Hydrological Summary
for the United Kingdom

December 2006

General
A notably dry interlude in mid-month aside, December was mild and wet with damaging storms early and late in the month. Precipitation totals across much of northern Britain were exceptionally high and most of the English Lowlands registered a 5th successive month with above average rainfall. Generally, this sequence constitutes the terminal phase of the drought but substantial rainfall deficiencies remain in parts of the South West and groundwater level recoveries have only recently been initiated in some eastern aquifers. Despite flood alleviation drawdown in some headwater reservoirs, overall stocks for England & Wales were considerably above average entering 2007 and well above corresponding stocks in 2006. However, stocks remain seasonally low parts of the South West, Colliford in particular. River flows exceeded previous maxima in parts of Scotland and floodplain inundations were common across much of the UK. Substantial recharge since mid November has greatly improved the groundwater resources outlook. The saturated soil conditions are conducive to further replenishment through the late winter but also contribute to the continuing risk of further flooding.

Rainfall
December was a mild month with abundant rainfall over the first fortnight followed by a notably dry spell – in parts of the English Lowlands precipitation was largely restricted to fog-drip over the 10 days from the 16th. The return of cyclonic conditions produced a tempestuous end to the year; damaging storms and substantial rainfall continued into January 2007. The December rainfall distribution reflected the prevailing synoptic pattern. Moist westerlies produced many notable storm totals (e.g 24-hr totals of 115mm at Capel Curig, N. Wales and 102mm at Inveruglas, Strathclyde on the 13th). In many mountainous catchments, these contributed to December rainfall totals of more than twice the 1961-90 average – a significant anomaly for one of the wettest months of the year. Below average rainfall was largely restricted to sheltered eastern areas (Peterhead reported < 40%) but Cornwall was also relatively dry. Provisionally, the UK registered its 4th wettest December since 1959 and the Oct-Dec period ranks 2nd wettest in over 50 years. The Nov/Dec rainfall was the highest for Scotland in a series from 1914 and, for the Thames closely equates to the combined totals for 2004 and 2005. Most of the drought-affected region (parts of the South West excepted) continued a sequence of relatively wet months stretching back to August; long term rainfall deficiencies have decreased substantially. 2006 regional rainfall totals are within the normal range but much of western Scotland was notably wet and residual pockets of significant rainfall deficiency remain (e.g. in Cornwall). Such areas aside, the autumn and early winter rainfall provided a clear termination to the meteorological drought.

River Flows
Although recessions predominated in the 3rd and 4th weeks, December was characterised by sustained spate conditions and floodplain inundations in rivers across much of the country. Flood warnings were common and most catchments were, again, very vulnerable to further rainfall in early 2007. In responsive catchments, the steep late-autumn recoveries in runoff rates continued into December. Very exceptional flow rates were recorded in North Wales, the northern Pennines, parts of Northern Ireland and, especially, rivers draining the Scottish Highlands. New maximum recorded flows were established on a number of Scottish Rivers including the Tay (at Pitnacree), the Teith and Allen Water with records of around 50 years. The Ballathie gauging station on the Tay recorded a remarkable peak of 1705 cumecs on the 14th. Substantial residential and commercial flooding was reported from eastern Scotland (e.g. at Callender, Stirling, Bridge of Allan, Dalguise). In the English Lowlands, where the drought's impact was most compelling, a seasonally late recovery in runoff rates gathered momentum in most permeable catchments. After depressed autumn flows, December runoff totals for most spring-fed streams returned to the normal range (the Darent in Kent was an exception), typically exceeding Dec. 2005 flows by a wide margin. For the Lambourn, flows approached the monthly mean after more than two years with seasonally depressed flows. Monthly runoff totals established new December records across much of northern Britain; the Earn exceeding the previous maxima in a 59-yr series. Elsewhere runoff totals were generally well within the normal range. Accumulated runoff totals provide echoes of the sustained drought conditions. Despite a modest upturn in the Mimram flows, the 2006 runoff was the 2nd lowest annual total in a 55-yr series and long term accumulated runoff deficiencies remain large across southern England.

Groundwater
With soil moisture deficits eliminated across almost all outcrop areas, the December rainfall was very beneficial for aquifer replenishment (helped by the moderate intensity of the frontal rainfall). Over wide areas, the period since mid-November has been the most productive for infiltration since late 2002, and estimated recharge has exceeded that for the full 2004/05 recharge season in some areas (e.g. parts of the North Downs). However, at many index sites – particularly where autumn groundwater levels were very depressed – much of this abundant recharge had yet to reach the water-table when the December levels were reported. Late-reporting wells in responsive aquifer units have captured notably steep recoveries with recent rises of 20 metres of more in some Chalk and Limestone outcrops areas (e.g. Rockley, Chilgrove, Alstonfield) – commonly leaving levels at their highest for at least three years. In the slower responding Chalk of the Chilterns (Stonor) modest upturns have been registered but the 2006 maximum levels should be exceeded in January. The storage characteristics of the Permo-Triassic sandstones of the Midlands ensure that the post-drought recovery is likely to be slow but the Weeford Flats borehole is no longer dry and levels rose smartly at Nuttals Farm through December. The last 8-10 weeks has seen a very major improvement in groundwater resources and the outlook is substantially healthier than a year ago.

Centre for Ecology & Hydrology
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British Geological Survey
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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Area	Rainfall	Dec 2006	Oct 06-Dec 06	RP	Aug 06-Dec 06	RP	Jan 06-Dec 06	RP	Nov 04-Dec 06	RP
England & Wales	**mm**	**128**	**354**		**520**		**929**		**1874**	
	%	**134**	**129**	**5-10**	**121**	**5-10**	**103**	**2-5**	**94**	**2-5**
North West	mm	**223**	535		772		1358		2698	
	%	**178**	141	10-20	127	5-15	112	5-10	100	2-5
Northumbrian	mm	**123**	316		507		881		1899	
	%	**150**	129	5-10	126	5-15	102	2-5	100	<2
Severn Trent	mm	**102**	271		426		775		1564	
	%	**131**	126	5-10	122	5-10	101	2-5	93	2-5
Yorkshire	mm	**121**	317		516		924		1789	
	%	**146**	133	5-10	134	10-20	111	2-5	98	2-5
Anglian	mm	**55**	195		362		631		1237	
	%	**98**	118	5-10	134	10-20	104	2-5	94	2-5
Thames	mm	**88**	287		429		742		1379	
	%	**124**	143	5-15	134	5-15	106	2-5	90	5-10
Southern	mm	**113**	331		466		801		1518	
	%	**136**	133	5-10	124	5-10	102	2-5	87	5-10
Wessex	mm	**116**	354		465		846		1724	
	%	**123**	136	5-10	116	2-5	99	2-5	91	2-5
South West	mm	**132**	431		545		1043		2292	
	%	**94**	112	2-5	96	2-5	87	2-5	86	5-15
Welsh	mm	**226**	569		748		1358		2827	
	%	**144**	130	5-10	113	2-5	101	2-5	94	2-5
Scotland	**mm**	**257**	**688**		**934**		**1635**		**3531**	
	%	**165**	**145**	**35-50**	**127**	**15-25**	**111**	**5-10**	**108**	**5-10**
Highland	mm	**337**	884		1142		1992		4447	
	%	**174**	152	50-80	130	15-25	114	5-15	115	30-40
North East	mm	**108**	386		556		993		2246	
	%	**110**	127	5-10	114	2-5	96	2-5	99	2-5
Tay	mm	**237**	600		840		1430		2980	
	%	**177**	151	30-40	136	20-30	111	2-5	105	2-5
Forth	mm	**187**	445		644		1182		2595	
	%	**164**	127	5-10	115	2-5	103	2-5	103	2-5
Tweed	mm	**153**	394		609		1046		2204	
	%	**158**	135	5-15	128	5-15	104	2-5	100	<2
Solway	mm	**238**	665		928		1632		3277	
	%	**159**	147	20-35	129	10-20	114	5-10	103	2-5
Clyde	mm	**327**	845		1179		2032		4204	
	%	**177**	149	30-50	132	20-30	116	5-15	109	5-10
Northern Ireland	**mm**	**139**	**399**		**624**		**1155**		**2395**	
	%	**127**	**121**	**2-5**	**119**	**5-10**	**105**	**2-5**	**99**	**2-5**

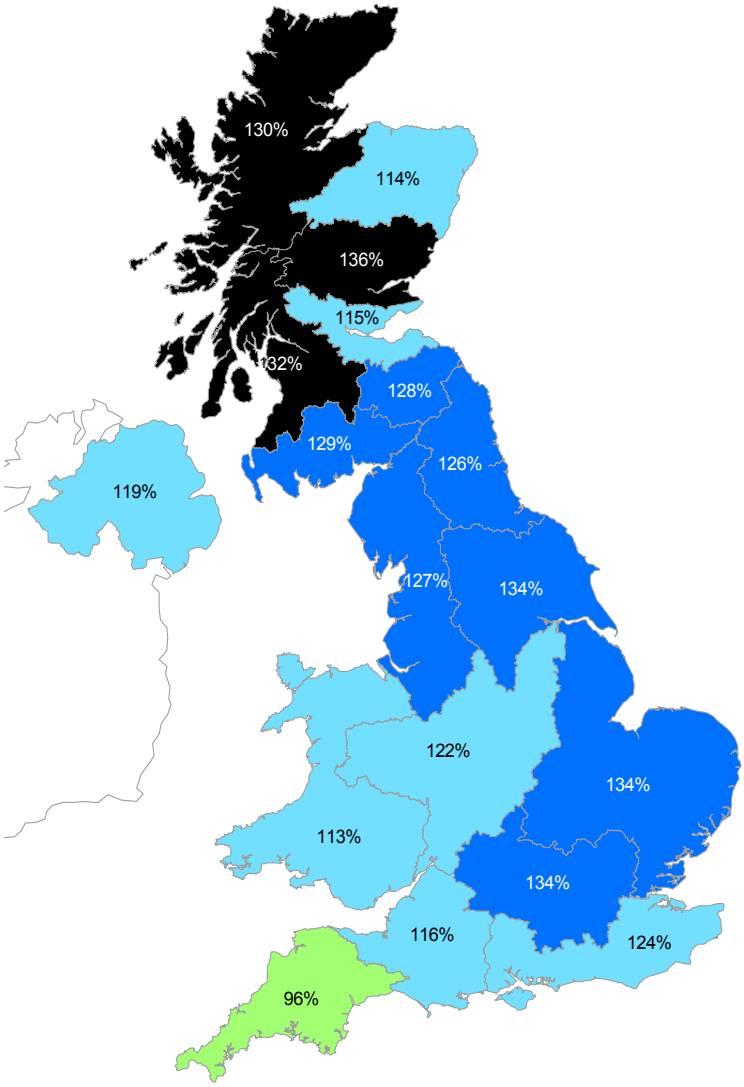
% = percentage of 1961-90 average *RP = Return period*

Important note: Figures in the above table may be quoted provided that their source is acknowledged. See page 12. Where appropriate, specific reference must be made to the uncertainties associated with the return period estimates. Generally, the return period estimates are based on tables provided by the Met Office but those for Northern Ireland are based on the estimates for north-west England. The estimates relate to the specified region and span of months only (RPs may be an order of magnitude less if n-month periods beginning in any month are considered), they reflect rainfall variability over the period 1911-70 only, and assume a stable climate. (For further details see Tabony, R. C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37). The timespans featured do not purport to represent the critical periods for any particular water resource management zone and, normally, for hydrological or water resources assessments of drought severity, river flows and groundwater levels provide a better guide than return periods based on rainfall totals. All monthly rainfall totals since August 2006 are provisional.

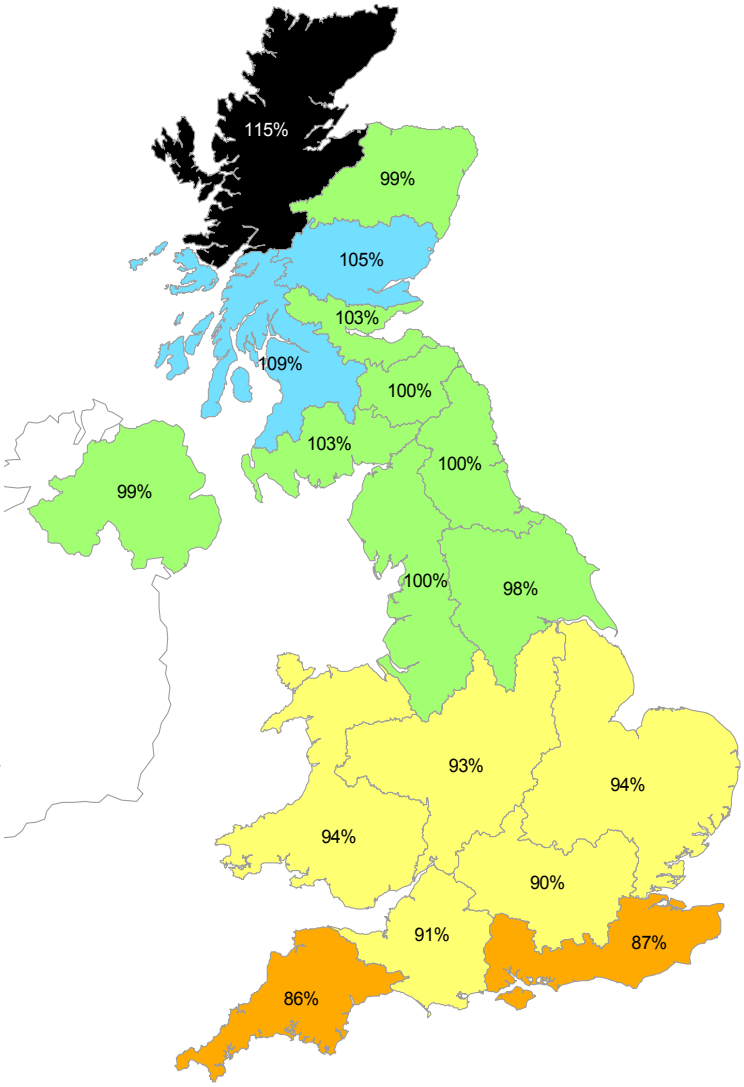
Rainfall . . . Rainfall . . .

Key

00% Percentage of 1961-90 average	Normal range
Very wet	Below average
Substantially above average	Substantially below average
Above average	Exceptionally low rainfall



August 2006 - December 2006

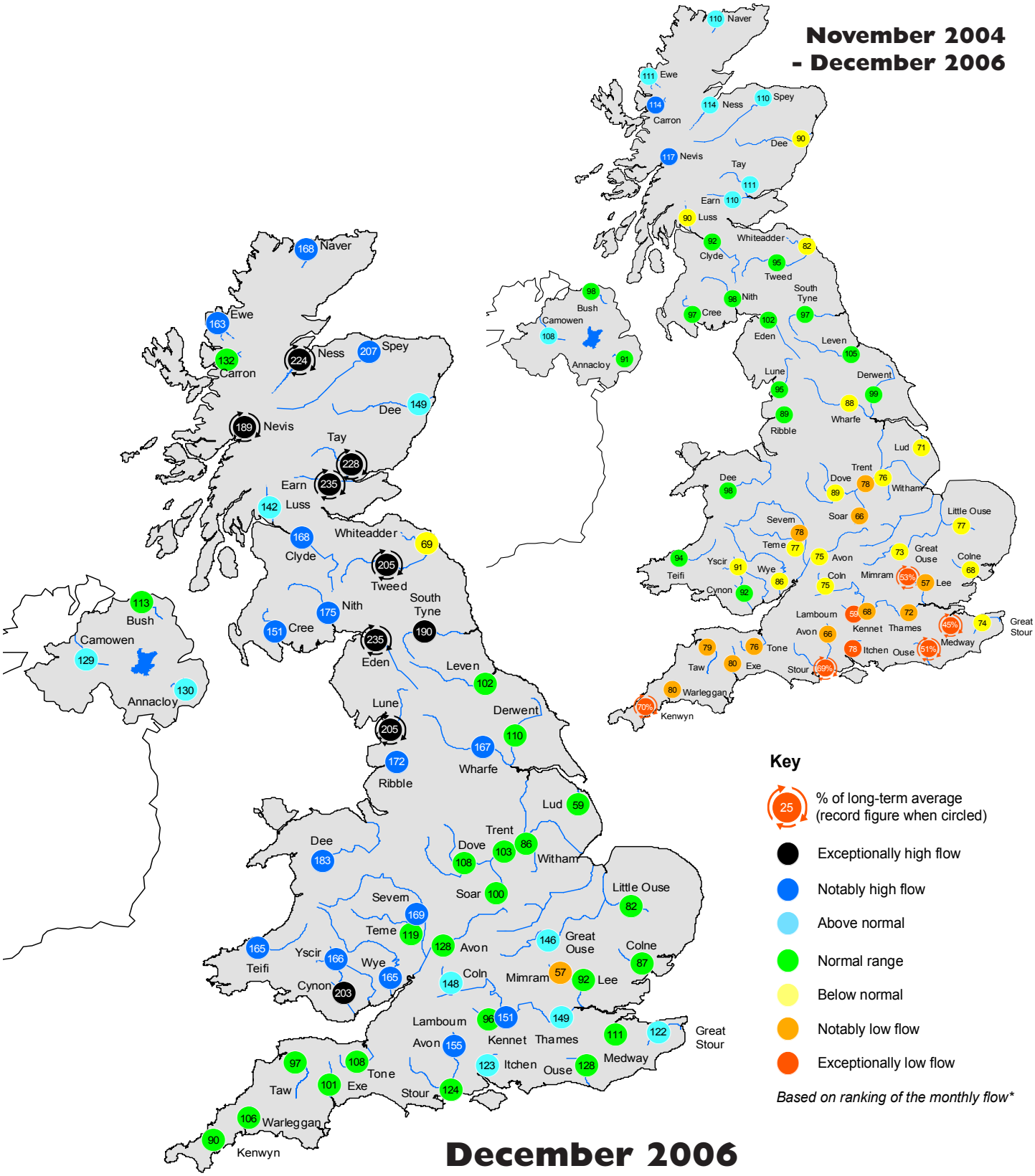


November 2004 - December 2006

Rainfall accumulation maps

For the UK as a whole the August-December period was the 2nd wettest since 1954 with rainfall in all regions substantially exceeding the average with the exception of the South West (where within-region variations in rainfall deficiencies are relatively large). In the November 2004 - December 2006 timeframe, moderate deficiencies can still be recognised across southern Britain, most notably for the South West where the rainfall total is the lowest in this timeframe since 1974-76.

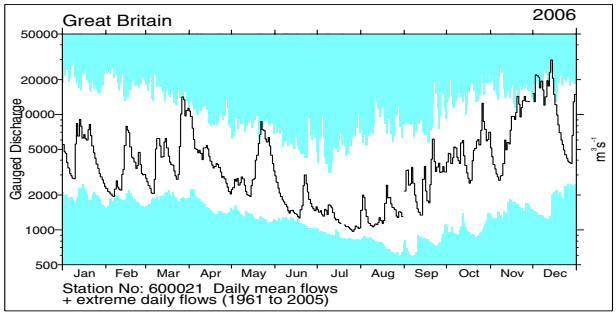
River flow . . . River flow . . .

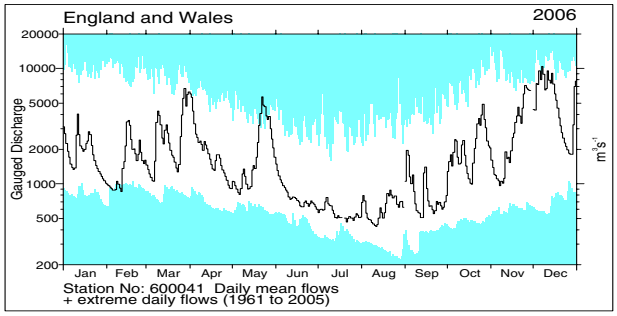


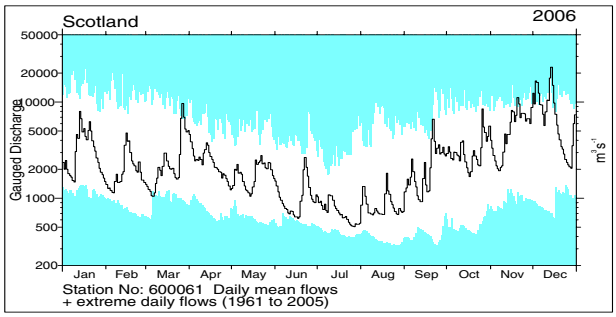
River flows

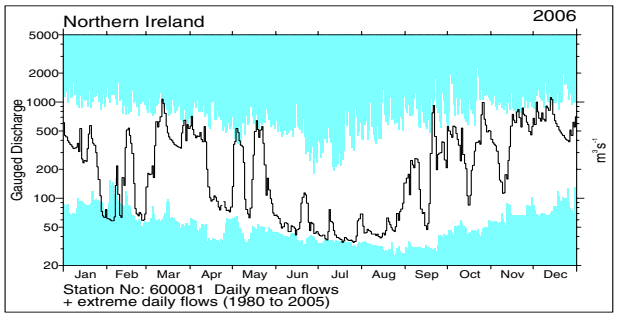
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

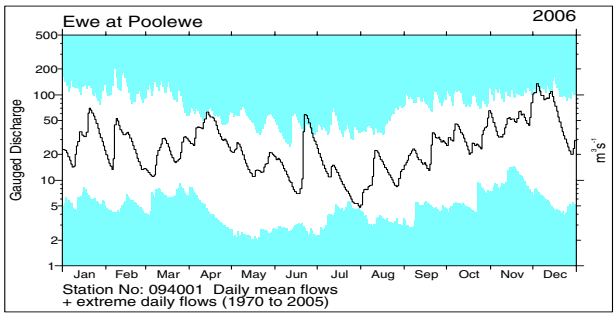
River flow . . . River flow . . .

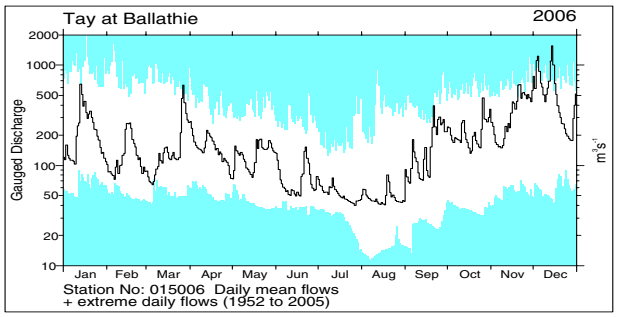


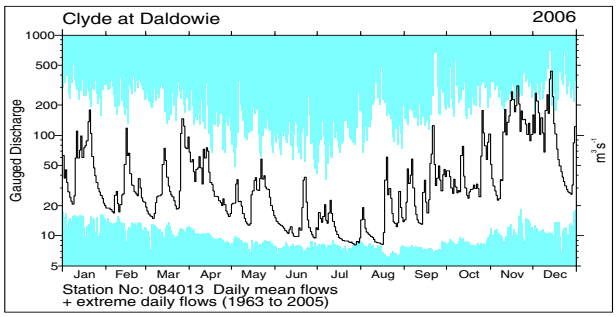


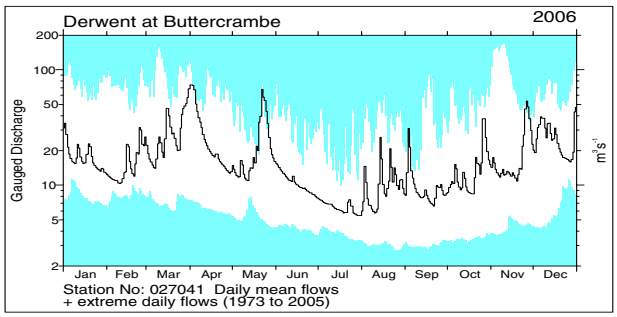


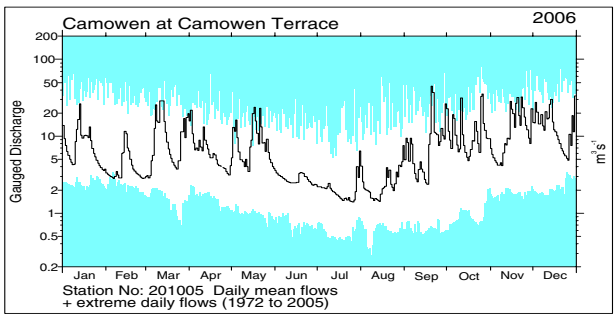


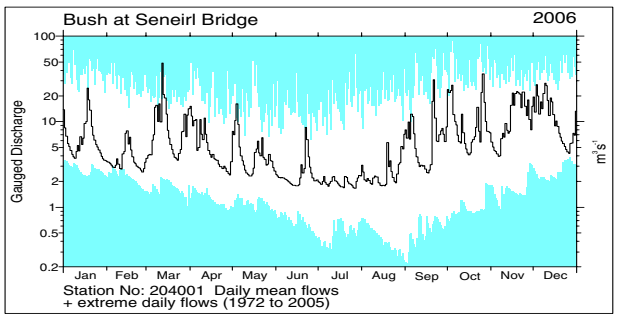








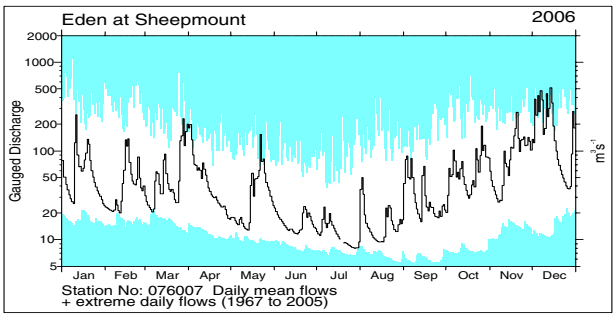


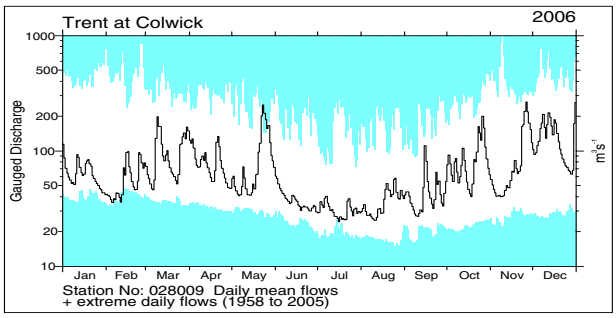


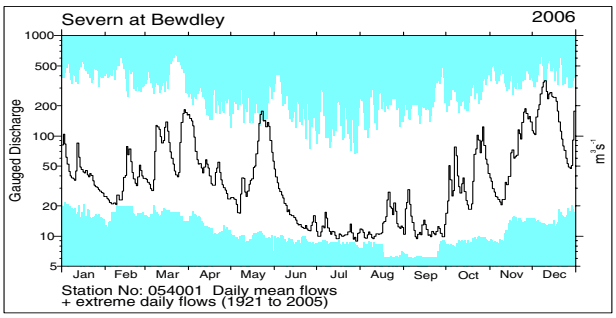
River flow hydrographs

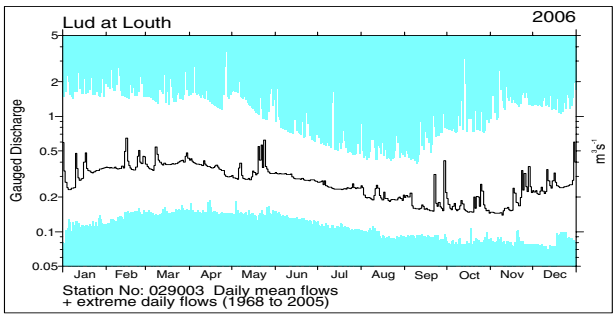
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to January 2006 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

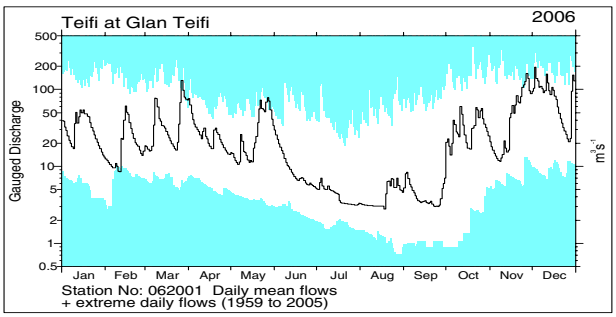
River flow . . . River flow . . .

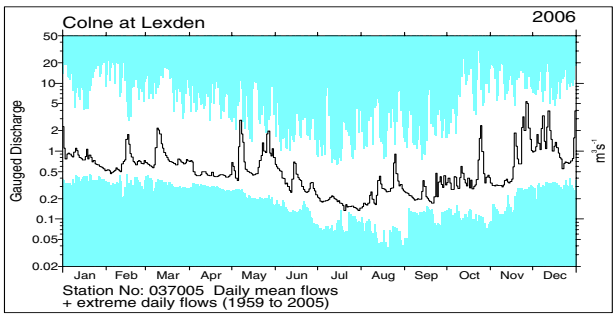


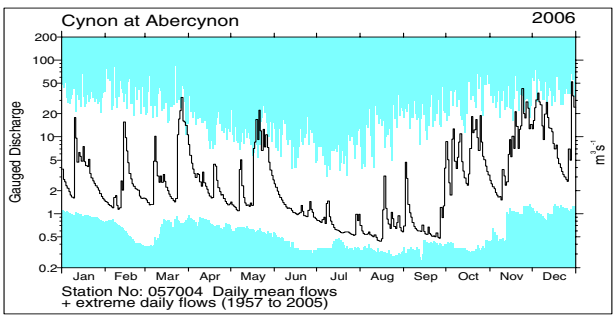


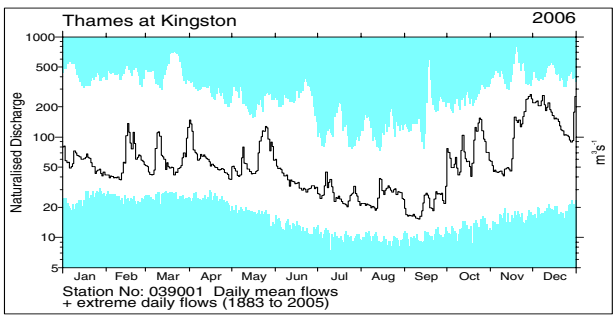


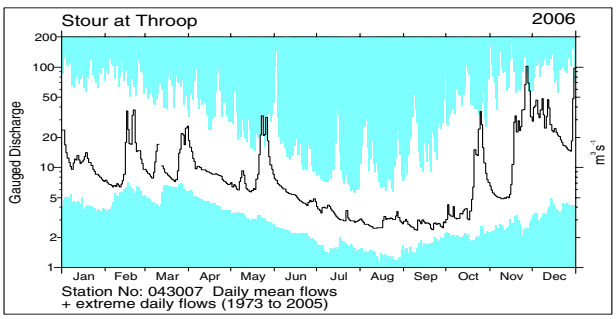


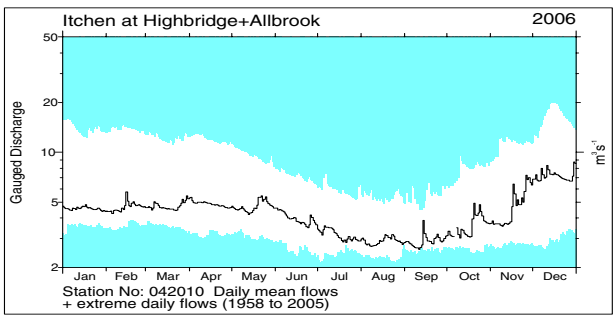










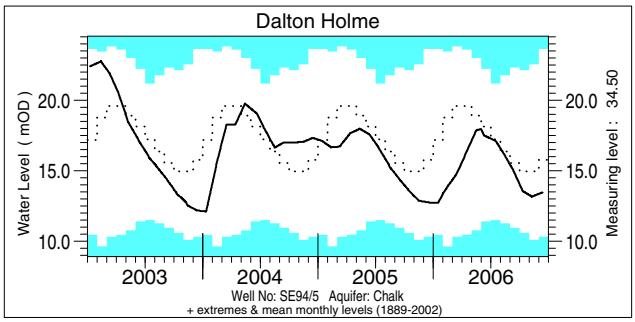


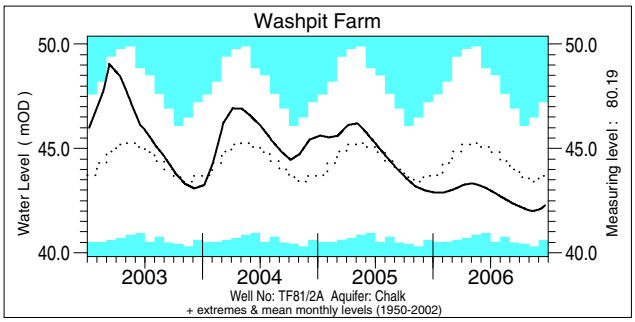
Notable runoff accumulations (a) October - December 2006, (b) November 2004 - December 2006

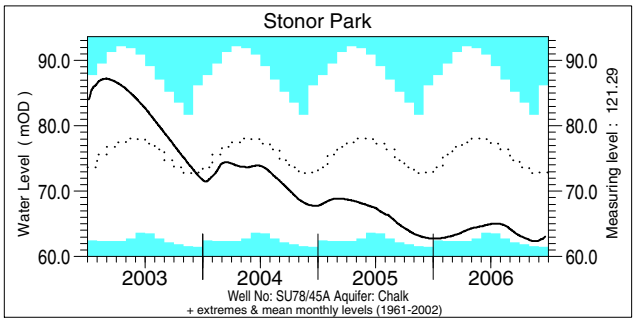
	River	%lta	Rank	River	%lta	Rank		River	%lta	Rank
a)	Ness	160	34/34	Eden	160	38/40	b)	Mimram	53	1/49
	Spey (Boat o'Brig)	158	54/55	Nith	154	48/50		Medway	45	1/40
	Tay	168	54/55	Clyde (Blairston)	153	46/48		Ouse (Gold Bridge)	51	1/37
	Earn	166	58/59	Leven (Linnbrane)	162	43/43		Test	67	1/46
	Forth	160	25/26	Nevis	209	25/25		Piddle	69	1/40
	Tweed (Boleside)	154	45/46	Carron	190	28/28		Otter	74	1/43
	Cynon	165	48/49	Naver	173	30/30		Kenwyn	70	1/37

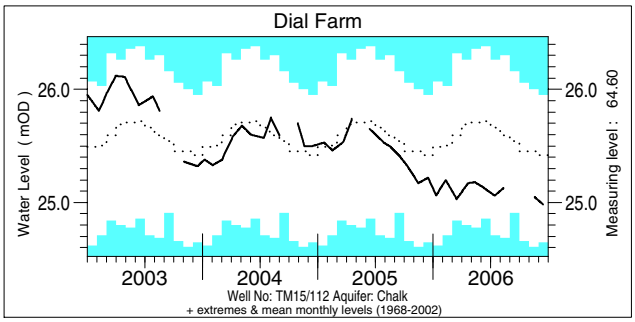
lta = long term average
Rank 1 = lowest on record

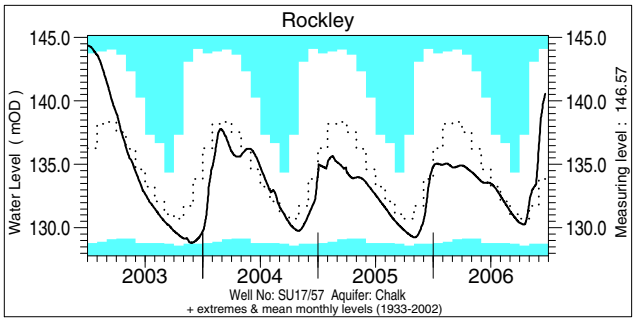
Groundwater . . . Groundwater

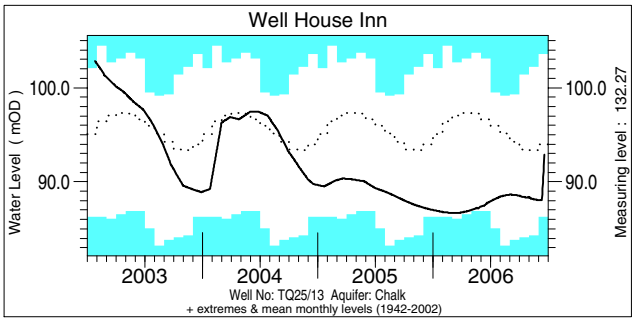


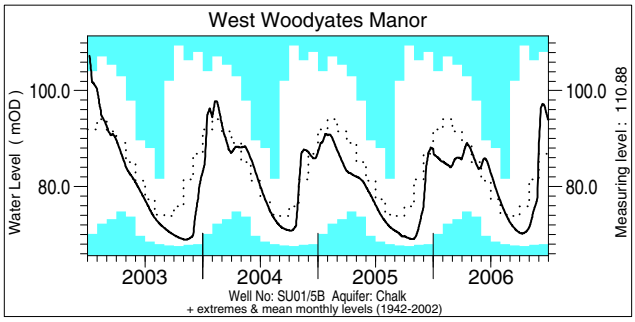


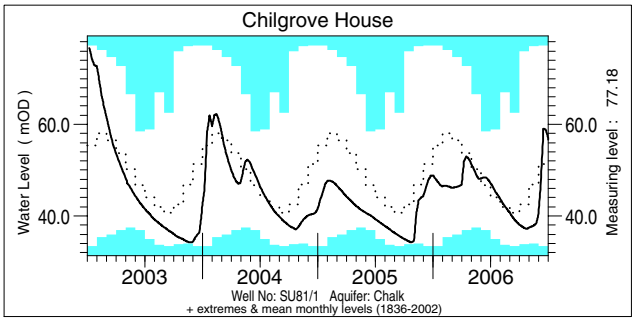


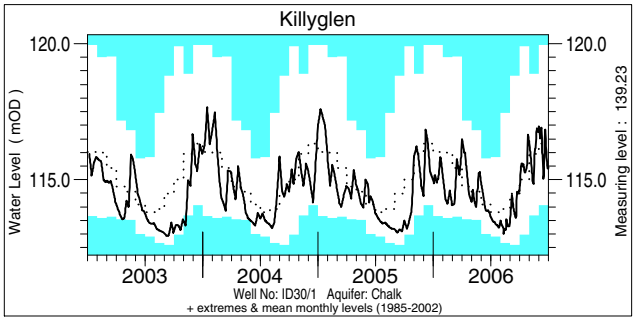


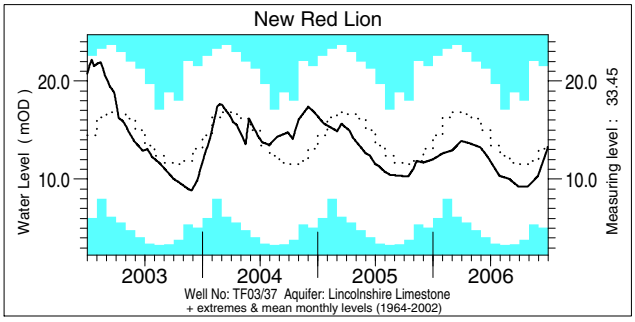






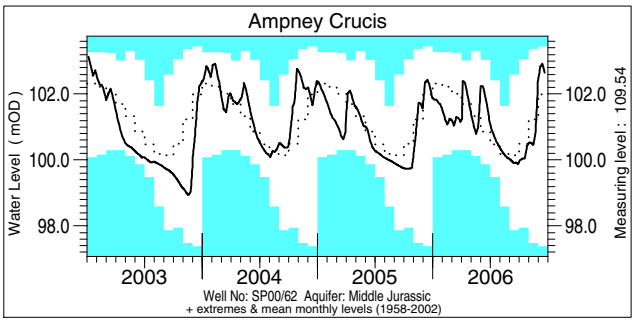


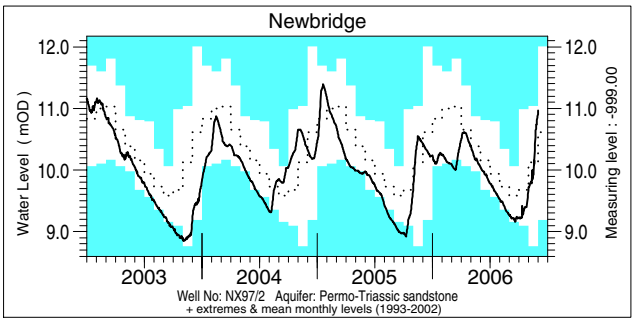


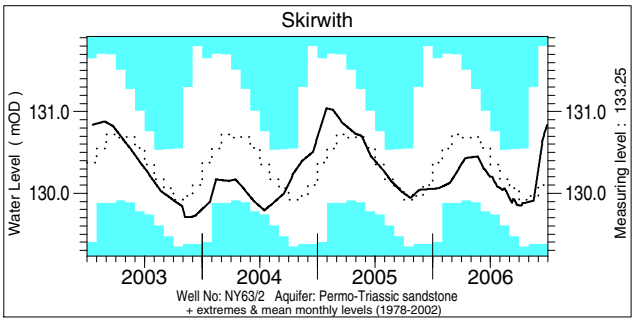


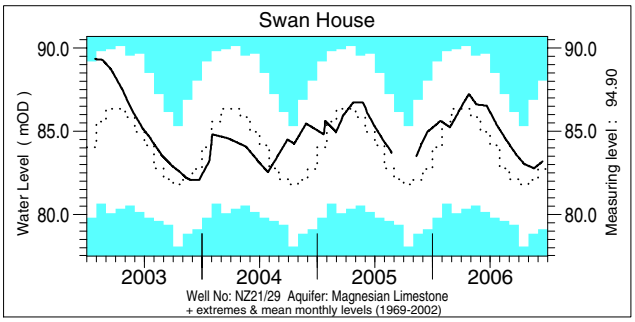
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

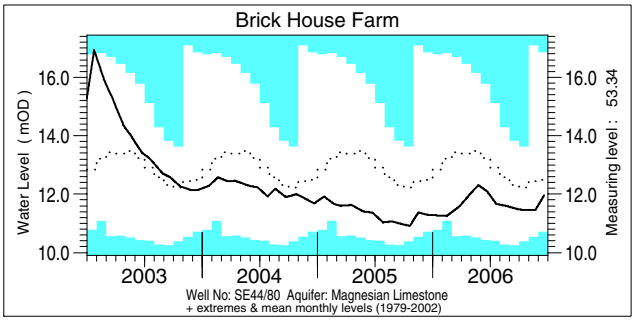
Groundwater . . . Groundwater

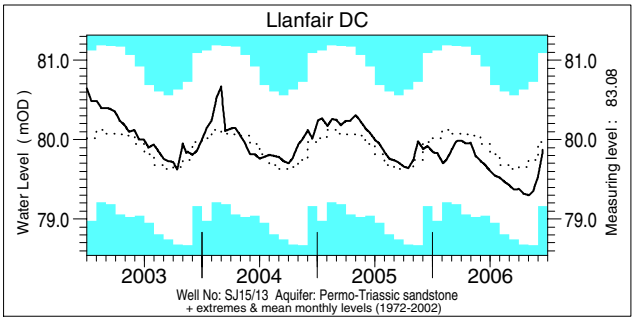


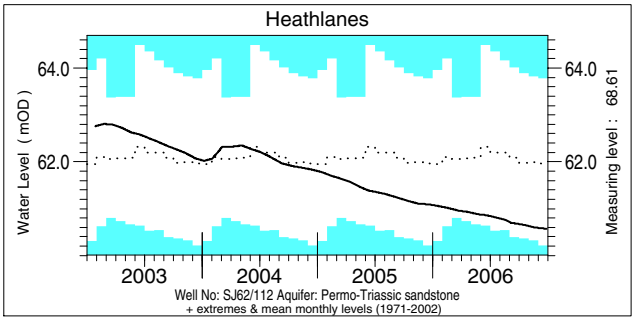


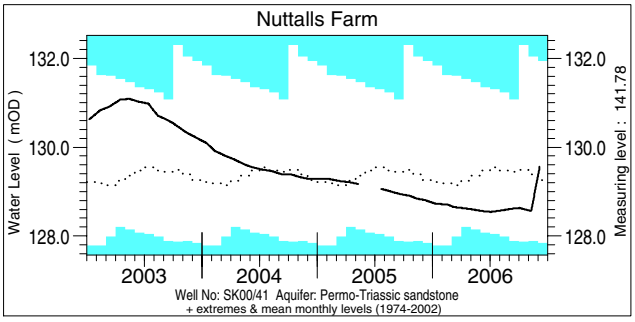


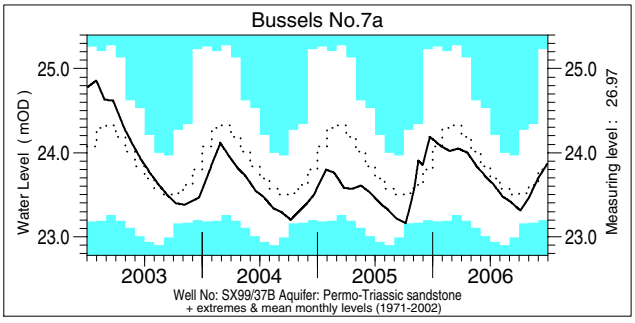


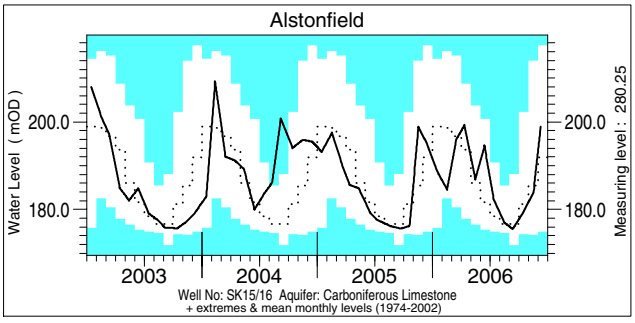










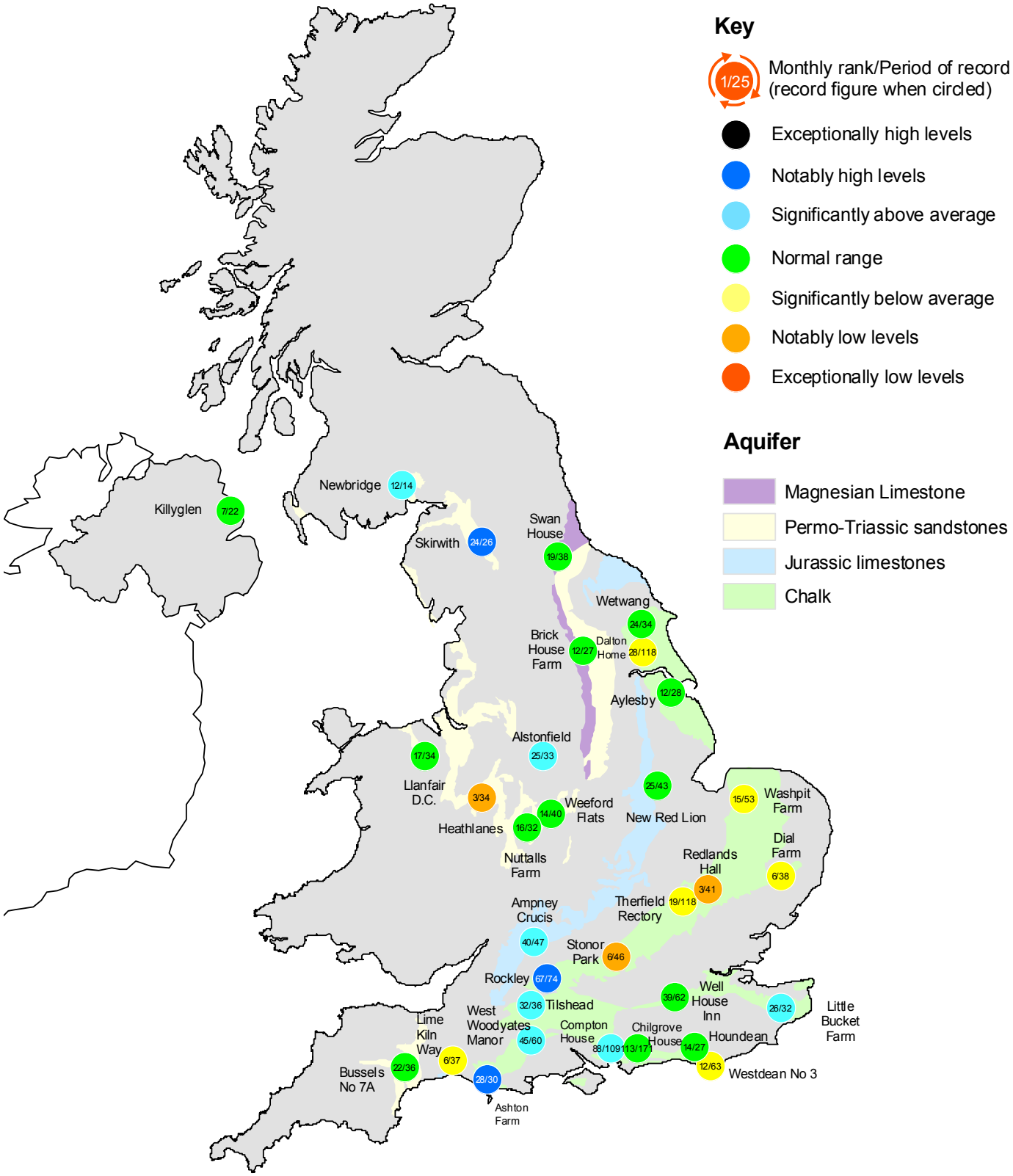


Groundwater levels December 2006 / January 2007

Borehole	Level	Date	Dec. av.	Borehole	Level	Date	Dec. av.	Borehole	Level	Date	Dec. av.
Dalton Holme	13.48	12/12	15.58	Chilgrove House	56.64	31/12	51.85	Brick House Farm	11.96	18/12	12.41
Washpit Farm	42.49	04/01	43.38	Killyglen	115.46	31/12	116.20	Llanfair DC	79.87	15/12	79.87
Stonor Park	63.79	02/01	72.53	New Red Lion	13.26	29/12	12.94	Heathlanes	60.57	27/12	61.92
Dial Farm	24.98	15/12	25.41	Ampney Crucis	102.82	02/01	101.92	Nuttalls Farm	129.56	05/12	129.48
Rockley	140.75	02/01	133.77	Newbridge	10.97	01/12	10.49	Bussels No.7a	23.87	28/12	23.84
Well House Inn	94.99	02/01	93.69	Skirwith	130.84	28/12	130.23	Alstonfield	198.89	08/12	192.61
West Woodyates	93.88	31/12	86.76	Swan House	83.19	15/12	83.05				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



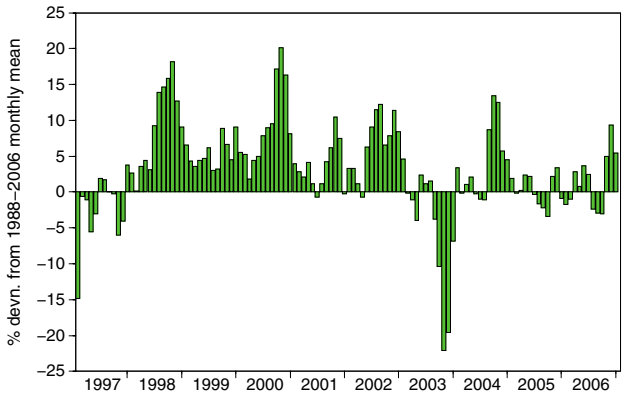
Groundwater levels - December 2006

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.

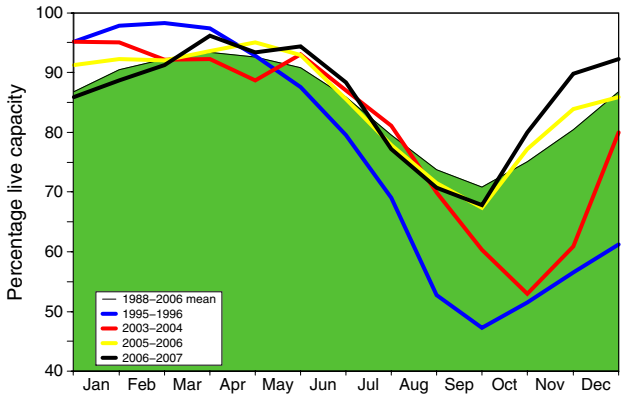
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.
iii. Data for Morris Dancers are currently under review.

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.

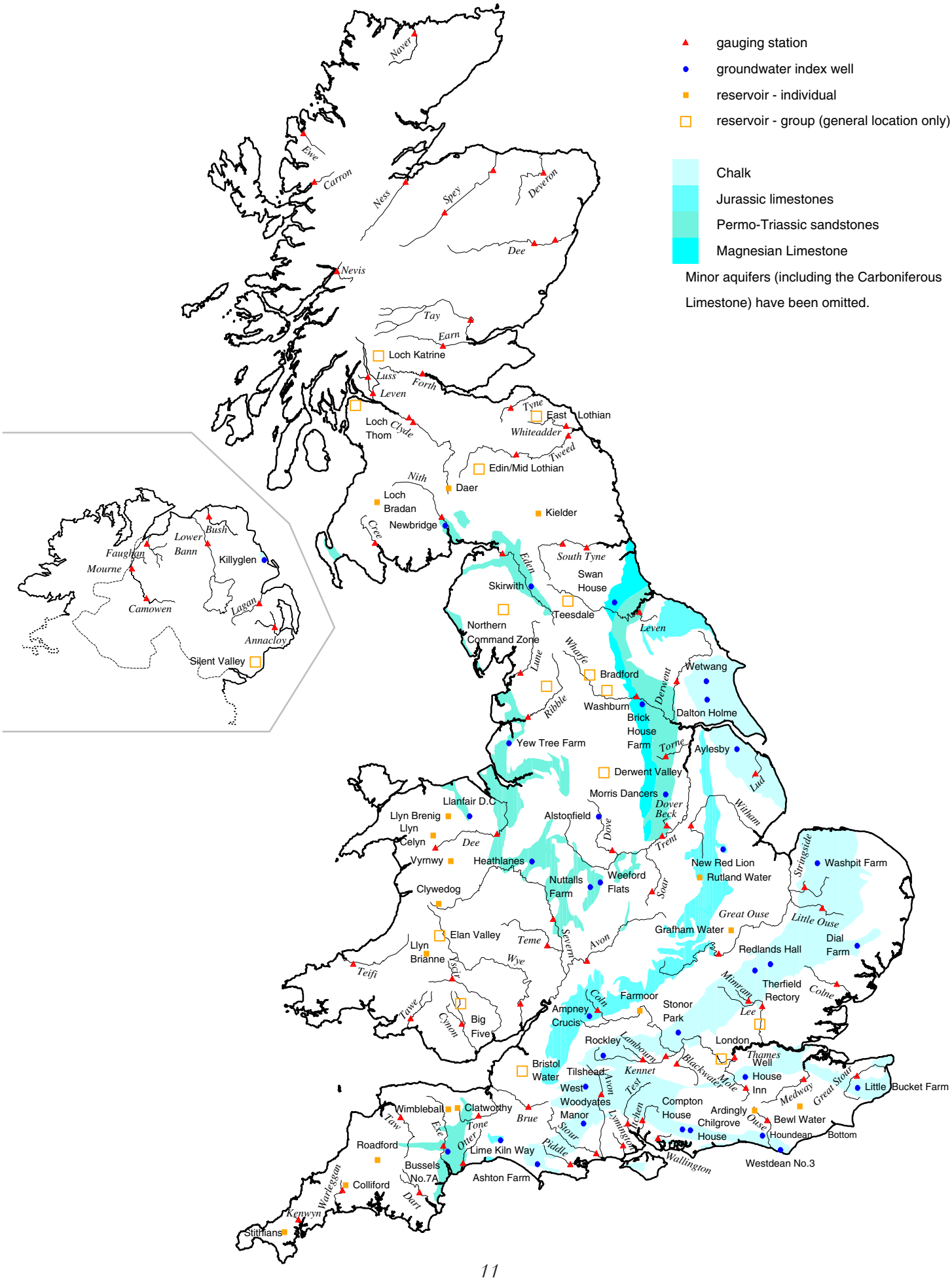
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2006 Nov	2006 Dec	2007 Jan	Jan Anom.	Min. Jan	Year* of min.	2006 **Jan**	Diff **07-06**
North West	N Command Zone	• 124929	77	97	**99**	14	51	1996	82	17
	Vyrnwy	55146	77	95	**99**	9	35	1996	85	14
Northumbrian	Teesdale	• 87936	82	100	**89**	2	41	1996	93	-4
	Kielder	(199175)	(89)	(94)	**(92)**	1	(70)	1990	(92)	0
Severn Trent	Clywedog	44922	69	82	**83**	-1	54	1996	86	-3
	Derwent Valley	• 39525	90	91	**87**	-2	10	1996	92	-5
Yorkshire	Washburn	• 22035	89	94	**96**	14	23	1996	92	4
	Bradford supply	• 41407	78	97	**100**	12	22	1996	81	19
Anglian	Grafham	(55490)	(85)	(88)	**(93)**	10	(57)	1998	(79)	14
	Rutland	(116580)	(71)	(75)	**(88)**	6	(60)	1991	(72)	16
Thames	London	• 202406	92	95	**92**	7	60	1991	87	5
	Farmoor	• 13822	91	84	**100**	9	71	1991	98	2
Southern	Bewl	28170	61	62	**83**	12	34	2006	34	49
	Ardingly	4685	73	88	**100**	17	41	2004	57	43
Wessex	Clatworthy	5364	51	70	**100**	9	54	2004	99	1
	Bristol WW	• (38666)	(66)	(69)	**(87)**	12	(40)	1991	(71)	16
South West	Colliford	28540	38	46	**53**	-24	46	1996	56	-3
	Roadford	34500	48	61	**70**	-7	23	1996	68	2
	Wimbleball	21320	59	73	**84**	2	46	1996	77	7
	Stithians	5205	33	43	**67**	-9	33	2002	74	-7
Welsh	Celyn and Brenig	• 131155	85	96	**98**	6	54	1996	94	4
	Brianne	62140	95	100	**100**	3	76	1996	97	3
	Big Five	• 69762	72	89	**96**	8	67	1996	97	-1
	Elan Valley	• 99106	80	100	**100**	4	56	1996	100	0
Scotland(E)	Edinburgh/Mid Lothian	• 97639	82	93	**100**	11	60	1999	93	7
	East Lothian	• 10206	66	78	**93**	-1	48	1990	93	0
Scotland(W)	Loch Katrine	• 111363	94	100	**100**	11	80	2004	82	18
	Daer	22412	99	100	**98**	1	83	1996	97	1
	Loch Thom	• 11840	95	97	**97**	0	90	2004	100	-3
Northern Ireland	Total+	• 67270	85	90	**90**	6	61	2002	92	-2
	Silent Valley	• 20634	84	93	**93**	13	39	2002	99	-6

() 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 1988-2007 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.

NATURAL ENVIRONMENT RESEARCH COUNCIL

The monthly rainfall figures are provided by the Met Office (National Climate Information Centre) and are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

*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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