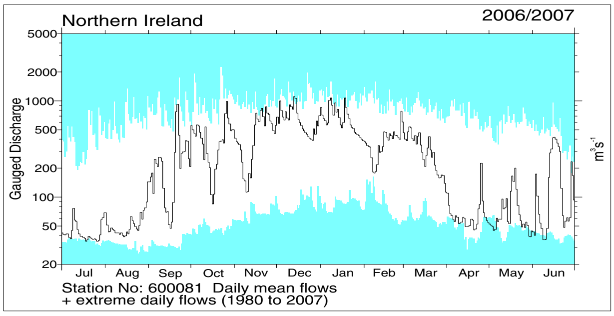
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much 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.

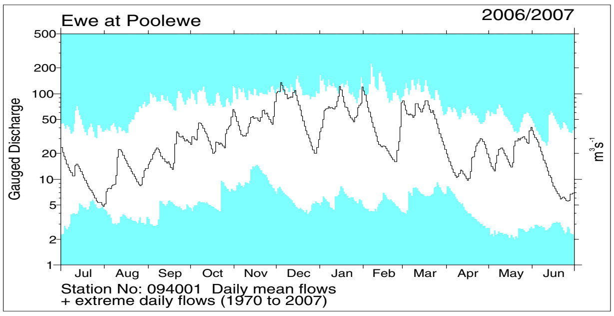
River flow . . . River flow . . .

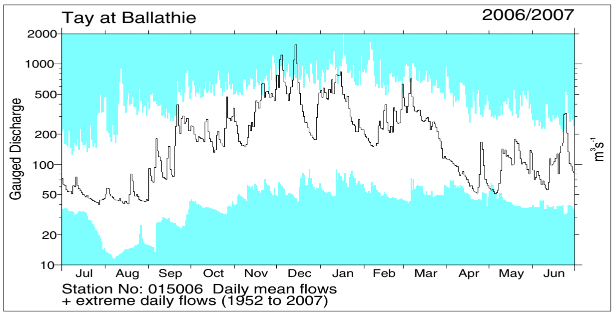


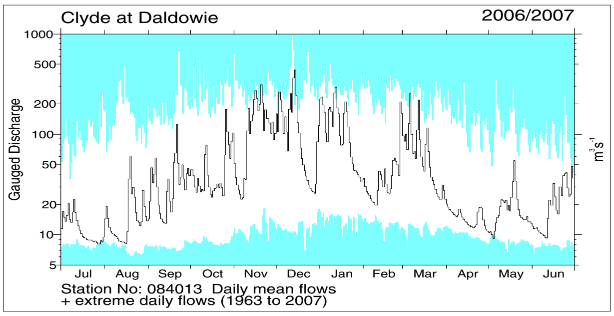


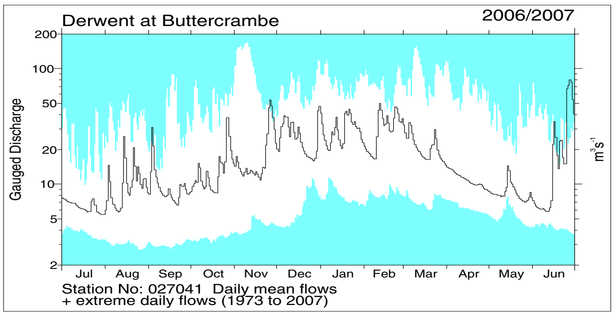


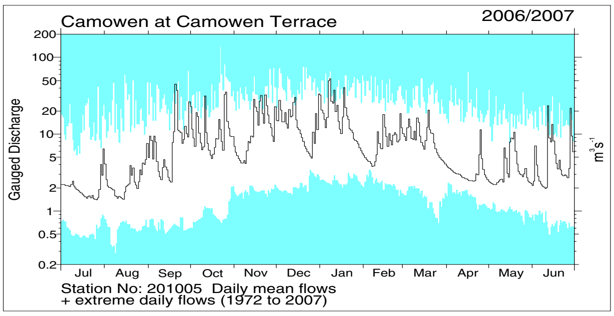


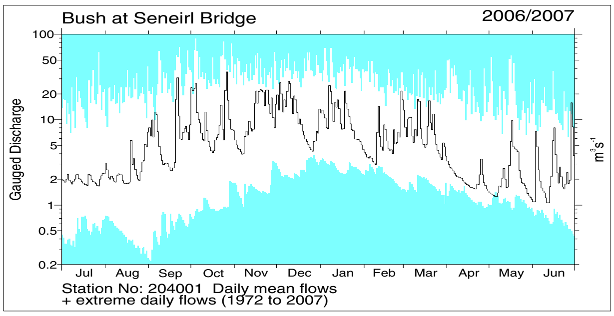








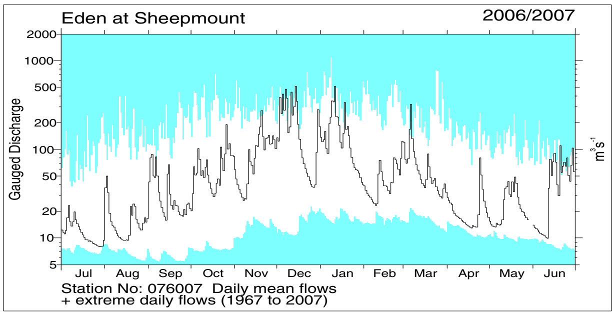


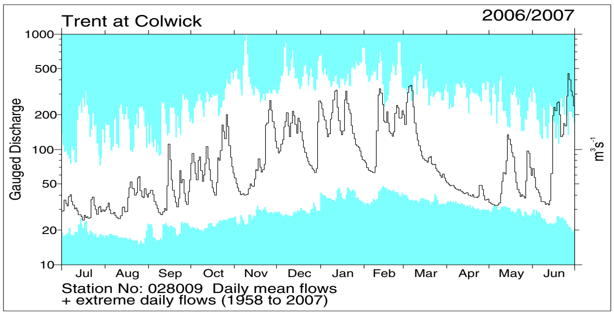


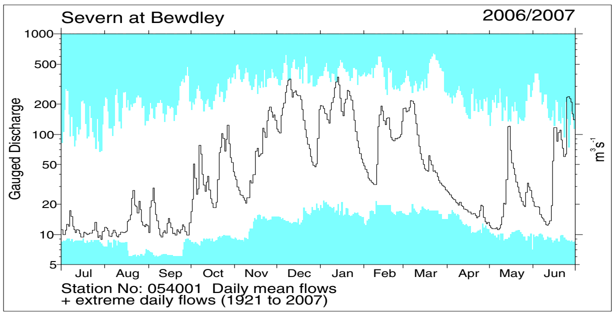
River flow hydrographs

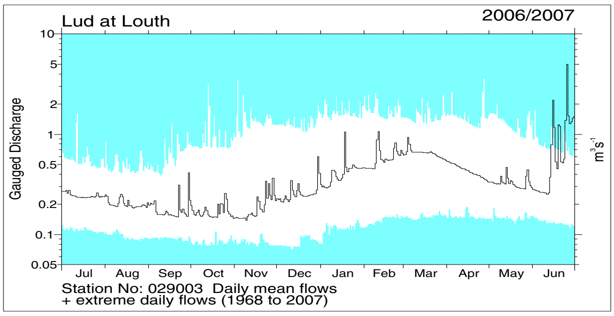
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to July 2006 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

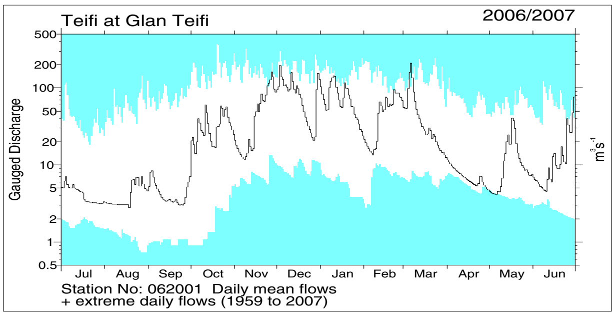
River flow . . . River flow . . .

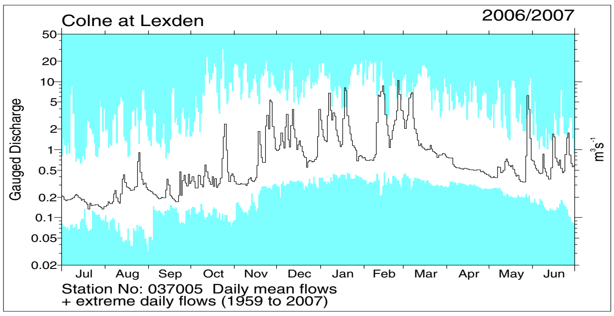


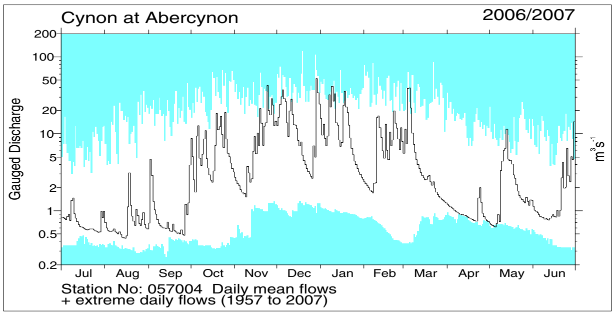


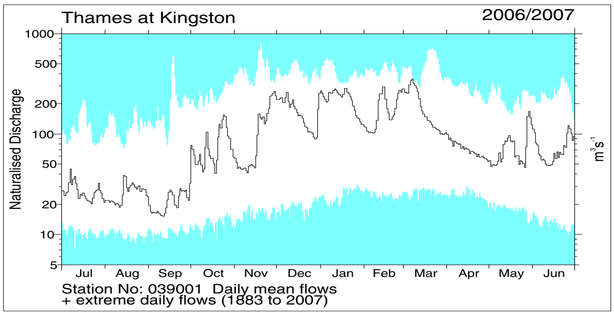


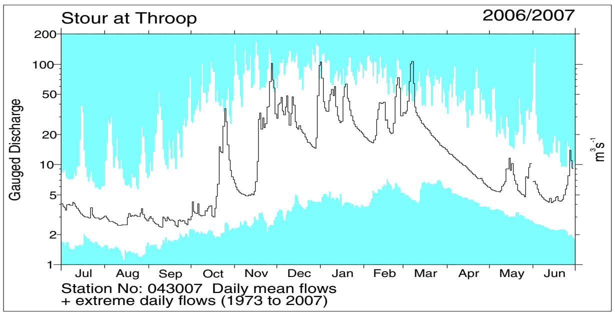


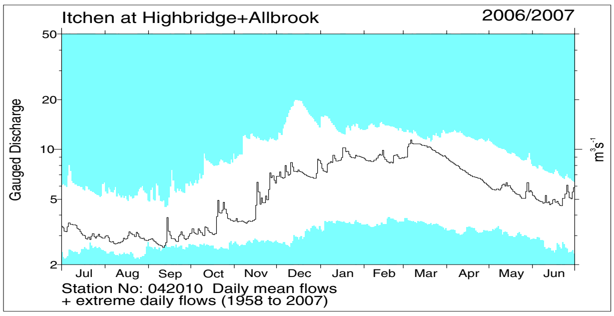












Notable runoff accumulations (a) June 2007, (b) October 2006 - June 2007

a)

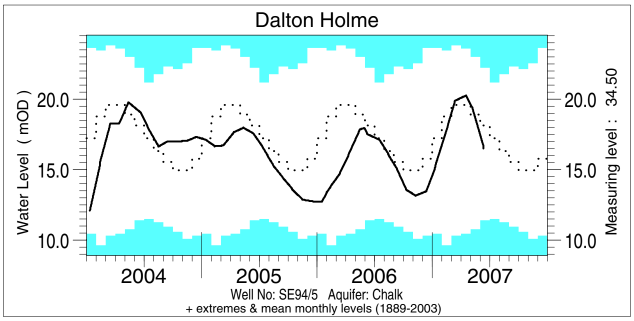
River	%lta	Rank	River	%lta	Rank
Tyne (Bywell)	399	51/51	Witham	469	49/49
S Tyne	399	45/45	Ouse (Bedford)	370	75/75
Leven(Leven Bridge)	396	47/47	Avon (Evesham)	354	71/71
Wharfe	386	52/52	Teme	531	38/38
Derwent	224	46/46	Dee (Manley Hall)	226	70/70
Trent	283	49/49	Lagan	341	35/35
Torne	824	37/37	Annacloy	621	28/28
Dover Beck	496	33/33			
Lud	221	39/39			

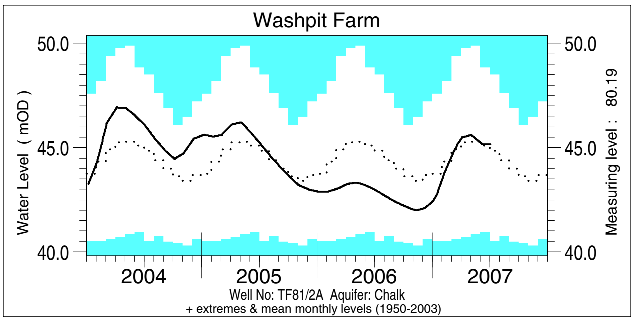
b)

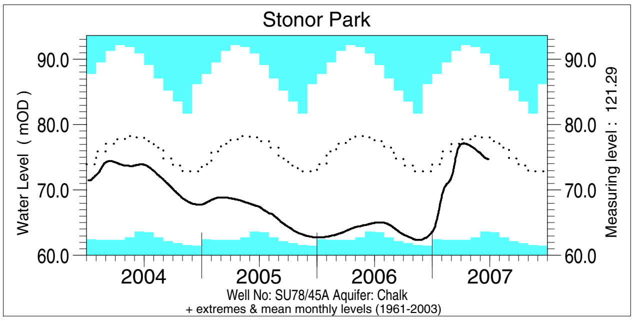
River	%lta	Rank
Tay (Ballathie)	140	54/55
Earn	139	58/59
Tweed (Boleside)	125	46/46
Cynon	144	49/49
Eden	133	40/40
Nevis	153	25/25
Naver	148	30/30

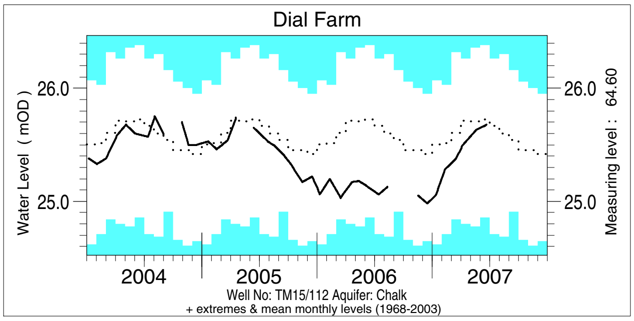
lta = long term average
Rank 1 = lowest on record

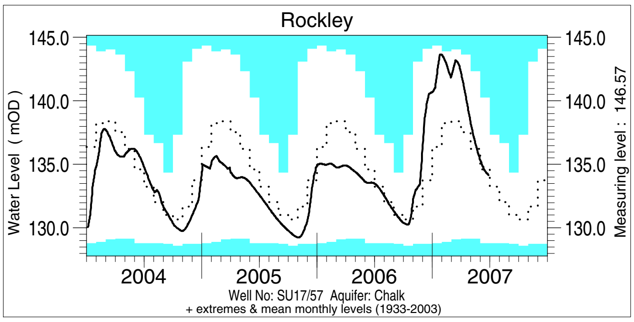
Groundwater . . . Groundwater

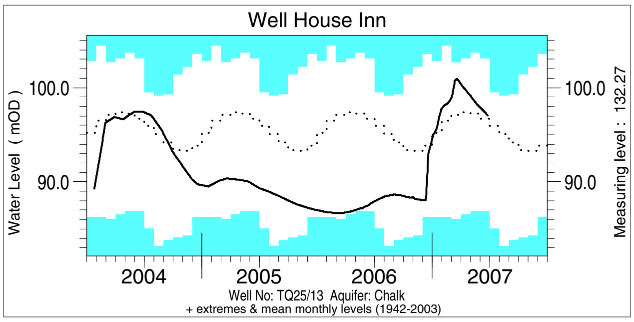


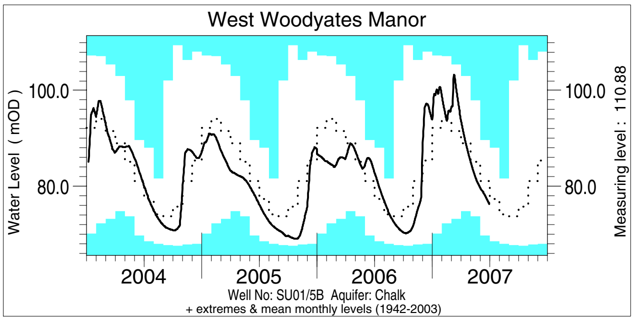


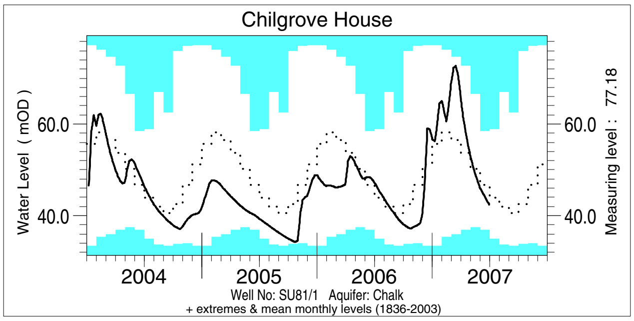


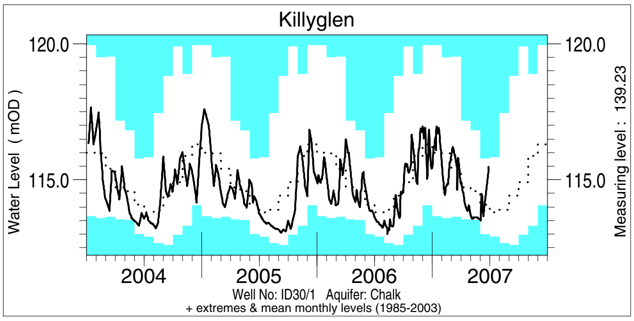


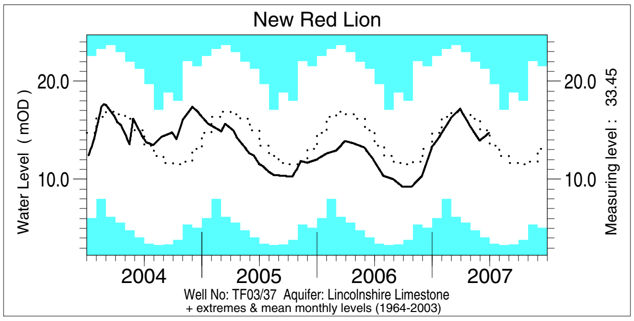






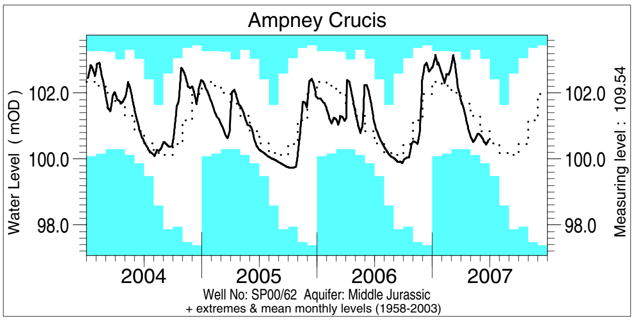


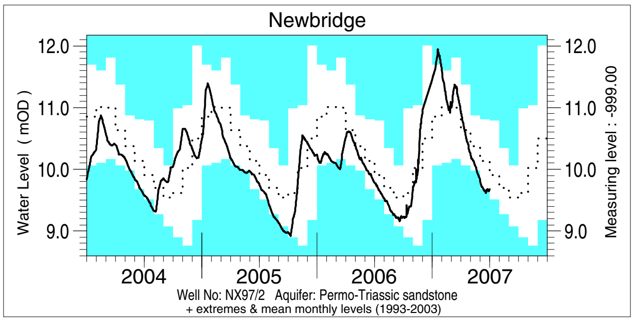


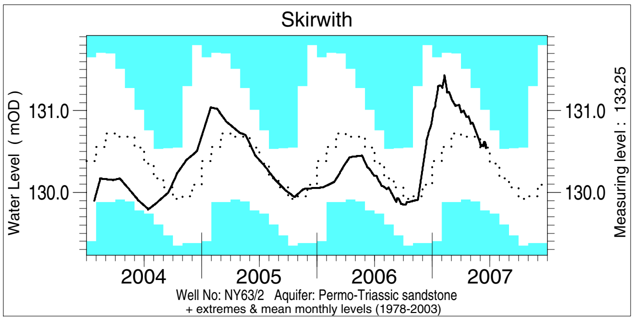


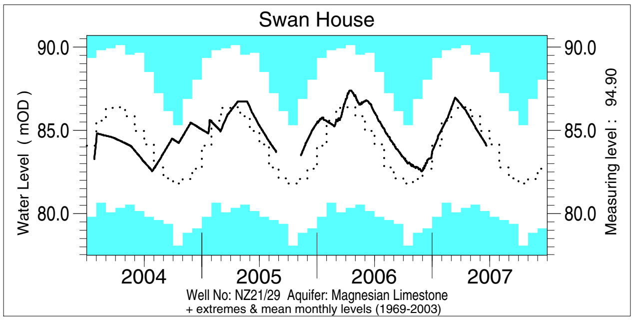
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined 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.

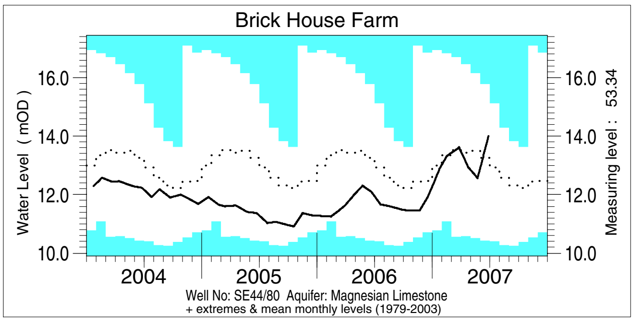
Groundwater . . . Groundwater

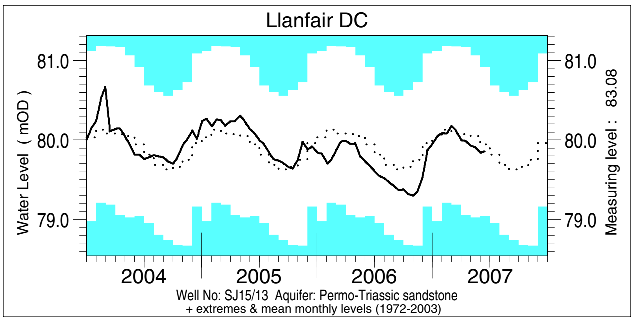


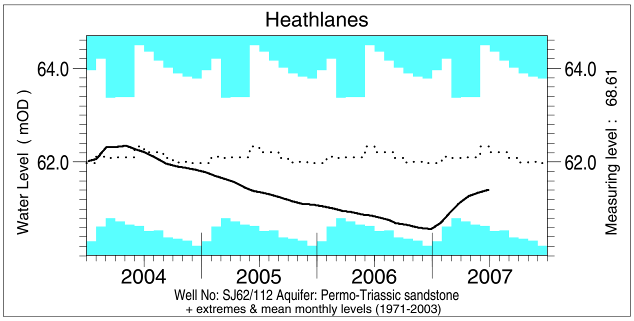


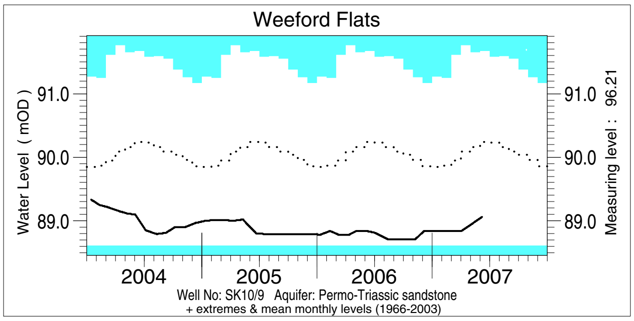


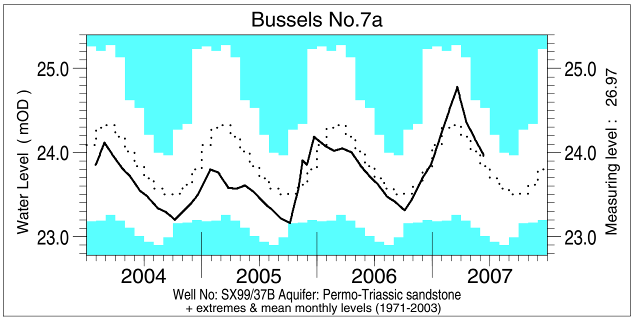


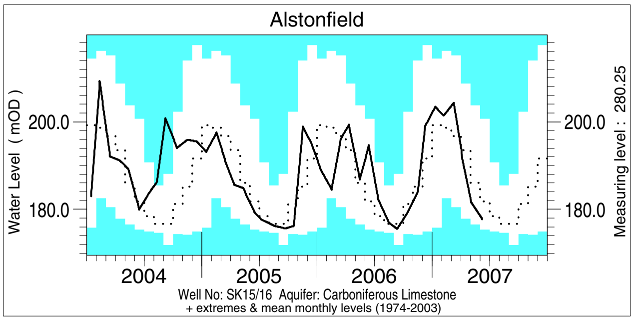










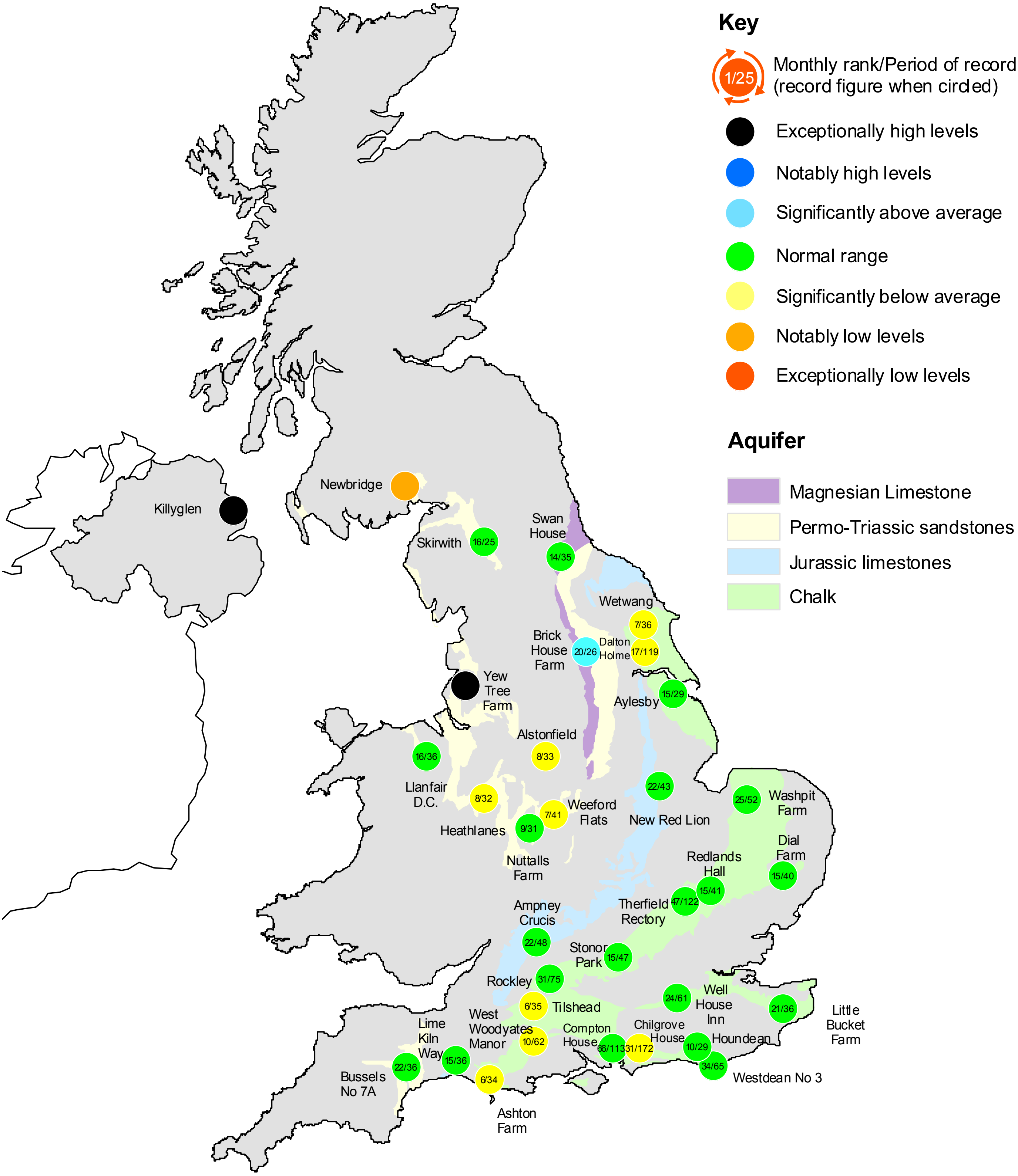


Groundwater levels June / July 2007

Borehole	Level	Date	June av.	Borehole	Level	Date	June av.	Borehole	Level	Date	June av.
Dalton Holme	16.49	12/06	18.13	Chilgrove House	42.43	30/06	46.01	Brick House Farm	14.01	27/06	13.10
Washpit Farm	45.17	04/07	45.17	Killyglen	115.48	28/06	113.99	Llanfair DC	79.86	15/06	79.87
Stonor Park	74.72	27/06	77.71	New Red Lion	14.73	29/06	14.53	Heathlanes	61.41	27/06	62.21
Dial Farm	25.68	22/06	25.70	Ampney Crucis	100.57	27/06	100.86	Weeford Flats	89.06	06/06	89.06
Rockley	134.18	27/06	134.57	Newbridge	9.68	01/07	10.07	Bussels No.7a	23.96	12/06	23.86
Well House Inn	97.01	25/06	96.42	Skirwith	130.59	20/06	130.49	Alstonfield	177.75	07/06	181.90
West Woodyates	76.33	30/06	80.98	Swan House	84.06	21/06	84.47				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



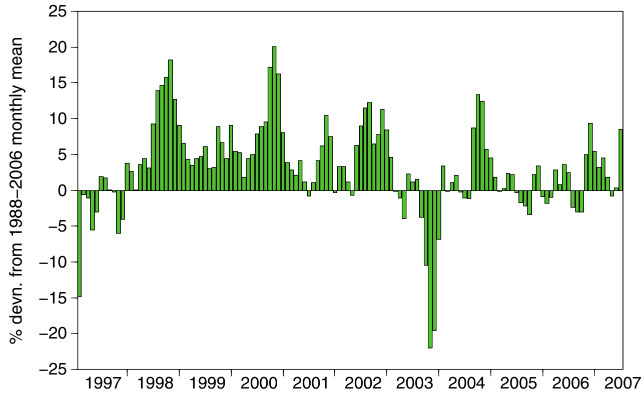
Groundwater levels - June 2007

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.

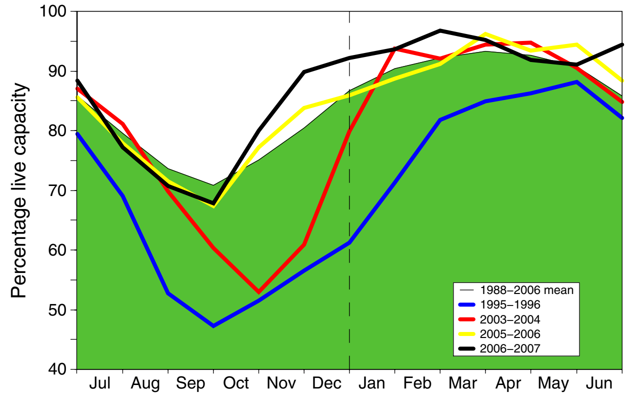
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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.

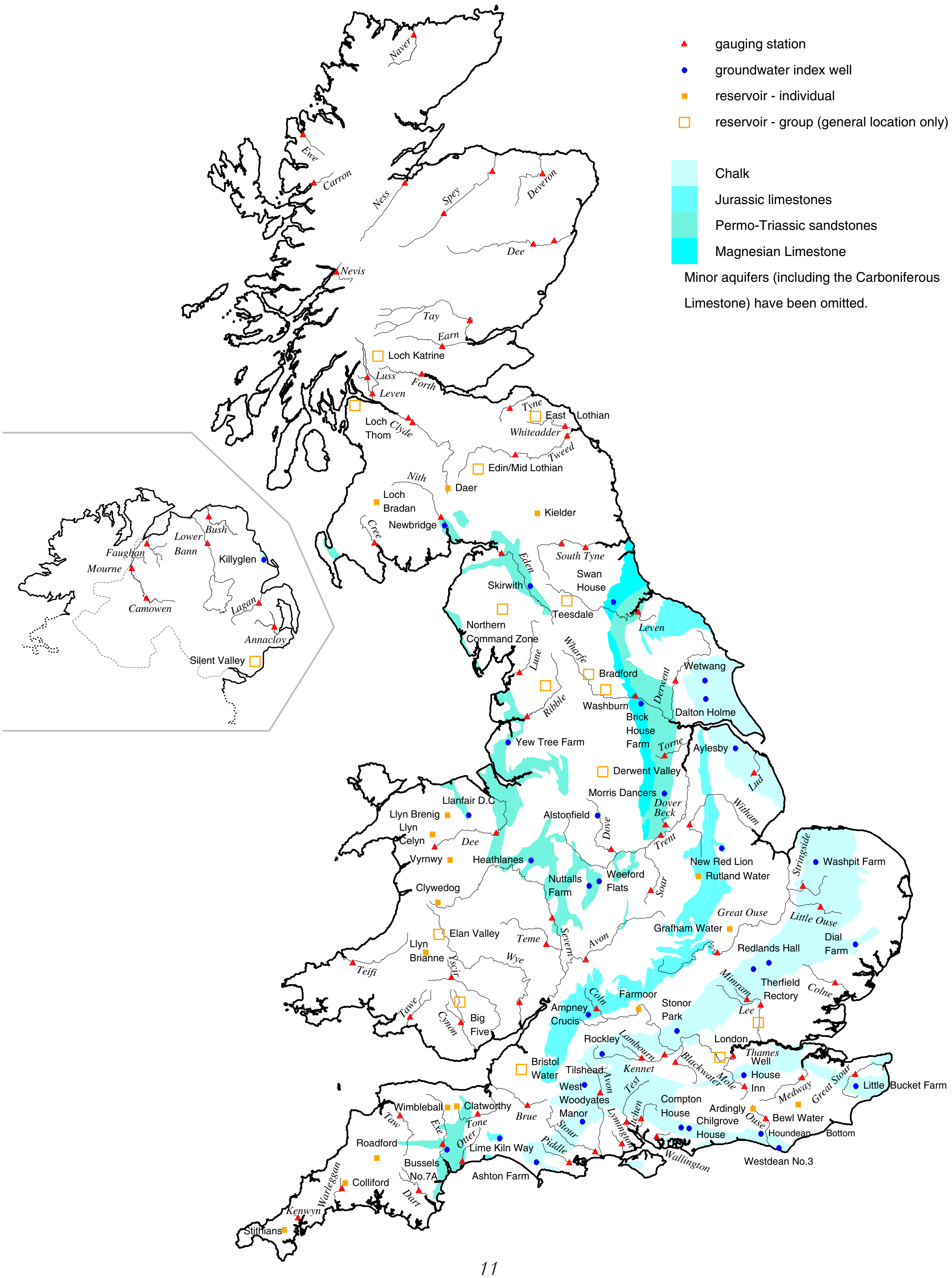
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2007 May	Jun	**Jul**	Jul Anom.	Min. Jul	Year* of min.	2006 Jul	**Diff 07-06**
North West	N Command Zone	• 124929	88	83	**82**	10	58	1995	77	5
	Vyrnwy	55146	88	85	**94**	11	65	1990	86	8
Northumbrian	Teesdale	• 87936	85	84	**98**	20	58	1989	84	14
	Kielder	(199175)	(89)	(93)	**(96)**	6	(71)	1989	(90)	6
Severn Trent	Clywedog	44922	98	98	**100**	7	72	1989	97	3
	Derwent Valley	• 39525	84	86	**100**	20	53	1996	88	12
Yorkshire	Washburn	• 22035	84	82	**99**	19	63	1995	87	12
	Bradford supply	• 41407	85	81	**96**	18	54	1995	85	11
Anglian	Grafham	(55490)	(97)	(98)	**(97)**	5	(70)	1997	(96)	1
	Rutland	(116580)	(94)	(96)	**(97)**	9	(75)	1997	(88)	9
Thames	London	• 202406	100	94	**89**	-2	85	1990	92	-3
	Farmoor	• 13822	100	98	**97**	-1	94	1995	100	-3
Southern	Bewl	28170	91	88	**85**	3	52	1990	85	0
	Ardingly	4685	100	99	**100**	5	82	2005	98	2
Wessex	Clatworthy	5364	85	80	**78**	-5	61	1995	95	-17
	Bristol WW	• (38666)	(90)	(92)	**(98)**	16	(64)	1990	(92)	6
South West	Colliford	28540	77	78	**79**	-1	51	1997	67	12
	Roadford	34500	89	91	**96**	16	49	1996	74	22
	Wimbleball	21320	94	92	**96**	11	63	1992	94	2
	Stithians	5205	90	87	**87**	9	53	1990	77	10
Welsh	Celyn and Brenig	• 131155	96	96	**99**	5	77	1996	97	2
	Brianne	62140	89	94	**97**	5	76	1995	94	3
	Big Five	• 69762	89	91	**96**	13	61	1989	81	15
	Elan Valley	• 99106	97	92	**100**	11	75	1989	89	11
Scotland(E)	Edinburgh/Mid Lothian	• 97639	92	89	**86**	1	54	1998	87	-1
	East Lothian	• 10206	97	95	**100**	7	81	1992	100	0
Scotland(W)	Loch Katrine	• 111363	84	78	**72**	-10	61	2001	86	-14
	Daer	22412	87	88	**88**	5	62	1994	91	-3
	Loch Thom	• 11840	90	86	**72**	-14	69	2000	100	-28
Northern Ireland	Total+	• 67270	77	71	**83**	-1	65	1995	80	3
	Silent Valley	• 20634	79	68	**92**	15	54	1995	82	10

() 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 1988-2006 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.

Location map . . . Location map



National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme (NHMP) was instigated in 1988 and is undertaken jointly by the Centre for Ecology and Hydrology Wallingford (formerly the Institute of Hydrology - IH) 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 Department of the Environment (NI). 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 the Northern Ireland Water Service.

The National River Flow Archive (maintained by CEH Wallingford) 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.

NATURAL ENVIRONMENT RESEARCH COUNCIL

*MORECS is the generic name for the Met Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain.

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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:

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Selected text and maps are available on the WWW at
http://www.nerc-wallingford.ac.uk/ih/nrfa/index.htm
Navigate via Water Watch

07/07