Hydrological Summary
for the United Kingdom

August 2003

General

August was an extremely warm month – the 38.1° C registered at Gravesend on the 10th established a new UK maximum – and exceptionally low rainfall totals characterised most regions. This arid combination was reflected in the parched landscape, minimal soil moisture, early leaf fall and, in impermeable catchments, depressed river flows with associated ecological stress (e.g. salmon fatalities were reported in the Aberdeenshire Dee). Abstraction restrictions limited replenishment to some pumped storage reservoirs (e.g. Rutland Water) and heat-wave conditions triggered increases in water demand. Overall reservoir stocks (for England & Wales) registered their second largest monthly decline on record. Nonetheless overall stocks remain within 4% of the late summer average and well above drought minima in almost all regions. This, together with groundwater levels that are (mostly) within the normal range, has moderated the impact on water resources of a very substantial rainfall deficiency that began early in the year - the provisional UK rainfall total for the Feb-Aug period was the lowest since 1984. The current extremely dry soils are very likely to delay substantially the seasonal recovery of river flows and runoff rates. In the event of a dry autumn, the water resources outlook will require careful monitoring over the coming winter.

Rainfall

Synoptic patterns during August were dominated by persistent anticyclonic conditions bringing stable, hot and dry weather to almost all of the UK; the few frontal incursions were largely limited to the north-western and southern extremities of Britain. Although the UK's longest absolute drought (73-days in East London in 1893) was not threatened, many notably arid interludes were reported – sequences of 26 or more rainless days being reported in parts of the English Lowlands. A few locally intense storms did occur, e.g. 48 mm in 15 minutes at Carlton-in-Cleveland, (N. Yorks), and significant rainfall on the 28th prevented existing August rainfall minima being eclipsed in many localities. Nonetheless, August totals were below 20% of average across the greater part of the UK, and some lowland catchments registered totals of less than 5mm. Provisional data suggest that August was the third driest (= to 1976) for the UK in a 104-year record. Parts of north-eastern Britain aside, summer (June-August) regional rainfall totals were generally well below average but, more significantly from a resources perspective, August was the seventh successive month with below average rainfall in some catchments in the English lowlands. Provisional figures suggest that the Feb-August rainfall was the second lowest in the last 65 years for the Thames Valley – 1976 was substantially drier. Deficiencies in this timeframe are also notable in much of northern England and eastern Scotland.

River Flow

Some increases in river flow occurred in western catchments towards month end but generally the summer recessions continued and, with natural storage greatly depleted in impermeable catchments, runoff rates were depressed during the second half of August. Daily mean flows were commonly the lowest since the 1995/96 drought and new absolute minimum flows were established for a few rivers (e.g. in the Tweed basin). Abstraction restrictions and other flow support measures were activated to mitigate low flows but, more generally, the benefit of baseflows to lowland rivers was underlined in many spring-fed rivers where flows remained in the normal range, albeit below average. August runoff totals were particularly depressed across much of northern Britain – the Deveron registered its 2nd lowest August flow in 42-year record – and very low also in some impermeable southern catchments, but generally well above drought minima. This is broadly true for the summer runoff totals also but the Spey, Dee and Whiteadder were among those rivers establishing new minimum June-Aug totals. Many recent droughts (including 1995, 1984 and 1976) have seen significant flow recoveries in the early autumn. Given the current parched condition of the catchments a repetition this year is unlikely. In the absence of exceptional late September rainfall, notably low flows may become very widespread over the coming weeks.

Groundwater

Soil Moisture Deficits in late August were exceptionally high – commonly 30-40 mm above the average for the end of summer (and unprecedented in a few areas – e.g. in eastern Scotland). As usual, many of the highest late summer deficiencies coincided with the outcrop areas of the major aquifers. Correspondingly, the summer groundwater level recessions continued leaving levels particularly depressed in parts of the southern Chalk – at Compton (in the South Downs) lower August levels have only been recorded during the 1976 drought – in a series extending back to 1894. Levels are also low in NI but throughout the greater part of the Chalk outcrop they are within the normal late summer range. Levels in the limestone aquifers are also within the normal range but considerably below average whilst levels remain healthy throughout the Permo-Triassic sandstones outcrops (note: Redbank is affected by groundwater abstraction). But given current smds – the equivalent of >12 weeks residual rainfall in some eastern areas - further declines are inevitable; even average rainfall would not generate significant recoveries before the early winter in many eastern outcrops.

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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Area	Rainfall	Aug 2003	Jun 03-Aug 03	RP	Feb 03-Aug 03	RP	Sep 02-Aug 03	RP	Sep 01-Aug 03	RP
England & Wales	**mm**	**21**	**170**		**359**		**959**		**1895**	
	%	**27**	**83**	**2-5**	**77**	**10-20**	**105**	**2-5**	**104**	**2-5**
North West	mm	20	181		473		1079		2451	
	%	18	66	5-15	80	5-10	90	2-5	102	2-5
Northumbrian	mm	15	131		299		764		1705	
	%	19	64	10-20	66	30-45	90	2-5	100	<2
Severn Trent	mm	16	140		308		740		1500	
	%	23	78	2-5	76	5-15	98	2-5	99	2-5
Yorkshire	mm	23	166		350		821		1701	
	%	31	86	2-5	80	5-10	100	<2	104	2-5
Anglian	mm	7	140		257		651		1289	
	%	13	90	2-5	77	5-15	109	2-5	108	2-5
Thames	mm	11	110		243		714		1451	
	%	20	68	5-10	66	20-30	104	2-5	105	2-5
Southern	mm	20	113		251		803		1605	
	%	36	71	5-10	65	20-35	103	2-5	103	2-5
Wessex	mm	16	141		311		901		1721	
	%	24	81	2-5	73	5-15	108	2-5	103	2-5
South West	mm	26	207		471		1164		2280	
	%	30	93	2-5	84	2-5	99	2-5	97	2-5
Welsh	mm	26	204		521		1276		2642	
	%	26	79	2-5	84	5-10	97	2-5	101	2-5
Scotland	**mm**	**44**	**199**		**537**		**1150**		**2860**	
	%	**37**	**67**	**15-25**	**78**	**10-20**	**80**	**30-40**	**100**	**<2**
Highland	mm	63	228		649		1249		3198	
	%	50	69	10-20	81	5-15	71	150-250	91	5-10
North East	mm	29	108		325		927		2030	
	%	34	48	80-120	65	70-100	95	2-5	104	2-5
Tay	mm	26	163		462		1083		2611	
	%	28	67	5-15	78	5-15	88	5-10	106	2-5
Forth	mm	26	167		412		952		2264	
	%	27	70	5-10	76	10-20	86	5-10	102	2-5
Tweed	mm	14	133		350		879		1979	
	%	16	59	20-30	70	20-35	91	2-5	102	2-5
Solway	mm	26	208		551		1293		2955	
	%	22	71	5-10	82	5-10	91	2-5	104	2-5
Clyde	mm	51	265		659		1342		3287	
	%	38	79	5-10	85	5-10	79	20-35	97	2-5
Northern Ireland	**mm**	**21**	**193**		**479**		**1063**		**2245**	
	%	**23**	**84**	**2-5**	**90**	**2-5**	**100**	**<2**	**106**	**2-5**

RP = Return period

 All monthly totals since December 1998 are provisional (see page 12). The figures for England & Wales are derived by the Hadley Centre and are updates of the homogenised series developed by the Climate Research Unit; the other national figures are derived from different raingauge networks to those used to derive the CRU data series. The return period estimates are based on tables provided by the Meteorological 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 . .

Key

00% Percentage of 1961-90 average

Very wet

Substantially above average

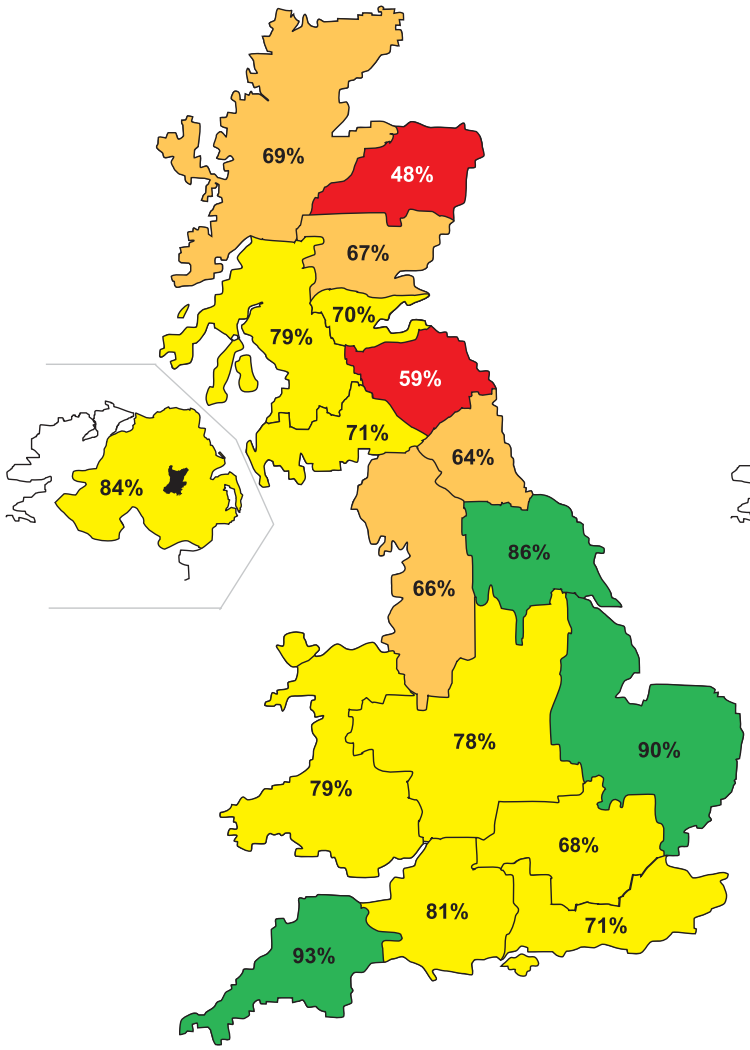
Above average

Normal range

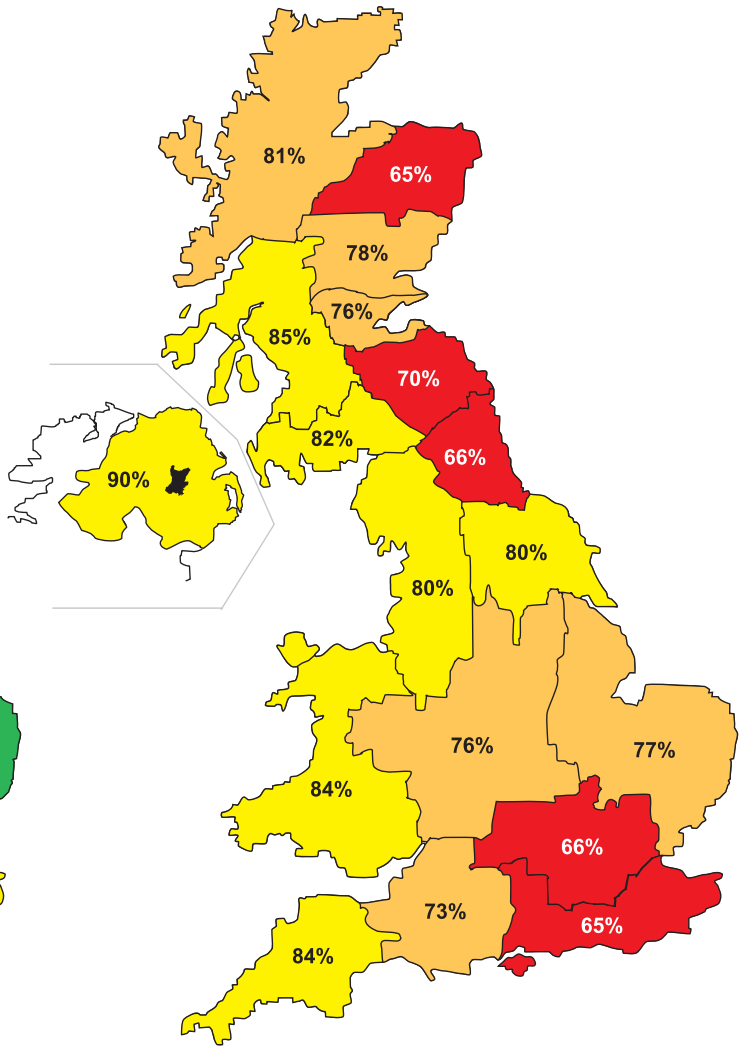
Below average

Substantially below average

Exceptionally low rainfall



June 2003 - August 2003

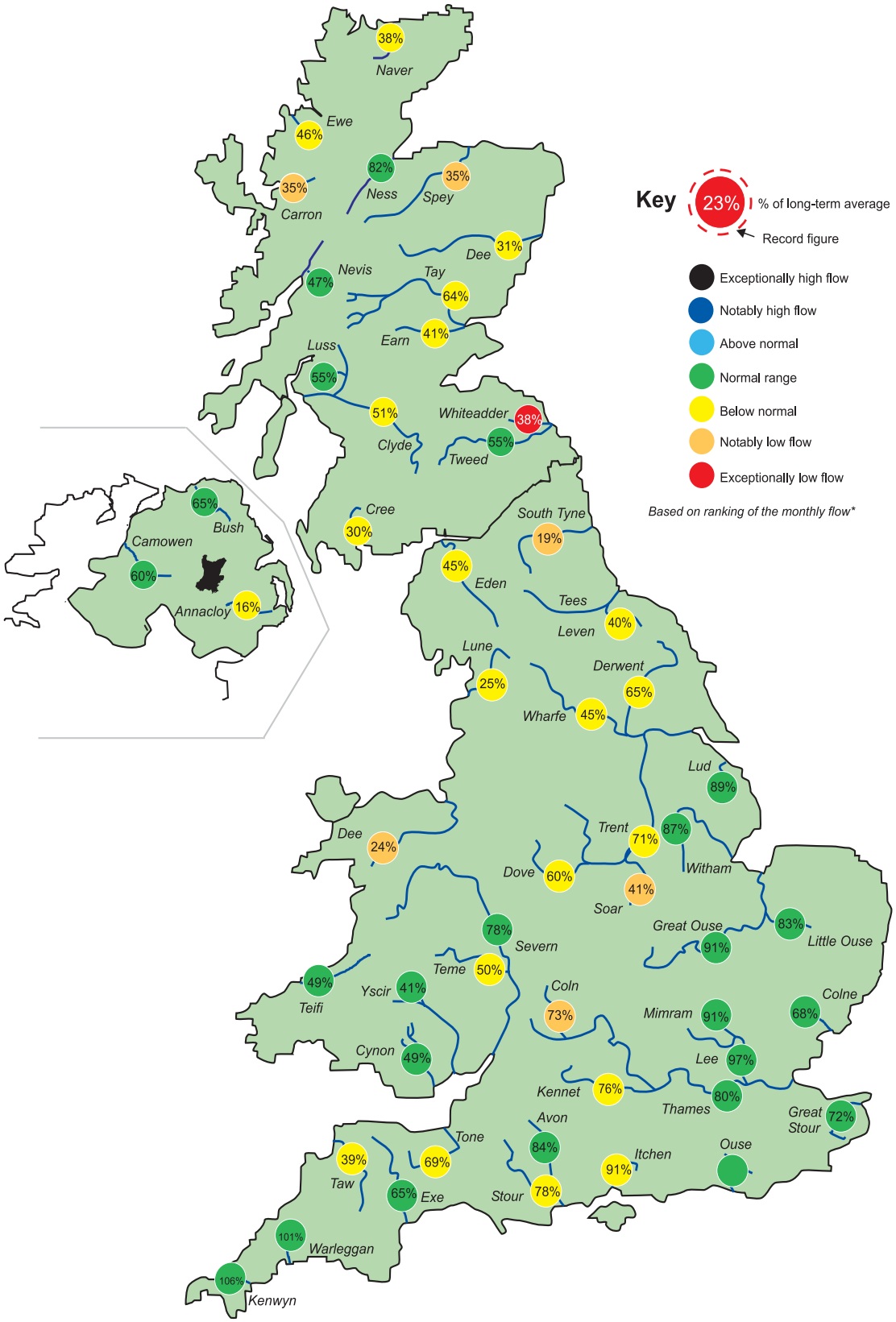


February 2003 - August 2003

Rainfall accumulation maps

Summer (June-August) rainfall totals were well below average in most regions, and particularly in north-eastern Scotland which had its second driest summer (after 1976) in at least 40 years. In the 7-month timeframe the regional rainfall deficiencies are generally more exceptional with notable droughts established across much of north-eastern and south-eastern Britain.

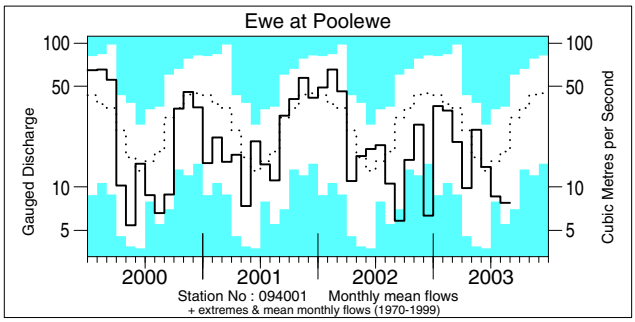
River flow . . . River flow . . .

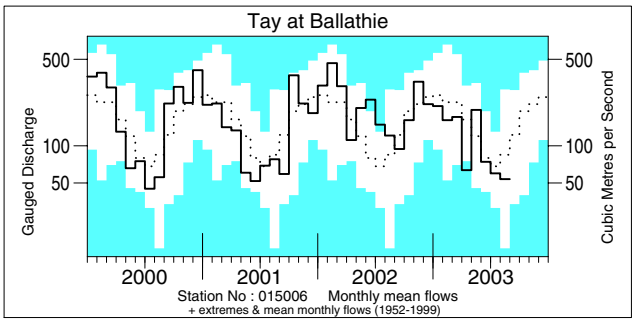


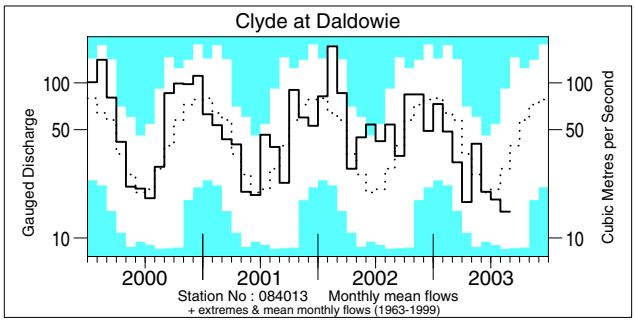
River flows - August 2003

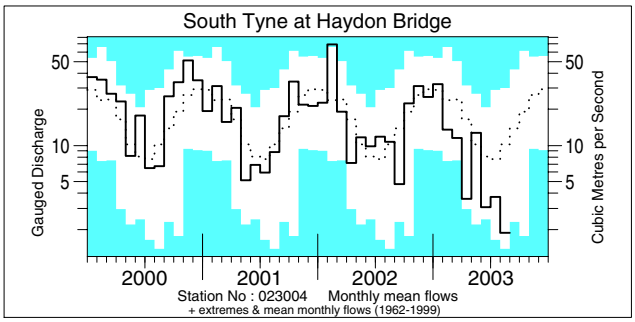
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

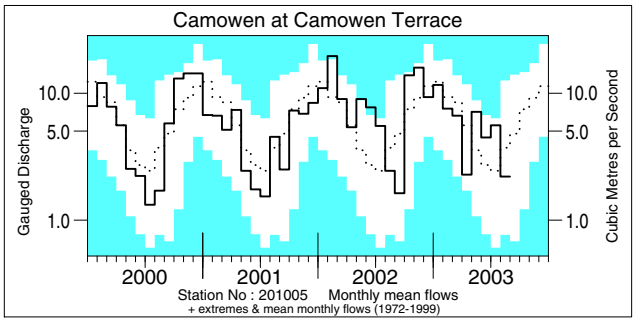
River flow . . . River flow . . .

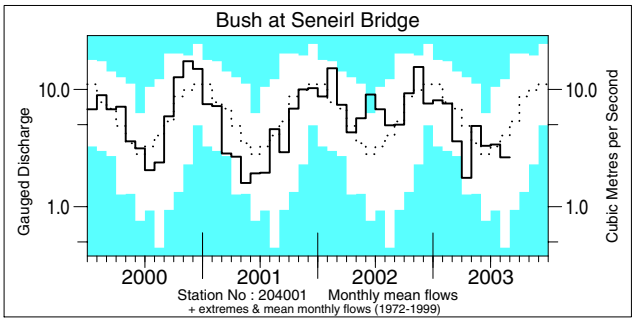


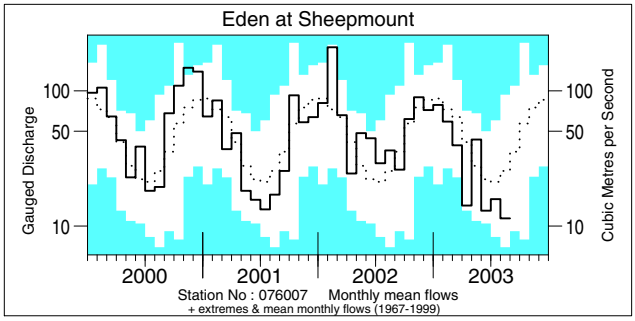


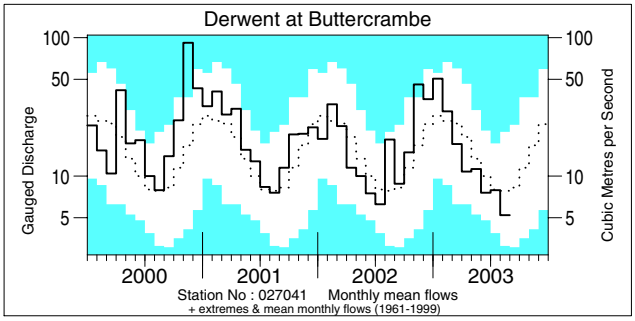


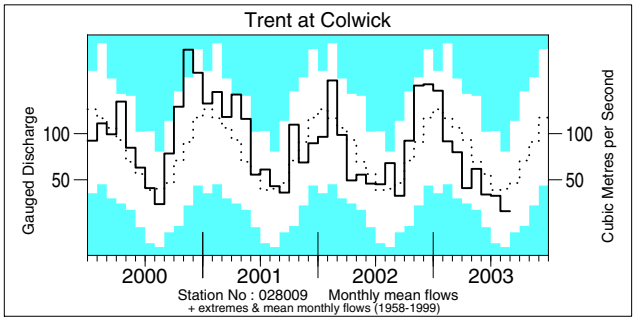


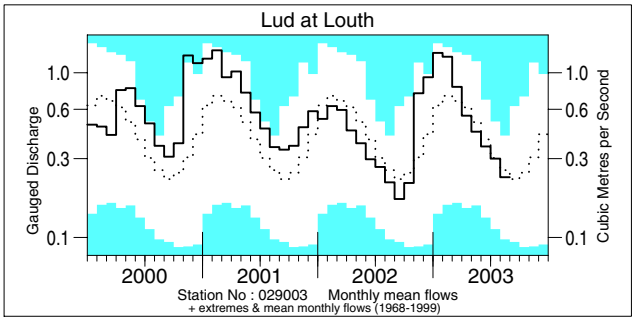








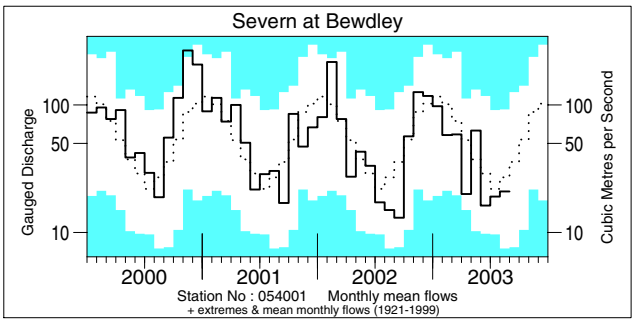


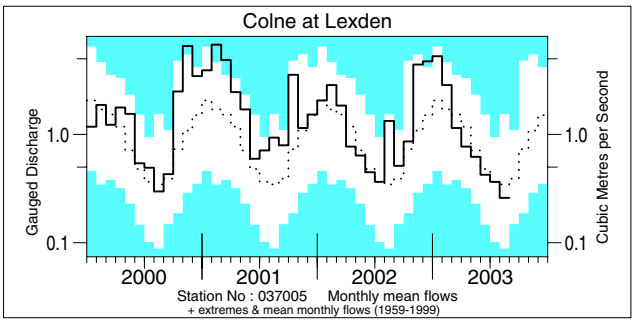


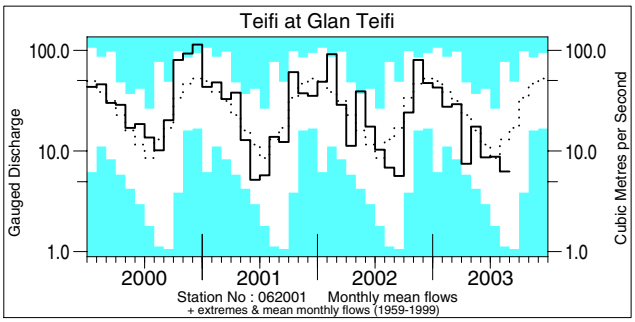
Monthly river flow hydrographs

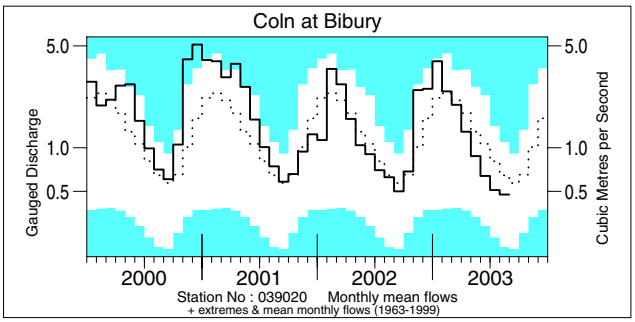
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 2000 (shown by the shaded areas). Monthly flows falling outside the maximum/ minimum range are indicated where the bold trace enters the shaded areas.

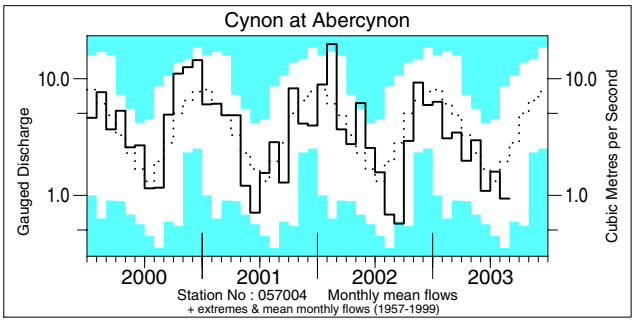
River flow . . . River flow . . .

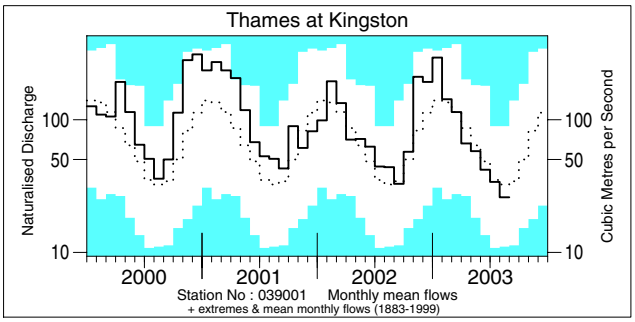


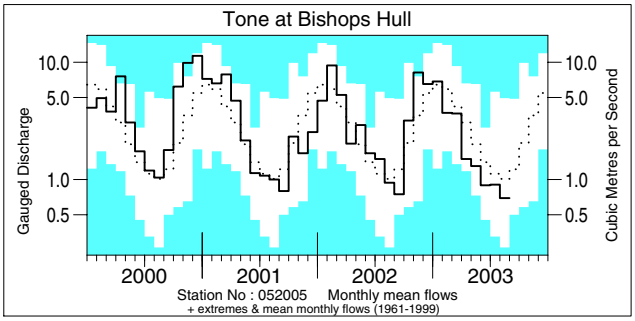


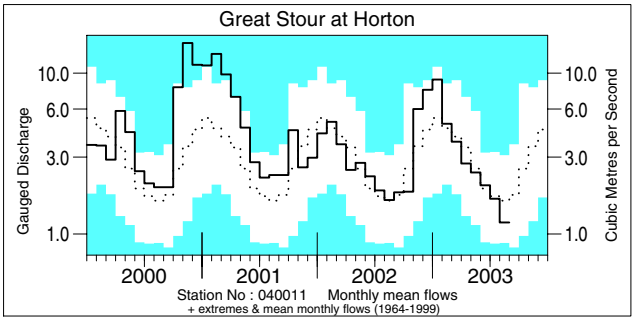


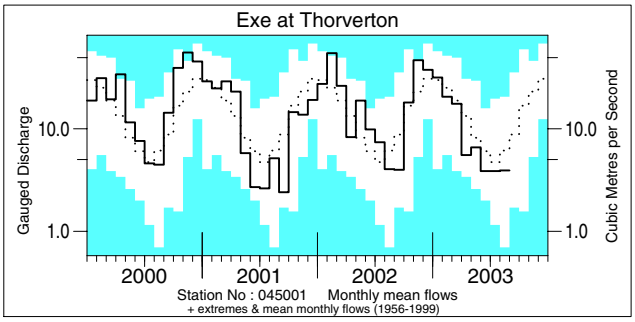


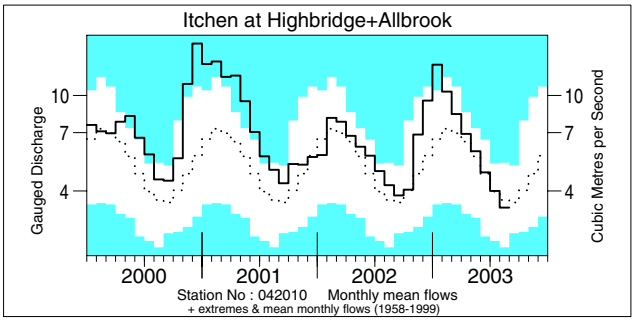












Notable runoff accumulations (a) August 2003, (b) June 2003 - August 2003, (c) February 2003 - August 2003

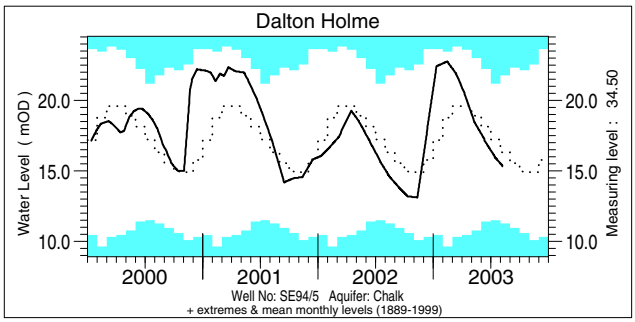
	River	%lta	Rank
a)	Deveron	31	2/42
	Don *(Grampian)*	42	2/35
	Tyne	34	5/38
	Whiteadder	38	2/34
	Soar	41	3/33
	Dee (New Inn)	24	5/35
	Annacloy	16	6/24

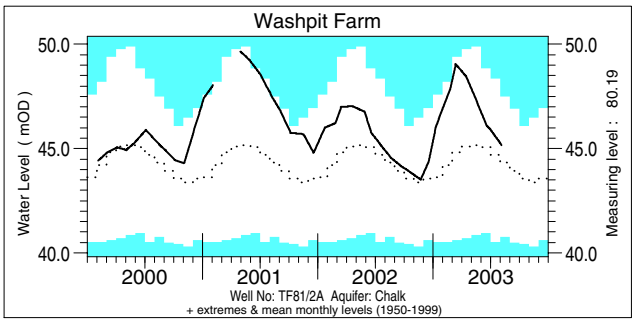
	River	%lta	Rank
b)	Spey (Boat o' Brig)	43	1/51
	Don *(Grampian)*	49	1/34
	Dee (Park)	42	1/31
	Whiteadder	47	1/34
	Coln	65	4/40
	Eden	58	6/36
	Ewe	67	6/33

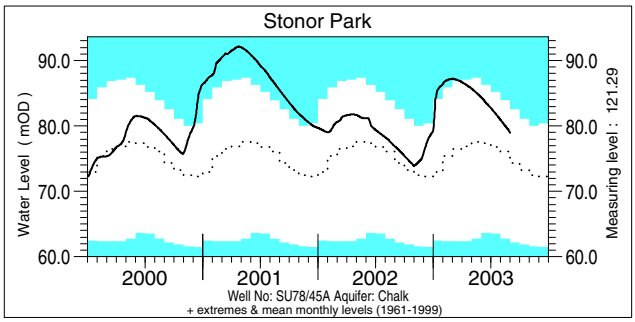
	River	%lta	Rank
c)	Ness	61	2/31
	S Tyne	50	1/40
	Taw	57	3/45
	Teme	62	4/33
	Luss	72	2/25
	Carron	52	1/25
	Naver	65	2/26

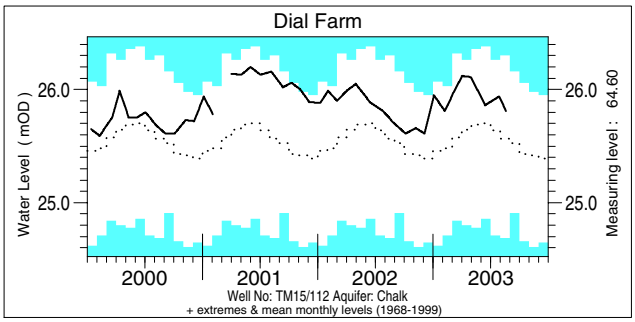
lta = long term average
Rank 1 = lowest on record

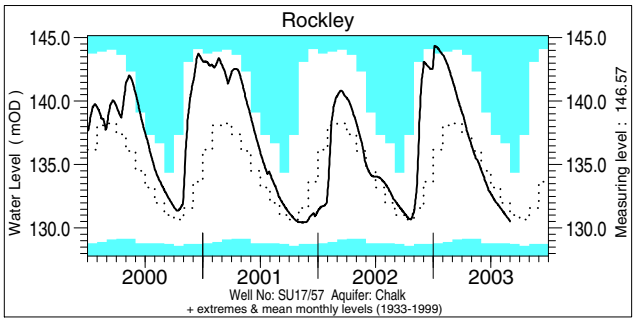
Groundwater . . . Groundwater

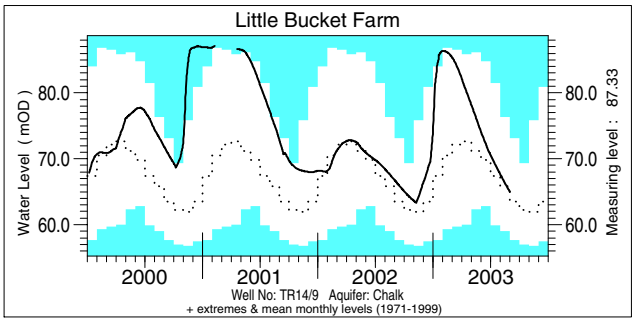


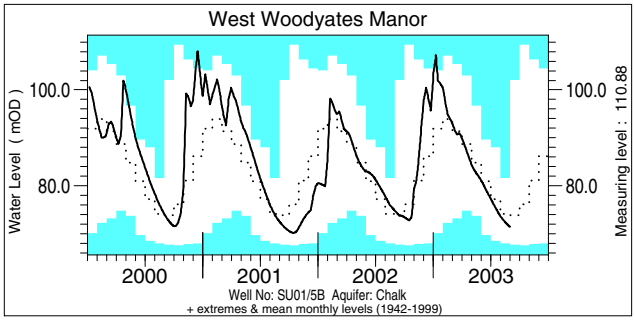


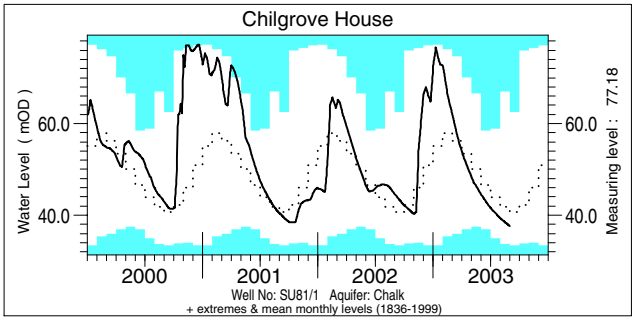


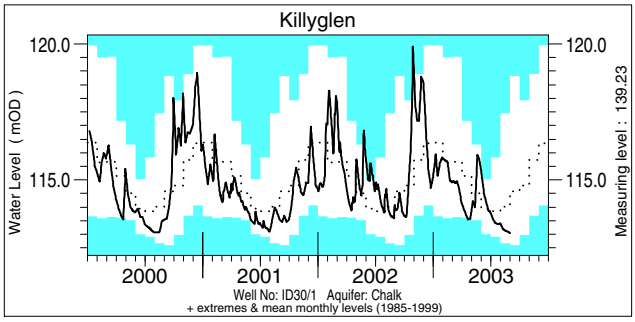


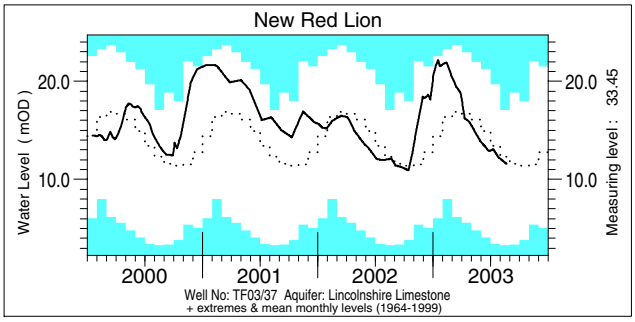






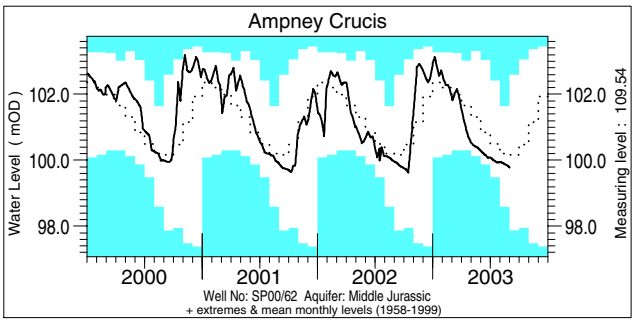


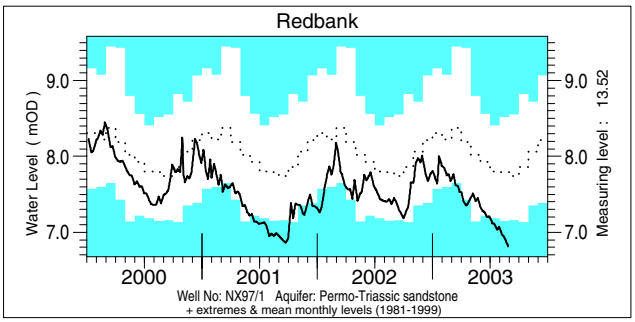


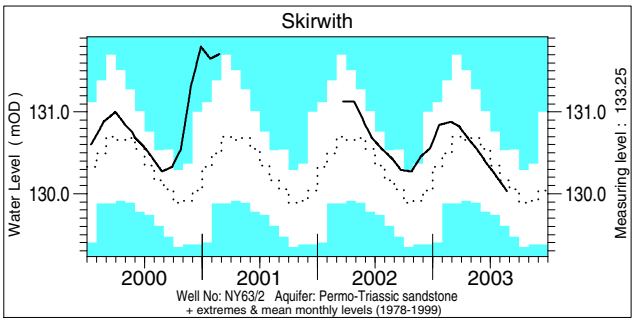


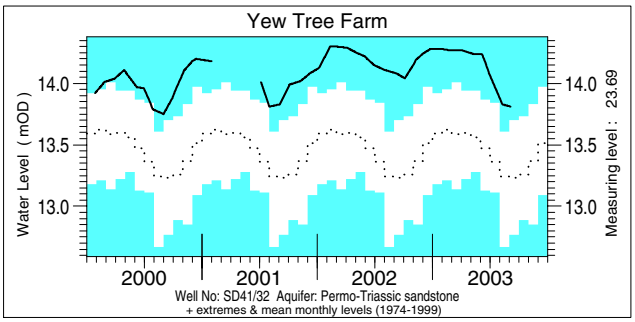
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

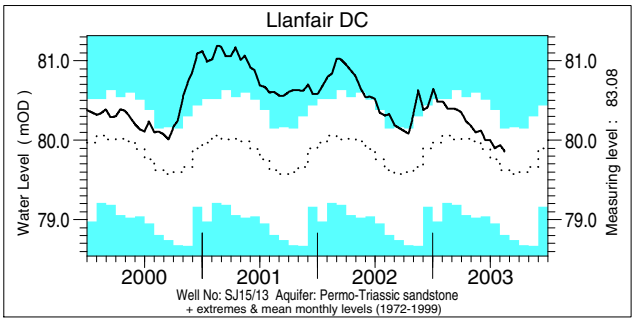
Groundwater . . . Groundwater

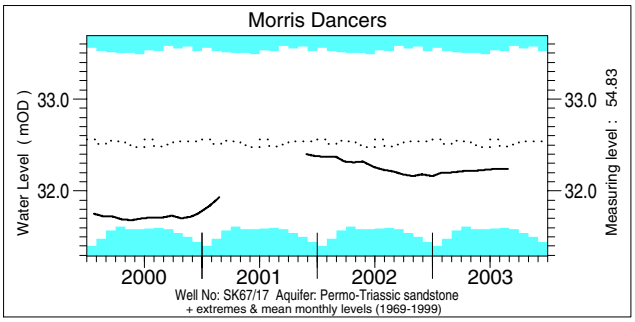


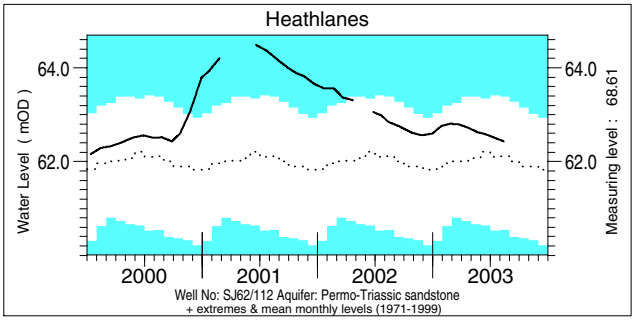


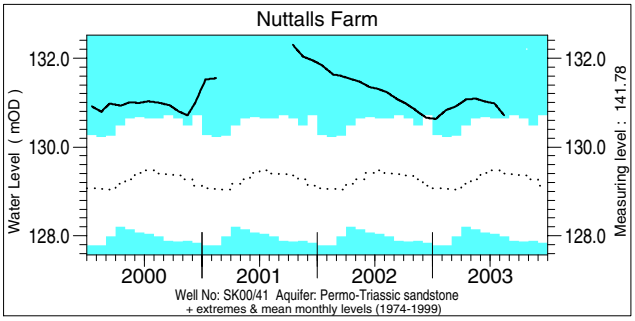


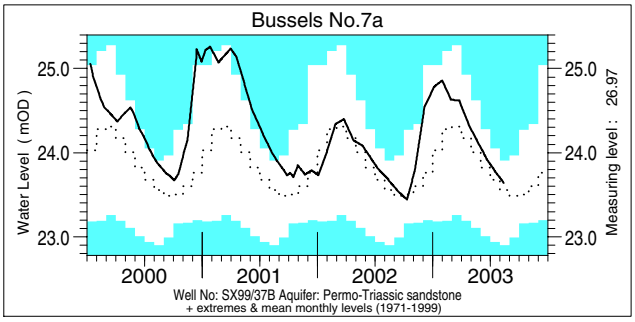


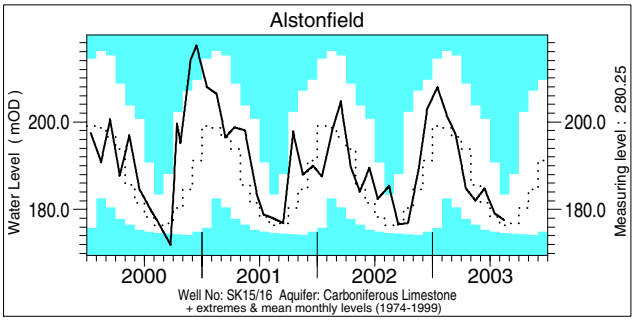










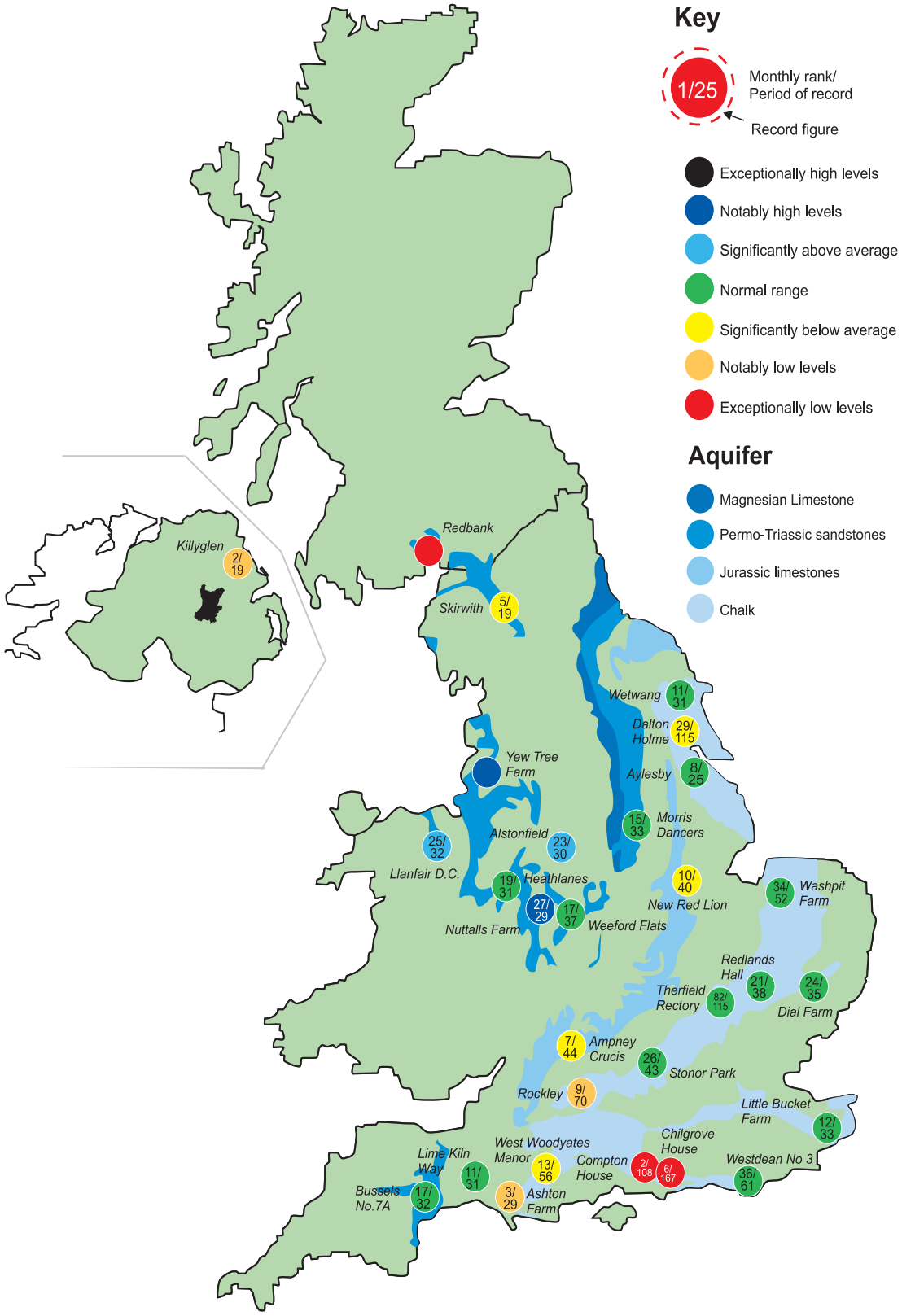


Groundwater levels August 2003 / September 2003

Borehole	Level	Date	Aug. av.	Borehole	Level	Date	Aug. av.	Borehole	Level	Date	Aug. av.
Dalton Holme	15.34	07/08	16.25	Chilgrove House	37.58	31/08	41.76	Llanfair DC	79.86	15/08	79.61
Washpit Farm	45.17	04/08	44.46	Killyglen	113.05	31/08	113.87	Morris Dancers	32.24	26/08	32.38
Stonor Park	78.95	01/09	76.24	New Red Lion	11.57	20/08	12.39	Heathlanes	62.43	13/08	62.16
Dial Farm	25.81	18/08	25.58	Ampney Crucis	99.78	01/09	100.17	Nuttalls Farm	130.71	14/08	129.60
Rockley	130.54	01/09	132.03	Redbank	6.81	27/08	7.70	Bussels No.7a	23.64	12/08	23.60
Little Bucket Farm	64.93	31/08	67.13	Skirwith	130.03	22/08	130.18	Alstonfield	177.53	15/08	177.15
West Woodyates	71.41	31/08	73.99	Yew Tree Farm	13.81	05/09	13.33				

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater

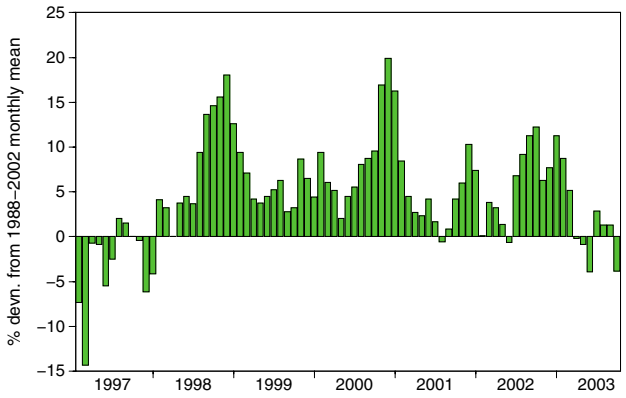


Groundwater levels - August 2003

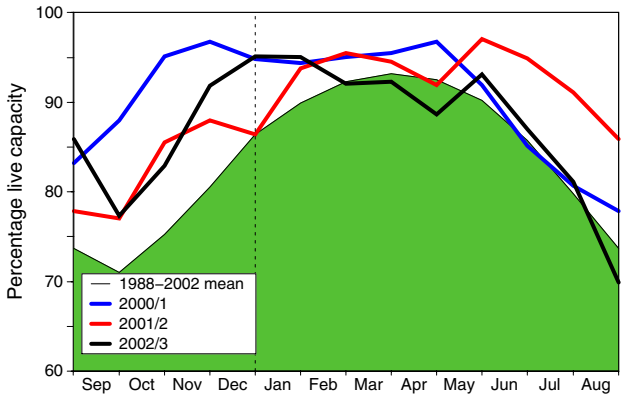
The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods of record. Rankings may be omitted where they are considered misleading.

(Note: Redbank is affected by groundwater abstraction.)

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.

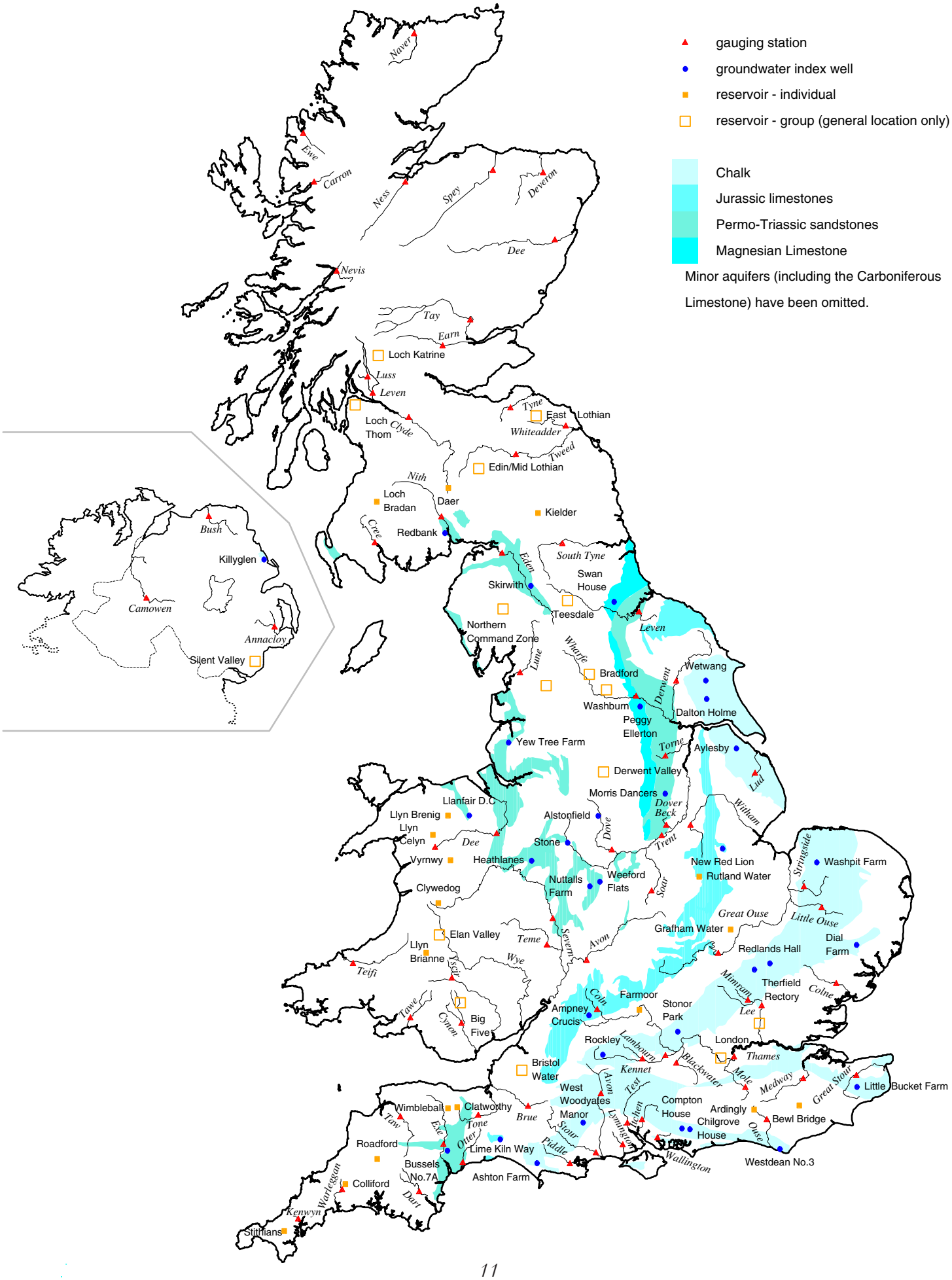
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2003 Apr	May	Jun	Jul	Aug	Sep	Min. Sep	Year* of min.
North West	N Command Zone	• 124929	88	74	85	69	62	**45**	24	1995
	Vyrnwy	55146	94	90	97	87	82	**70**	36	1995
Northumbrian	Teesdale	• 87936	77	74	75	72	60	**48**	38	1995
	Kielder	(199175)	(90)	(92)	(97)	(91)	(86)	**(81)**	(66)	1989
Severn Trent	Clywedog	44922	96	97	99	97	95	**82**	38	1989
	Derwent Valley	• 39525	96	86	94	80	80	**62**	34	1995
Yorkshire	Washburn	• 22035	90	78	90	82	79	**69**	34	1995
	Bradford supply	• 41407	94	85	95	82	74	**58**	21	1995
Anglian	Grafham	(55490)	(91)	(94)	(97)	(95)	(89)	**(79)**	(59)	1997
	Rutland	(116580)	(93)	(95)	(94)	(91)	(87)	**(79)**	(66)	1995
Thames	London	• 202340	94	94	94	93	87	**71**	62	1995
	Farmoor	• 13830	93	94	91	95	89	**71**	64	1995
Southern	Bewl	28170	92	90	86	79	71	**62**	38	1990
	Ardingly	4685	100	100	100	92	77	**53**	47	1996
Wessex	Clatworthy	5364	99	86	79	65	55	**43**	31	1995
	Bristol WW	• (38666)	(96)	(91)	(88)	(79)	(79)	**(79)**	(43)	1990
South West	Colliford	28540	83	81	81	79	76	**71**	43	1997
	Roadford	34500	91	87	83	79	75	**71**	40	1995
	Wimbleball	21320	98	92	86	77	68	**57**	40	1995
	Stithians	5205	96	89	86	81	76	**68**	30	1990
Welsh	Celyn and Brenig	• 131155	98	94	100	98	93	**84**	49	1989
	Brianne	62140	95	88	100	94	95	**85**	55	1995
	Big Five	• 69762	95	86	96	87	79	**64**	29	1995
	Elan Valley	• 99106	96	87	99	89	76	**62**	46	1995
Scotland(E)	Edinburgh/Mid Lothian	• 97639	94	87	92	84	76	**67**	45	1998
	East Lothian	• 10206	96	95	91	82	75	**67**	63	1989
Scotland(W)	Loch Katrine	• 111363	89	87	88	84	77	**66**	50	2000
	Daer	22412	97	89	98	70	74	**66**	41	1995
	Loch Thom	• 11840	94	88	95	85	85	**77**	58	1997
Northern Ireland	Total+	•	94	80	93	89	84	**77**	35	1995
	Silent Valley	• 20634	93	79	95	92	86	**78**	33	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 1988-2003 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 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. An initiative is underway with The Met Office to provide more accurate areal figures and, since October 1999, to include more raingauges in the analysis. A significant number of additional monthly rainfall totals are currently being provided by the Environment Agencies. 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 Meteorological 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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