Hydrological Summary
for the United Kingdom

July 2007

General

Unprecedented May-July rainfall across much of southern Britain, with many catchments close to saturation in July, produced hydrological conditions with no close modern parallel for the summer (June-Aug) in England and Wales. Localised flash flooding was very common during the wettest July since 1888 which culminated in extensive, severe and protracted floodplain inundations on the 20-25th – more damaging than the exceptional June floods and, in the worst affected areas, comparable with the extreme flooding of March 1947 (a snowmelt event). Peak river flows eclipsed previous recorded maxima in some – mostly central England – catchments, runoff patterns were more typical of a wet winter and summer flow regimes were redefined over wide areas. More than 300,000 consumers in Gloucestershire were temporarily without water supplies in late July but the unseasonally high runoff left overall reservoir stocks at a late-summer maximum for England and Wales. The outstandingly wet summer soils allowed substantial aquifer recharge in some areas; a very rare circumstance in the context of the last 100 years. The limited time for large soil moisture deficits to become re-established implies an extended aquifer recharge season and an enhanced flood risk through the coming autumn and winter.

Rainfall

The strength, and southerly track, of the Jet Stream – together with elevated sea surface temperatures – contributed to a continuation of very unsettled, cyclonic weather conditions through July – across E&W especially. Thunderstorms triggered a number of flash floods during the first week (e.g. in south London on the 3rd). On the 19/20th a moist, subtropical airmass moving north from France stagnated over central England producing extreme rainfall totals over a range of durations: Maidenhead registered 51mm in 63 minutes, Langley (Gloucs) 110mm in 12hrs and Pershore 145mm in 25hrs (return period > 1000 yrs). Embedded convective cells contributed to significant spatial variability but a defining characteristic of the storm was the large area (>30,000 km^2) registering exceptional rainfall totals. About 30% of E&W reported >30mm and around 3,500km^2 >100mm (a very rare occurrence but embracing a lesser area than the storms of Sept 1968 and Aug 1912). In western Scotland, and parts of East Anglia, July rainfall totals were below average. By contrast, totals exceeded 250% in many catchments in a zone from the North York Moors to the Bristol Channel, rising to >400% in the lower Severn/Avon basins. The accumulated May-July rainfall totals are as outstanding (see page 3). Substantial parts of England reported the equivalent of 6 months average rainfall in this timespan and the E&W total eclipsed the previous May-July maximum (in a series from 1766) by an appreciable margin. Many wetter 3-month periods can be found for E&W but none since 1912 fall in the summer half-year (May-Sept).

River Flows

The hydrological character of the month was established in the first few days when previous July maximum flows were exceeded in a number of widely distributed rivers (including the Leven, Lymington and Annacloy). Further notable summer spates followed before an episode of extreme flooding was initiated by the exceptional rainfall of the 19/20th. The episode had several relatively distinctive phases: flash flooding with surface runoff (even in permeable catchments) and landslides; extremely high flows in small responsive catchments, e.g. the Teme and Ock (Oxon) and, subsequently, extensive floodplain inundations as the runoff concentrated in the major river basins (Trent, Gt Ouse, Thames and, especially, the Warwickshire Avon and Severn). Sustained high levels in the major rivers hampered the drainage of floodwaters away from afflicted communities. Around 40% of index rivers in E&W reported new July maximum flows; a significant minority, including the Teme (which eclipsed the June peak) and Lambourn (a spring-fed river where surface runoff was a significant factor) established new period-of-record maxima. Levels in the Warwickshire Avon at Evesham were the highest in an (incomplete) series from 1848, the runoff contributing to levels in the lower Severn (at Gloucester Locks) which were closely comparable with the extreme March 1947 peak. In Lincolnshire, the two highest flows in a 40-yr series for the Lud have been recorded in June and July this year (note, however, that the May 1920 flood was an order of magnitude greater). July runoff totals exceeded previous maxima in the great majority of index catchments – commonly >5 times the mean. Estimated total outflows from E&W were approximately *twice* the previous July maximum (in 1968) and well above winter monthly averages.

Groundwater

Dry soil conditions normally preclude widespread aquifer recharge during the summer. There are rare exceptions including 1879, 1912 and, now, 2007. With soil moisture deficits the lowest on record (for July) across much of E&W, the exceptional summer rainfall produced very substantial infiltration in some areas. As a consequence, previous maximum summer groundwater levels have been exceeded, by wide margins in some cases. Examples include, the Jurassic Limestone of the Cotswolds, Alstonfield (Carboniferous Limestone) and, more notably, in the slower-responding Chalk of the Lincolnshire and Yorkshires Wolds. In the latter, levels at Dalton Holme were the highest for the summer in a 120-yr series. Exceptional summer responses also occurred in parts of the western Chalk (e.g. at Rockley) but in the South East most 2007 groundwater level recessions have barely been interrupted. This reflects a number of factors including lower rainfall, greater depth to the water-table, and differing aquifer characteristics. July groundwater levels across much of the southern and eastern Chalk remained within the normal seasonal range. This is true of many Permo-Triassic sandstones outcrops also. However, water still descending through the unsaturated zone may be expected to produce further rises in the water-table. More significantly, given normal autumn rainfall patterns, the near-saturated state of soils in late July implies an early onset of the winter recharge season. In the event of a wet winter, water-tables in some areas could reach exceptionally high levels.

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

Rainfall accumulations and return period estimates

Area	Rainfall	Jul 2007	May 07-Jul 07	RP	Jan 07-Jul 07	RP	Oct 06-Jul 07	RP	Aug 06-Jul 07	RP
England & Wales	**mm**	**141**	**396**		**683**		**1040**		**1205**	
	%	**227**	**209**	**>>100**	**143**	**>100**	**139**	**>100**	**133**	**>100**
North West	mm	**166**	439		797		1323		1553	
	%	**191**	179	>100	130	15-25	134	50-80	128	40-50
Northumbrian	mm	**127**	361		607		902		1080	
	%	**190**	189	>100	131	15-25	127	20-30	125	20-30
Severn Trent	mm	**157**	421		667		944		1101	
	%	**284**	241	>>100	159	>>100	149	>100	143	>100
Yorkshire	mm	**117**	405		650		932		1134	
	%	**189**	220	>>100	145	50-80	135	50-80	136	>100
Anglian	mm	**91**	325		492		678		838	
	%	**182**	215	>>100	148	>100	136	50-80	139	>100
Thames	mm	**126**	339		561		843		985	
	%	**253**	211	>>100	147	50-80	145	>100	141	>100
Southern	mm	**116**	313		556		881		1013	
	%	**239**	199	>>100	136	20-30	134	30-50	129	30-40
Wessex	mm	**131**	372		652		1018		1136	
	%	**246**	216	>>100	144	40-60	143	>100	133	40-60
South West	mm	**141**	435		882		1362		1483	
	%	**199**	203	>>100	141	40-60	135	40-60	124	15-25
Welsh	mm	**212**	510		962		1573		1754	
	%	**262**	207	>>100	141	50-80	140	>100	130	50-80
Scotland	**mm**	**135**	**382**		**944**		**1643**		**1889**	
	%	**141**	**143**	**40-50**	**128**	**40-50**	**136**	**>>100**	**128**	**>100**
Highland	mm	**139**	403		1137		2015		2275	
	%	**130**	134	10-20	132	50-80	140	>>100	131	>100
North East	mm	**139**	374		694		1094		1262	
	%	**181**	171	>100	128	20-30	129	40-50	123	25-35
Tay	mm	**152**	412		909		1547		1777	
	%	**185**	168	>100	135	40-60	145	>>100	138	>100
Forth	mm	**130**	344		779		1345		1565	
	%	**168**	153	40-50	133	40-50	144	>>100	137	>100
Tweed	mm	**139**	368		679		1085		1303	
	%	**186**	171	>100	128	15-25	132	50-80	130	50-80
Solway	mm	**128**	417		890		1560		1820	
	%	**138**	157	50-80	124	10-20	133	80-120	127	40-60
Clyde	mm	**120**	378		1051		1909		2237	
	%	**105**	123	5-10	122	10-20	134	>100	128	>100
Northern Ireland	**mm**	**124**	**353**		**678**		**1072**		**1300**	
	%	**174**	**162**	**50-80**	**119**	**5-10**	**119**	**5-10**	**118**	**5-15**

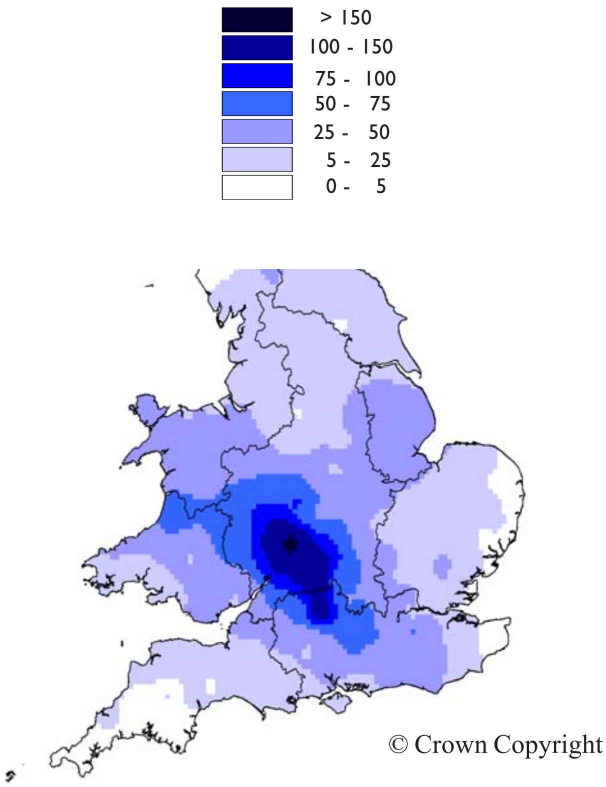
% = percentage of 1961-90 average *RP = Return period*

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.

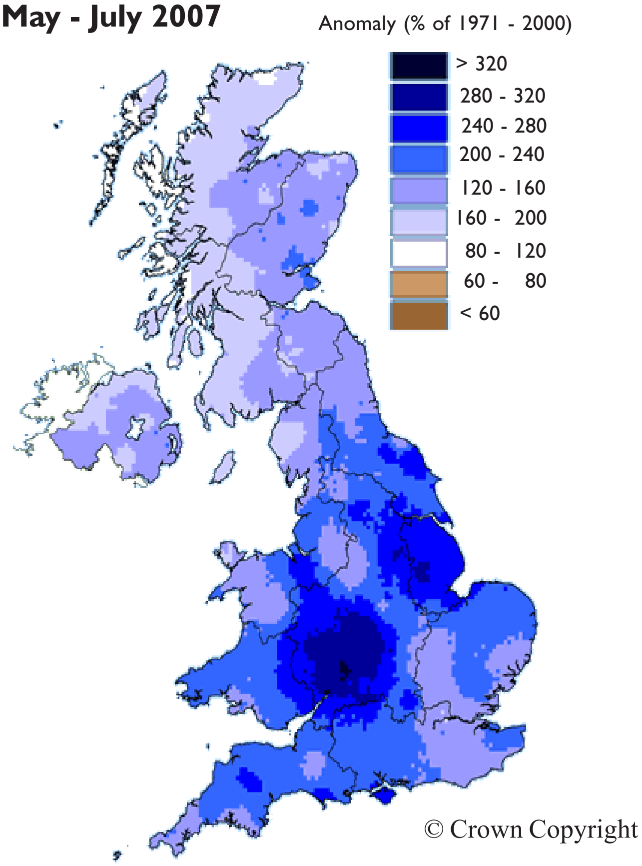
All monthly rainfall totals since March 2007 are provisional.

Rainfall . . . Rainfall . . .

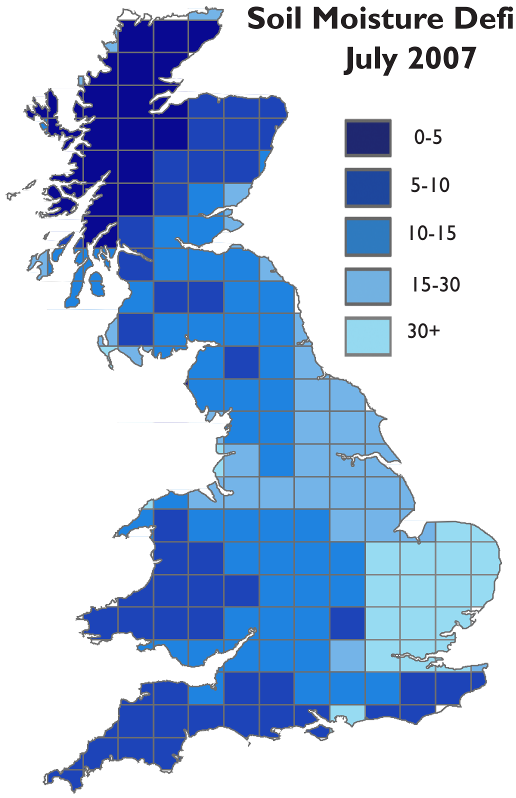
Rainfall (mm)
19-20 July 2007



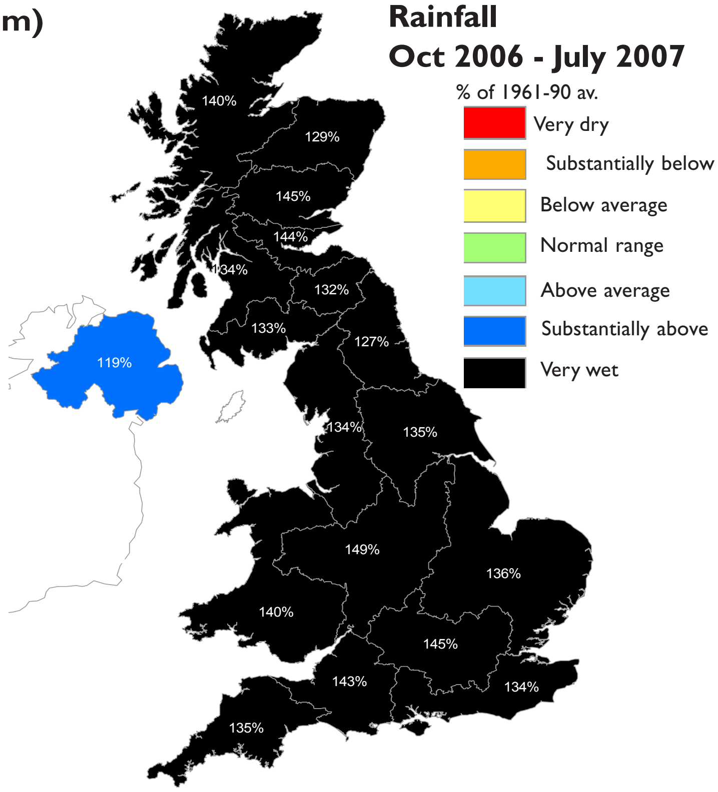
Rainfall anomaly
May - July 2007



Soil Moisture Deficit (mm)
July 2007

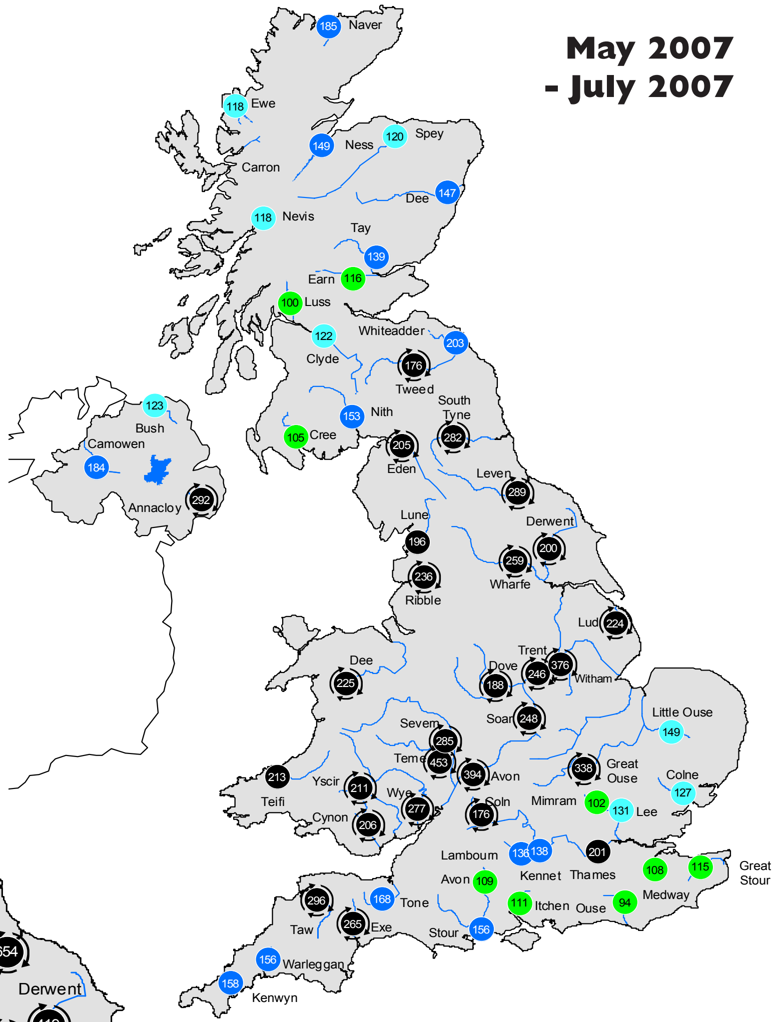


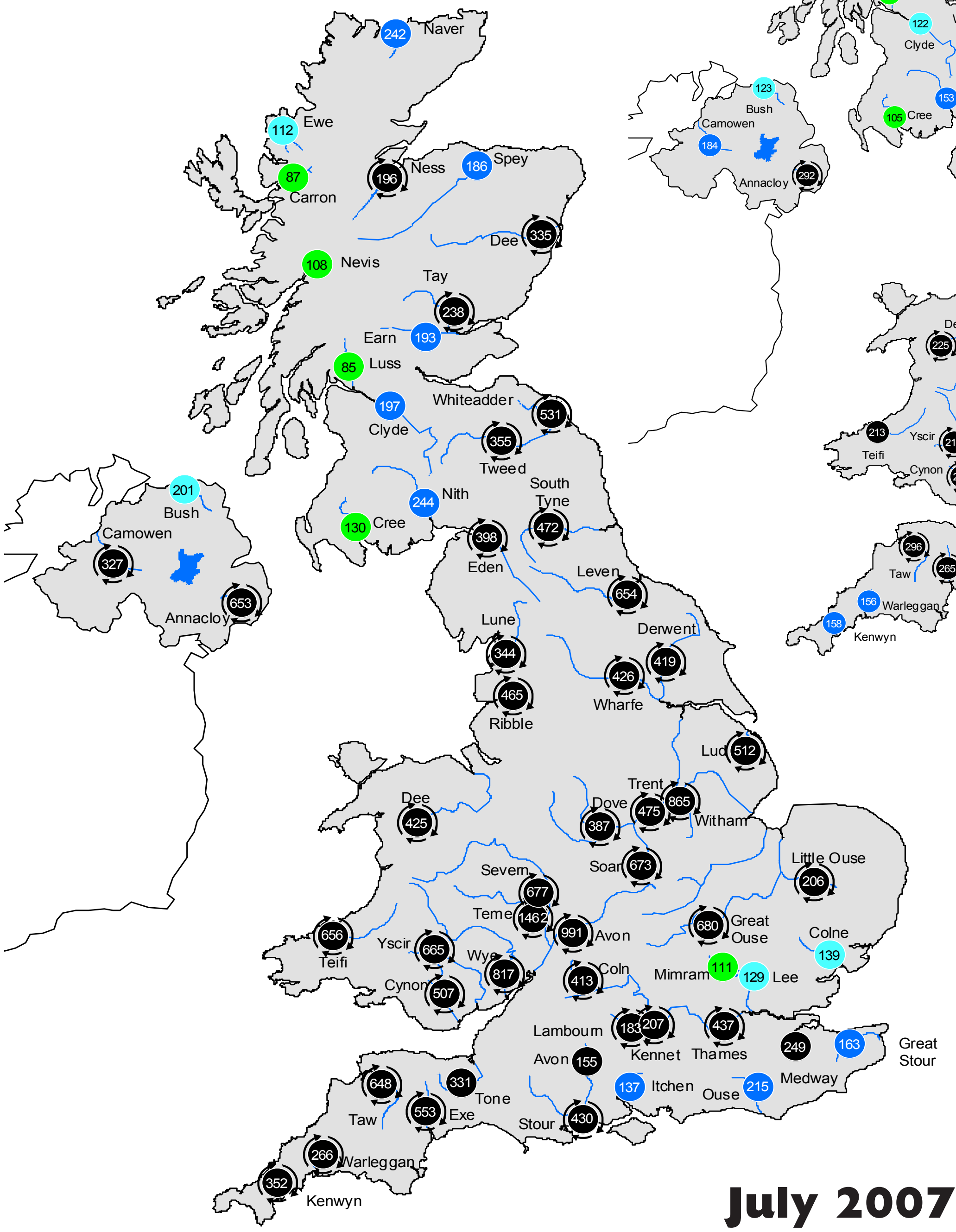
Rainfall
Oct 2006 - July 2007



The rainfall maps are based on provisional data and, for the 19/20th July rainfall in particular, a limited number of raingauges. The soil moisture deficit map is based on MORECS (see page 12) and assumes a grasss cover. End-of-July deficits averaged across England and Wales are the lowest in a series from 1961 and across most of southern Britain were 60-100mm below the 1961-90 end-of-July average.

May 2007 - July 2007





Key

% of long-term average (record figure when circled)

- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

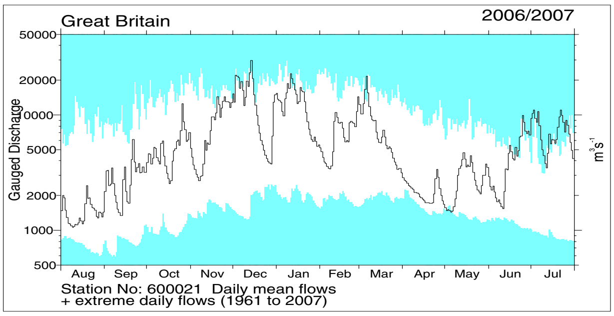
*Based on ranking of the monthly flow**

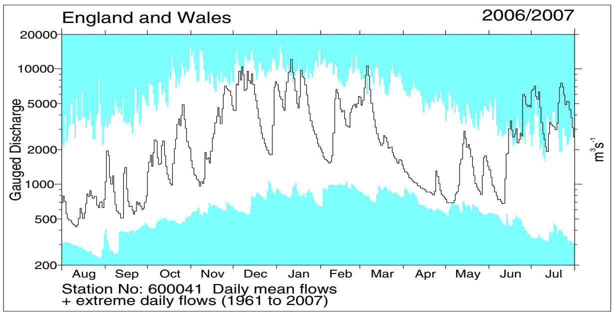
July 2007

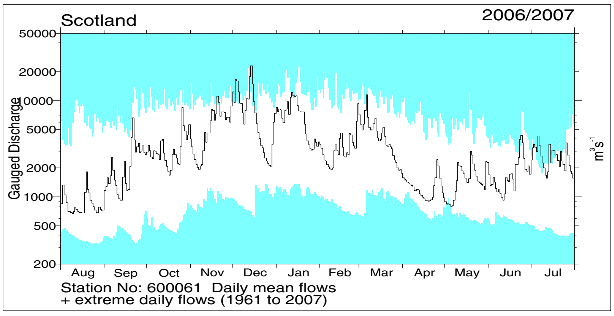
River flows

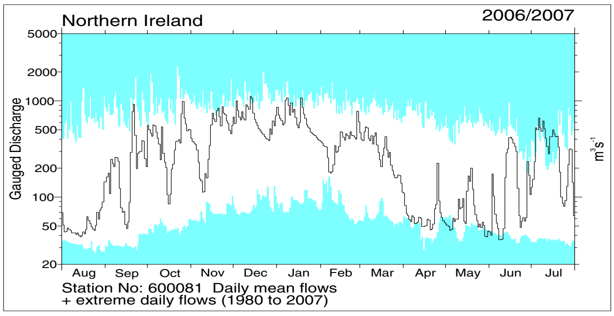
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

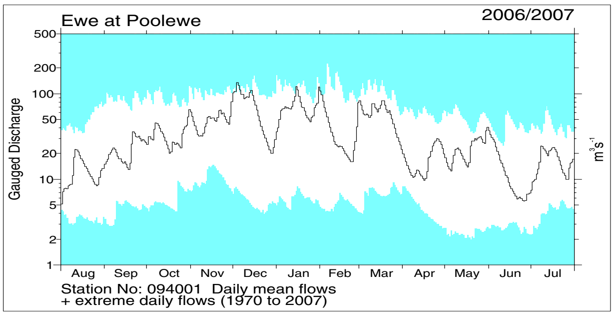
River flow . . . River flow . . .

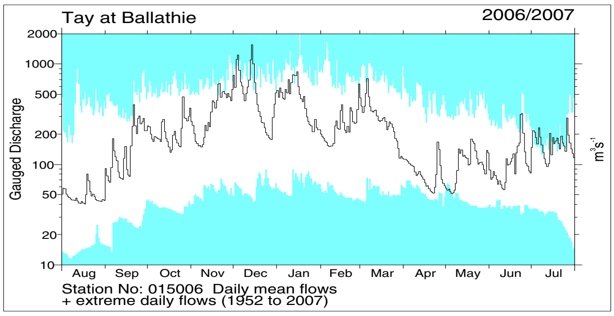


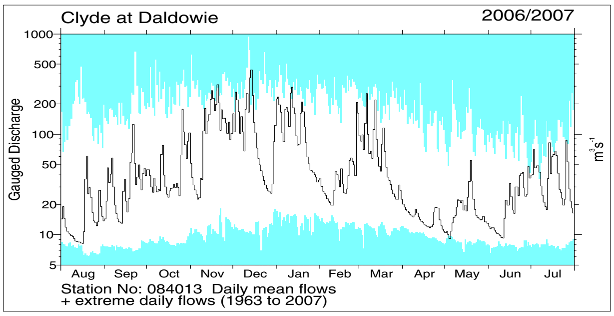


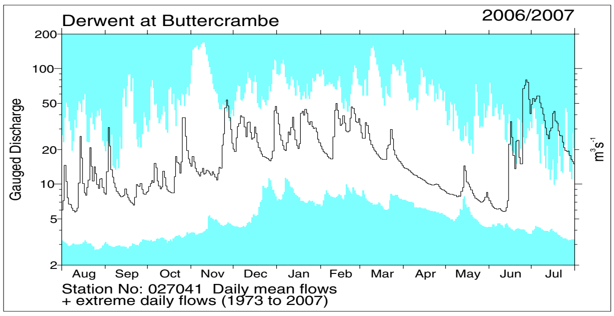


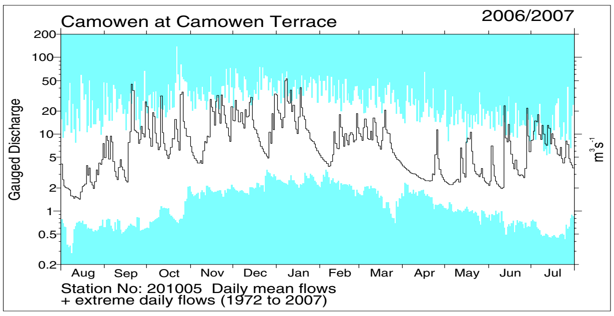


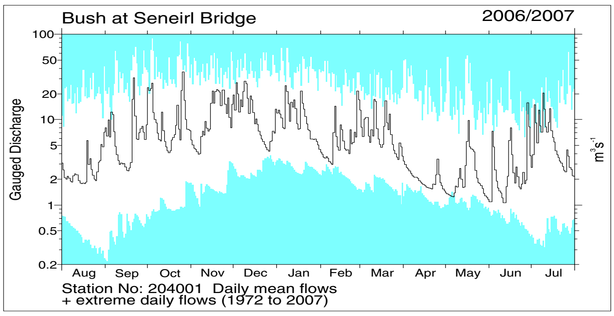








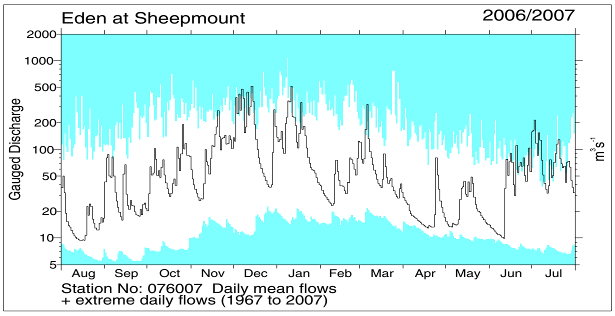


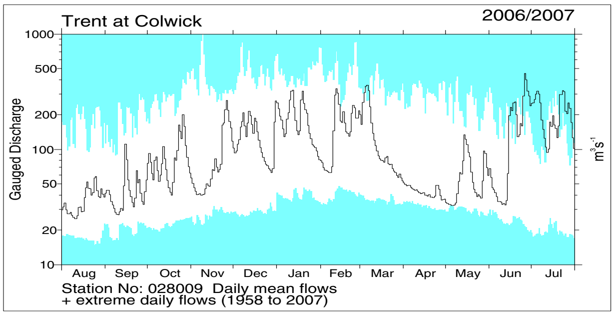


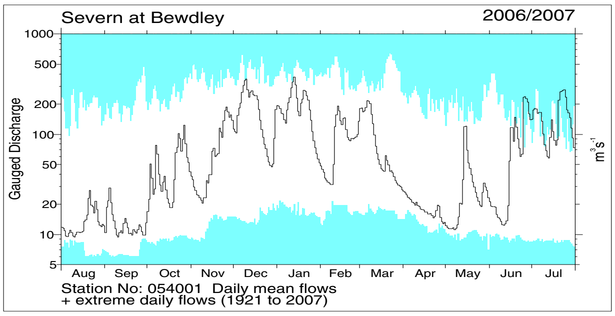
River flow hydrographs

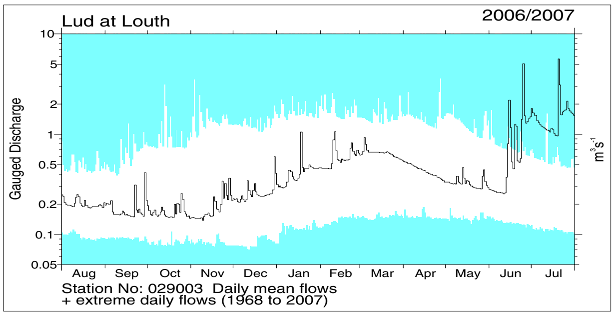
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to August 2006 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

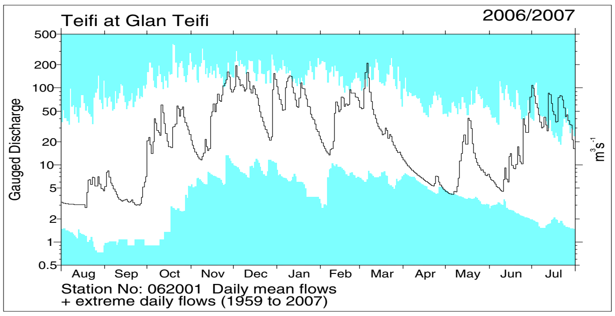
River flow . . . River flow . . .

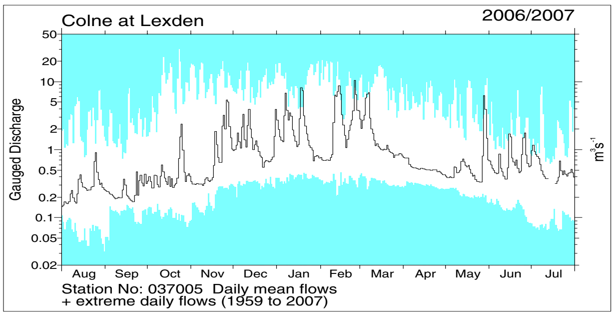


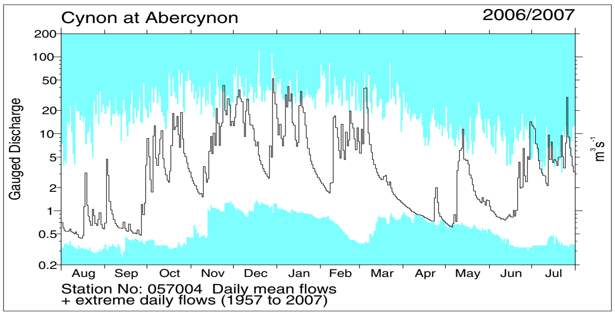


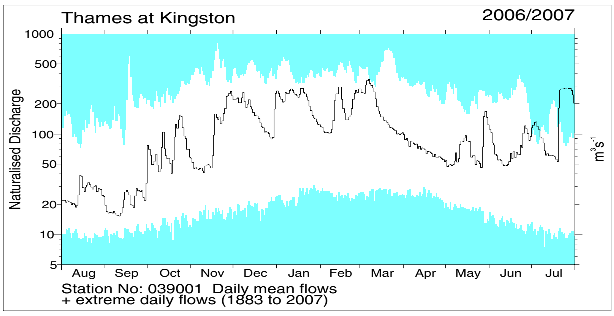


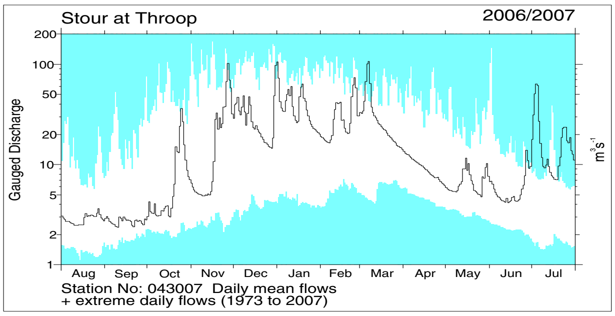


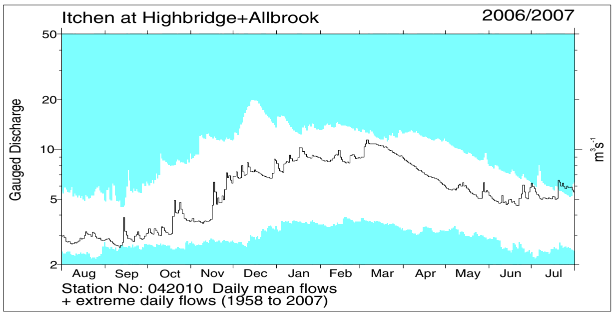












Notable runoff accumulations (a) July 2007, (b) May 2007 - July 2007

a)

River	%lta	Rank
Dee (Woodend)	277	78/78
Tay	238	55/55
Leven	654	48/48
Trent	475	49/49
Lud	512	39/39
Ouse (Bedford)	680	75/75
Thames	437	125/125
Lambourn	183	45/45
Lymington	745	47/47
Exe	553	52/52

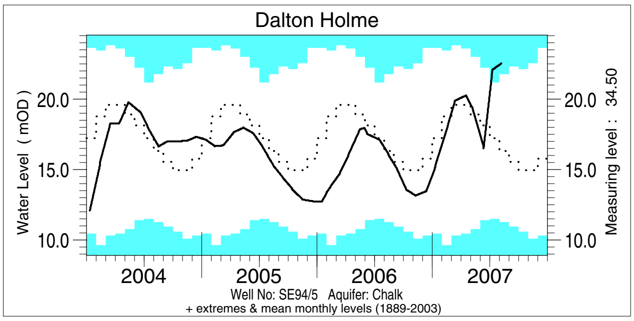
River	%lta	Rank
Severn	677	87/87
Avon (Evesham)	991	71/71
Teme	1462	38/38
Wye	817	71/71
Dee (Manley Hall)	454	70/70
Camowen	327	36/36
Annacloy	653	28/28

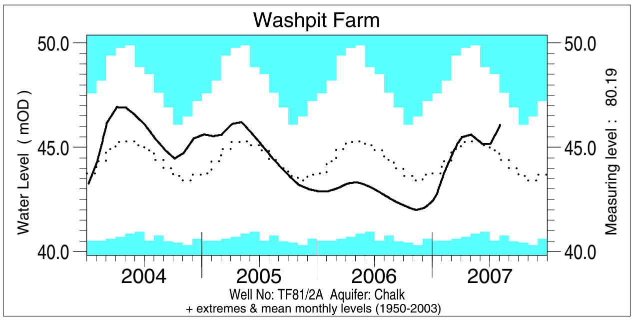
b)

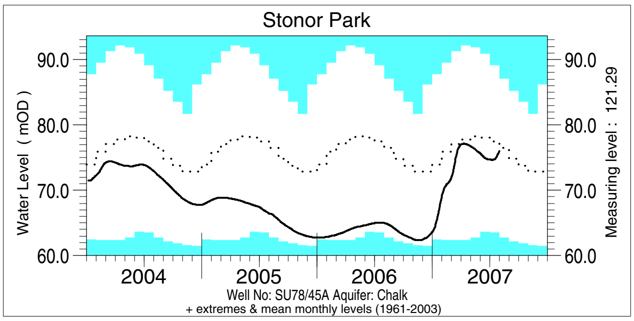
River	%lta	Rank
Tweed (Boleside)	176	47/47
S Tyne	282	44/44
Wharfe	259	52/52
Blackwater	178	55/55
Cynon	206	49/49
Ribble	236	48/48
Eden	205	40/40

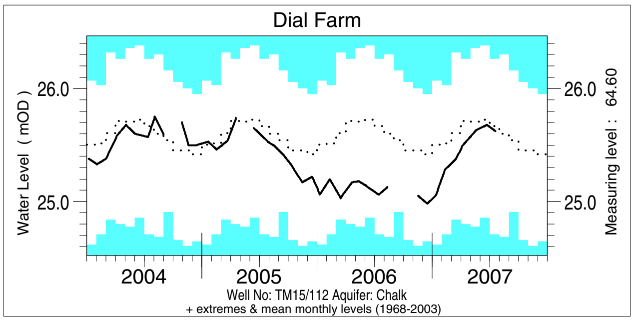
lta = long term average
Rank 1 = lowest on record

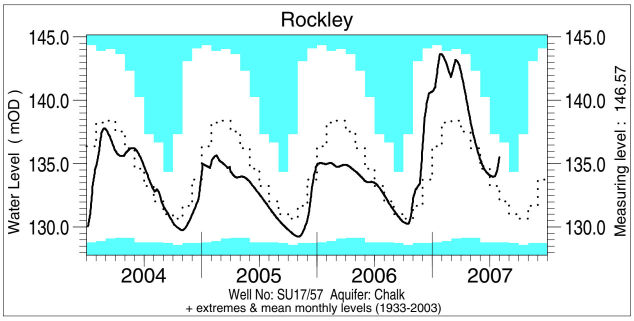
Groundwater . . . Groundwater

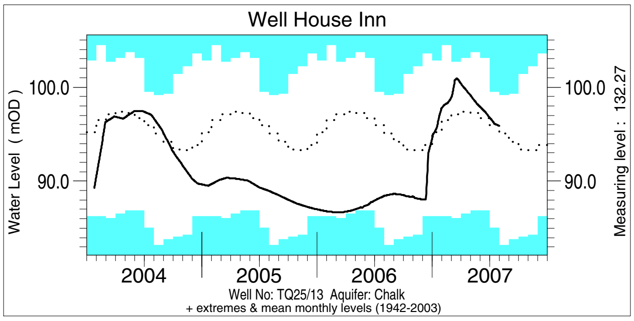


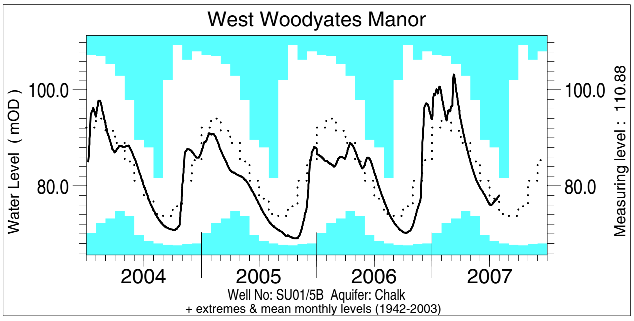


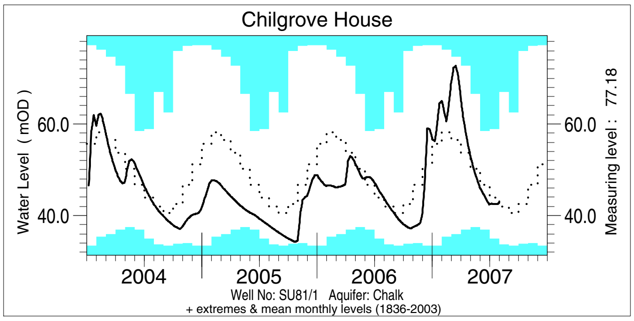


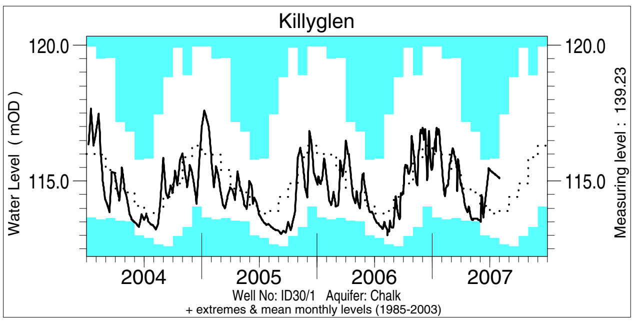


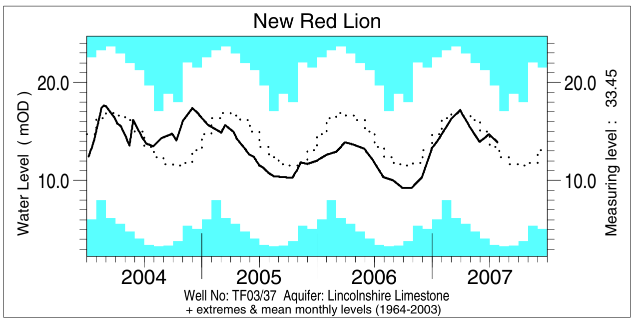






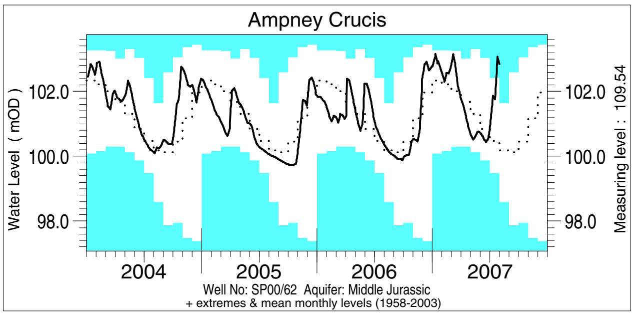


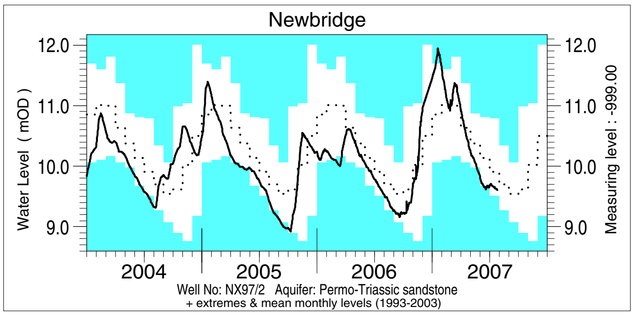


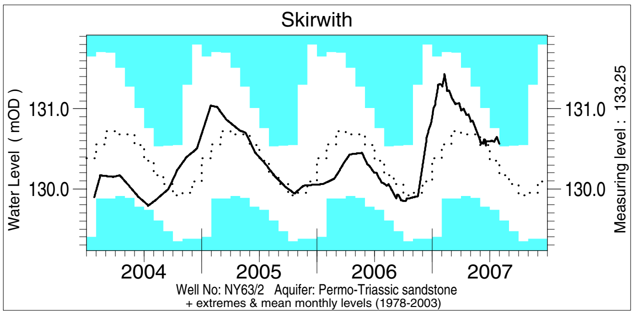


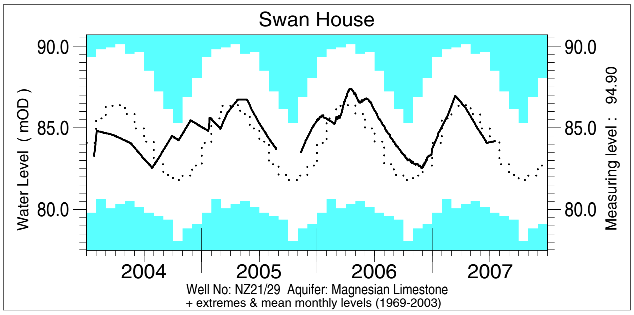
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

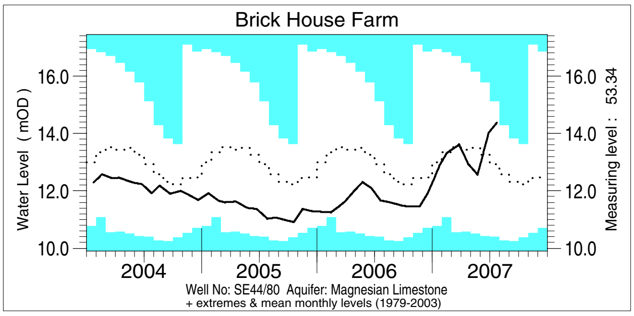
Groundwater . . . Groundwater

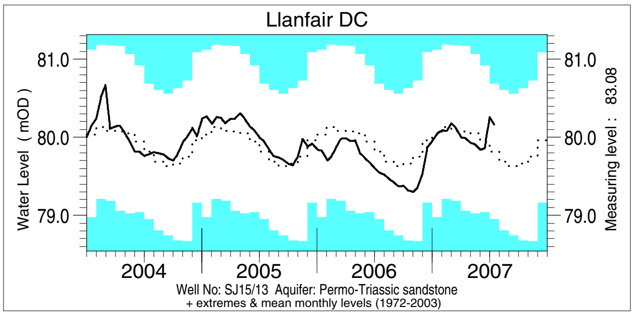


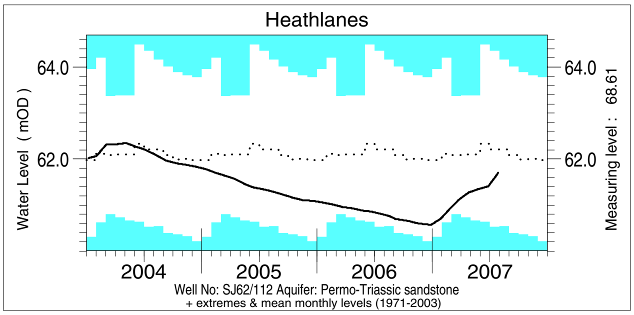


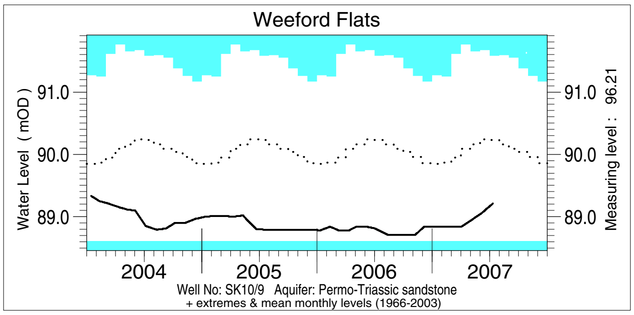


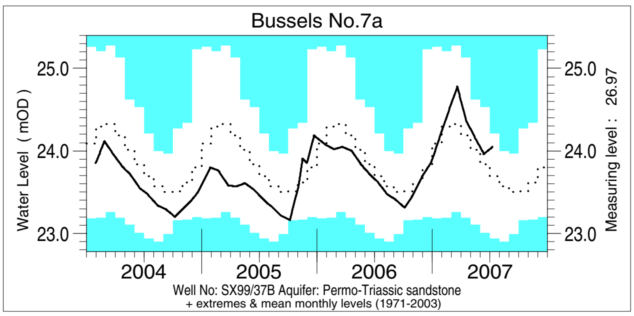


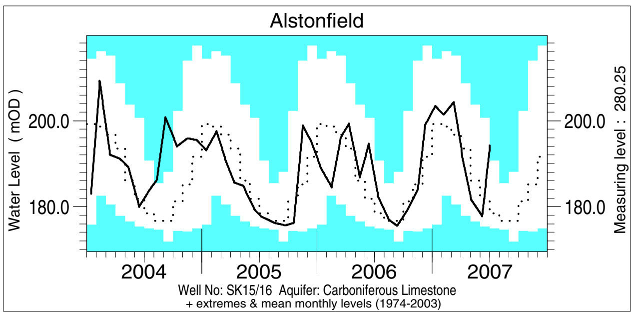








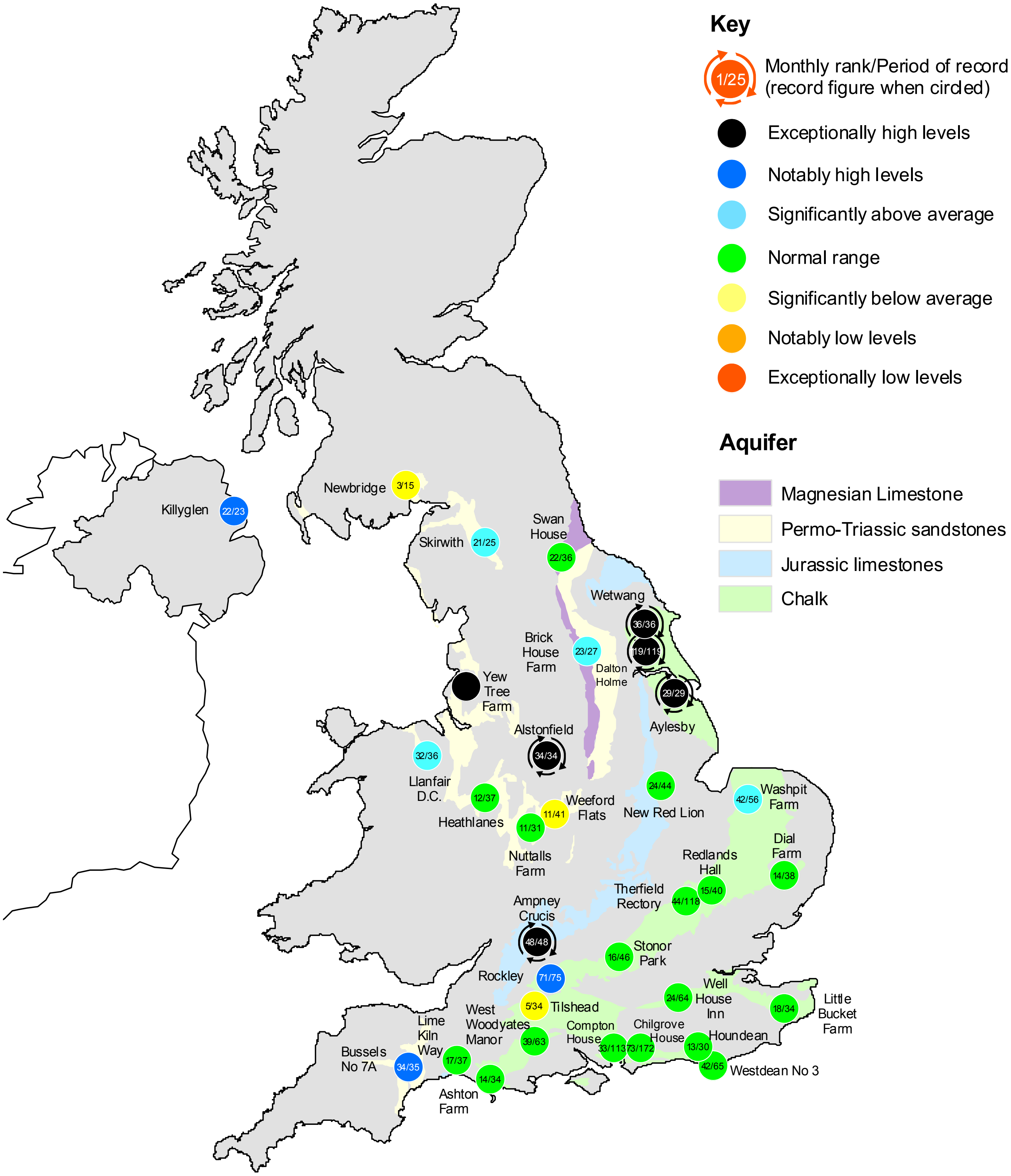




Groundwater levels July / August 2007

Borehole	Level	Date	Jul. av.	Borehole	Level	Date	Jul. av.	Borehole	Level	Date	Jul. av.
Dalton Holme	22.53	06/08	17.19	Chilgrove House	42.83	31/07	43.57	Brick House Farm	14.38	23/07	12.76
Washpit Farm	46.07	03/08	44.87	Killyglen	115.10	01/08	113.72	Llanfair DC	80.16	15/07	79.74
Stonor Park	75.99	31/07	77.14	New Red Lion	13.86	26/07	13.27	Heathlanes	61.70	27/07	62.14
Dial Farm	25.62	20/07	25.66	Ampney Crucis	102.85	31/07	100.44	Weeford Flats	89.21	11/07	89.90
Rockley	135.53	31/07	133.21	Newbridge	9.60	25/07	9.83	Bussels No.7a	24.05	10/07	23.71
Well House Inn	95.86	31/07	95.75	Skirwith	130.56	31/07	130.26	Alstonfield	194.30	02/07	179.25
West Woodyates	78.02	31/07	76.97	Swan House	84.18	18/07	83.63				

Levels in metres above Ordnance Datum



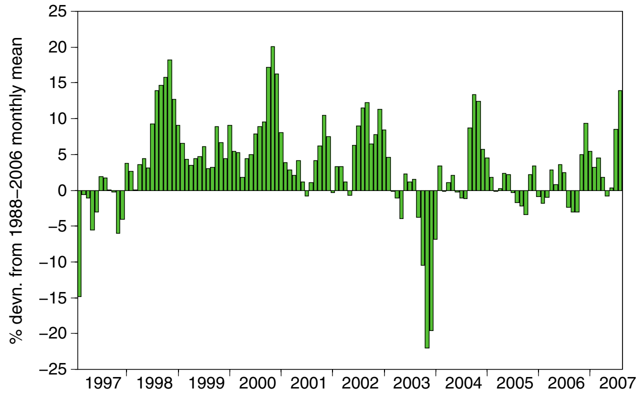
Groundwater levels - July 2007

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.

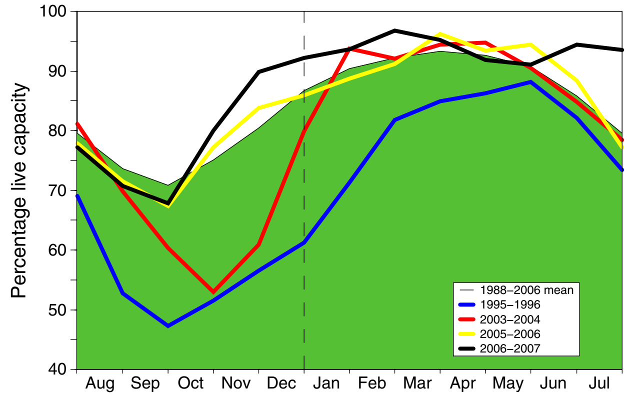
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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.

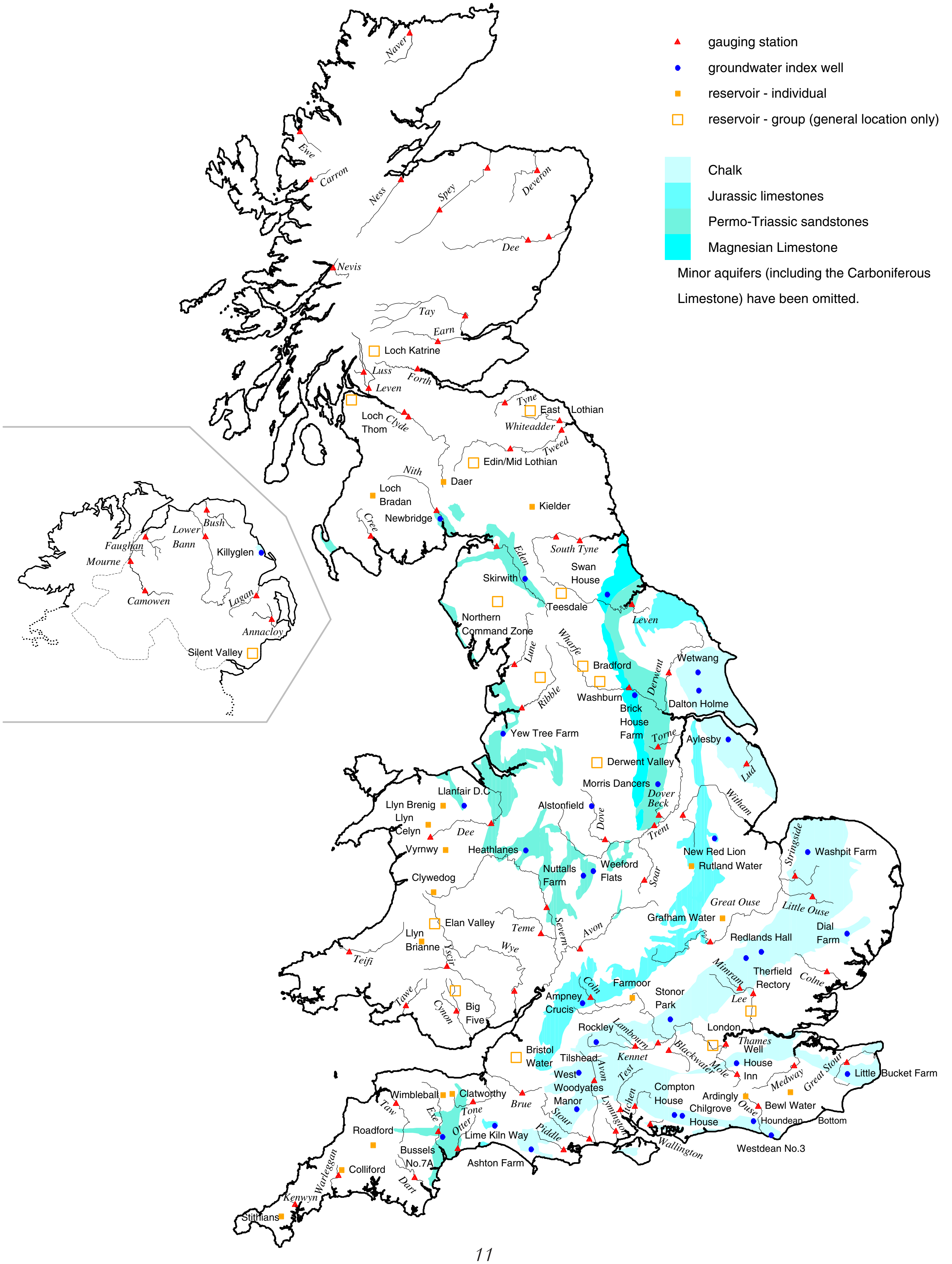
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2007 Jun	Jul	Aug	Aug Anom.	Min. Aug	Year* of min.	2006 Aug	Diff 07-06
North West	N Command Zone	• 124929	83	82	**85**	24	38	1989	64	21
	Vyrnwy	55146	85	94	**96**	21	56	1996	72	24
Northumbrian	Teesdale	• 87936	84	98	**98**	29	45	1989	69	29
	Kielder	(199175)	(93)	(96)	**(94)**	7	(66)	1989	(82)	12
Severn Trent	Clywedog	44922	98	100	**100**	16	57	1989	74	26
	Derwent Valley	• 39525	86	100	**100**	28	43	1996	71	29
Yorkshire	Washburn	• 22035	82	99	**95**	23	50	1995	78	17
	Bradford supply	• 41407	81	96	**97**	29	38	1995	69	28
Anglian	Grafham	(55490)	(98)	(97)	**(94)**	5	(66)	1997	(88)	6
	Rutland	(116580)	(96)	(97)	**(94)**	9	(74)	1995	(81)	13
Thames	London	• 202406	94	89	**82**	-3	73	1990	83	-1
	Farmoor	• 13822	98	97	**94**	-2	84	1990	100	-6
Southern	Bewl	28170	88	85	**83**	8	45	1990	76	7
	Ardingly	4685	99	100	**100**	15	65	2005	88	12
Wessex	Clatworthy	5364	80	78	**100**	29	43	1992	77	23
	Bristol WW	• (38666)	(92)	(98)	**(96)**	23	(53)	1990	(84)	12
South West	Colliford	28540	78	79	**82**	7	47	1997	58	24
	Roadford	34500	91	96	**99**	23	46	1996	67	32
	Wimbleball	21320	92	96	**100**	24	53	1992	84	16
	Stithians	5205	87	87	**90**	22	39	1990	64	26
Welsh	Celyn and Brenig	• 131155	96	99	**100**	13	65	1989	84	16
	Brianne	62140	94	97	**100**	13	67	1995	85	15
	Big Five	• 69762	91	96	**98**	24	41	1989	65	33
	Elan Valley	• 99106	92	100	**99**	18	63	1989	76	23
Scotland(E)	Edinburgh/Mid Lothian	• 97639	89	86	**91**	11	51	1998	80	11
	East Lothian	• 10206	95	100	**100**	13	72	1992	78	22
Scotland(W)	Loch Katrine	• 111363	78	72	**70**	-4	53	2000	72	-2
	Daer	22412	88	88	**100**	23	58	1994	83	17
	Loch Thom	• 11840	86	72	**71**	-11	59	2000	82	-11
Northern Ireland	Total+	• 67270	71	83	**86**	11	54	1995	70	16
	Silent Valley	• 20634	68	92	**92**	25	42	2000	72	20

() 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

08/07