Hydrological Summary
for the United Kingdom

September 2006

General

September was a very warm month throughout the UK – the warmest on record in the 337-yr Central England Temperature series. Monthly rainfall totals again displayed substantial spatial variation but, despite a recent amelioration in the South-East, the drought's focus remains on southern England where in some areas 23-month rainfall accumulations are among the lowest three since 1932-34. Overall reservoir stocks for England and Wales are around 3% below average and marginally healthier than at the corresponding time in 2005. However, levels in some reservoirs in Wales and the South-West are relatively depressed; Colliford (Devon) reported its lowest October level in a 19-yr series. Seasonal river flow recoveries are well underway in many northern catchments but in the English Lowlands continuing recessions and notably low flows characterise most spring-fed streams. The associated contraction in the stream network is the greatest since 1992 in some areas. At the national scale, only a very moderate groundwater drought can be recognised but September groundwater levels were still mostly in decline and water-tables are near to long-term minima in some aquifer units – mostly in central southern England and the Midlands. Here particularly, above average late autumn rainfall is needed to trigger and sustain seasonal recoveries in recharge rates.

Rainfall

Indian Summer conditions characterised much of the UK during early September, thereafter synoptic patterns became much more unsettled. Damaging storms on the 14th (with tornadoes in the Midlands) generated some notable rainfall totals (40mm at Brize Norton) and a week later, the remnant of Hurricane Gordon produced widespread and sustained rainfall across Northern Ireland and southern Scotland (Glasgow reported 34 mm). September rainfall totals showed substantial regional and local variations - a defining feature of the last four months. Northern Ireland registered its 2nd wettest September since 1985 and parts of the Borders, Cairngorms and NE England were also very wet. By contrast parts of Scotland were dry as was much of Wales and South West; the latter has seen a notable intensification in the drought since May – the June-Sept period is the 2nd driest since 1921. Aug-Sept rainfall exceeded the average throughout most of the English Lowlands (parts of East Anglia especially), moderating the drought's intensity but evaporation demands greatly restricted its hydrological effectiveness. Notwithstanding the recent relatively wet episode, long term (23-month) rainfall deficiencies exceed 25% in large parts of the South East and Cornwall with the most severe deficiencies distributed very patchily across southern England.

River flows

September saw seasonal river flow recoveries well established in most northern catchments. High flows typified many Pennine rivers at the beginning of the month – the Ribble registered its highest Sept flow since 1985 on the 2nd – and spates were recorded across much of Scotland in the third week. Flash flooding was common in eastern England (e.g. Lowestoft and Yarmouth on the 25th) but flows remain in recession in most spring-fed southern rivers, and approached absolute minima in a few rivers (e.g. the Itchen and Mimram). Runoff rates were also very depressed in the South-West (in the Taw especially). September runoff totals were mostly in the normal range in northern parts of the country but differing rainfall patterns and catchment geologies made for a complex picture in southern Britain. New monthly runoff minima were established for the Warleggan and Mimram; the latter in a 53-yr record. For many permeable catchments September flows were very similar to those in 2005. The drought's intensification in the South-West is evidenced by the June-Sept runoff – the 2nd lowest after 1976 for the Otter (Devon). Generally, the drought's regional focus and intensity is best captured by long term runoff deficiencies. In the 23-month timeframe (see map) many index rivers (from the Warleggan to the Medway) have established new runoff minima; in NI the Faughan also eclipsed its previous minimum. A direct reflection of the very limited recharge over the last two winters is provided by flows in the Lambourn: runoff since August 2003 has closely approached the 36-month minimum (established in 1990-92) in a series from 1962.

Groundwater

September rainfall patterns generally favoured the outcrop areas of the major aquifers but notably high evaporative demands in southern Britain produced outstandingly dry mid-September soils in some areas. Soils were mostly less arid by month end but September recharge was, as usual, minimal (some isolated recharge was reported in the eastern Chalk outcrops and the Sandringham Sands). Generally, the summer recessions continued with few signs of a seasonal upturn, although levels at Compton (in the Chalk of the South Downs) increased marginally over later half of the month. September groundwater levels were mostly considerably below average but well above drought minima. The overall status of groundwater resources is similar to September 2005 but concern for the outlook focuses on those aquifer units where index levels are lower than a year ago. In the Chalk, these include Stonor, Therfield and Redlands where, in a 43-yr record, only in 1997 and 1992 have levels been similarly depressed. In the Permo-Triassic sandstones at Nuttals Farm, levels are similar to the drought minima in 1997, 1992 and 1976; more notably, levels in the slow-responding Morris Dancers borehole are matched only by autumn 1998 in a series from 1970. Above average late September soil moisture deficits in many of the zones of maximum depletion emphasise the need for above average Oct/Nov rainfall.

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Rainfall . . . Rainfall . . .

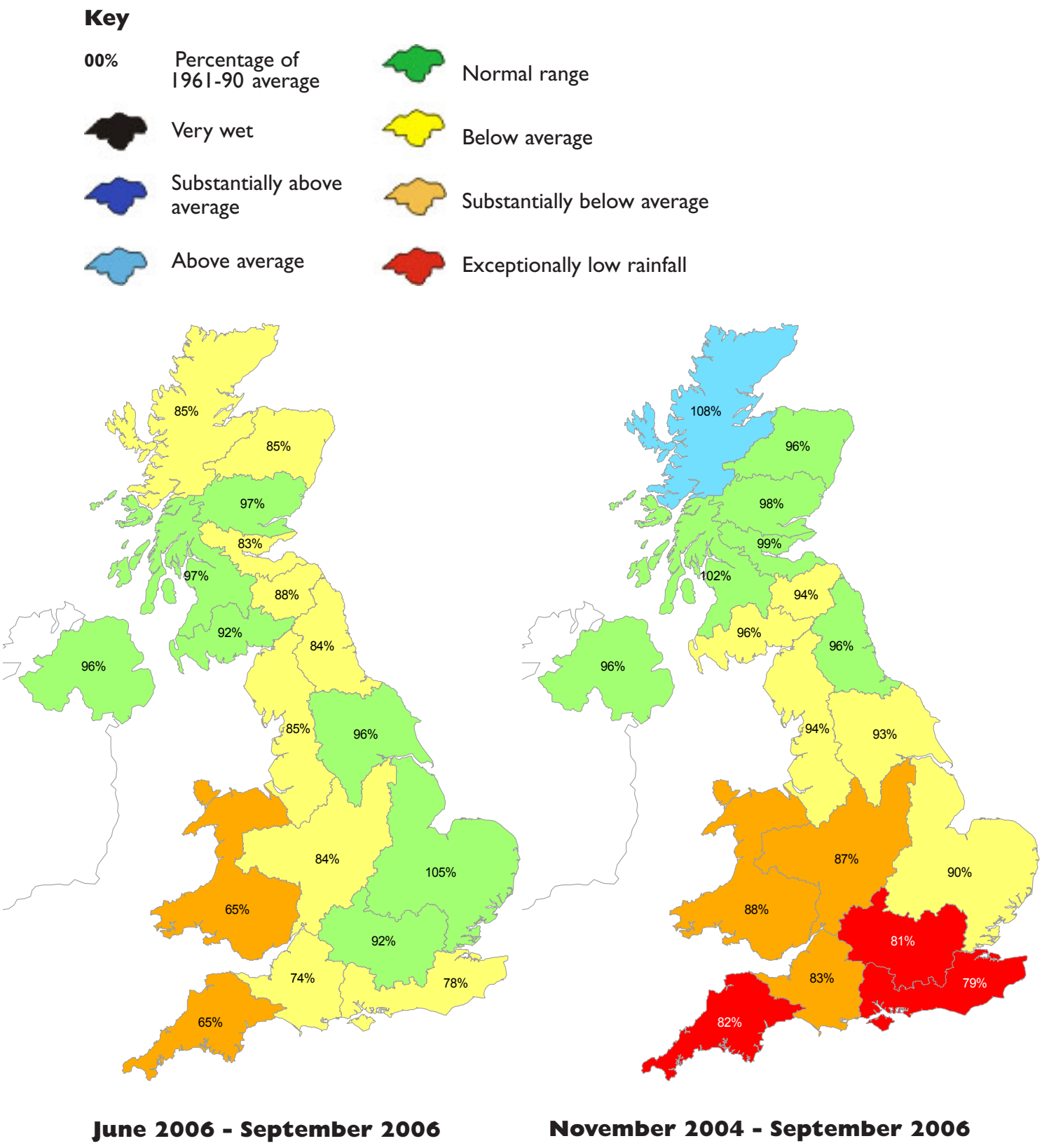
Rainfall accumulations and return period estimates

Area	Rainfall	Sep 2006	Jun 06- Sep 06	RP	May 06- Sep 06	RP	Oct 05- Sep 06	RP	Nov 04- Sep 06	RP
England & Wales	**mm**	**76**	**232**		**341**		**852**		**1517**	
	%	**97**	**82**	**2-5**	**99**	**2-5**	**94**	**2-5**	**88**	**5-15**
North West	mm	**116**	338		457		1204		2172	
	%	**99**	85	2-5	97	2-5	99	2-5	94	2-5
Northumbrian	mm	**91**	241		335		841		1585	
	%	**123**	84	2-5	96	2-5	97	2-5	96	2-5
Severn Trent	mm	**69**	209		315		725		1282	
	%	**106**	84	2-5	102	2-5	94	2-5	87	5-15
Yorkshire	mm	**78**	259		370		834		1477	
	%	**111**	96	2-5	112	2-5	100	<2	93	2-5
Anglian	mm	**66**	219		303		565		1039	
	%	**130**	105	2-5	118	2-5	94	2-5	90	5-10
Thames	mm	**78**	206		298		638		1089	
	%	**130**	92	2-5	107	2-5	91	2-5	81	15-25
Southern	mm	**67**	180		274		690		1181	
	%	**96**	78	2-5	96	2-5	88	2-5	79	30-40
Wessex	mm	**60**	187		294		776		1355	
	%	**82**	74	5-10	94	2-5	91	2-5	83	10-20
South West	mm	**64**	208		327		1045		1862	
	%	**68**	65	10-20	83	2-5	88	2-5	82	20-30
Welsh	mm	**80**	251		410		1277		2247	
	%	**68**	65	10-20	87	2-5	95	2-5	88	5-10
Scotland	**mm**	**149**	**393**		**510**		**1405**		**2845**	
	%	**104**	**89**	**2-5**	**97**	**2-5**	**96**	**2-5**	**102**	**2-5**
Highland	mm	**150**	431		565		1641		3565	
	%	**89**	85	2-5	94	2-5	94	2-5	108	5-10
North East	mm	**82**	279		357		1001		1873	
	%	**89**	85	2-5	89	2-5	97	2-5	96	2-5
Tay	mm	**163**	368		478		1254		2382	
	%	**135**	97	2-5	103	2-5	97	2-5	98	2-5
Forth	mm	**128**	297		398		1083		2141	
	%	**113**	83	2-5	91	2-5	95	2-5	99	2-5
Tweed	mm	**116**	285		368		992		1798	
	%	**126**	88	2-5	93	2-5	99	2-5	94	2-5
Solway	mm	**171**	409		518		1432		2615	
	%	**119**	92	2-5	98	2-5	100	<2	96	2-5
Clyde	mm	**218**	519		666		1673		3361	
	%	**119**	97	2-5	106	2-5	96	2-5	102	2-5
Northern Ireland	**mm**	**134**	**327**		**440**		**1078**		**1993**	
	%	**133**	**96**	**2-5**	**107**	**2-5**	**98**	**2-5**	**96**	**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 June 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 . . .



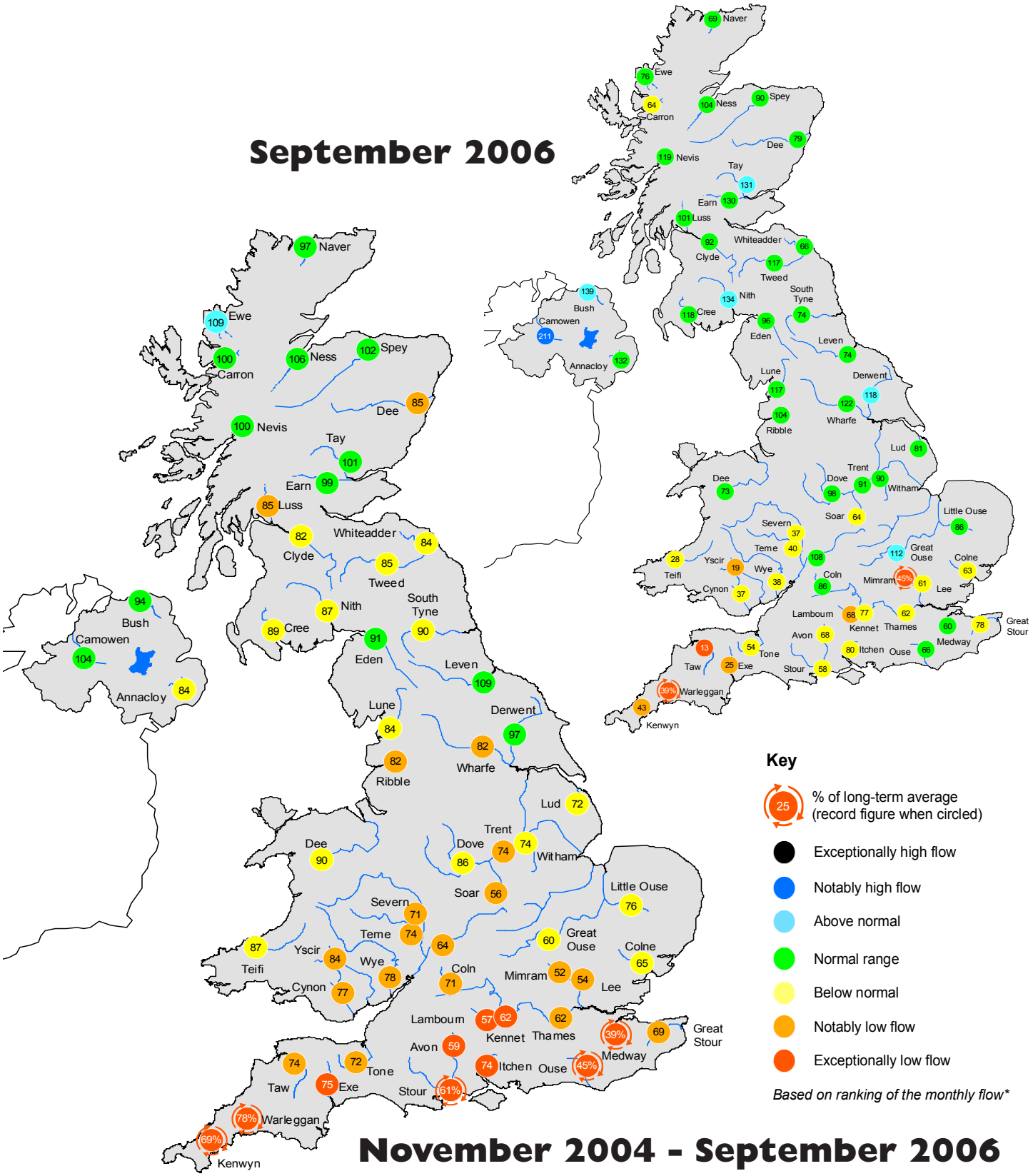
June 2006 - September 2006

November 2004 - September 2006

Rainfall accumulation maps

The UK registered its 2nd lowest June-September rainfall in the last 10 years with particularly notable deficiencies in the South-West and Wales – the 4-month totals ranking, respectively, 2nd and 3rd lowest since 1959. Over the full compass of the drought the contrast between northern and southern Britain is clearly evident (but sub-regional contrasts in drought intensity across southern England are also substantial).

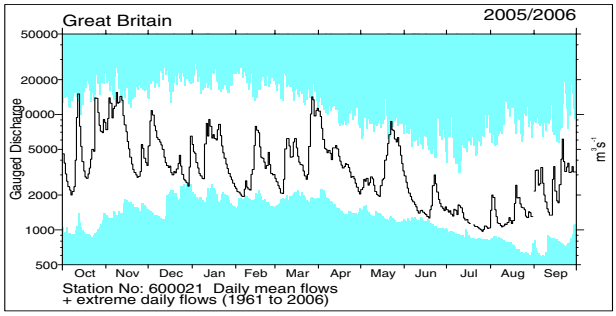
River flow . . . River flow . . .

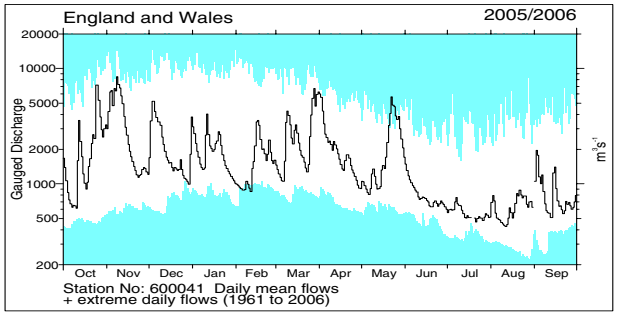


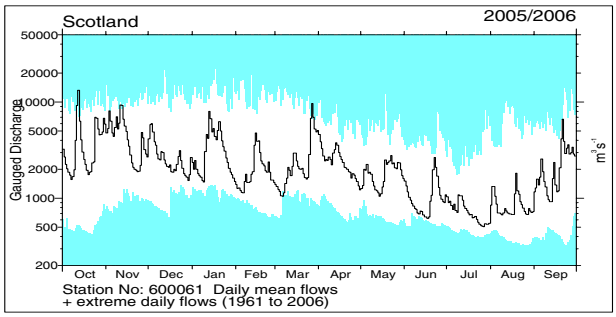
River flows

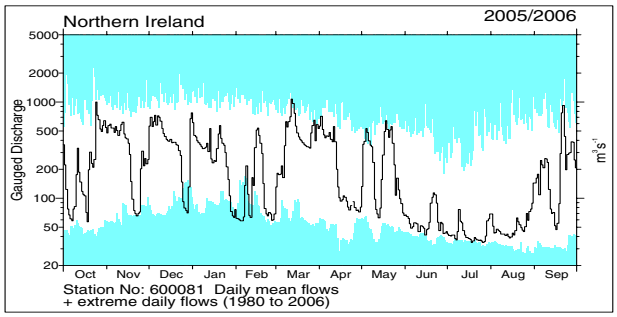
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

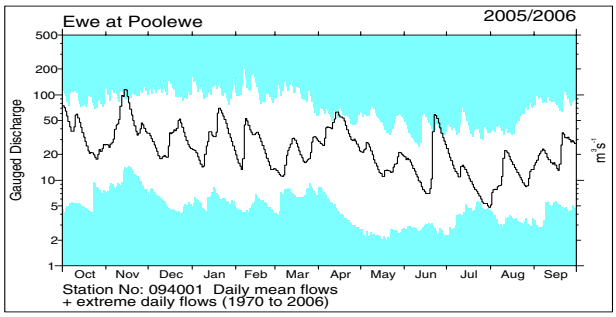
River flow . . . River flow . . .

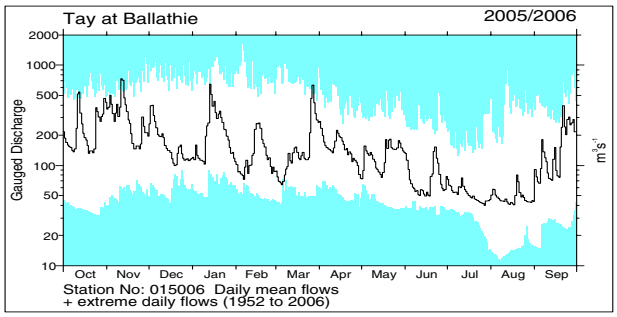


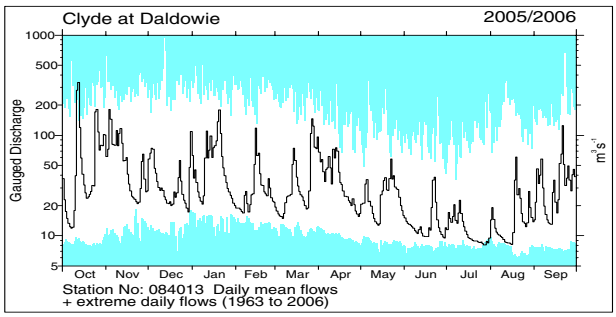


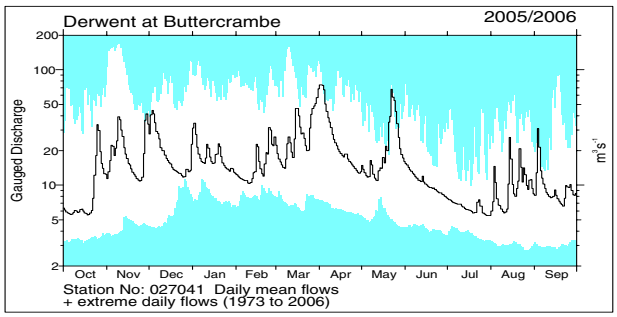


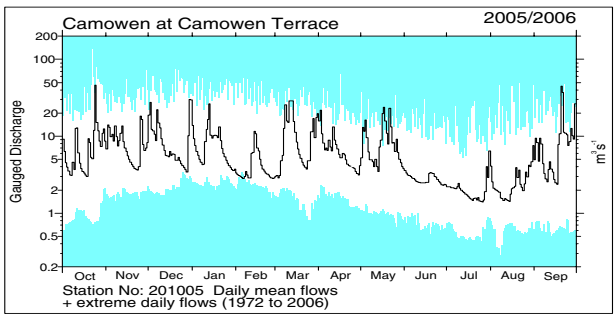


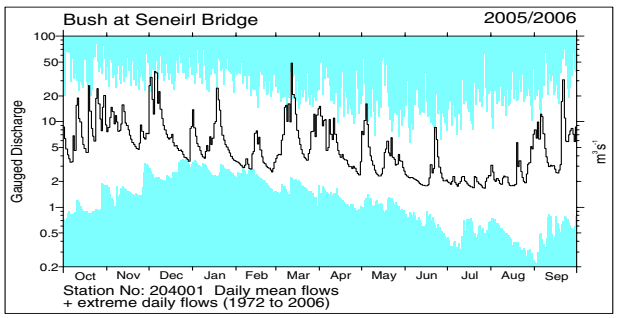








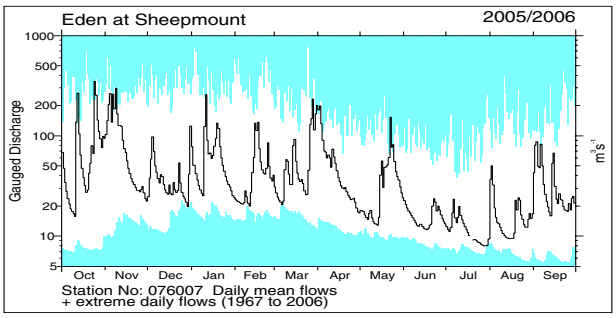


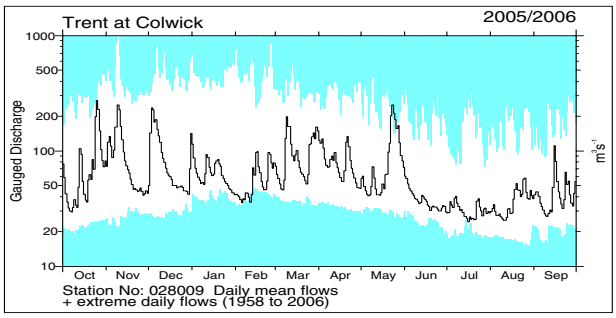


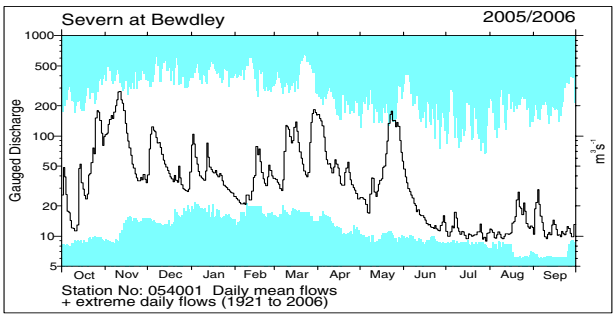
River flow hydrographs

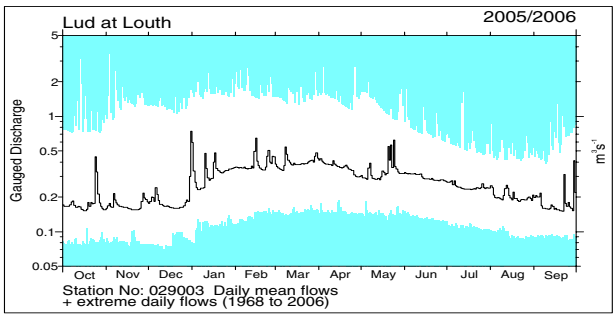
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to October 2005 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

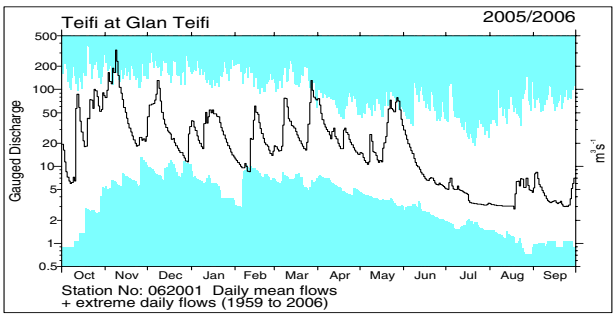
River flow . . . River flow . . .

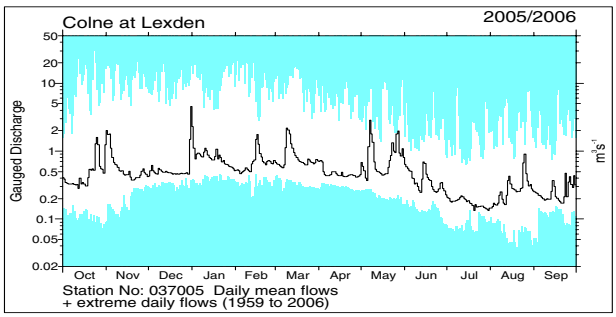


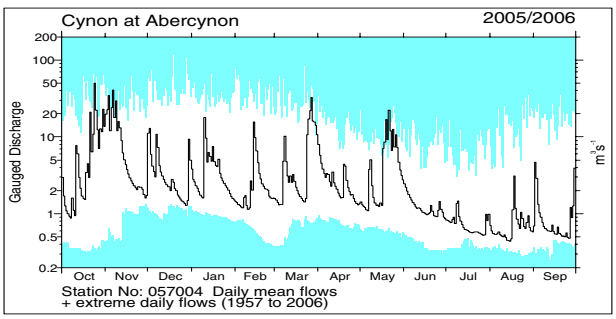


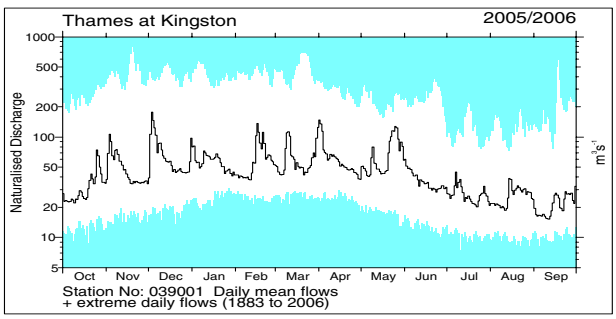


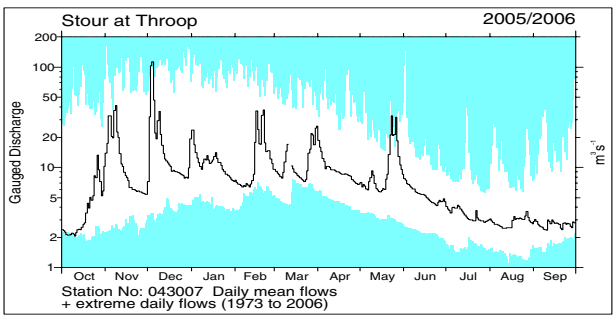


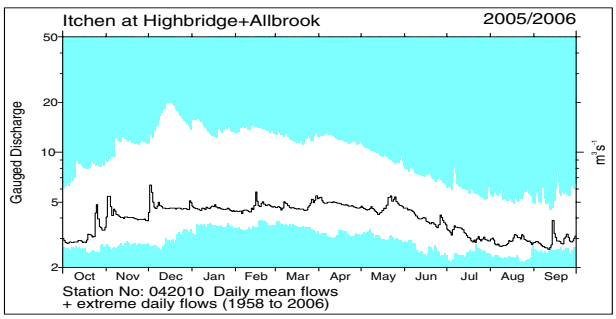












Notable runoff accumulations (a) Jun - Sep 2006, (b) Jan - Sep 2006, (c) Nov 2004 - Sep 2006

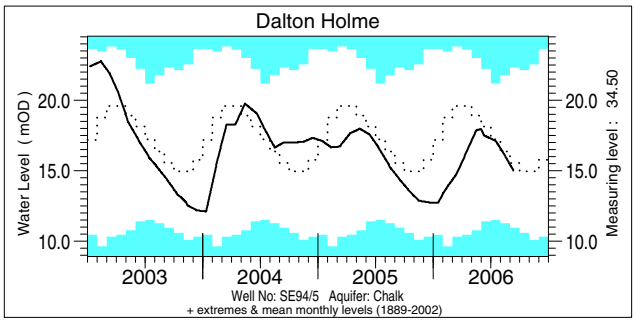
	River	%lta	Rank
a)	Soar	56	4/35
	Lambourn	59	5/44
	Lymington	25	2/44
	Otter	67	2/44
	Severn	50	9/86
	Yscir	39	3/35
	Tawe	41	3/48

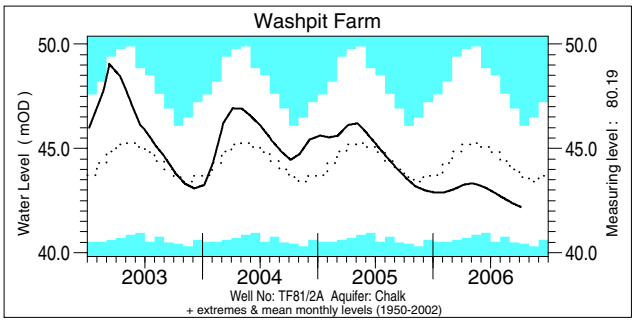
	River	%lta	Rank
b)	Lee	49	10/120
	Mimram	43	1/52
	Ouse (Gold Bridge)	49	5/42
	Avon (Amesbury)	61	5/41
	Luss	78	2/26
	Carron	82	4/27
	Mourne	84	2/24

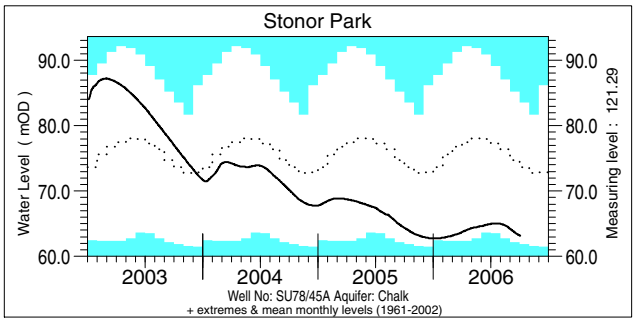
	River	%lta	Rank
c)	Forth	86	3/24
	Medway	39	1/41
	Test	63	1/46
	Stour (Throop)	61	1/32
	Piddle	64	1/40
	Warleggan	78	1/36
	Faughan	73	1/29

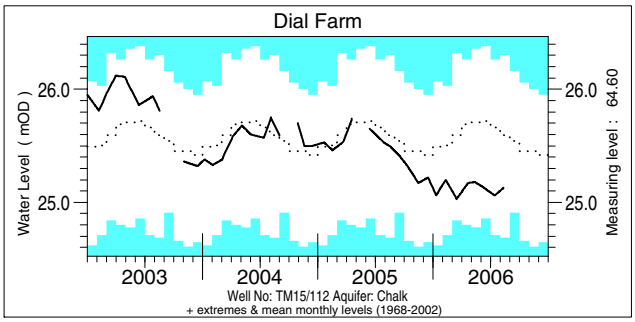
lta = long term average
Rank 1 = lowest on record

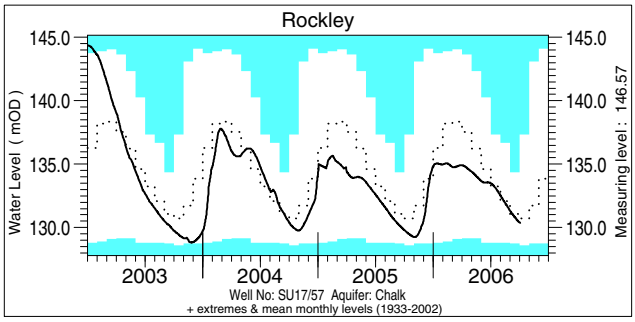
Groundwater . . . Groundwater

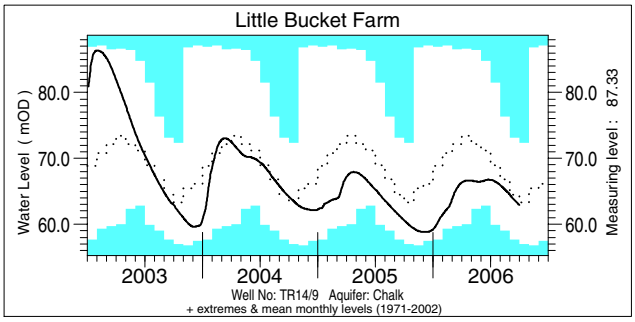


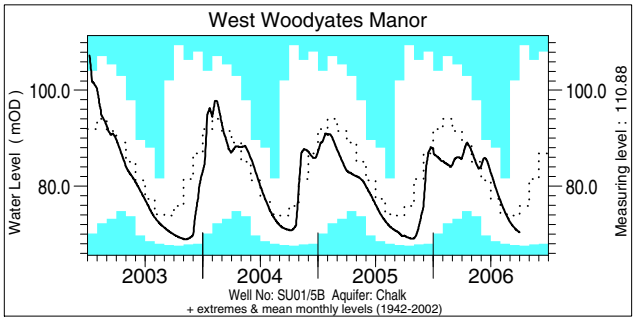


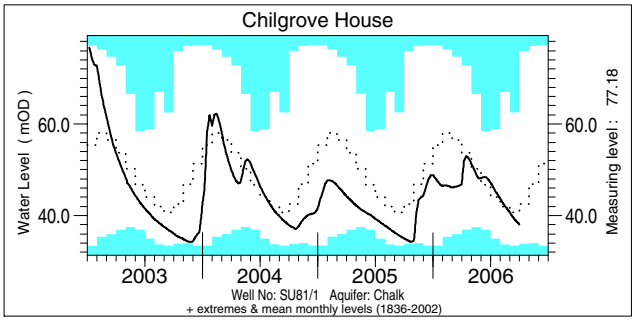


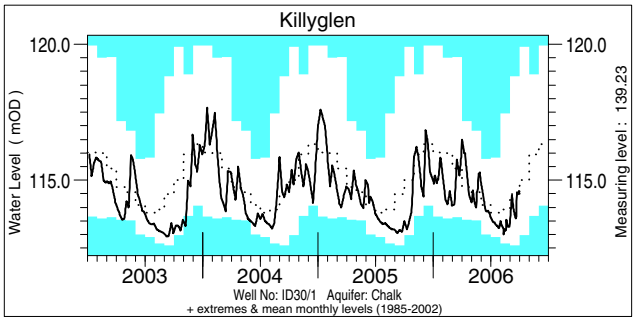


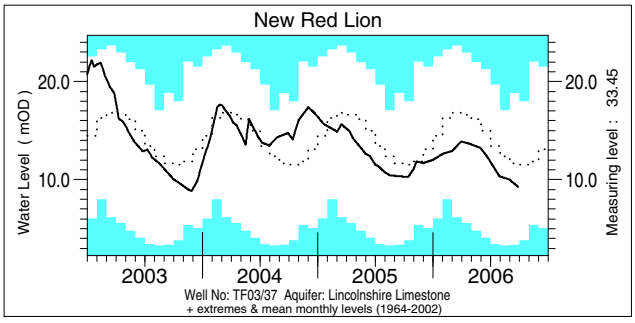






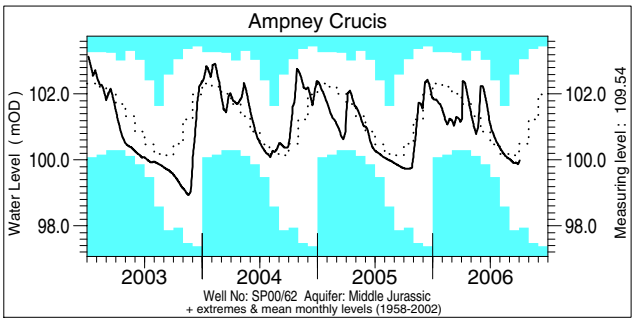


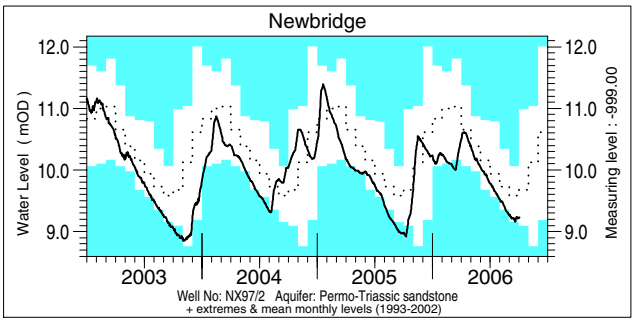


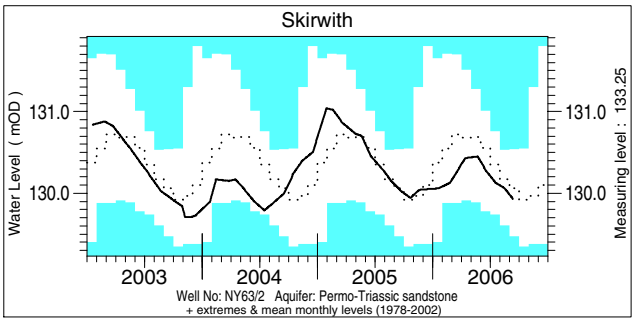


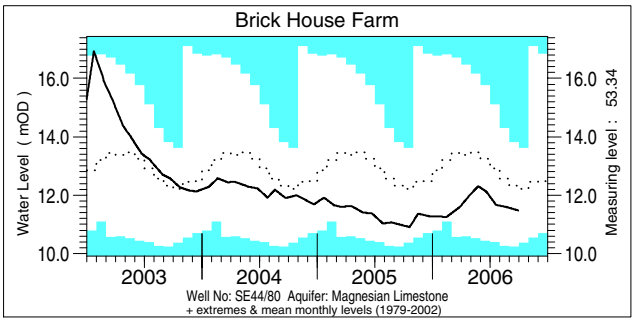
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

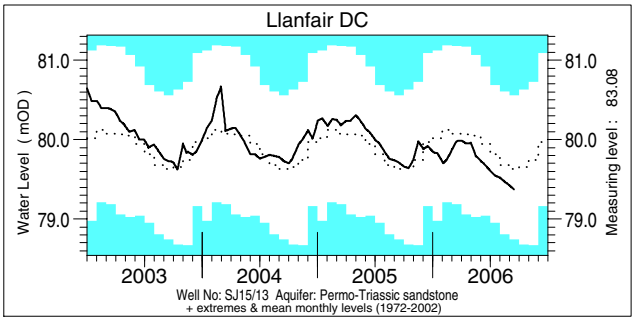
Groundwater . . . Groundwater

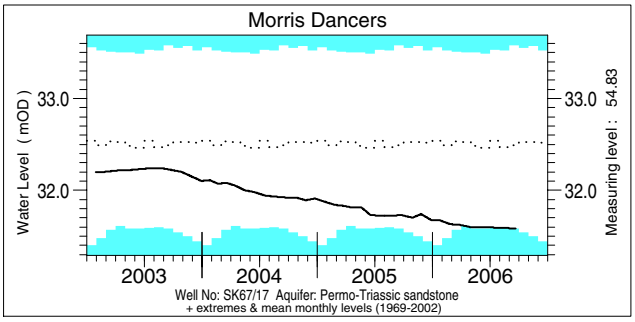


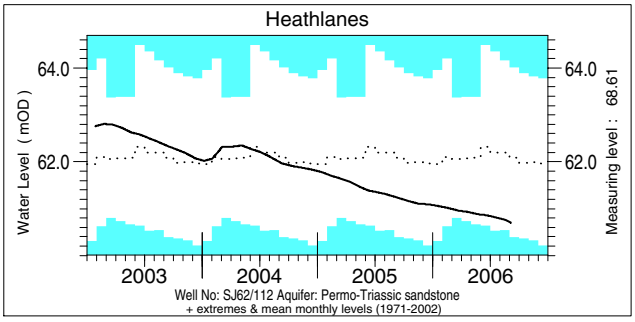


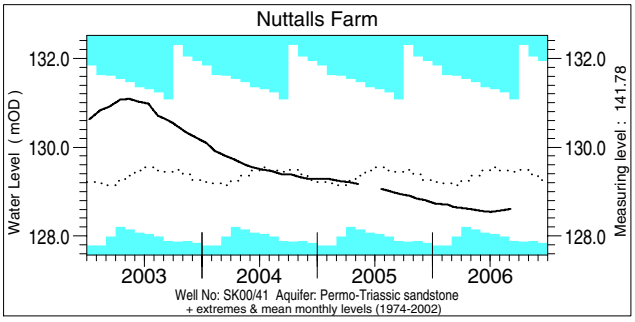


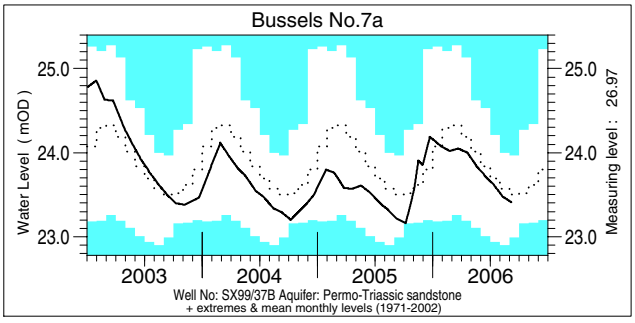


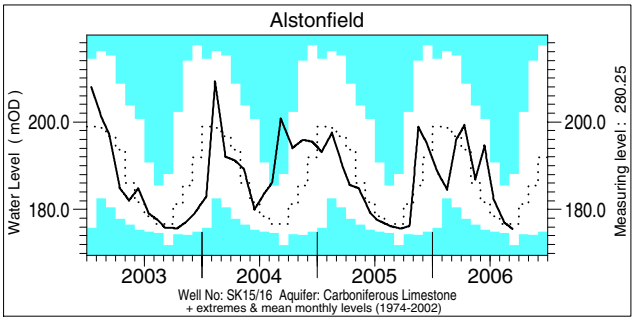










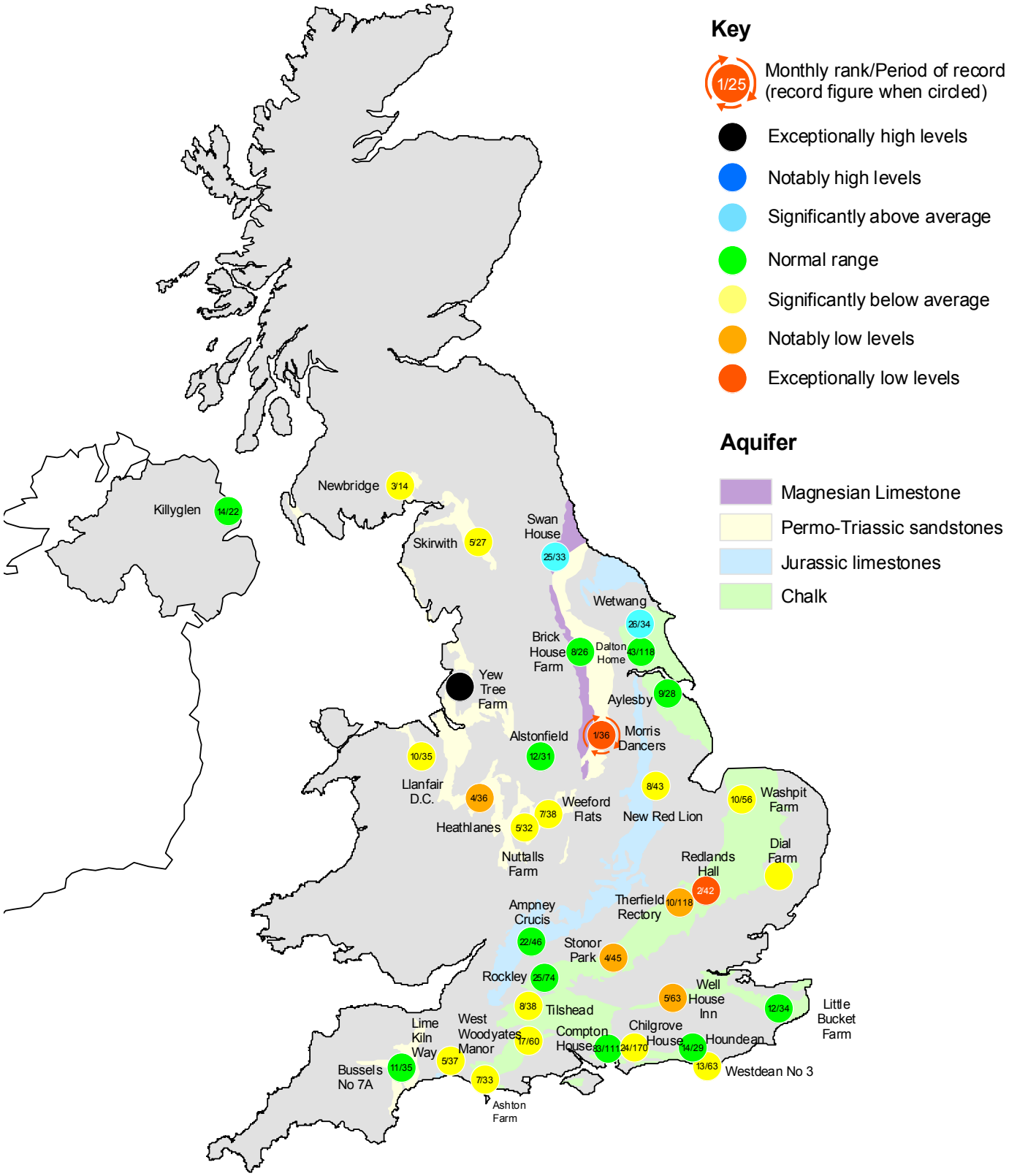


Groundwater levels September / October 2006

Borehole	Level	Date	Sep. av.	Borehole	Level	Date	Sep. av.	Borehole	Level	Date	Sep. av.
Dalton Holme	15.01	11/09	15.42	Chilgrove House	38.10	30/09	40.74	Llanfair DC	79.37	15/09	79.55
Washpit Farm	42.19	05/10	44.00	Killyglen	114.58	30/09	114.34	Morris Dancers	31.58	20/09	32.34
Stonor Park	63.15	02/10	74.61	New Red Lion	9.26	26/09	11.66	Heathlanes	60.70	05/09	62.04
Dial Farm	25.13	11/08	25.55	Ampney Crucis	99.99	02/10	100.07	Nuttalls Farm	128.61	05/09	129.58
Rockley	130.39	02/10	131.01	Newbridge	9.23	02/10	9.53	Bussels No.7a	23.41	06/09	23.50
Well House Inn	88.50	02/10	94.08	Skirwith	129.93	11/09	130.07	Alstonfield	175.51	11/09	177.49
West Woodyates	70.37	30/09	72.91	Brick House Farm	11.48	28/09	12.26				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



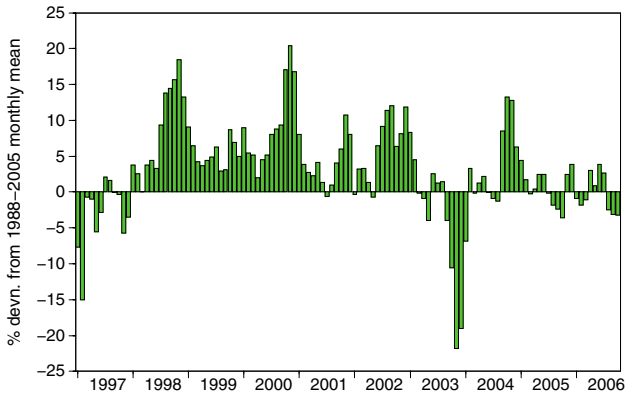
Groundwater levels - September 2006

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.

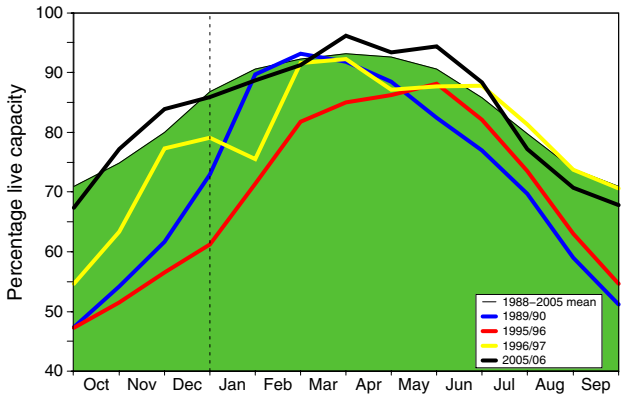
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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.

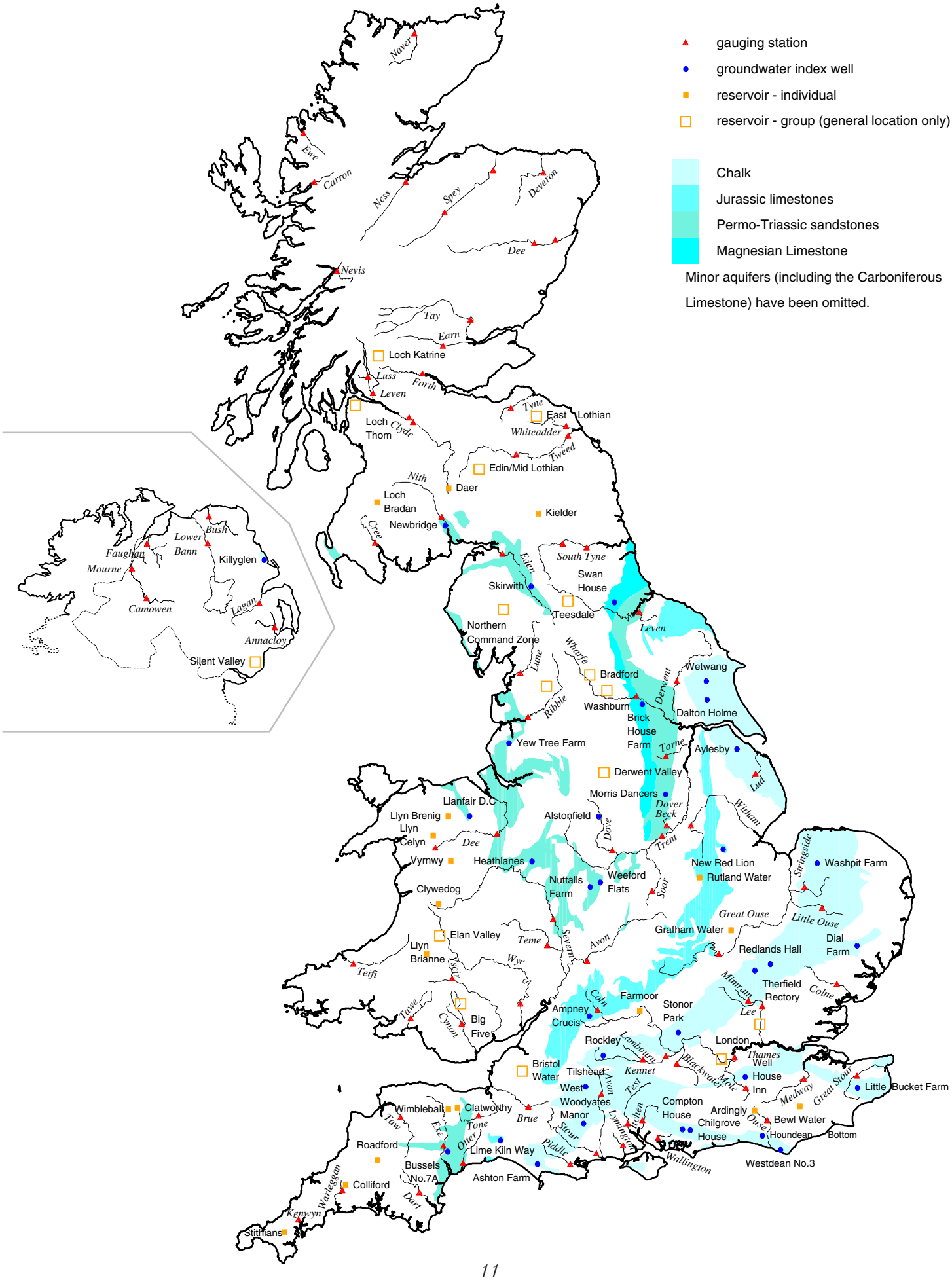
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2006 Aug	Sep	Oct	Oct Anom.	Min. Oct	Year* of min.	2005 Oct	Diff 06-05
North West	N Command Zone	• 124929	64	57	**58**	6	13	1995	52	6
	Vyrnwy	55146	72	64	**59**	-7	26	1995	56	3
Northumbrian	Teesdale	• 87936	69	65	**62**	-1	31	1995	73	-11
	Kielder	(199175)	(82)	(82)	**(83)**	-1	(59)	1989	(86)	-3
Severn Trent	Clywedog	44922	74	62	**51**	-17	24	1989	70	-19
	Derwent Valley	• 39525	71	66	**70**	10	24	1989	55	15
Yorkshire	Washburn	• 22035	78	77	**77**	16	24	1995	57	20
	Bradford supply	• 41407	69	69	**65**	2	15	1995	55	10
Anglian	Grafham	(55490)	(88)	(83)	**(80)**	-1	(46)	1997	(80)	0
	Rutland	(116580)	(81)	(76)	**(71)**	-7	(61)	1995	(76)	-5
Thames	London	• 202406	83	77	**75**	1	53	1997	65	10
	Farmoor	• 13822	100	99	**98**	10	54	2003	98	0
Southern	Bewl	28170	76	68	**61**	-2	32	1990	44	17
	Ardingly	4685	88	76	**66**	3	32	2003	47	19
Wessex	Clatworthy	5364	77	62	**49**	-3	25	2003	53	-4
	Bristol WW	• (38666)	(84)	(76)	**(69)**	10	(31)	1990	(47)	22
South West	Colliford	28540	58	46	**38**	-28	38	2006	45	-7
	Roadford	34500	67	55	**47**	-22	26	1995	53	-6
	Wimbleball	21320	84	71	**60**	-1	30	1995	61	-1
	Stithians	5205	64	47	**36**	-17	22	1990	41	-5
Welsh	Celyn and Brenig	• 131155	84	75	**76**	-2	39	1989	77	-1
	Brianne	62140	85	78	**77**	-5	48	1995	82	-5
	Big Five	• 69762	65	52	**44**	-19	19	1995	54	-10
	Elan Valley	• 99106	76	65	**58**	-16	34	1995	64	-6
Scotland(E)	Edinburgh/Mid Lothian	• 97639	80	77	**79**	5	43	1998	72	7
	East Lothian	• 10206	78	69	**66**	-11	52	1989	66	0
Scotland(W)	Loch Katrine	• 111363	72	63	**77**	5	43	1995	81	-4
	Daer	22412	83	63	**86**	16	32	1995	69	17
	Loch Thom	• 11840	82	79	**94**	17	56	1995	87	7
Northern Ireland	Total+	• 67270	70	68	**76**	8	29	1995	65	11
	Silent Valley	• 20634	72	66	**72**	12	27	1995	64	8

() 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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10/06