Hydrological Summary *for the United Kingdom*

July 2006

General

July was the warmest month in the 337-year Central England Temperature series and, with very modest rainfall in most areas, the drought intensified and extended its range considerably. The 2nd lowest June/July rainfall for the UK since 1984, combined with outstanding open water evaporation losses and increased water demand (where unconstrained) contributed to a 17% decline in overall reservoir stocks for E&W, leaving stocks for early August at their lowest for a decade. In groundwater terms the drought is currently less severe than in 1997 or 1992 but groundwater levels are well below average over wide areas and very depressed in some aquifers in the English Lowlands. Notwithstanding thunderstorm-generated flash flooding in many localities, river flows are also very low across most of the country. Meagre flows and low oxygen levels are causing environmental and fisheries concern. Given normal rainfall patterns over the next three months, the exceptionally dry soil conditions foreshadow a continuation of river flow and groundwater level recessions well into the autumn. The likely delay in the seasonal recovery of runoff and recharge rates underlines the current fragility of the water resources outlook, in southern Britain especially. A third successive dry winter/early spring could bring extreme drought conditions with groundwater levels falling to their lowest for a century in parts of the English Lowlands.

Rainfall

Some north-western areas of the UK apart, synoptic patterns in July were dominated by a westerly extension of a persistent European high pressure cell. Many July (and some absolute) temperature records were eclipsed during an outstandingly sunny month (at Oxford sunshine hours were the 2nd highest since 1881). Lengthy sequences of days without appreciable rainfall were common (e.g. 20 on Anglesey) but the hot and humid conditions encouraged frequent convective storms (Royston reported 75.5mm in 2 hrs on the 26th) triggering flash flooding. The thunderstorms made for very limited spatial coherence in July precipitation totals. Above average rainfall was largely confined to central southern England, northern Scotland and some eastern catchments in Northern Ireland. Many other areas, coastal localities especially, registered <40%, with a few reporting <20% of average. Rainfall deficiencies since late May have significantly extended the region affected by notable drought conditions; some parts of eastern Britain registered their 2nd driest June/July since 1925. Generally however, longer term rainfall deficiencies remain the key to the drought's current impact. England and Wales recorded its 3rd lowest 21-month total (for accumulations beginning in November) since the mid-1930s with deficiencies in this timeframe being the lowest in more than 70 years across much of central England and the South East; over a wider area (including the South-West) the Nov 2004-July 2006 rainfall ranks 2nd lowest. Given that this period embraces two dry winters, substantial hydrological and water resources impacts are inevitable.

Flows

Runoff patterns in July were characterised by a combination of localised, mostly urban, flooding as drainage capacities were overwhelmed during thunderstorms (e.g. Edinburgh on the 3rd, Lincolnshire, 27th, the South East, 28th) and by depressed runoff rates in most rivers across the country. Flows over the latter half of the month approached, or eclipsed, previous July daily minima in a significant minority of index rivers, including the Soar, Little Ouse, Mimram, Clyde and Whiteadder. For the latter, the July runoff was the lowest on record (37 yrs), a distinction shared with the Faughan in Northern Ireland (31 yrs). Depressed flows, high temperatures and associated low oxygen levels increased the risk of algal blooms and fish stress. Correspondingly, further low flow augmentation schemes were activated (e.g. on the Darent and in the headwaters of the Itchen). Thunderstorm-generated spates allowed July runoff to exceed the average for the Gt Ouse but runoff fell below the normal range across much of the UK. The drought's regional dimension is more evident in the longer term runoff accumulations. For the year thus far, runoff for the Mimram is the lowest in a 54-yr series and the Nov 2004-July 06 accumulations confirm the drought's sustained severity in much of southern England; the Kenwyn, Sussex Ouse and Medway establishing new minima in this timeframe. The failure of higher-level spring sources has left many chalk streams very depleted. The Mimram and Wendover Springs both reported flows close to the 1976 July minima. The exceptionally dry soil conditions imply that widespread notably low autumn flows are in prospect.

Groundwater

Well below average rainfall across almost all aquifer outcrop areas (the Cotswolds excepted), together with outstandingly high evaporation demands ensured that, as usual, July infiltration totals were negligible. Following one of the most erratic recharge seasons in the recent past, summer recessions are now established in all but the slowest-responding aquifer units. Differences in rainfall patterns, the responsiveness of individual aquifer units and groundwater levels prior to the onset of drought conditions make for large regional, and more local, variations in current groundwater resource status. In the Chalk, levels in some northern, western and southern outcrops (where the benefit of late-spring recharge can still be recognised), remain in the normal range. By contrast, July levels were very depressed in parts of the Chilterns and the North Downs, where levels were the 2nd lowest since 1944 at Well House Inn. Similarly depressed resources characterise a number of Permo-Triassic sandstone outcrops in the Midlands. Generally levels are within the normal range in most limestone outcrops but steep recent declines typify some minor aquifers (e.g. the Essex Gravels). Importantly, the outlook for groundwater resources is more fragile than the July levels suggest. In 1976, 1992 and 1997 when groundwater levels were extensively and severely depressed, above average summer and/or autumn rainfall heralded brisk groundwater recoveries. This year, with early August soil moisture deficits close to theoretical maxima over wide areas, recessions are likely to be protracted, underlining the need for substantial and sustained rainfall to prevent a continuation of drought conditions well into 2007.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Rainfall . . . Rainfall . . .

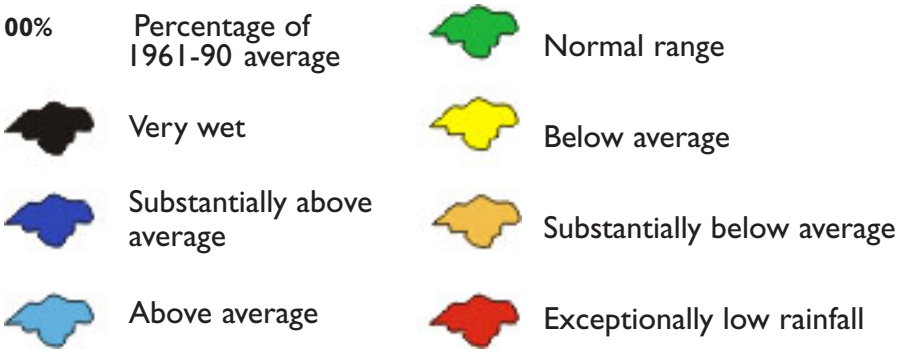
Rainfall accumulations and return period estimates

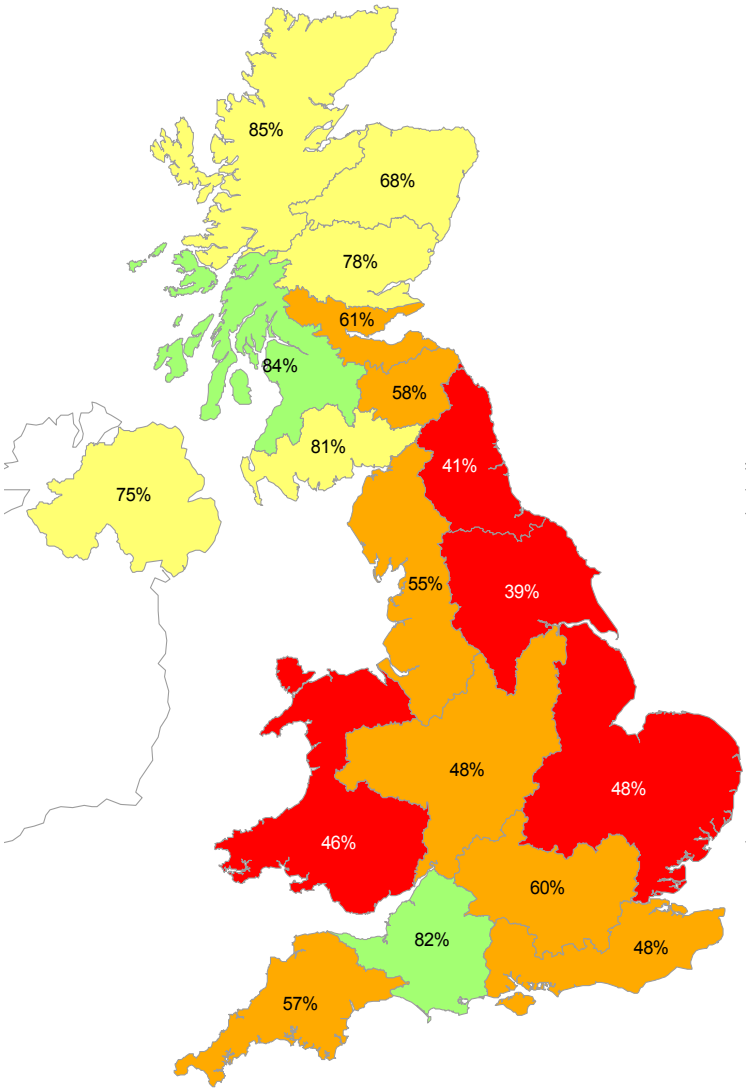
Area	Rainfall	July 2006	Jun 06- Jul 06	RP	Jan 06- Jul 06	RP	Aug 05- Jul 06	RP	Nov 04- Jul 06	RP
England & Wales	**mm**	**39**	**64**		**400**		**809**		**1345**	
	%	**63**	**51**	**15-25**	**84**	**5-10**	**89**	**2-5**	**86**	**10-20**
North West	mm	**50**	94		556		1118		1896	
	%	**58**	55	10-20	91	2-5	92	2-5	91	2-5
Northumbrian	mm	**26**	52		377		779		1396	
	%	**39**	41	30-50	81	5-10	90	2-5	93	2-5
Severn Trent	mm	**39**	55		330		677		1119	
	%	**70**	48	15-25	79	5-10	88	2-5	84	10-20
Yorkshire	mm	**32**	49		397		746		1262	
	%	**52**	39	20-30	88	2-5	89	2-5	87	5-15
Anglian	mm	**34**	49		277		531		883	
	%	**67**	48	15-25	83	5-10	88	2-5	84	10-20
Thames	mm	**48**	63		319		604		955	
	%	**96**	60	5-10	84	2-5	86	5-10	78	25-40
Southern	mm	**28**	50		328		651		1046	
	%	**58**	48	10-20	80	5-10	83	5-10	77	30-45
Wessex	mm	**57**	91		375		759		1253	
	%	**107**	82	2-5	83	2-5	89	2-5	84	10-20
South West	mm	**42**	80		461		1013		1710	
	%	**59**	57	5-10	74	10-20	85	5-10	82	15-25
Welsh	mm	**40**	74		601		1264		2070	
	%	**50**	46	15-25	88	2-5	94	2-5	89	10-20
Scotland	**mm**	**72**	**145**		**697**		**1426**		**2592**	
	%	**76**	**80**	**2-5**	**95**	**2-5**	**97**	**2-5**	**103**	**2-5**
Highland	mm	**84**	174		845		1759		3300	
	%	**79**	85	2-5	98	2-5	101	2-5	110	5-10
North East	mm	**53**	99		438		948		1691	
	%	**68**	68	5-10	81	5-15	92	2-5	95	2-5
Tay	mm	**61**	124		605		1207		2154	
	%	**74**	78	2-5	90	2-5	94	2-5	97	2-5
Forth	mm	**47**	92		506		1033		1918	
	%	**61**	61	5-15	86	2-5	90	2-5	98	2-5
Tweed	mm	**50**	82		433		907		1592	
	%	**67**	58	10-20	82	5-10	90	2-5	92	2-5
Solway	mm	**71**	144		707		1370		2352	
	%	**76**	81	2-5	99	2-5	95	2-5	96	2-5
Clyde	mm	**89**	177		842		1664		3014	
	%	**78**	84	2-5	98	2-5	95	2-5	101	2-5
Northern Ireland	**mm**	**69**	**108**		**530**		**1034**		**1769**	
	%	**97**	**75**	**5-10**	**93**	**2-5**	**94**	**2-5**	**94**	**2-5**

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

The monthly rainfall figures* provided by the Met Office (National Climate Information Centre) are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation. **All monthly totals since February 2006 are provisional (see page 12).** 1961-2003 regional monthly totals were revised by the Met Office in 2004. Most of the return period estimates are based on tables provided by the Met Office (see Tabony, R. C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37) and relate to the specified span of months only (return periods may be up to an order of magnitude less if n-month periods beginning in any month are considered); RP estimates for Northern Ireland are based on the tables for north-west England. The tables reflect rainfall over the period 1911-70 and assume a stable climate. Artifacts, in the Scottish rainfall series in particular, can exaggerate the relative wetness of the recent past. *See page 12.

Rainfall . . . Rainfall . . .





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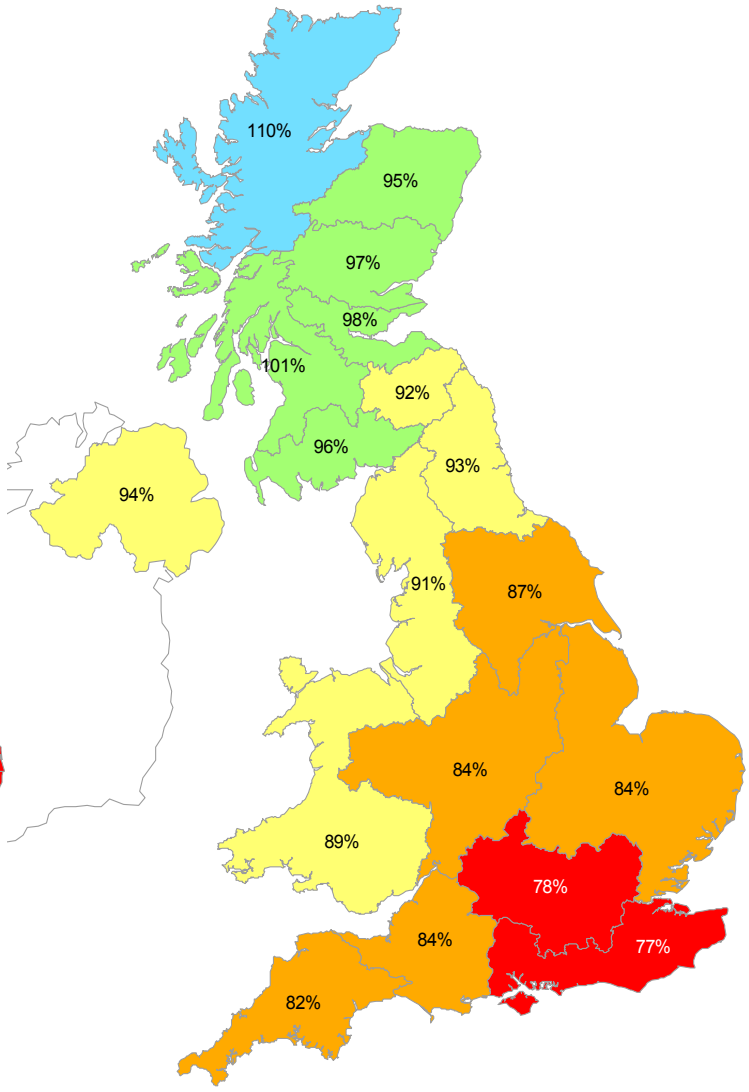
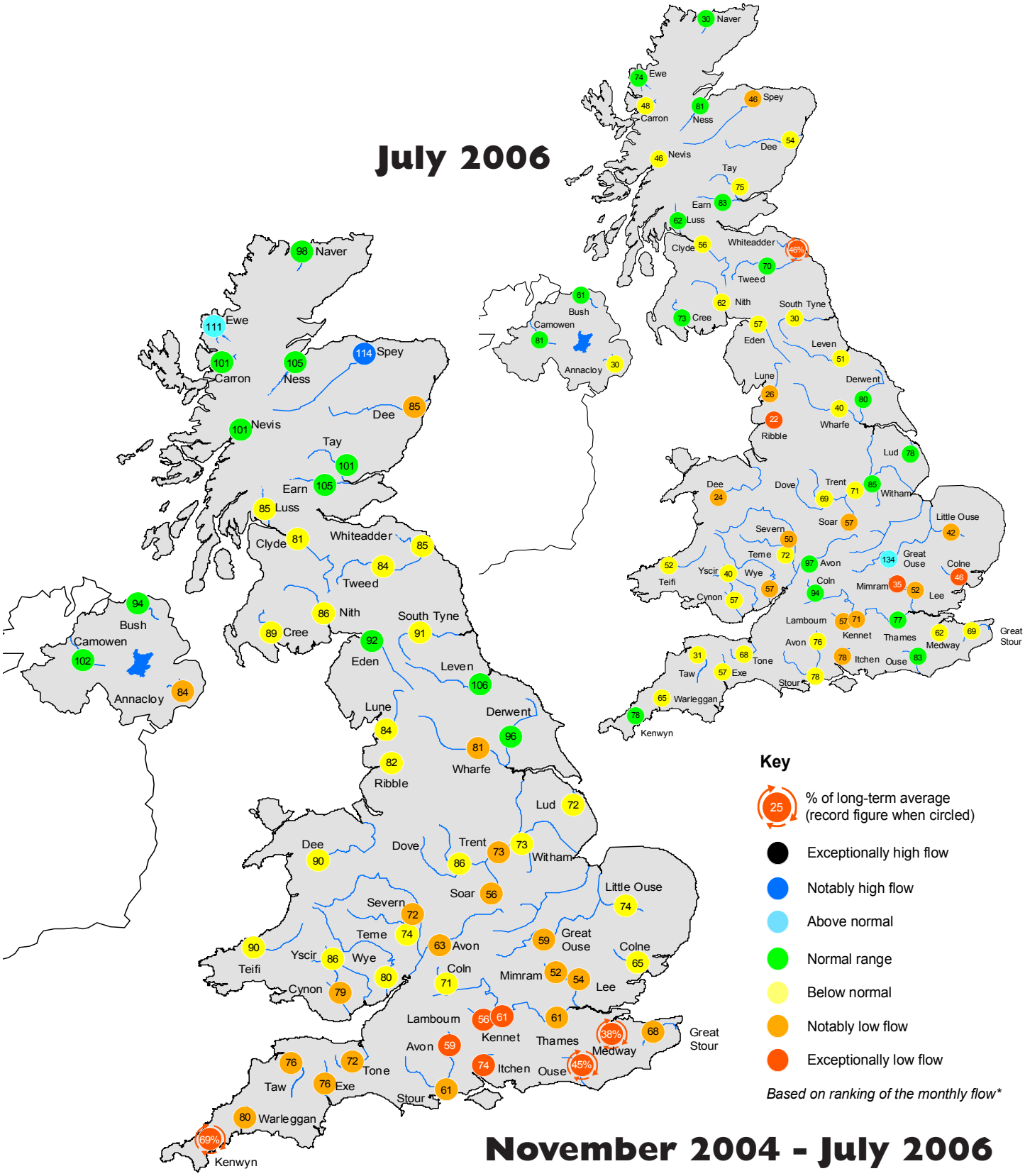


November 2004 - July 2006

Rainfall accumulation maps

The combined June and July rainfall totals are below average in almost all regions of the UK and for England and Wales only 1995 and 1976 have been drier in this timespan since 1921. Rainfall has also been below average for all regions in 2006 thus far. A strong regional dimension to the drought is confirmed by the rainfall accumulations since October 2004; rainfall deficiencies are greatest in parts of the South-East (extending to Dorset and the Isle of Wight) and Cornwall.

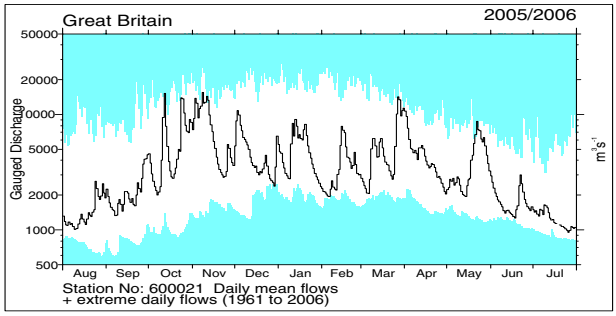
River flow . . . River flow . . .

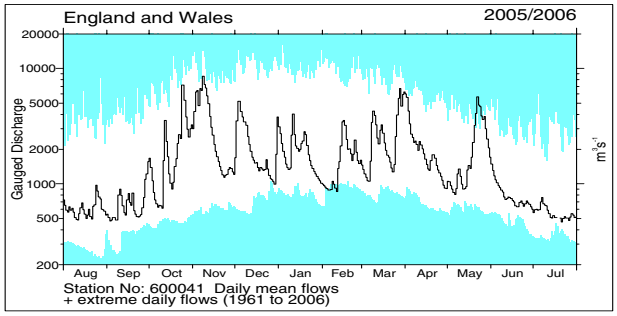


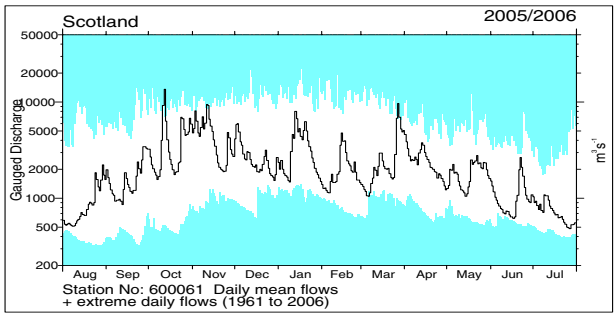
River flows

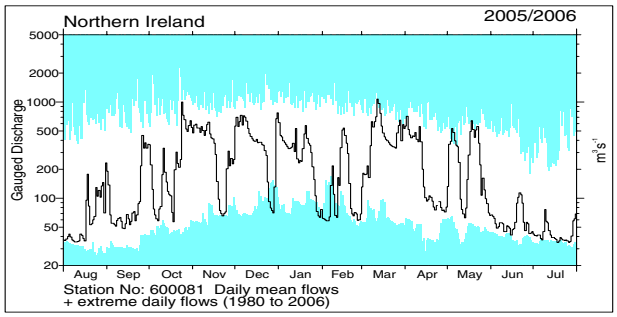
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

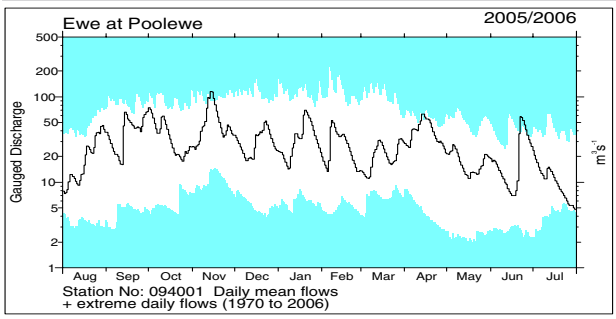
River flow . . . River flow . . .

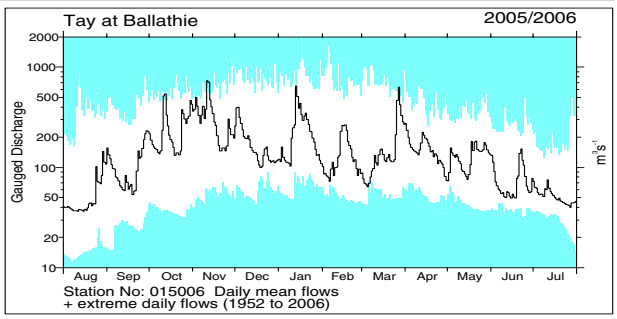


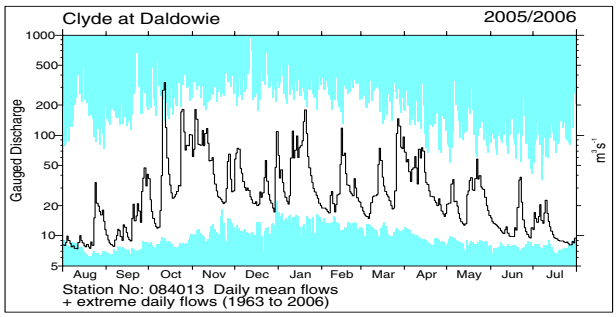


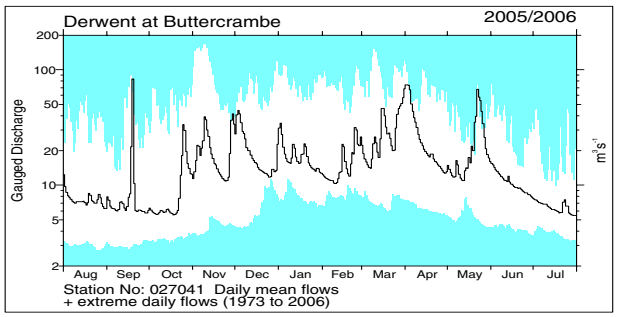


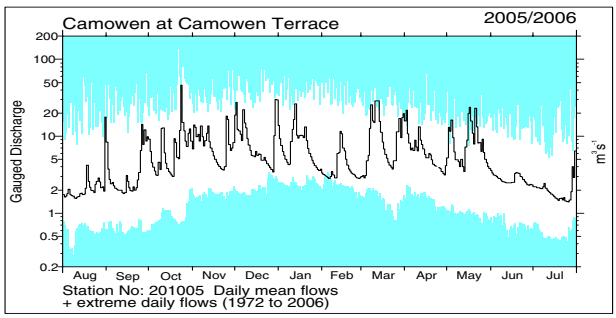


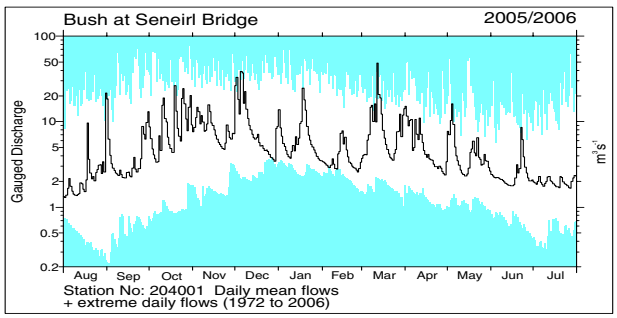








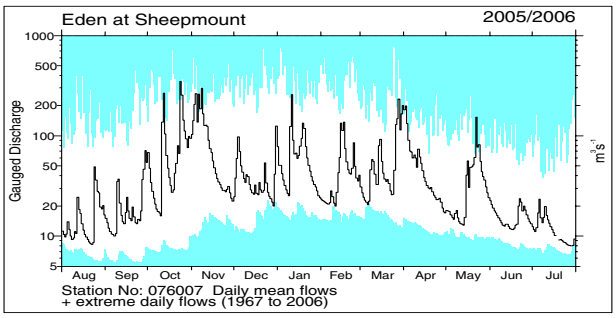


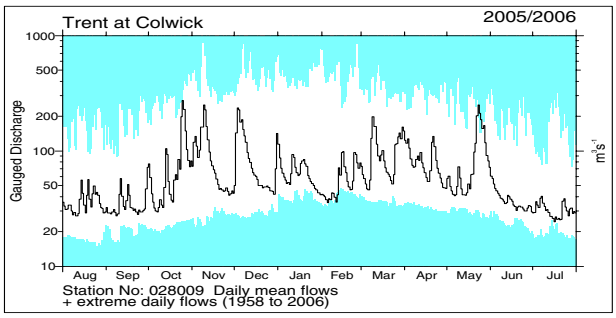


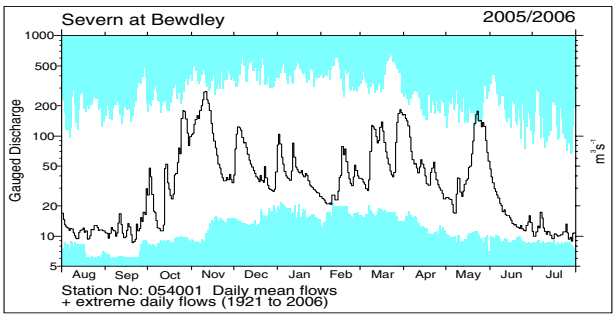
River flow hydrographs

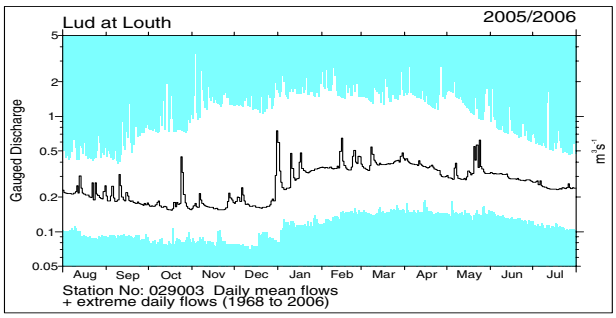
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to August 2005 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

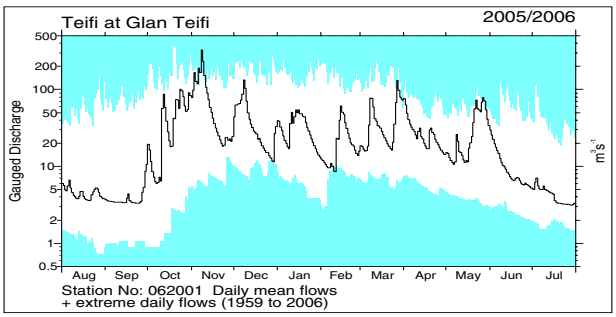
River flow . . . River flow . . .

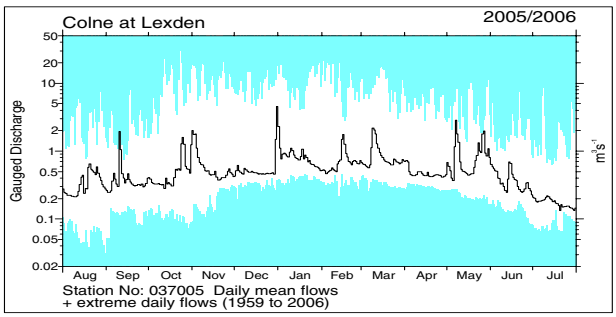


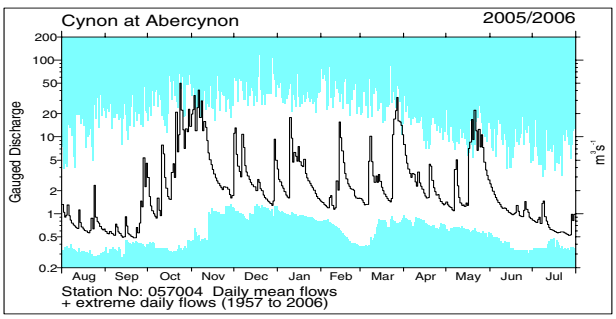


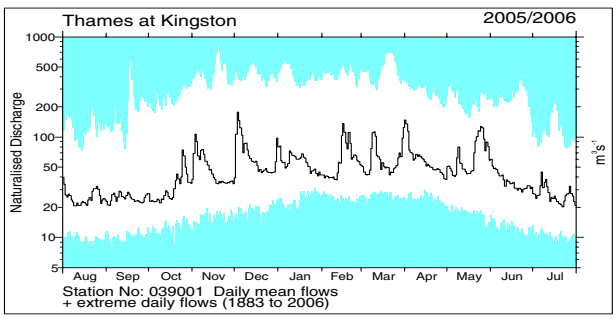


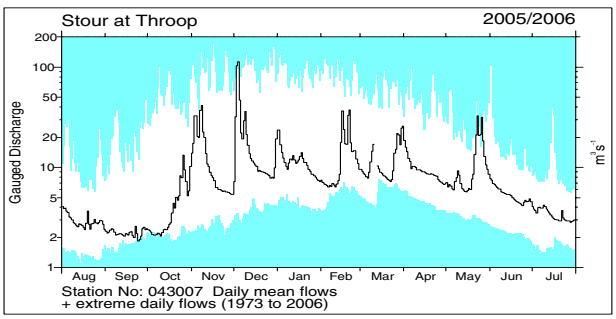


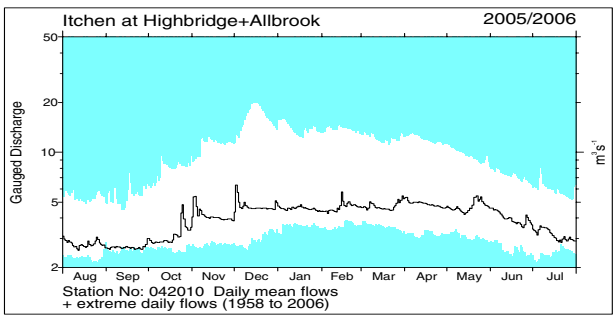












Notable runoff accumulations (a) January - July 2006, (b) November 2004 - July 2006

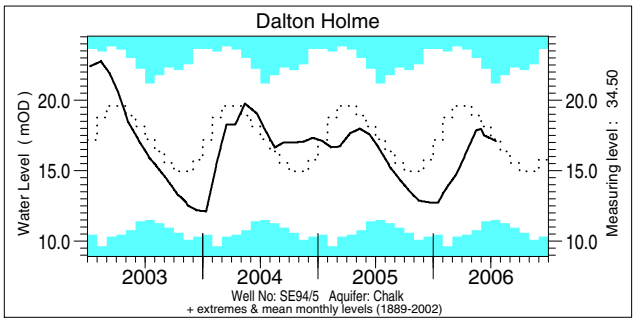
	River	%lta	Rank
a)	Spey (Boat o'Garten)	67	4/55
	Forth	72	4/25
	Tweed (Norham)	74	4/47
	Mimram	39	1/54
	Lee	47	11/120
	Warleggan	70	4/37
	Naver	71	4/29
	Faughan	68	2/30

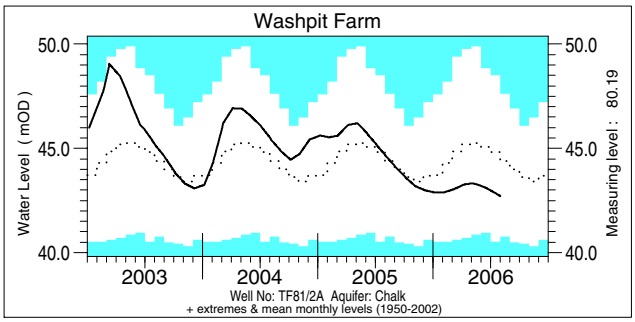
	River	%lta	Rank
b)	Soar	56	2/34
	Thames	61	9/122
	Lambourn	56	2/43
	Mole	64	1/29
	Medway	38	1/41
	Ouse (Gold Bridge)	45	1/38
	Wallington	46	1/46

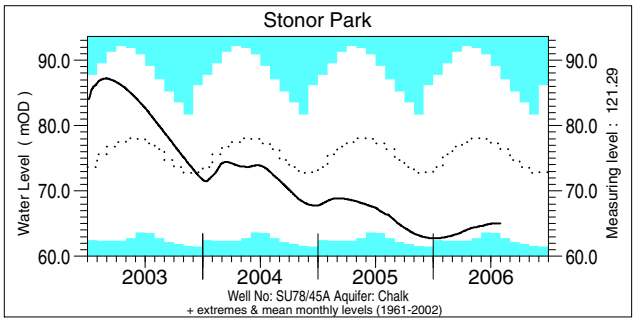
River	%lta	Rank
Test	63	1/46
Itchen	74	2/47
Avon (Amesbury)	59	2/40
Stour (Throop)	61	2/32
Piddle	64	1/40
Kenwyn	69	1/37
Annacloy	84	2/25

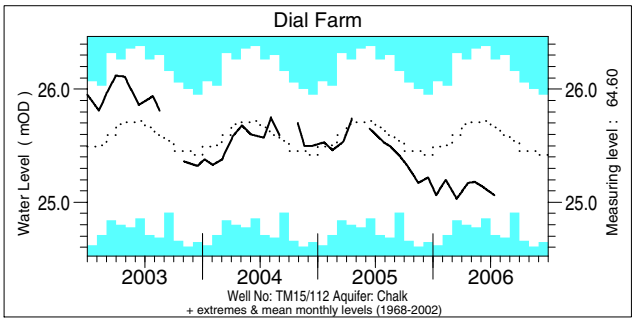
lta = long term average
Rank 1 = lowest on record

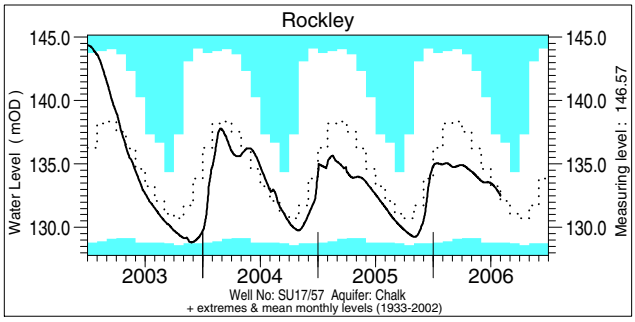
Groundwater . . . Groundwater

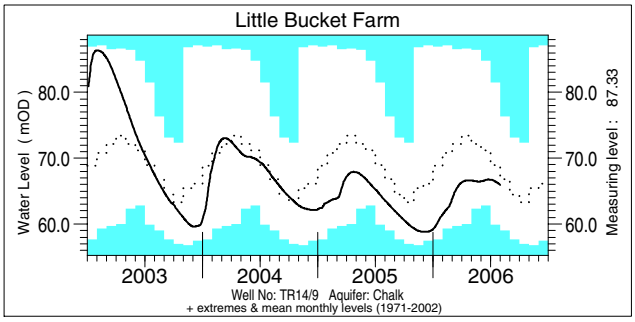


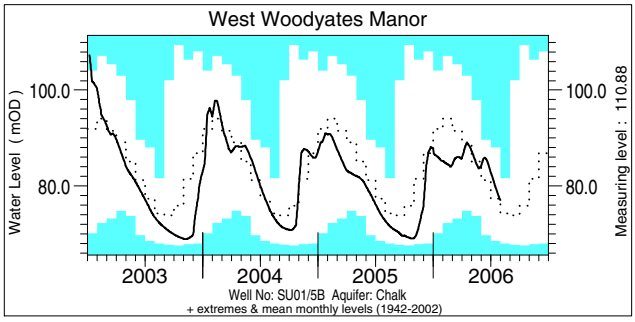


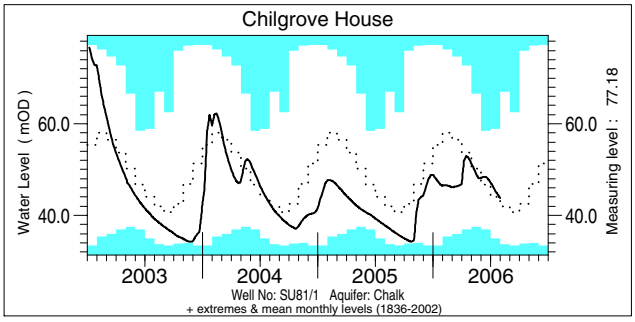


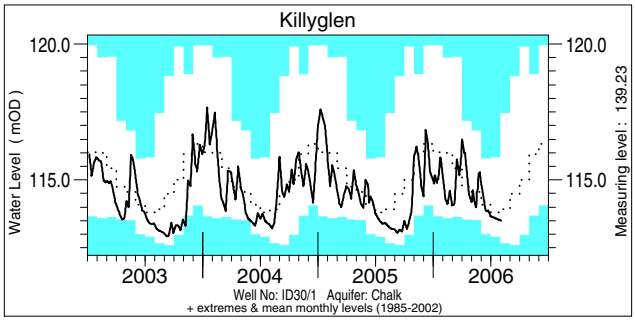


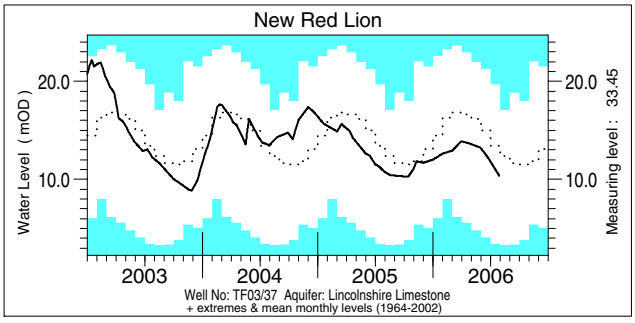






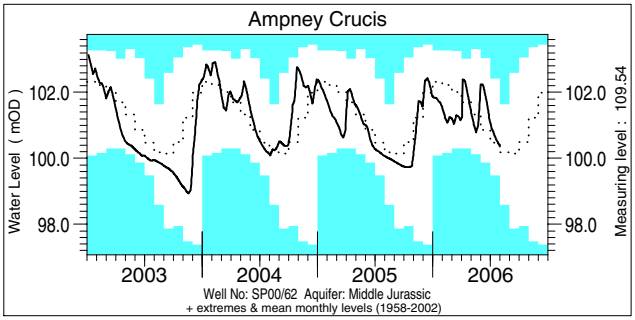


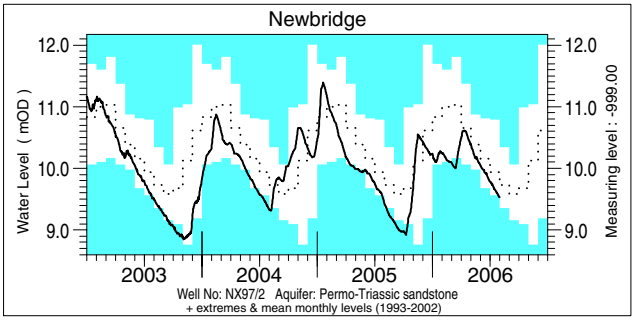


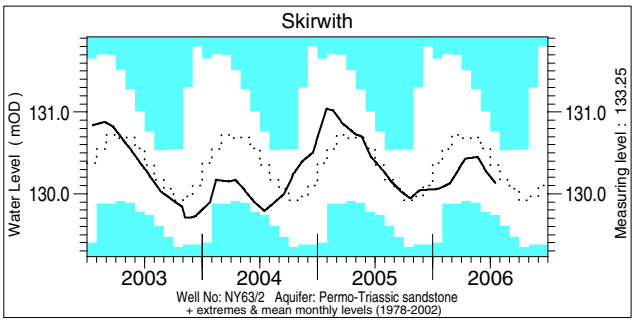


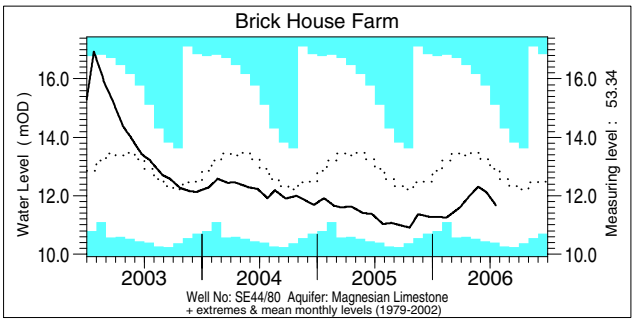
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

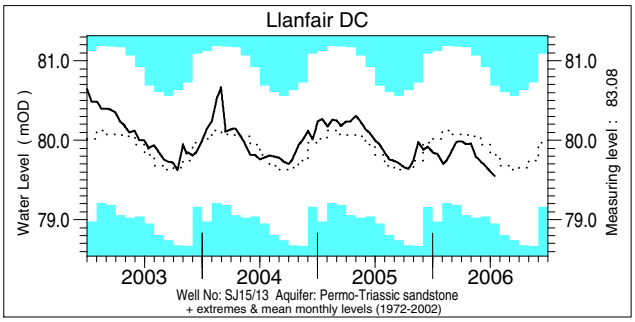
Groundwater . . . Groundwater

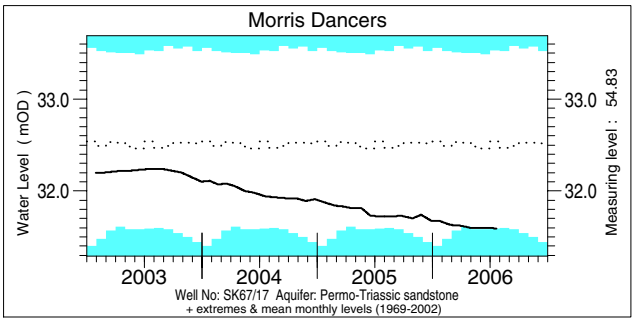


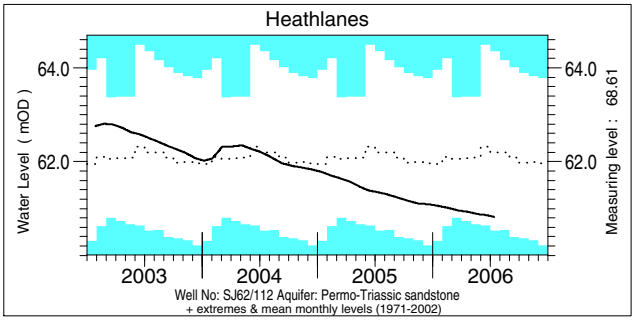


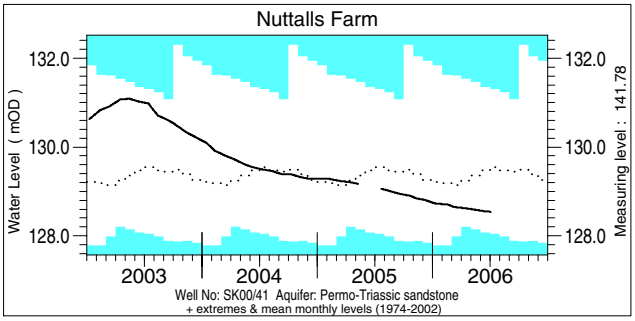


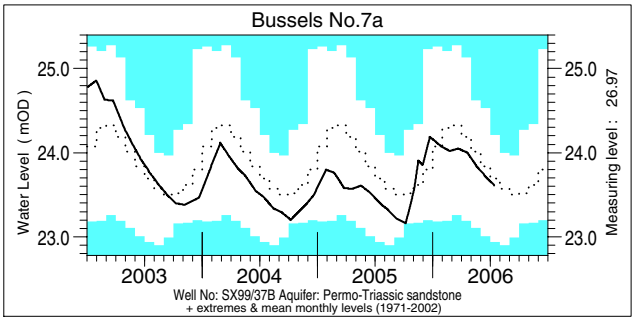


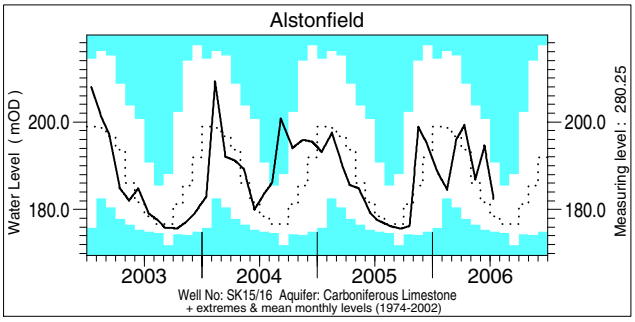










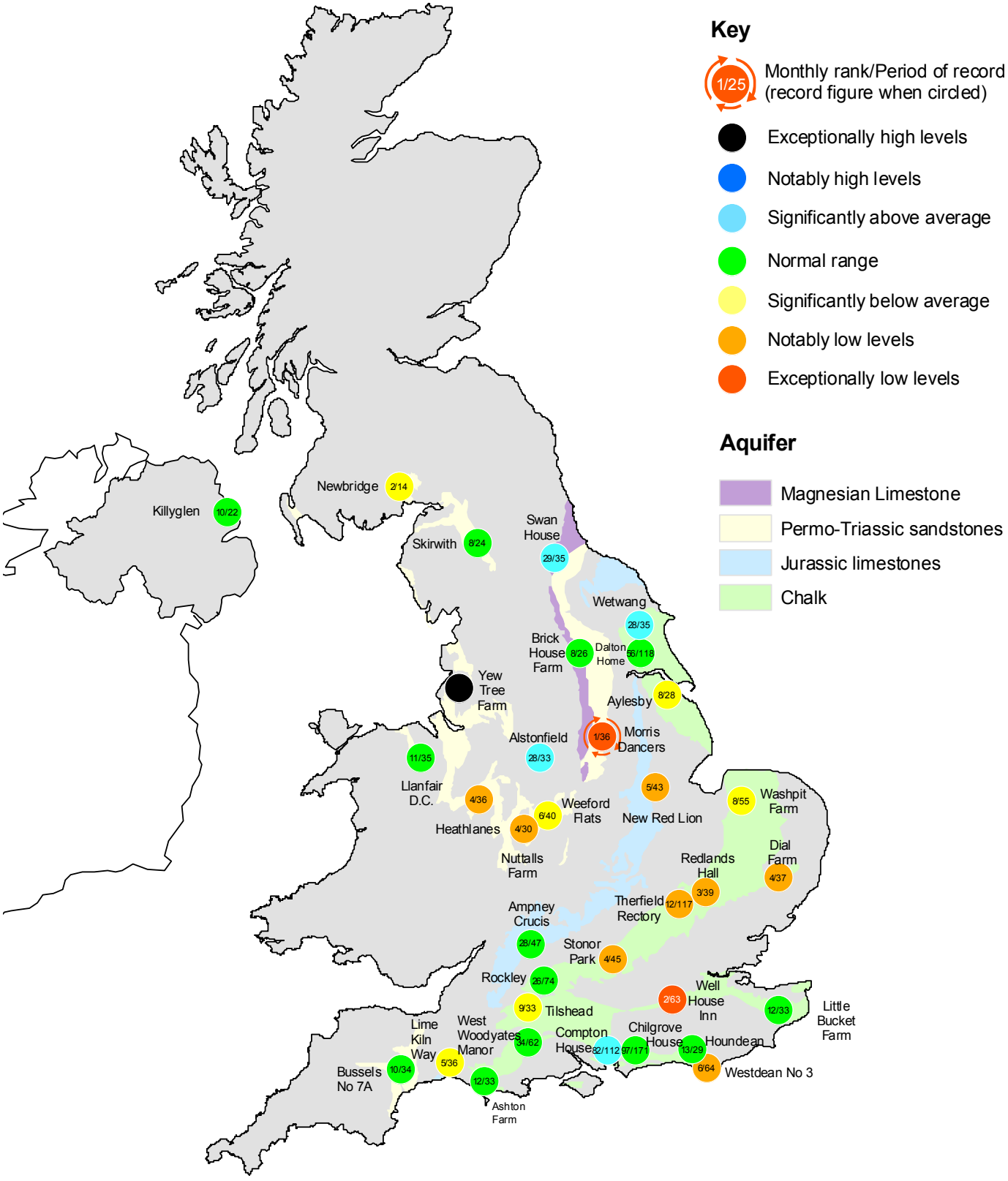


Groundwater levels July / August 2006

Borehole	Level	Date	Jul. av.	Borehole	Level	Date	Jul. av.	Borehole	Level	Date	Jul. av.
Dalton Holme	17.11	17/07	17.19	Chilgrove House	43.76	31/07	43.56	Llanfair DC	79.55	15/07	79.75
Washpit Farm	42.70	01/08	44.91	Killyglen	113.50	02/08	113.74	Morris Dancers	31.59	21/07	32.33
Stonor Park	64.99	01/08	77.42	New Red Lion	10.35	28/07	13.34	Heathlanes	60.82	14/07	62.18
Dial Farm	25.06	14/07	25.67	Ampney Crucis	100.35	01/08	100.43	Nuttalls Farm	128.54	03/07	129.62
Rockley	132.51	01/08	133.21	Newbridge	9.53	31/07	9.85	Bussels No.7a	23.61	14/07	23.72
Well House Inn	88.43	01/08	95.87	Skirwith	130.13	17/07	130.27	Alstonfield	182.42	12/07	179.15
West Woodyates	77.01	31/07	76.92	Brick House Farm	11.67	19/07	12.80				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



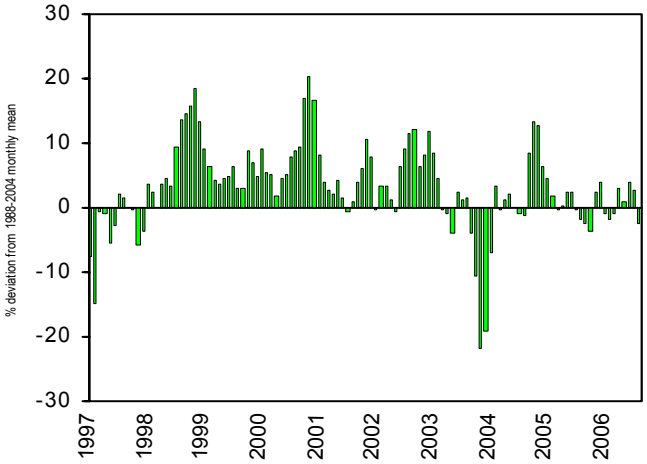
Groundwater levels - July 2006

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.

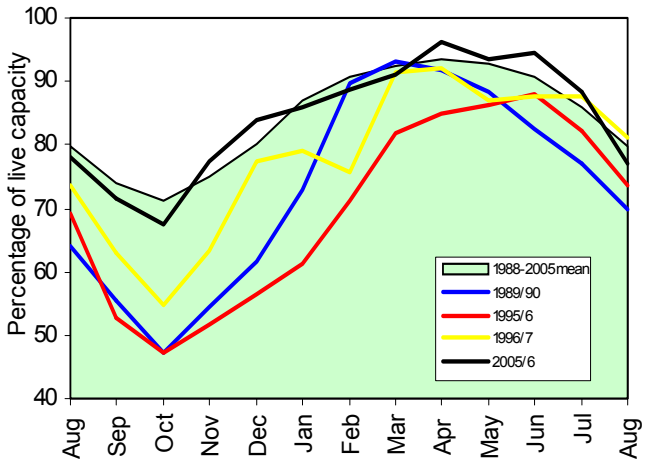
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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.

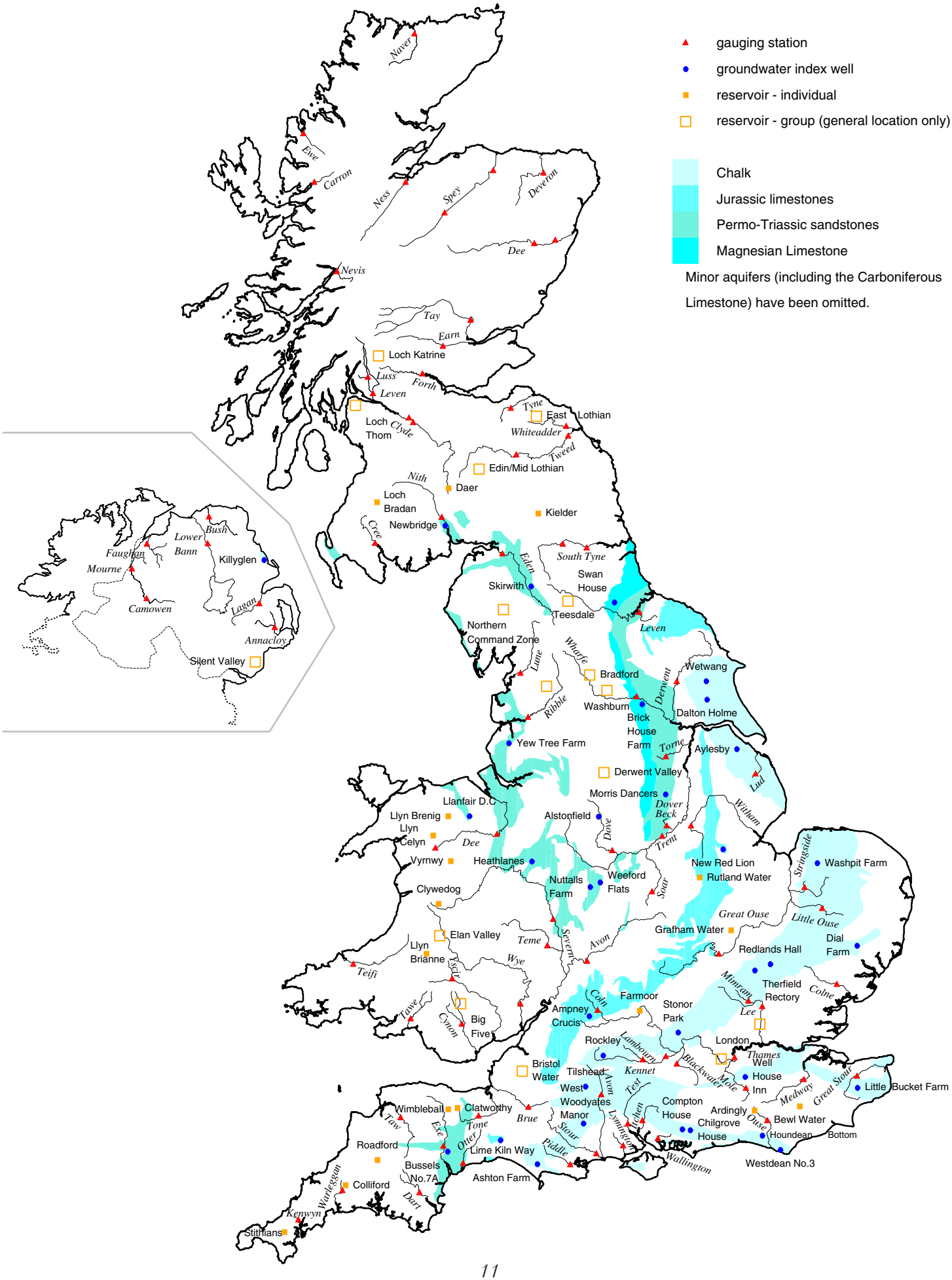
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2006 Apr	May	Jun	Jul	Aug	Avg. Aug	Min. Aug	Year* of min.
North West	N Command Zone	• 124929	100	91	85	77	**64**	61	38	1989
	Vyrnwy	55146	100	98	98	86	**72**	76	56	1996
Northumbrian	Teesdale	• 87936	100	94	95	84	**69**	69	45	1989
	Kielder	(199175)	(98)	(89)	(93)	(90)	**(82)**	(88)	(66)	1989
Severn Trent	Clywedog	44922	99	100	100	97	**74**	84	57	1989
	Derwent Valley	• 39525	100	99	100	88	**71**	72	43	1996
Yorkshire	Washburn	• 22035	99	94	98	87	**78**	71	50	1995
	Bradford supply	• 41407	97	95	99	85	**69**	68	38	1995
Anglian	Grafham	(55490)	(96)	(99)	(100)	(96)	**(88)**	(89)	(66)	1997
	Rutland	(116580)	(88)	(91)	(93)	(88)	**(81)**	(85)	(74)	1995
Thames	London	• 202406	99	91	93	92	**83**	86	73	1990
	Farmoor	• 13822	97	99	100	100	**100**	95	84	1990
Southern	Bewl	28170	65	85	91	85	**76**	75	45	1990
	Ardingly	4685	88	100	100	98	**88**	85	65	2005
Wessex	Clatworthy	5364	100	98	86	95	**77**	70	43	1992
	Bristol WW	• (38666)	(87)	(92)	(96)	(92)	**(84)**	(72)	(53)	1990
South West	Colliford	28540	68	70	70	67	**58**	76	47	1997
	Roadford	34500	76	75	77	74	**67**	77	46	1996
	Wimbleball	21320	100	99	100	94	**84**	76	53	1992
	Stithians	5205	96	94	90	77	**64**	68	39	1990
Welsh	Celyn and Brenig	• 131155	100	100	100	97	**84**	87	65	1989
	Brianne	62140	100	100	100	94	**85**	88	67	1995
	Big Five	• 69762	99	97	96	81	**65**	74	41	1989
	Elan Valley	• 99106	100	99	100	89	**76**	82	63	1989
Scotland(E)	Edinburgh/Mid Lothian	• 97639	96	92	92	87	**80**	80	51	1998
	East Lothian	• 10206	100	100	99	100	**78**	87	72	1992
Scotland(W)	Loch Katrine	• 111363	99	94	98	86	**72**	74	53	2000
	Daer	22412	100	97	94	91	**83**	76	58	1994
	Loch Thom	• 11840	100	100	100	100	**82**	82	59	2000
Northern Ireland	Total+	• 67270	93	89	89	80	**70**	76	54	1995
	Silent Valley	• 20634	98	93	94	82	**72**	67	42	2000

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

Details of the individual reservoirs in each of the groupings listed above are available on request. The featured reservoirs may not be representative of the storage conditions across each region; this can be particularly important during droughts. The storage figures relate to the 1988-2006 period only (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.

*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

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08/06