Hydrological Summary
for the United Kingdom

March 2006

General
March was a cool month with large spatial variations in precipitation totals. Well above average rainfall generated very brisk river flow recoveries in many western and northern catchments but the very protracted drought continued to develop across much of the English Lowlands where rainfall deficiencies over the last two winter/spring periods exceed 30% over wide areas. Nonetheless, the near-average March rainfall was sufficient to edge flows in many drought-affected rivers above seasonal minima. Reservoir stocks also increased in all regions, leaving overall stocks for England and Wales at their highest for early April since 1999. The drought's continuing regional focus is emphasised by depressed groundwater levels across much of the southern Chalk and very moderate stocks in a few reservoirs in the South-East (e.g. Bewl). The fragile water resources outlook triggered further extensions to water-use restrictions – affecting around 13 million consumers. The coldest March for a decade has delayed the onset of spring and provided limited scope for further aquifer recharge. A wet April would have a significant moderating impact but as evaporation rates accelerate no sustained recovery in many lowland river flows can be anticipated before the autumn.

Rainfall
Wintry conditions extended well into March as a northerly airflow brought substantial snowfall (Glenlivet reported 26cm of lying snow on the 5th) and widespread transport disruption (Edinburgh and Glasgow airports both closed on the 12th). From around mid-month, Atlantic frontal systems became more influential – resulting in some significant daily rainfall totals in the west particularly (e.g. Lusa 43mm on the 23rd, Capel Curig 60mm on the 27th). The March rainfall pattern was unusual: the Scottish Highlands and much of the South East registered <80% of the monthly average whilst the rest of the UK was wet with some coastal catchments, in Scotland particularly, recording >200%. The UK precipitation total was considerably above average with Northern Ireland registering its 4th highest March total in a 92-year record. Unfortunately, the lowest rainfall across England broadly coincided with the most drought-affected regions. For E&W the 17-month period from Oct 2004 is the 2nd driest in the last 30 years; the large regional contrasts in drought severity reflect the spatial and temporal distribution of the rainfall over this period. In Anglian Region the Nov-March rainfall totals for 2004/05 and 2005/06 are the lowest since 1975/76. Even more notably, for parts of the South-East the previous lowest winter/early spring rainfall totals for successive years (recorded in 1932-34) have been eclipsed. Such deficiencies inevitably imply a substantial degree of drought stress.

River flow
Exceptionally low early March flows typified many UK rivers; particularly notable minima were registered in rivers draining eastern Scotland (e.g. the Earn and Forth). Generally, runoff rates recovered from the second week, with snowmelt a significant factor in many northern catchments (e.g. on the 9th in the Grampians). New March maximum flows were established on the Lune, Brue and Annacloy and notable spates were reported across much of Scotland approaching month-end, when nine Flood Warnings were in operation in E&W. Correspondingly, March runoff totals were healthy across most of the UK and notably high in a few responsive catchments (e.g. the Bervie, in eastern Scotland which reported its highest March runoff in a 27-yr record). By contrast, March runoff was very low in some west Highland catchments and, more extensively, in permeable catchments across the English Lowlands where seasonal flow recoveries have mostly been very weak. The Mimram recorded its 2nd lowest March flow since 1973 but, importantly, March runoff totals throughout much of the South-East were a little greater than for the same month in the droughts of 1997, 1992, 1976, 1973 and 1965. While this provides some encouragement regarding the likely scale of the contraction in the stream network through the coming summer, the current water resources stress is a reflection of long term runoff deficiencies. The Medway, Sussex Ouse and Piddle are among a number of southern rivers for which runoff totals over 24 and 36 months are the lowest on record (for *any* start month) – underlining both the duration and intensity of the drought in the worst affected regions.

Groundwater
The lowest March rainfall totals broadly coincided with the outcrop areas of the Chalk (and some minor aquifers in East Anglia). Fortunately, the cool temperatures moderated the seasonal increase in evaporation rates and infiltration to the Chalk during March, although again well below average, was important in the context of the dryness of the preceding winter. The modest late pulse of recharge should help to ensure that the 2006 seasonal recessions commence above the (depressed) spring maxima registered during recent groundwater droughts. Provisional data suggest that overall storage in the Chalk is healthier than at the same time in 1997, 1992 and several earlier droughts. Evidence of the drought's regional footprint is provided by exceptionally low levels in parts of the South East (e.g. North Downs and Chilterns – where Stonor reported its 2nd lowest March level in a 44-year record). Above average March infiltration in the Cotswolds triggered a significant rise in the Oolitic Limestone; similar increases left levels within the normal range in index wells in the Carboniferous, Lincolnshire and Magnesian Limestone outcrops. Levels remain depressed in many parts of the Midlands Permo-Triassic sandstones (Morris Dancers reported its 2nd lowest March level in a series from 1969) but most western and northern outcrops are well above drought minima. As usual during drought episodes, April rainfall may well have a modest, but important, influence on groundwater levels through the coming summer.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall . . . Rainfall . . .

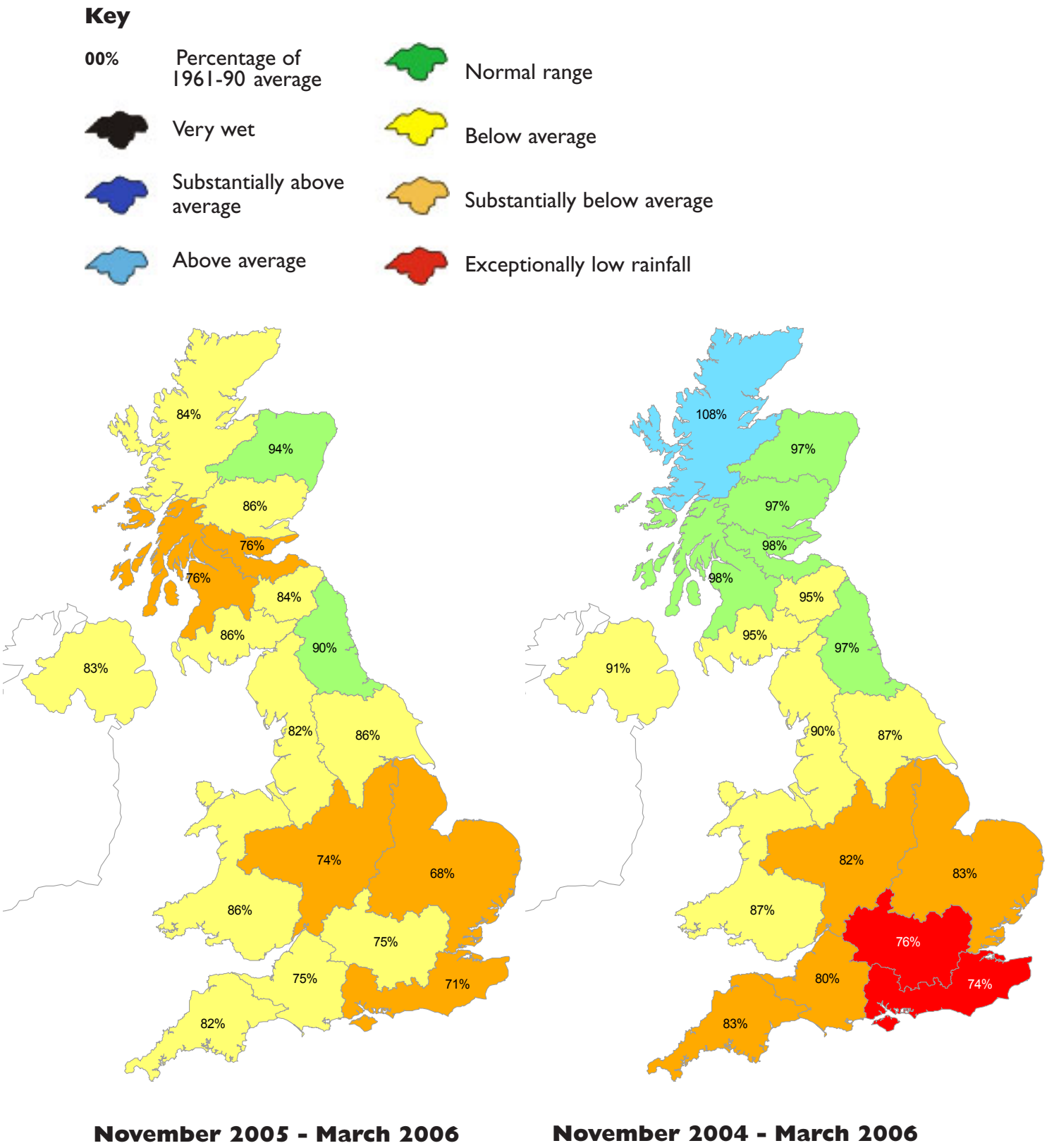
Rainfall accumulations and return period estimates

Area	Rainfall	Mar 2006	Jan 06-Mar 06	RP	Nov 05-Mar 06	RP	Apr 05-Mar 06	RP	Nov 04-Mar 06	RP
England & Wales	**mm**	**87**	**175**		**330**		**825**		**1117**	
	%	**119**	**77**	**5-10**	**80**	**5-10**	**91**	**2-5**	**85**	**5-15**
North West	mm	**125**	254		447		1103		1579	
	%	**130**	86	2-5	82	5-10	91	2-5	90	5-10
Northumbrian	mm	**107**	200		346		887		1215	
	%	**149**	93	2-5	90	2-5	102	2-5	97	2-5
Severn Trent	mm	**67**	127		249		688		911	
	%	**109**	68	5-15	74	5-15	90	5-10	82	10-20
Yorkshire	mm	**103**	187		317		792		1052	
	%	**151**	91	2-5	86	2-5	95	2-5	87	5-10
Anglian	mm	**41**	96		170		537		706	
	%	**87**	71	5-10	68	10-20	89	2-5	83	10-20
Thames	mm	**57**	120		231		575		762	
	%	**100**	71	5-10	75	5-10	82	5-10	76	30-40
Southern	mm	**56**	146		260		641		855	
	%	**88**	73	5-10	71	5-15	82	5-15	74	30-50
Wessex	mm	**66**	143		304		754		1005	
	%	**94**	63	5-15	75	5-10	88	2-5	80	10-20
South West	mm	**111**	232		502		1122		1496	
	%	**111**	68	5-10	82	5-10	94	2-5	83	10-20
Welsh	mm	**155**	284		561		1267		1744	
	%	**142**	80	2-5	86	2-5	94	2-5	87	5-10
Scotland	**mm**	**130**	**315**		**583**		**1431**		**2207**	
	%	**101**	**81**	**5-10**	**83**	**5-10**	**97**	**2-5**	**102**	**2-5**
Highland	mm	**123**	359		720		1718		2816	
	%	**78**	77	5-10	84	5-10	99	2-5	108	5-10
North East	mm	**102**	203		429		998		1447	
	%	**124**	80	2-5	94	2-5	97	2-5	97	2-5
Tay	mm	**152**	304		534		1276		1856	
	%	**134**	85	2-5	86	2-5	99	2-5	97	2-5
Forth	mm	**118**	238		404		1089		1640	
	%	**120**	80	2-5	76	5-15	95	2-5	98	2-5
Tweed	mm	**105**	219		373		986		1375	
	%	**128**	87	2-5	84	2-5	98	2-5	95	2-5
Solway	mm	**181**	357		576		1398		2000	
	%	**152**	96	2-5	86	2-5	97	2-5	95	2-5
Clyde	mm	**143**	371		637		1633		2536	
	%	**94**	80	5-10	76	5-15	93	2-5	98	2-5
Northern Ireland	**mm**	**140**	**230**		**417**		**1022**		**1462**	
	%	**155**	**80**	**2-5**	**83**	**2-5**	**93**	**2-5**	**91**	**2-5**

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

 All monthly totals since October 2005 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 . . .

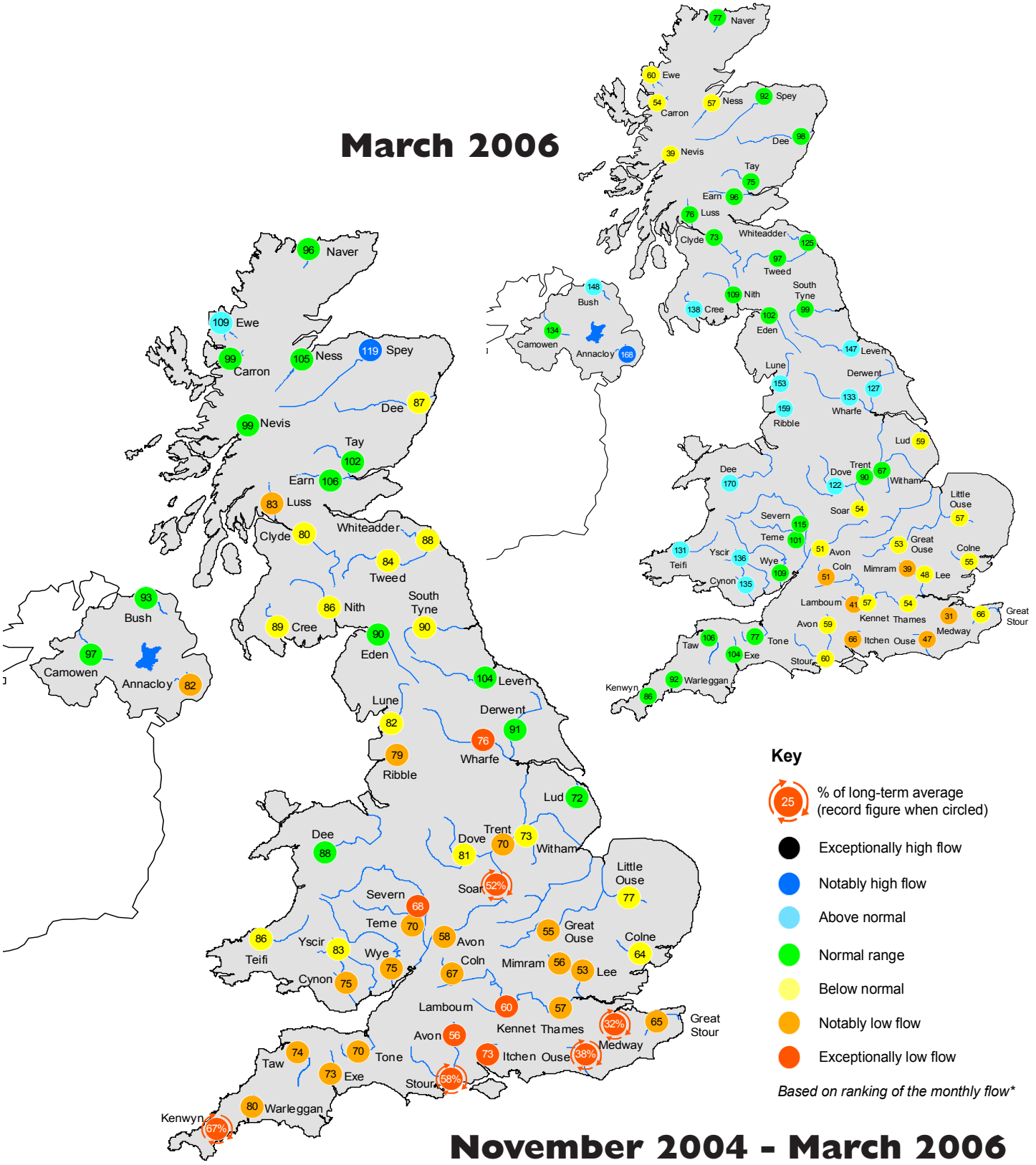


November 2005 - March 2006 **November 2004 - March 2006**

Rainfall accumulation maps

November-March rainfall totals were below average in all regions, notably so in parts of central Scotland and the English Lowlands where deficiencies exceeded 30% in some eastern areas. The drought's regional dimension is well captured by the rainfall accumulations since October 2004. Some parts of the English Lowlands have reported only one month with above average rainfall in this 17-month timespan and for both the Thames and Southern Regions the 17-month totals (ending in March) are the lowest since 1934.

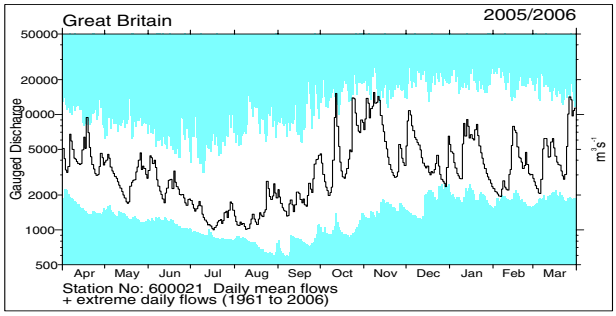
River flow . . . River flow . . .

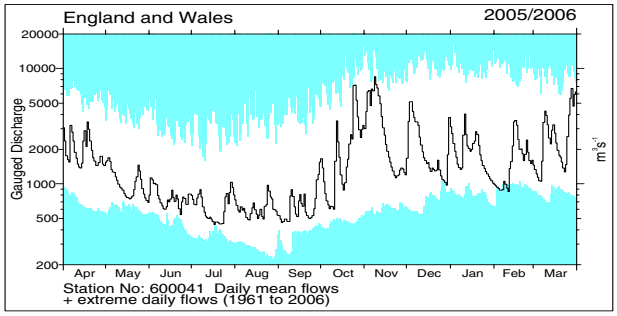


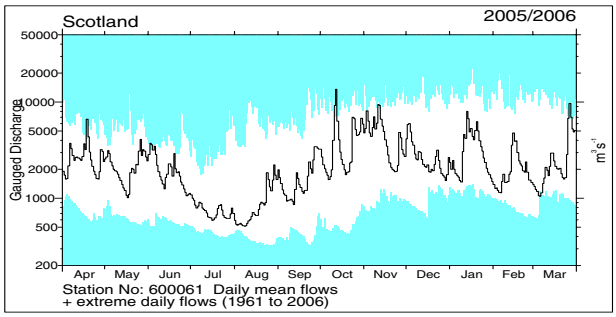
River flows

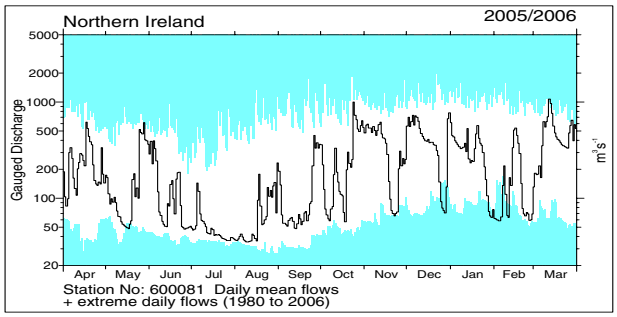
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

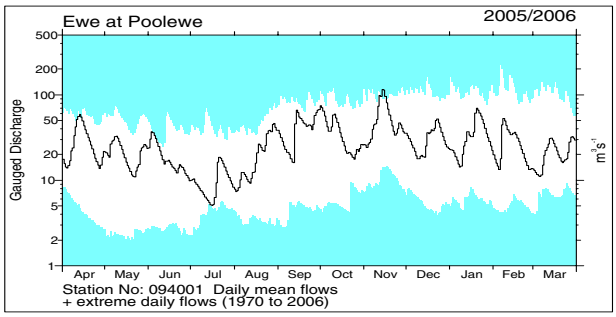
River flow . . . River flow . . .

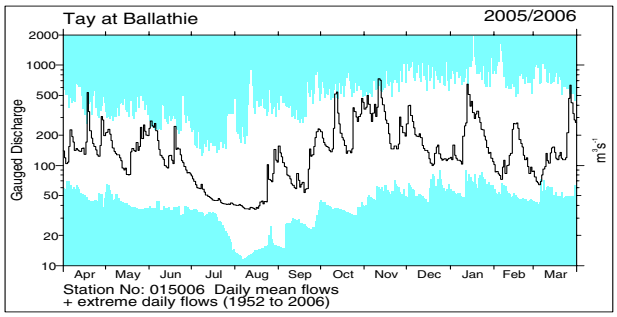


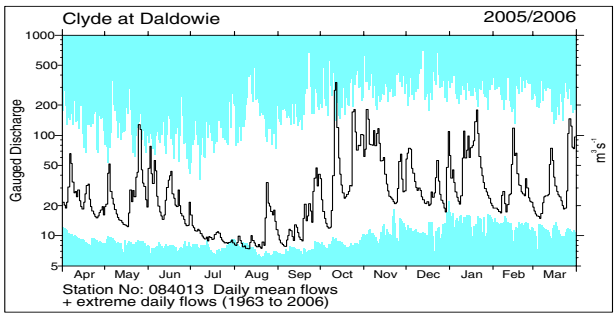


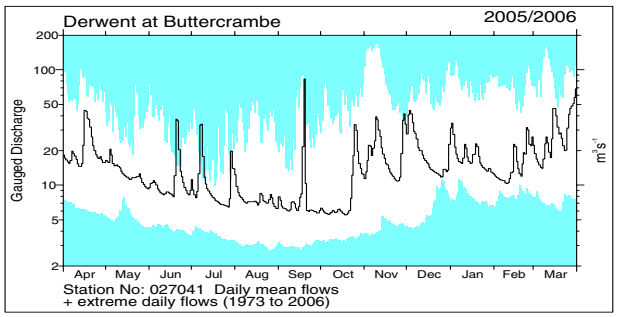


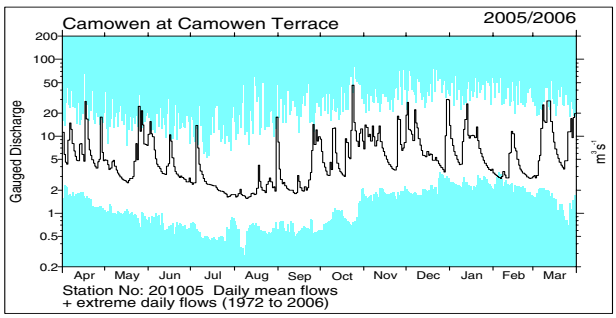


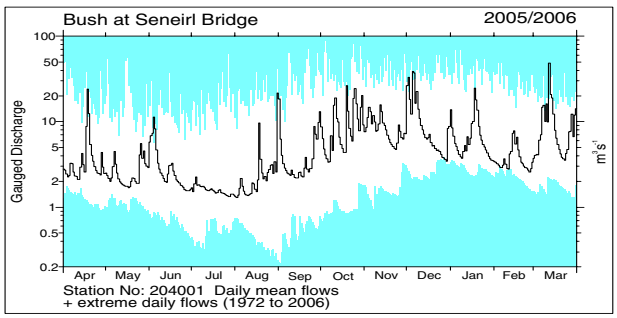








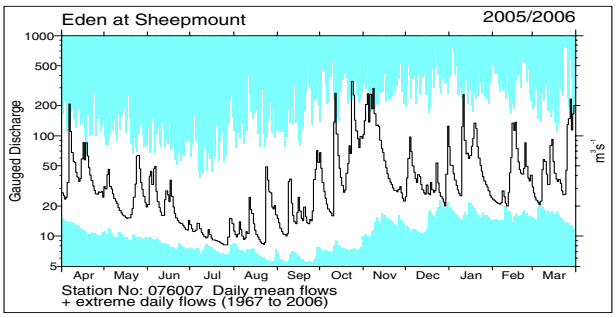


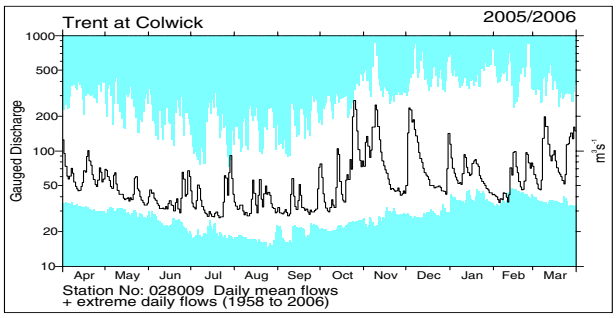


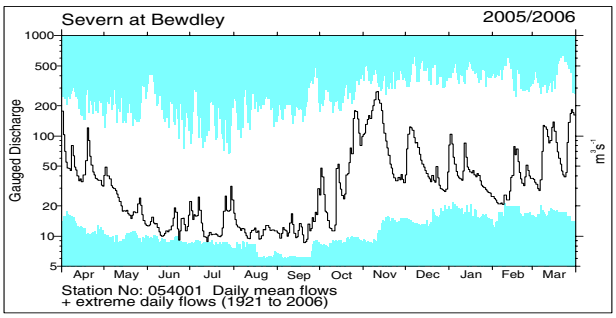
River flow hydrographs

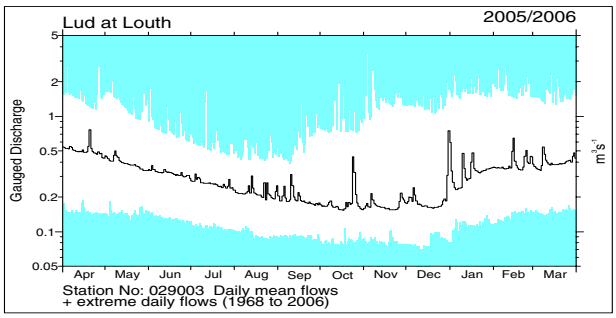
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to April 2005 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

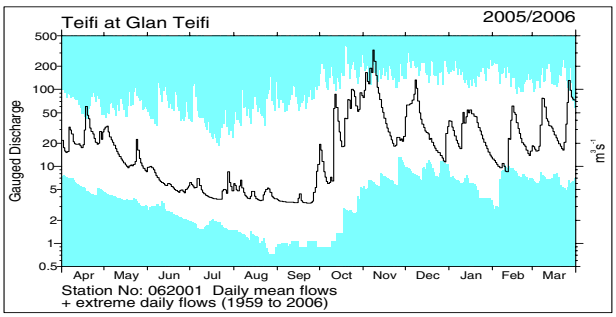
River flow . . . River flow . . .

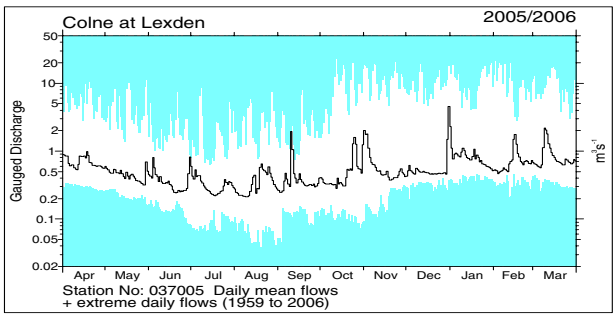


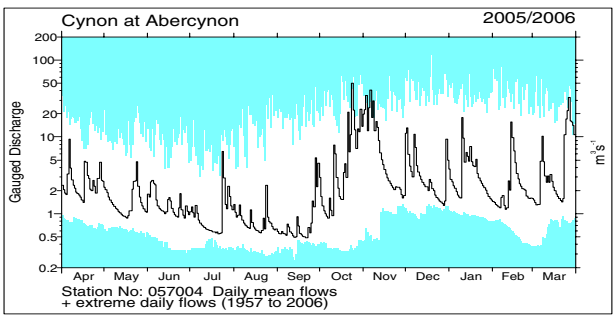


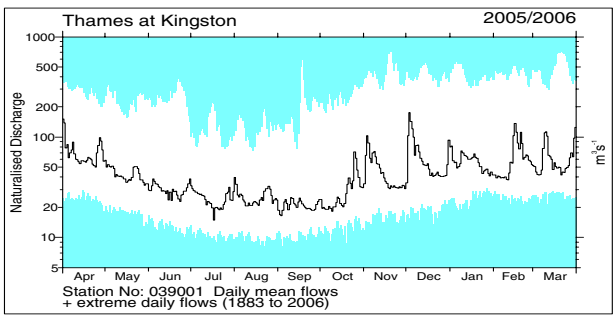


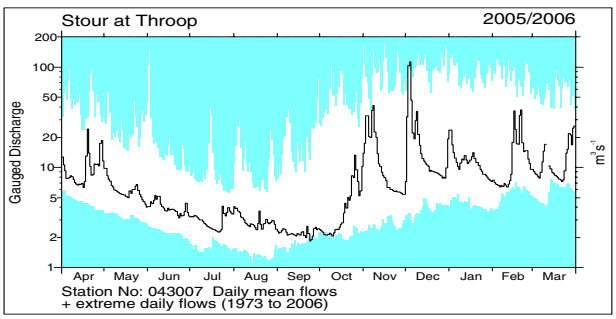


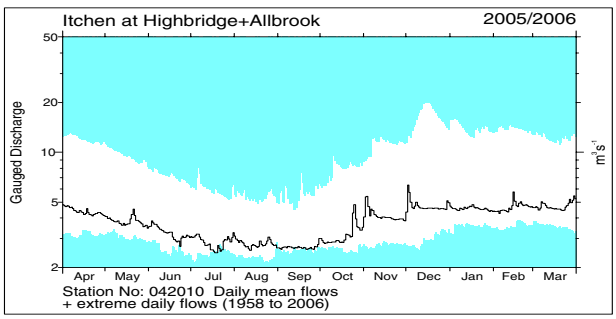












Notable runoff accumulations (a) November 2005- March 2006, (b) November 2004 - March 2006

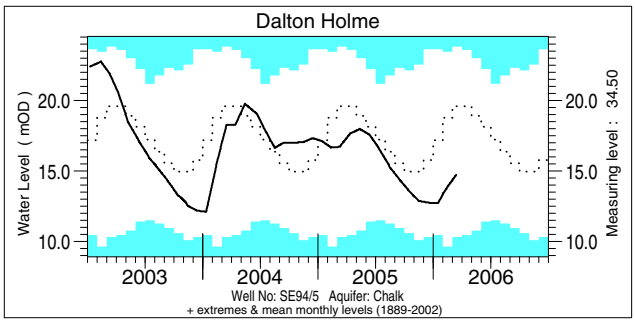
	River	%lta	Rank
a)	Forth	63	2/25
	Mimram	44	2/52
	Medway	28	2/46
	Ouse (Gold Bridge)	34	1/43
	Luss	68	2/27
	Naver	67	2/29
	Faughan	69	2/30

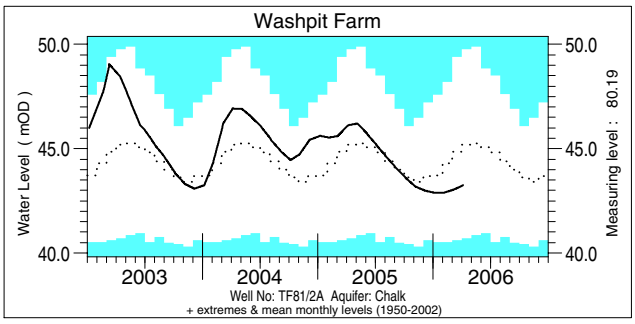
	River	%lta	Rank
b)	Wharfe	76	2/50
	Soar	52	1/34
	Thames	57	8/122
	Kennet	60	2/44
	Mole	57	1/29
	Wallington	43	1/48
	Test	63	1/47

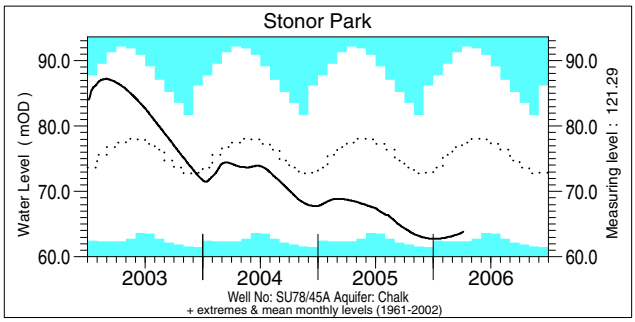
River	%lta	Rank
Itchen	73	2/47
Avon (Amesbury)	56	2/40
Stour (Throop)	58	1/32
Piddle	60	1/40
Kenwyn	67	1/37
L Bann	76	1/25

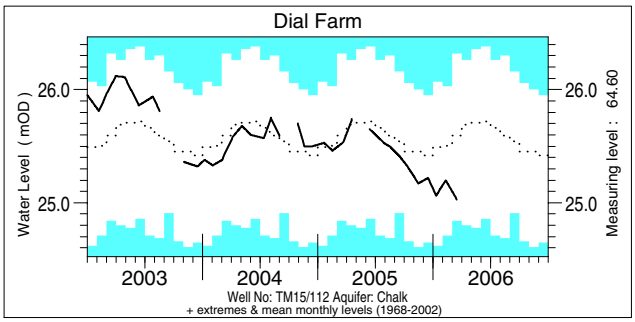
lta = long term average
Rank 1 = lowest on record

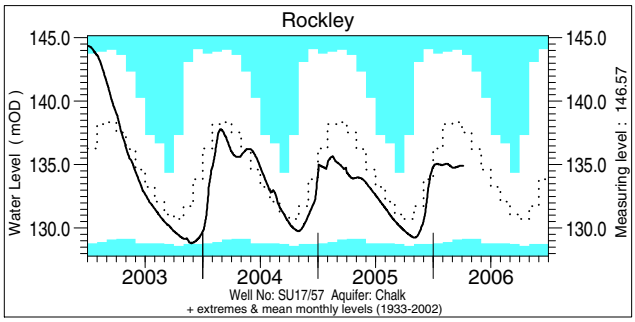
Groundwater . . . Groundwater

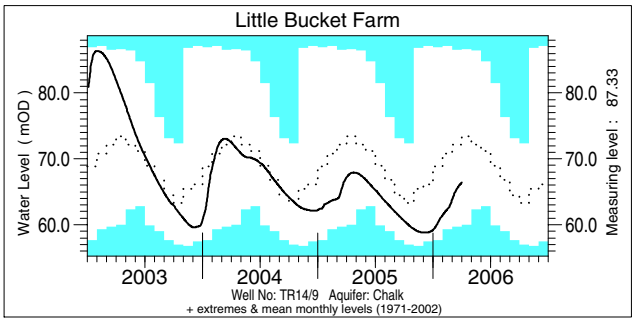


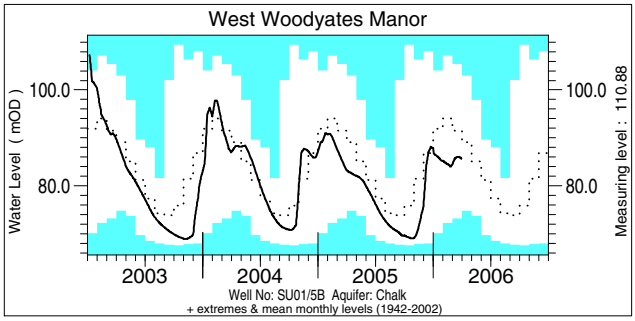


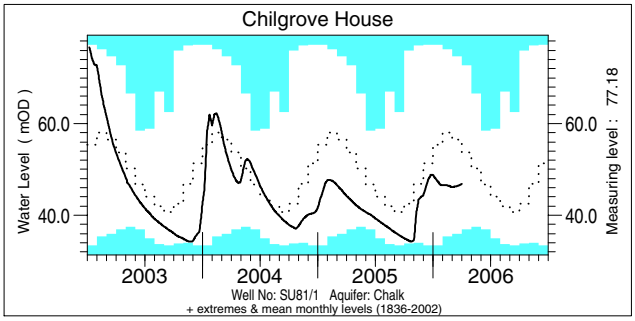


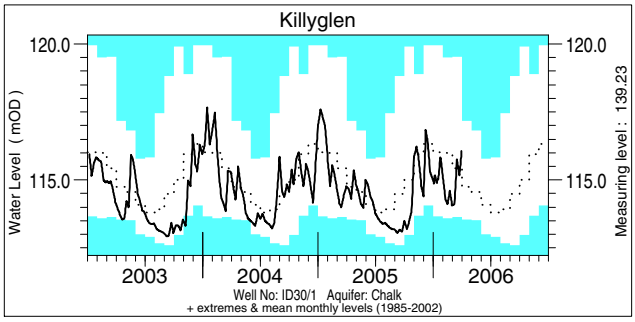


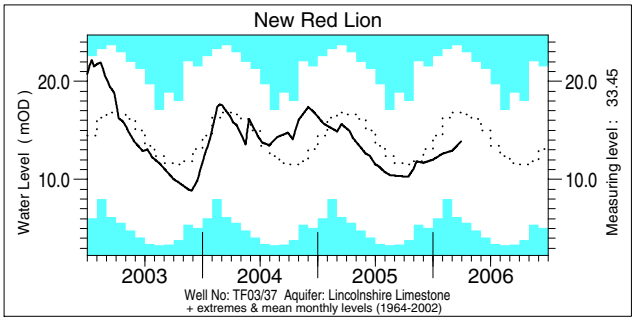






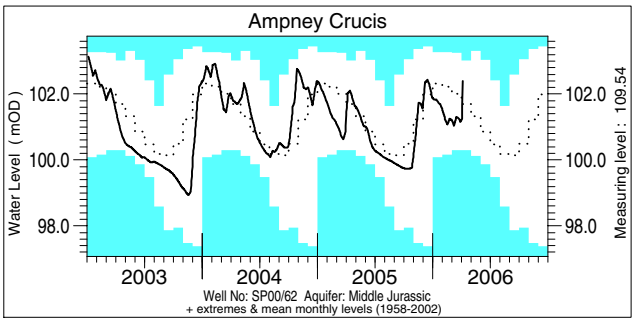


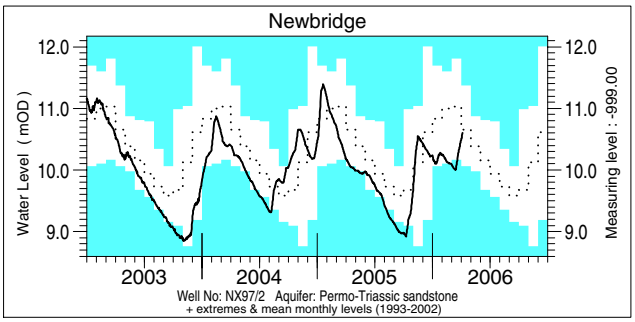


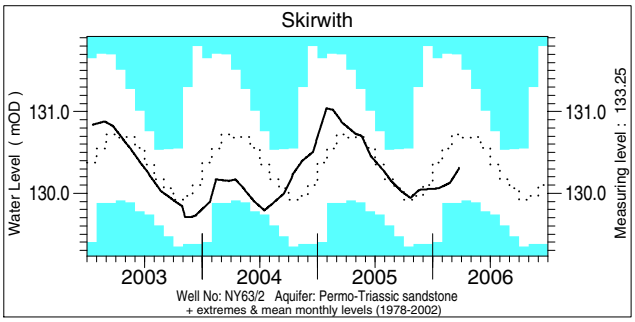


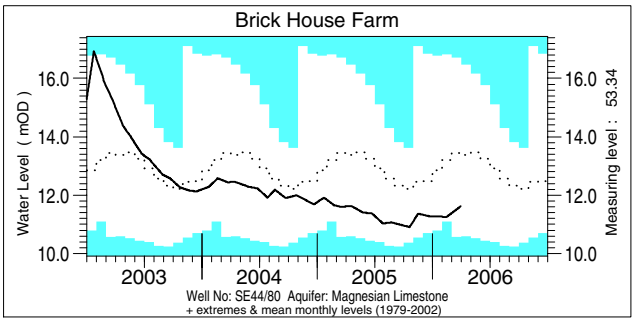
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

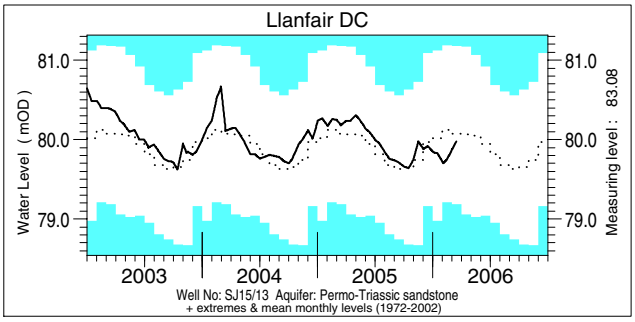
Groundwater . . . Groundwater

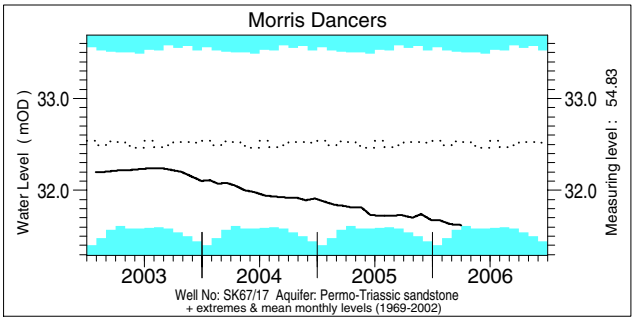


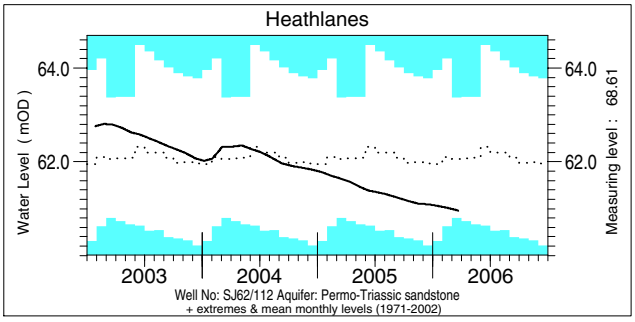


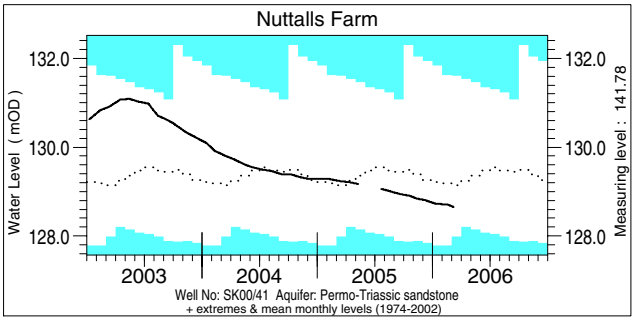


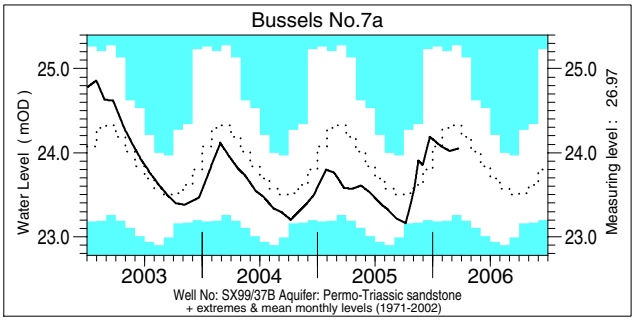


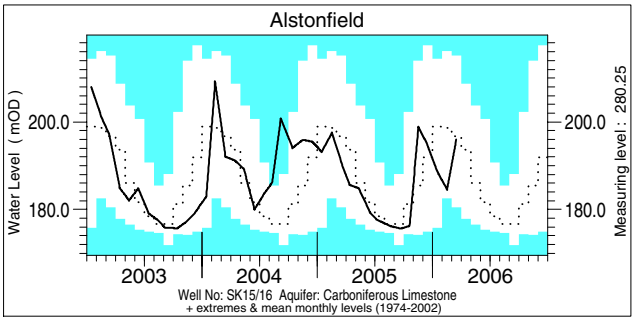










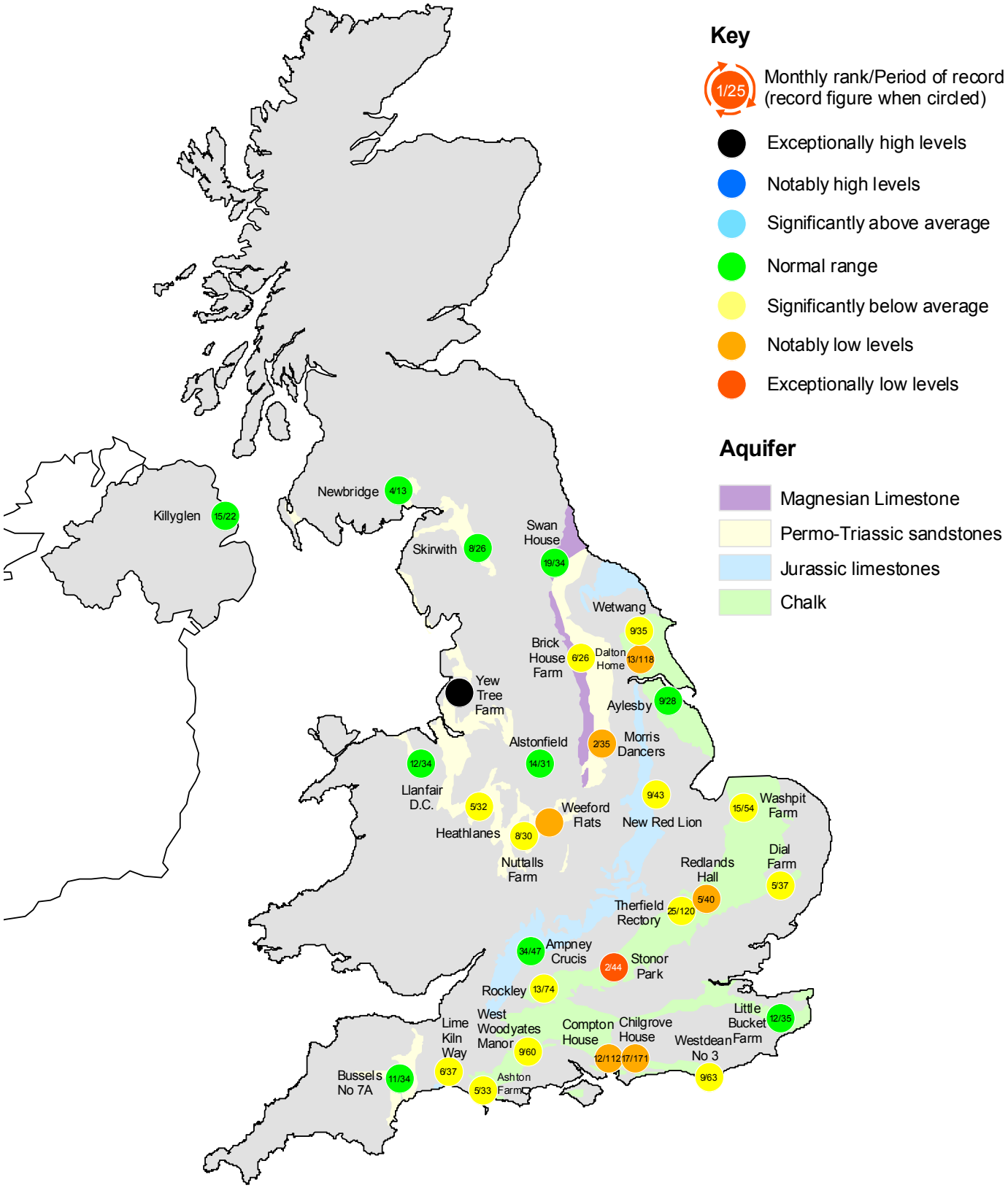


Groundwater levels March / April 2006

Borehole	Level	Date	Mar. av.	Borehole	Level	Date	Mar. av.	Borehole	Level	Date	Mar. av.
Dalton Holme	14.75	13/03	19.49	Chilgrove House	46.83	31/03	55.50	Llanfair DC	79.98	15/03	80.07
Washpit Farm	43.26	06/04	45.02	Killyglen	116.06	31/03	115.51	Morris Dancers	31.62	31/03	32.37
Stonor Park	63.81	05/04	76.91	New Red Lion	13.90	29/03	16.69	Heathlanes	60.96	21/03	62.04
Dial Farm	25.03	15/03	25.60	Ampney Crucis	102.39	05/04	102.01	Nuttalls Farm	128.65	08/03	129.40
Rockley	134.90	05/04	138.40	Newbridge	10.60	05/04	10.91	Bussels No.7a	24.05	21/03	24.31
Little Bucket Farm	66.38	31/03	72.02	Skirwith	130.31	24/03	130.67	Alstonfield	195.92	15/03	196.24
West Woodyates	85.62	31/03	90.66	Brick House Farm	11.63	30/03	13.35				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



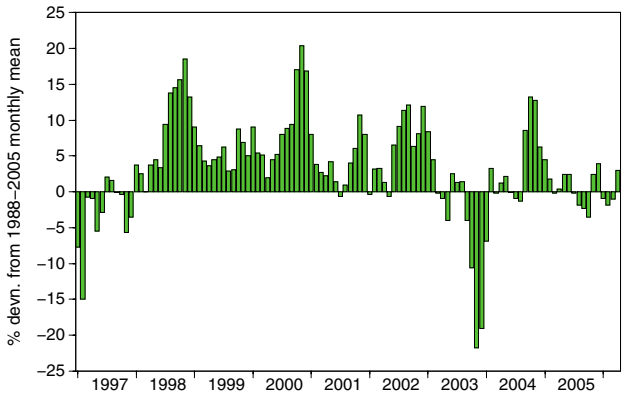
Groundwater levels - March 2006

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.

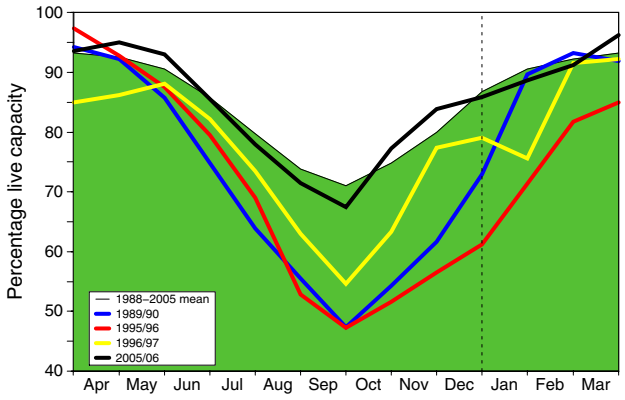
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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.

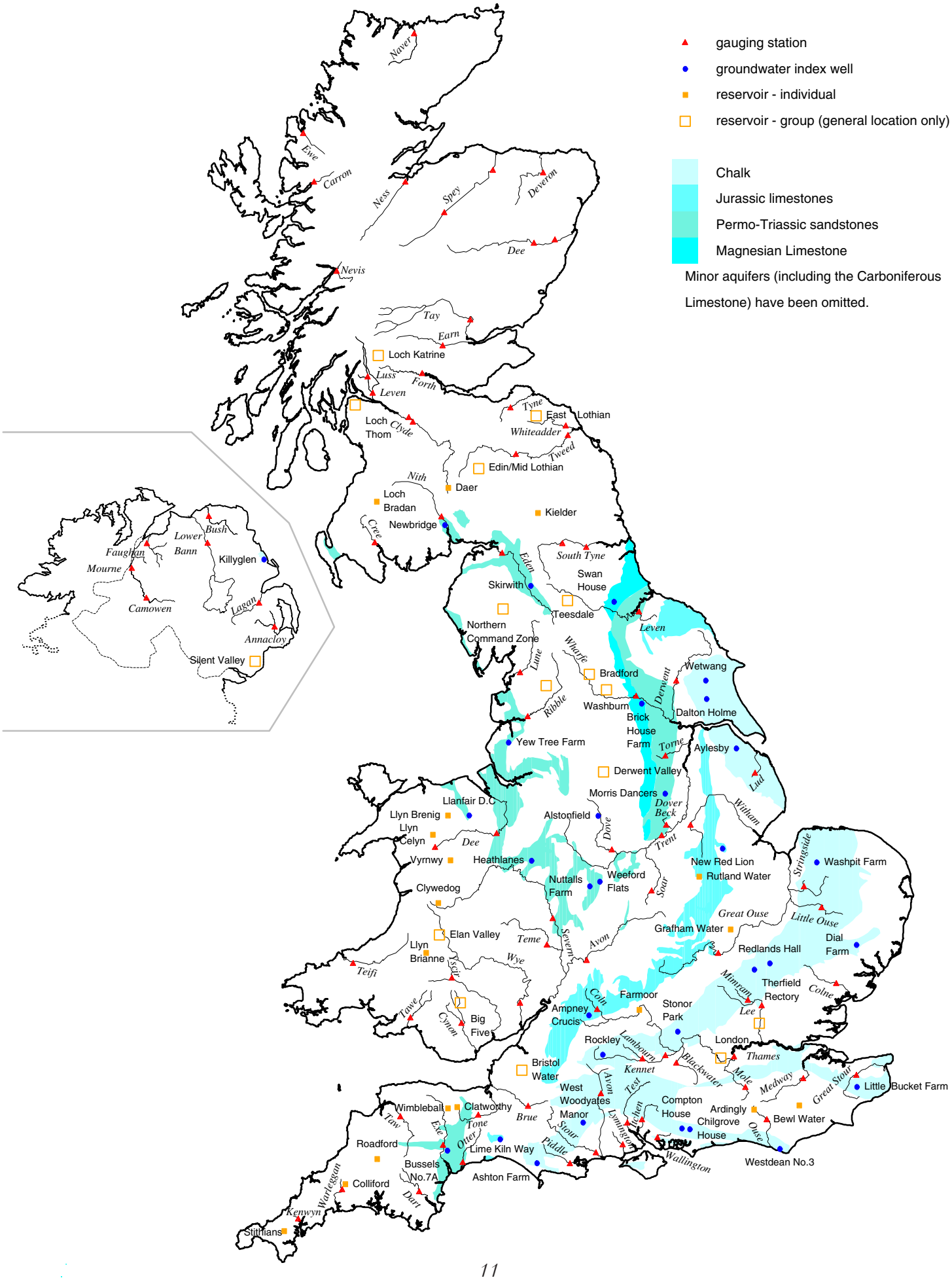
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2005 Dec	2006 Jan	Feb	Mar	Apr	Avg. Apr	Min. Apr	Year* of min.
North West	N Command Zone	• 124929	90	82	89	90	**100**	93	77	1993
	Vyrnwy	55146	88	85	91	90	**100**	95	64	1996
Northumbrian	Teesdale	• 87936	91	93	94	100	**100**	92	77	2003
	Kielder	(199175)	(91)	(92)	(93)	(92)	**(98)**	(92)	(81)	1993
Severn Trent	Clywedog	44922	82	86	87	88	**99**	94	86	1996
	Derwent Valley	• 39525	86	92	93	98	**100**	94	54	1996
Yorkshire	Washburn	• 22035	79	92	85	89	**99**	92	70	1996
	Bradford supply	• 41407	80	81	82	83	**97**	94	59	1996
Anglian	Grafham	(55490)	(81)	(79)	(85)	(89)	**(96)**	(91)	(77)	1997
	Rutland	(116580)	(73)	(72)	(80)	(83)	**(88)**	(90)	(74)	1992
Thames	London	• 202406	80	87	92	98	**99**	94	88	1990
	Farmoor	• 13822	99	98	93	99	**97**	95	84	1992
Southern	Bewl	28170	36	34	37	50	**65**	90	58	1989
	Ardingly	4685	50	57	65	77	**88**	100	88	2006
Wessex	Clatworthy	5364	92	99	100	100	**100**	97	82	1992
	Bristol WW	• (38666)	(59)	(71)	(76)	(81)	**(87)**	(93)	(71)	1992
South West	Colliford	28540	51	56	60	62	**68**	86	58	1997
	Roadford	34500	63	68	69	71	**76**	84	37	1996
	Wimbleball	21320	73	77	84	95	**100**	95	78	1996
	Stithians	5205	64	74	83	88	**96**	93	52	1992
Welsh	Celyn and Brenig	• 131155	95	94	96	98	**100**	97	72	1996
	Brianne	62140	92	97	95	95	**100**	98	90	1993
	Big Five	• 69762	87	97	97	97	**99**	95	78	1993
	Elan Valley	• 99106	98	100	98	98	**100**	98	89	1993
Scotland(E)	Edinburgh/Mid Lothian	• 97639	94	93	95	94	**96**	94	71	1998
	East Lothian	• 10206	93	93	100	99	**100**	99	95	1990
Scotland(W)	Loch Katrine	• 111363	88	82	94	95	**99**	94	88	2001
	Daer	22412	98	97	100	99	**100**	98	93	2001
	Loch Thom	• 11840	100	100	100	100	**100**	98	93	2001
Northern Ireland	Total+	• 67270	85	92	90	88	**93**	88	83	2002
	Silent Valley	• 20634	92	99	94	90	**98**	81	57	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.

The Met Office
FitzRoy Road
Exeter
Devon
EX1 3PB

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

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

Subscription

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

Hydrological Summaries
National Water Archive
CEH Wallingford
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB

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

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

NATURAL ENVIRONMENT RESEARCH COUNCIL

04/06