Hydrological summary
for the United Kingdom

September 2001

General

September was a cloudy and cool month with rainfall again favouring eastern regions of the UK; many western catchments were notably dry. Correspondingly some reservoir stocks (e.g. Stithians in the South-West) showed a significant decline through the month but overall stocks for England and Wales remain around 10% above the early autumn average. Similarly, groundwater levels are above average throughout most major aquifers, and exceptionally high in some areas. Away from the English Lowlands, river flows were generally modest, but mostly within the normal range. However, substantial rainfall over the last fortnight has triggered brisk recoveries in the west. A repeat of the momentous rainfall of last autumn is statistically very improbable, but as soil moisture deficits are satisfied so the flood risk – from both rivers and rising water-tables – will increase. Vigilance will be required even with average rainfall through the autumn.

Rainfall

Despite a damp autumnal complexion to the weather, rainfall over the first three weeks of September was below average in most regions – the South-West especially, Penzance reported less than 5 mm up the 23rd, and water was shipped to Lundy to replenish stocks. Weather patterns became more unsettled thereafter as vigorous frontal systems crossed the UK. On the 25th a remarkably intense thunderstorm produced a 65 mm fall in just over an hour at Oulton (Norfolk); significant local flooding ensued (some due to the melting of massive hail drifts). More widespread frontal rainfall on the 30th – including 52.5 mm in 24 hours at Vyrnwy in North Wales - heralded a very wet interlude extending well into October. September rainfall exceeded the 1961-90 average across a broad swathe of eastern England; a few areas (e.g. in Lincolnshire) reporting more than twice the September average. To the west and north, percentage rainfall totals declined with large parts of the South-West and Northern Ireland recording less than 50% of average. Provisional data suggest that for both Scotland and Northern Ireland the September rainfall total was amongst the five lowest since 1972, and substantial rainfall deficiencies have developed across western regions of the UK. The May-Sept rainfall total in the South-West is similar to that recorded during the 1989 drought and, for Northern Ireland, the Jan-Sept total is the third lowest in a series from 1900. By contrast, large parts of eastern and southern England have registered their wettest Jan-Sept period for over 25 years, and the water-year (Oct-Sept) rainfall total for England and Wales is the highest since 1876/77.

River Flows

In most catchments, September saw a continuation of the summer recessions until late in the month. Localised flooding followed thunderstorms in the east and runoff rates picked-up more generally around month-end (in rivers draining from the Pennines particularly); continuing spate conditions triggered flood alerts in early October. September runoff totals were considerably below average in most western and northern catchments (including the Annacloy, Taw and Warleggan, the latter registering its lowest September mean flow in a record from 1969) but high groundwater contributions combined - in some areas - with significant surface runoff, produced well above average runoff in many eastern rivers. The Mimram, which has a 49-year flow record, established a new maximum monthly runoff for the 8th successive month. Accumulated runoff totals remain exceptionally high over most of southern Britain - initial analyses suggest that around 70% of gauging stations in England & Wales have established new maximum water-year (Oct-Sept) runoff totals. Some existing maxima have been eclipsed by wide margins – around 25% for the Thames in a record from 1883.

Groundwater

Soil moisture deficits continued to increase in early September, but declined steeply from around the 23rd and, at month-end, were below average in large parts of eastern England. Some localised infiltration, mostly associated with thunderstorms, was reported but overall recharge was minimal and most water-tables continued a gentle seasonal decline. Nonetheless, away from the south-western and north-eastern extremities of the outcrop, levels in the Chalk remain close to, or above, early autumn maxima. This is also true of some limestone aquifers (e.g. the Magnesian Limestone). Whilst levels in most Permo-Triassic sandstones fell during September, over wide areas they also remain amongst the highest on record for September. Given average October rainfall, significant infiltration should begin in around 4-6 weeks. Largely as a consequence of the remarkable recharge over the winter of 2000/01, the seasonal recovery in groundwater levels is likely to begin from notably high levels in many aquifer units – commonly higher than in 2000 in eastern areas. If the late autumn and winter is moderately wet, there will be a continuing risk of sustained groundwater flooding (e.g. in the Chilterns and South Downs).

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
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Rainfall . . . Rainfall . . . Rainfall. .

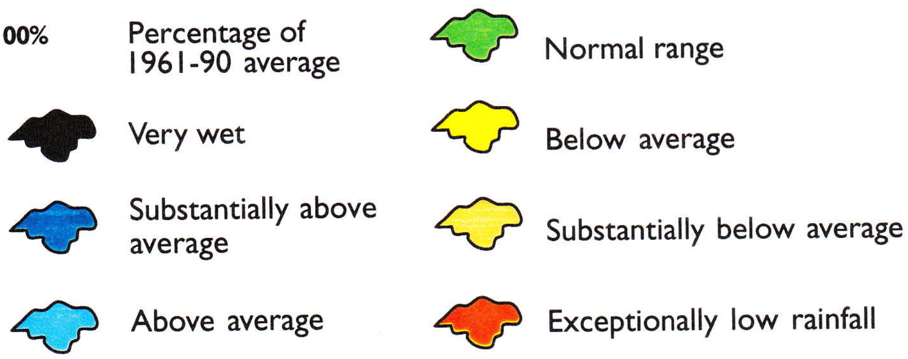
Rainfall accumulations and return period estimates

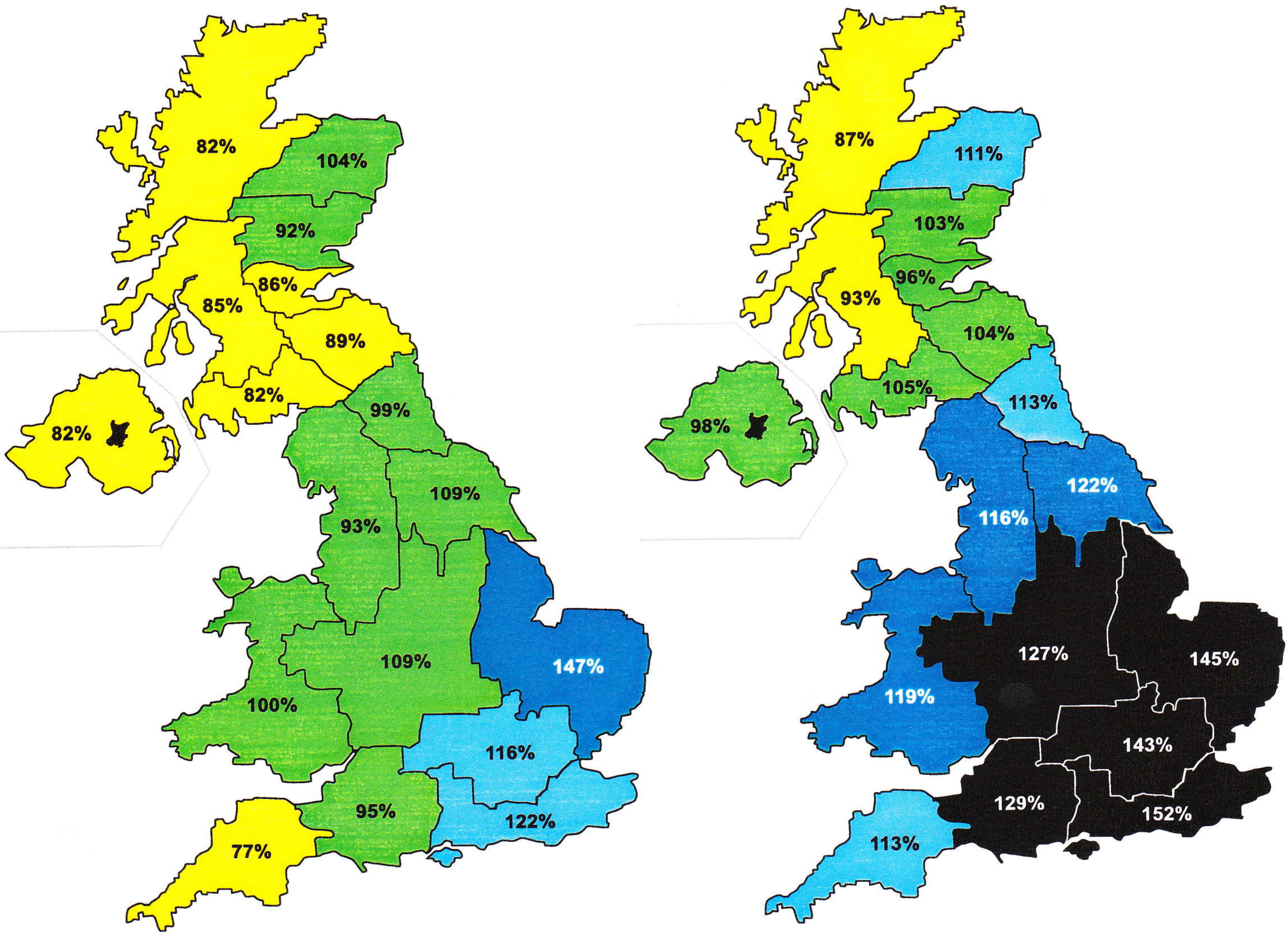
Area	Rainfall	Sep 2001	Jul01-Sep01	RP	Apr01-Sep01	RP	Jan01-Sep01	RP	Oct00-Sep01	RP
England	**mm**	**78**	**231**		**416**		**708**		**1215**	
& Wales	**%**	**100**	**106**	**2-5**	**102**	**2-5**	**111**	**2-5**	**133**	**80-120**
North West	mm	123	286		511		753		1395	
	%	107	93	2-5	96	2-5	91	2-5	116	5-10
Northumbrian	mm	91	218		379		578		965	
	%	124	99	2-5	95	2-5	95	2-5	113	5-10
Severn Trent	mm	60	201		388		574		961	
	%	94	109	2-5	109	2-5	106	2-5	127	20-35
Yorkshire	mm	94	219		395		583		998	
	%	139	109	2-5	104	2-5	100	<2	122	10-20
Anglian	mm	81	224		377		574		863	
	%	165	147	10-20	127	5-15	133	30-40	145	>>200
Thames	mm	61	193		343		593		984	
	%	103	116	2-5	105	2-5	121	5-10	143	120-170
Southern	mm	84	212		332		660		1184	
	%	121	122	2-5	99	2-5	124	5-15	152	>>200
Wessex	mm	37	180		319		605		1085	
	%	51	95	2-5	88	2-5	104	2-5	129	20-35
South West	mm	45	189		362		709		1326	
	%	49	77	5-10	79	5-10	89	2-5	113	5-10
Welsh	mm	81	294		532		853		1557	
	%	70	100	<2	100	<2	97	2-5	119	5-15
Scotland	**mm**	**91**	**297**		**496**		**756**		**1334**	
	%	**64**	**84**	**2-5**	**83**	**5-10**	**77**	**30-40**	**93**	**2-5**
Highland	mm	107	332		583		855		1531	
	%	62	82	2-5	85	5-10	74	35-50	87	5-10
North East	mm	82	258		395		637		1082	
	%	94	104	2-5	89	2-5	93	2-5	111	5-10
Tay	mm	70	263		422		738		1269	
	%	61	92	2-5	84	5-10	87	5-10	103	2-5
Forth	mm	62	240		403		642		1069	
	%	57	86	2-5	84	5-10	83	5-10	96	2-5
Tweed	mm	69	223		393		609		1009	
	%	77	89	5-10	89	2-5	88	2-5	104	2-5
Solway	mm	99	288		502		779		1499	
	%	69	82	2-5	84	5-10	80	10-15	105	2-5
Clyde	mm	95	360		592		898		1585	
	%	53	85	2-5	86	2-5	78	10-20	93	2-5
Northern	**mm**	**50**	**209**		**388**		**570**		**1035**	
Ireland	**%**	**51**	**82**	**2-5**	**84**	**2-5**	**77**	**10-20**	**98**	**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 . . . Rainfall





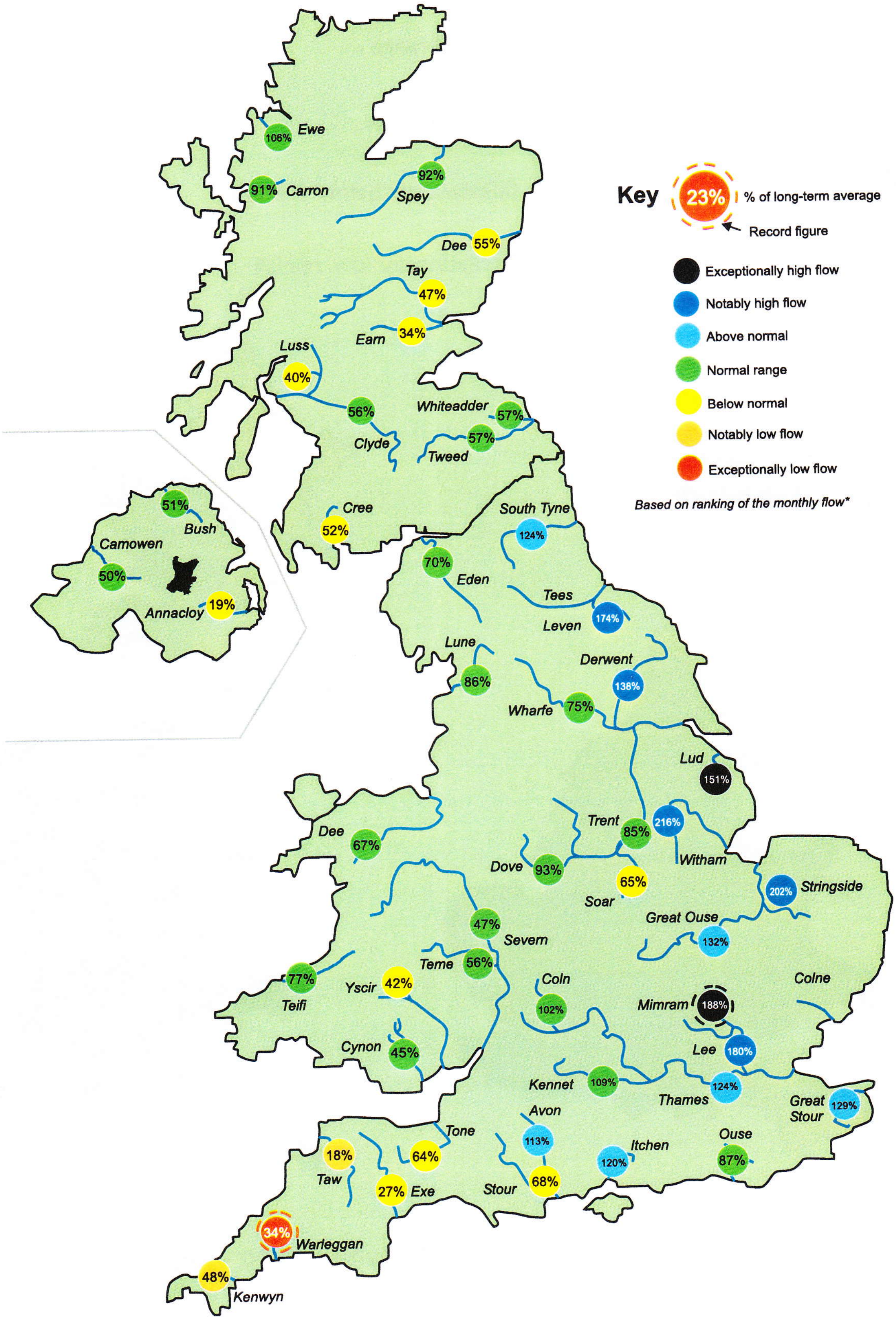
July 2001 -September 2001

October 2000 - September 2001

Rainfall accumulation maps

A sustained moderation in the normal north-west/south-east rainfall gradient across the UK is evident in the 3- and 12-month regional rainfall accumulations. The exceptionally low rainfall in much of western and northern Scotland (across a range of timeframes) together with record longer term rainfall accumulations across much of the English lowlands has contributed to an extension of the range of recorded flows in many river systems.

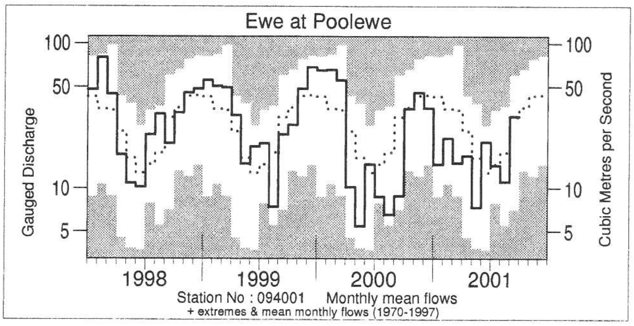
River flow . . . River flow . . .

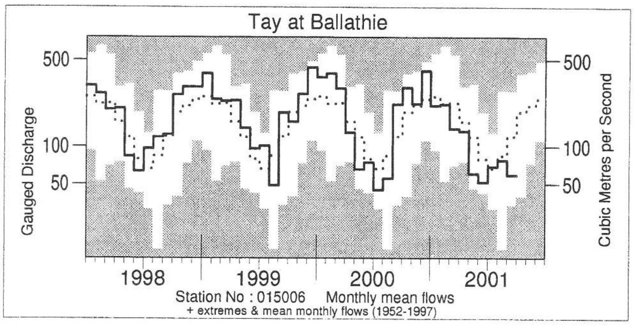


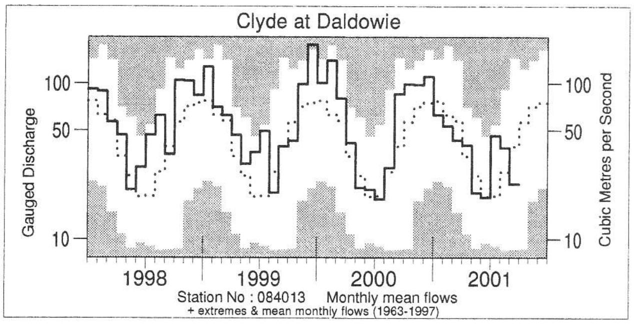
River flows - September 2001

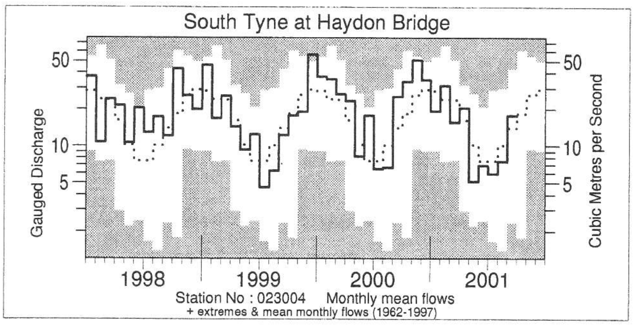
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the period of record on which these percentages are based varies from station to station.

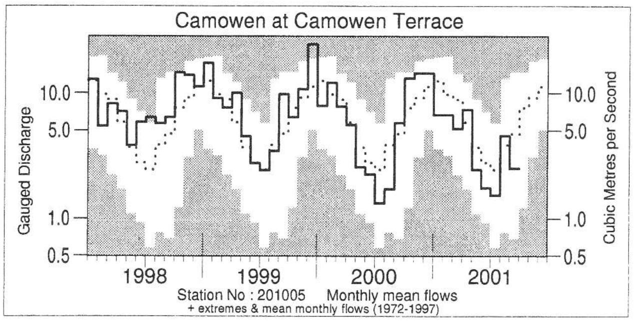
River flow . . . River flow . . .

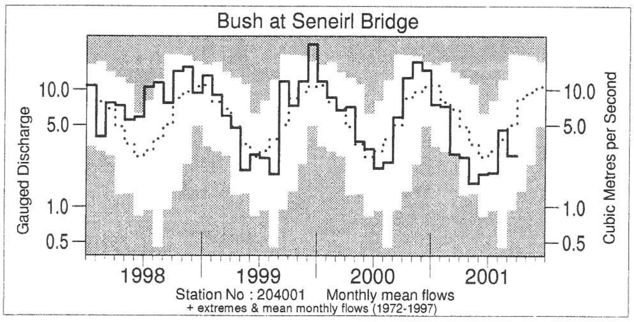


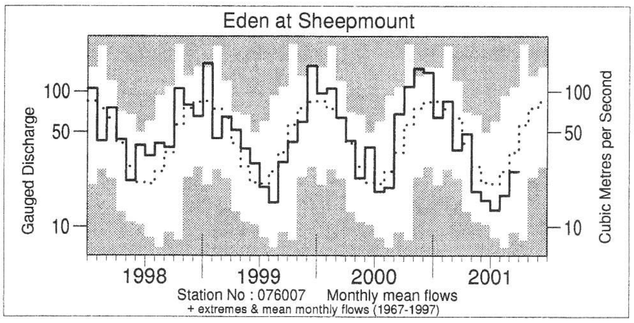


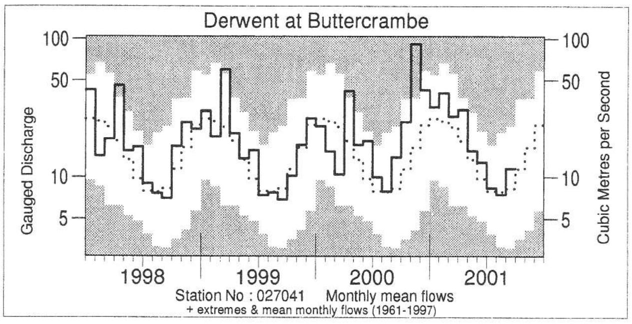


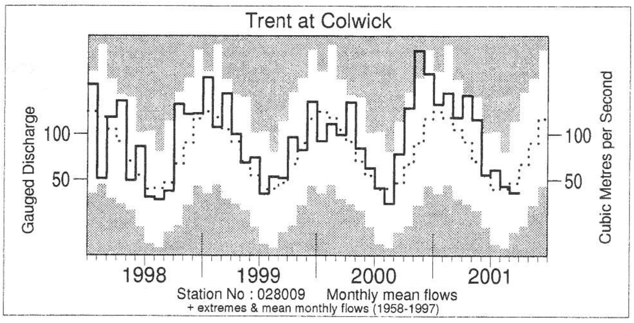


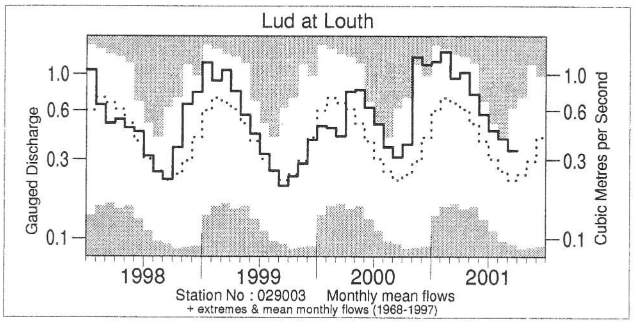










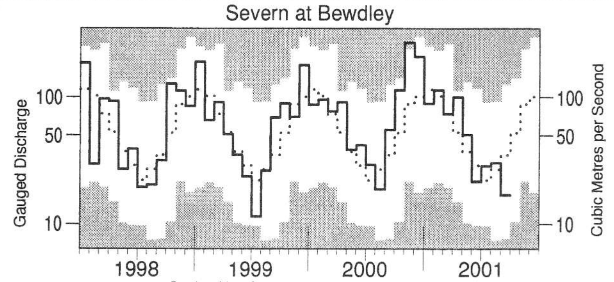


Monthly river flow hydrographs

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 1998 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

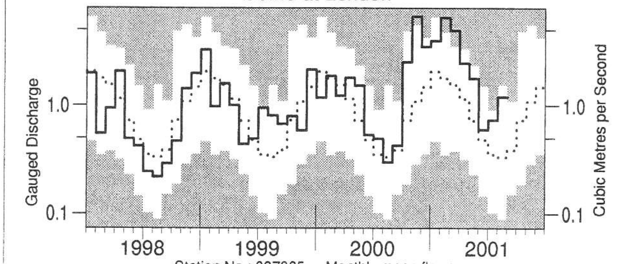
River flow . . . River flow . . .

Severn at Bewdley



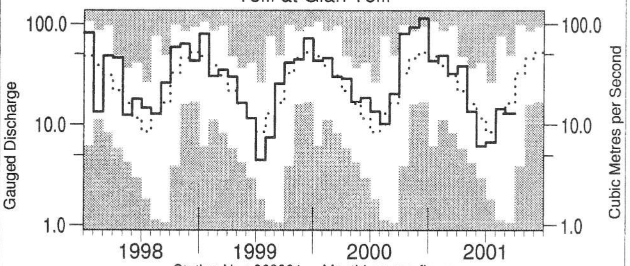
Station No : 054001 Monthly mean flows
+ extremes & mean monthly flows (1921-1997)

Colne at Lexden



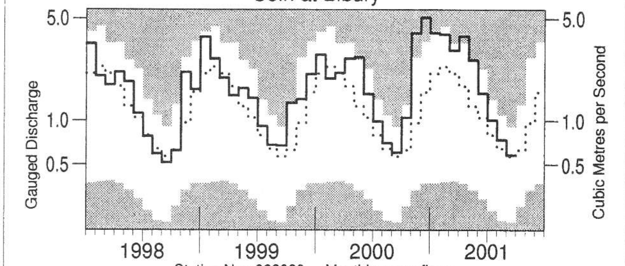
Station No : 037005 Monthly mean flows
+ extremes & mean monthly flows (1959-1997)

Teifi at Glan Teifi



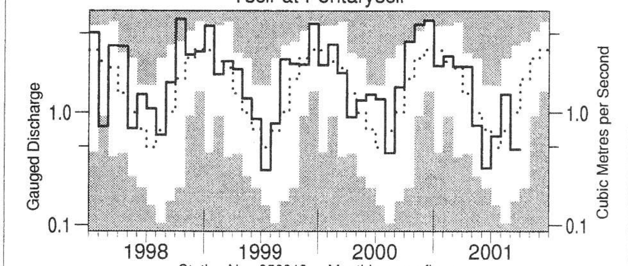
Station No : 062001 Monthly mean flows
+ extremes & mean monthly flows (1959-1997)

Coln at Bibury



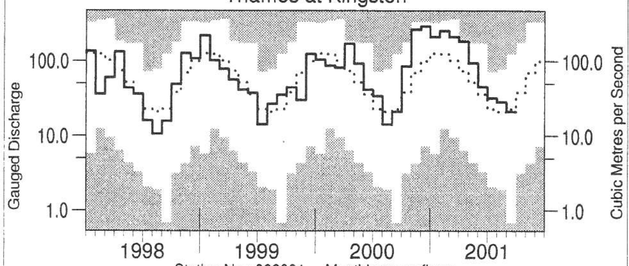
Station No : 039020 Monthly mean flows
+ extremes & mean monthly flows (1963-1997)

Yscir at Pontaryscir



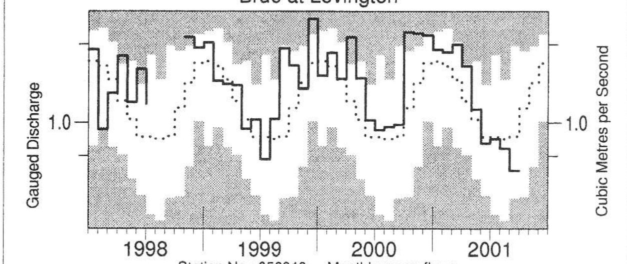
Station No : 056013 Monthly mean flows
+ extremes & mean monthly flows (1972-1997)

Thames at Kingston



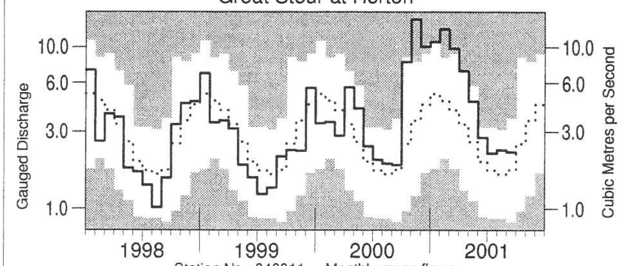
Station No : 039001 Monthly mean flows
+ extremes & mean monthly flows (1883-1997)

Brue at Lovington



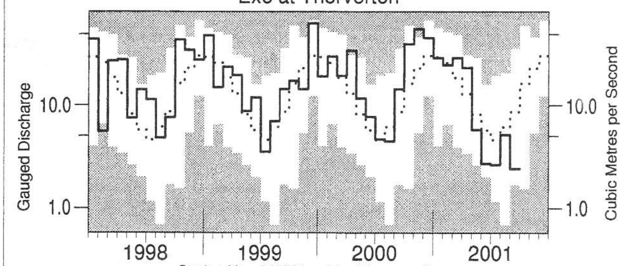
Station No : 052010 Monthly mean flows
+ extremes & mean monthly flows (1964-1997)

Great Stour at Horton



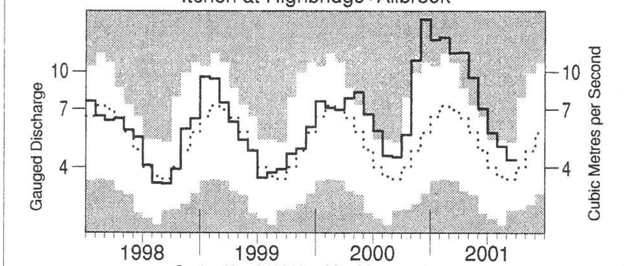
Station No : 040011 Monthly mean flows
+ extremes & mean monthly flows (1964-1997)

Exe at Thorverton



Station No : 045001 Monthly mean flows
+ extremes & mean monthly flows (1956-1997)

Itchen at Highbridge+Allbrook



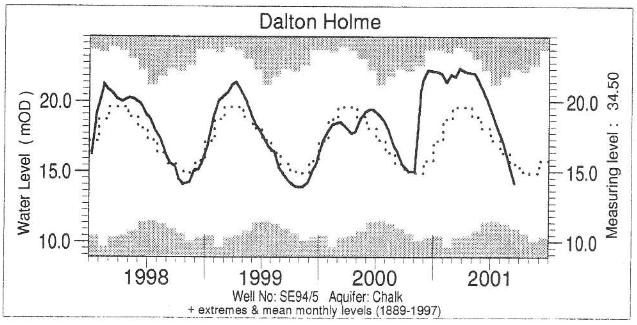
Station No : 042010 Monthly mean flows
+ extremes & mean monthly flows (1958-1997)

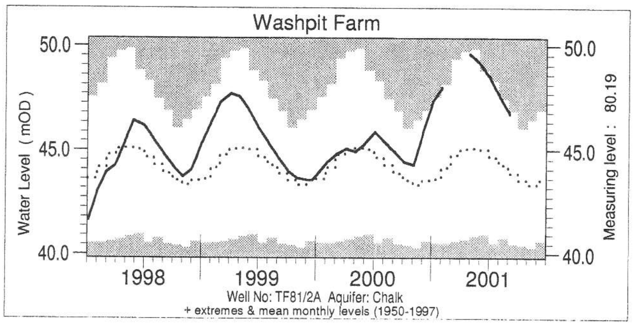
Notable runoff accumulations (a) July 2001 - September 2001, (b) October 2000 - September 2001

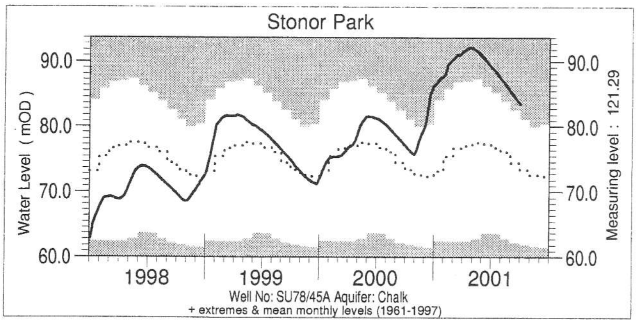
	River	%lta	Rank	River	%lta	Rank	River	%lta	Rank
(a)	Witham	304	43/43	Stringside	202	34/34	Warleggan	146	32/32
	Mimram	194	49/49	Lee	264	115/115	Severn	149	80/80
(b)	York. Leven	177	41/41	Thames	210	118/118	Teifi	145	42/42
	Derwent	174	40/40	Great Stour	224	34/34	Welsh Dee	137	64/64
	Trent	167	43/43	Itchen	179	43/43	Luss	78	1/21
	Bedford Ouse	219	68/68	Hants. Avon	206	36/36	Annacloy	144	21/21

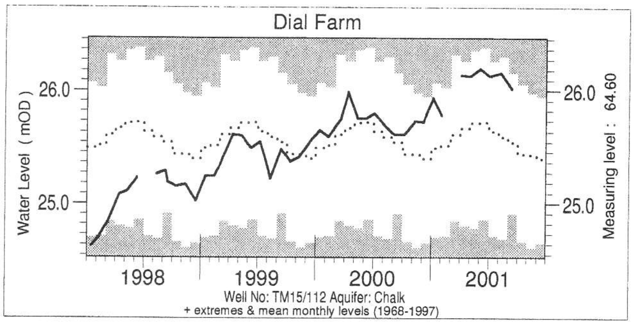
lta = long term average
Rank 1 = lowest on record

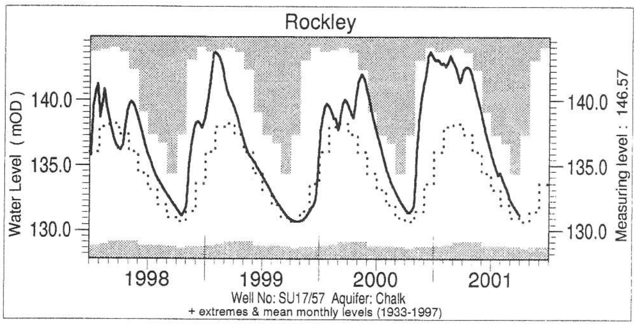
Groundwater . . . Groundwater

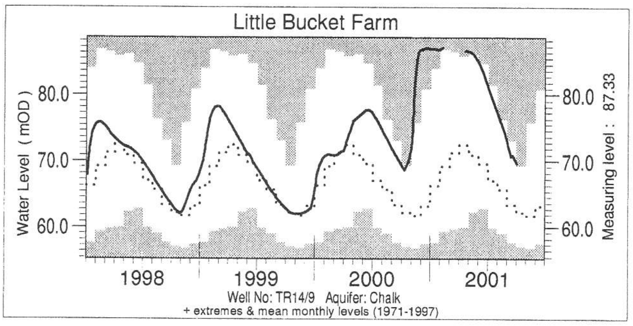


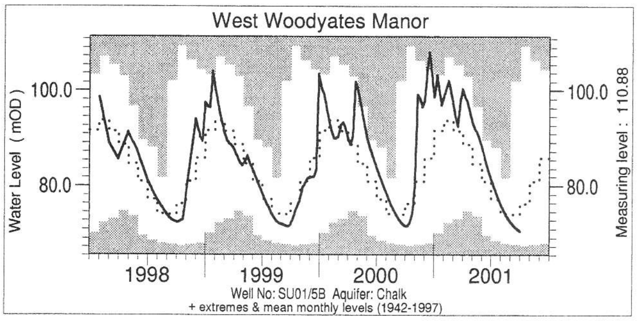


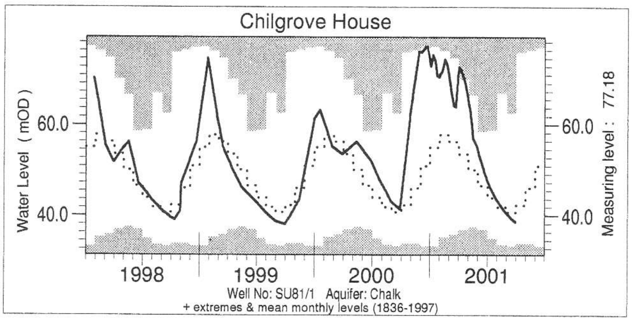


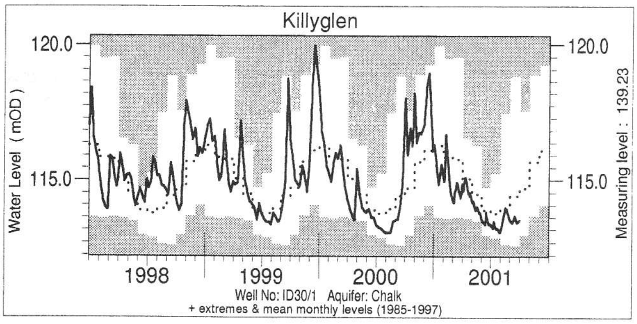


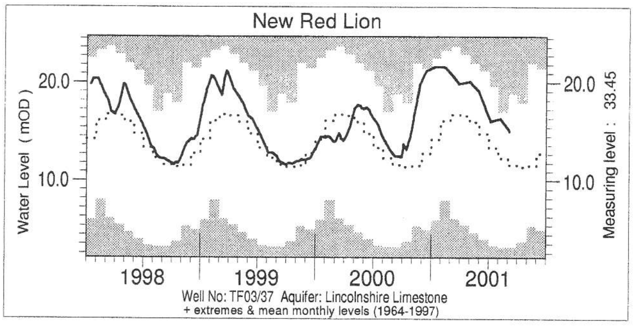








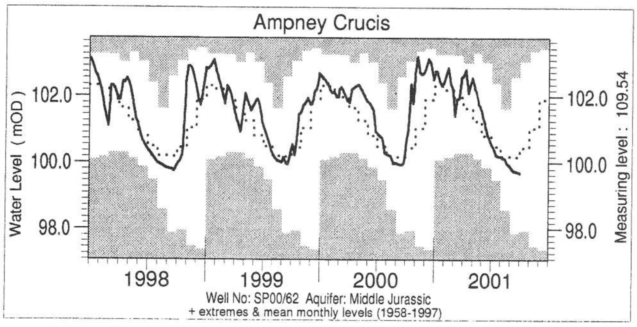


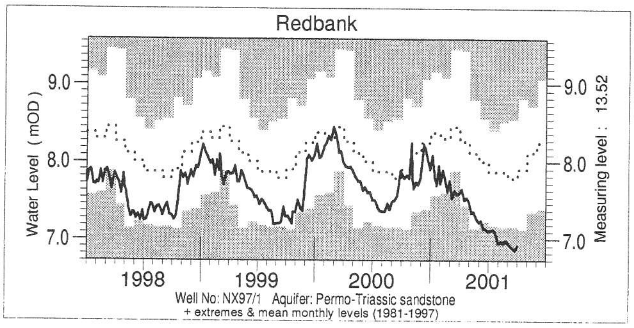


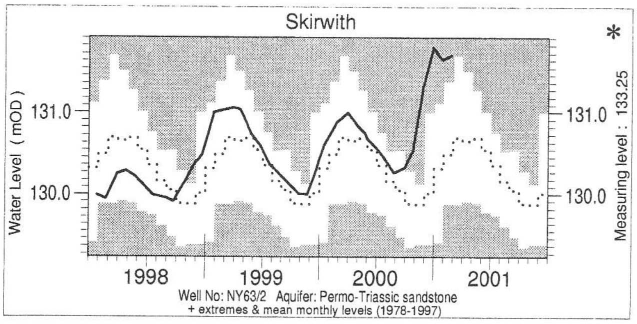
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

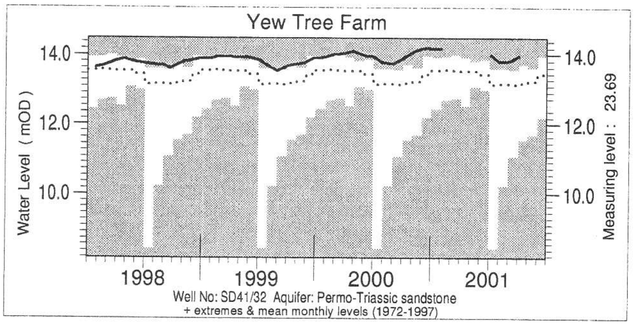
* No March - September groundwater levels available.

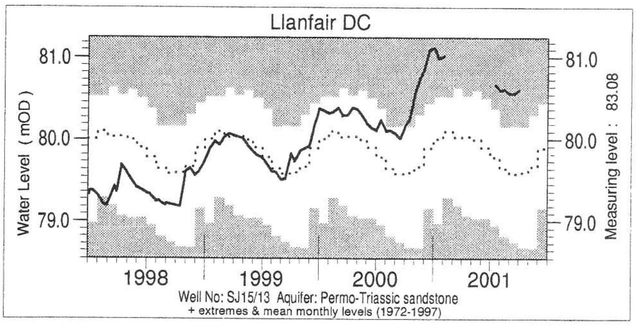
Groundwater . . . Groundwater

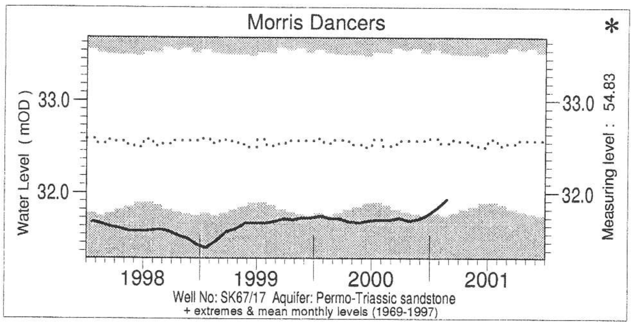


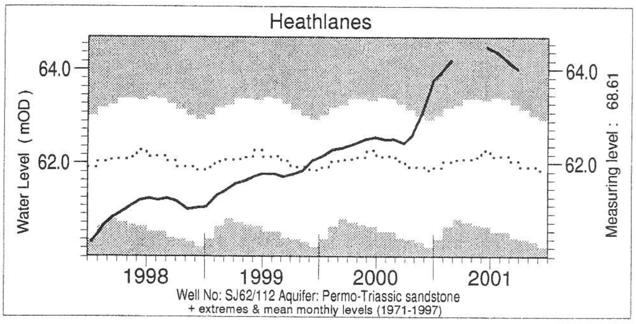


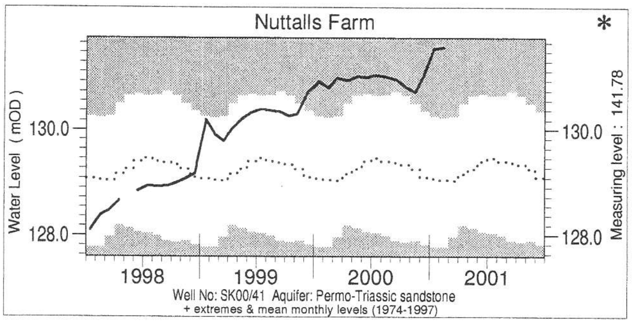


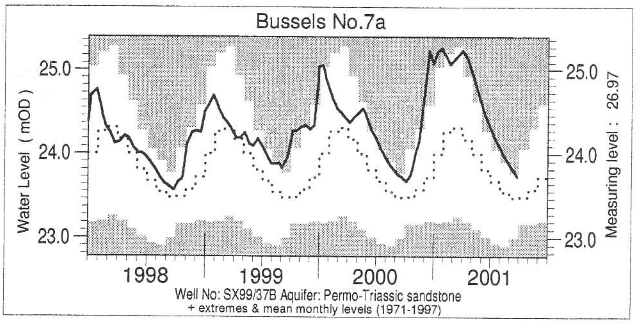


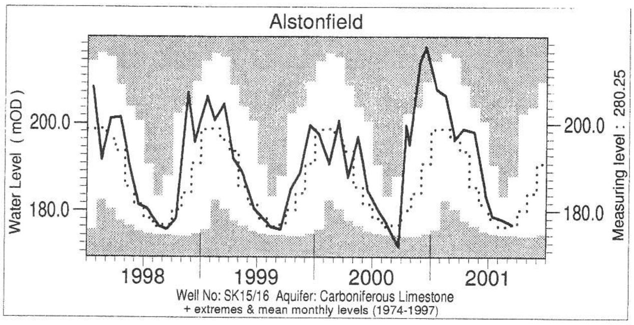












Groundwater levels September / October 2001

Borehole	Level	Date	Sep. av.
Dalton Holme	14.19	14/09	15.45
Washpit Farm	46.76	05/09	43.91
Stonor Park	83.54	01/10	74.58
Dial Farm	26.02	11/09	25.54
Rockley	131.17	01/10	131.01
Little Bucket Farm	69.77	30/09	64.62
West Woodyates	70.55	30/09	73.06

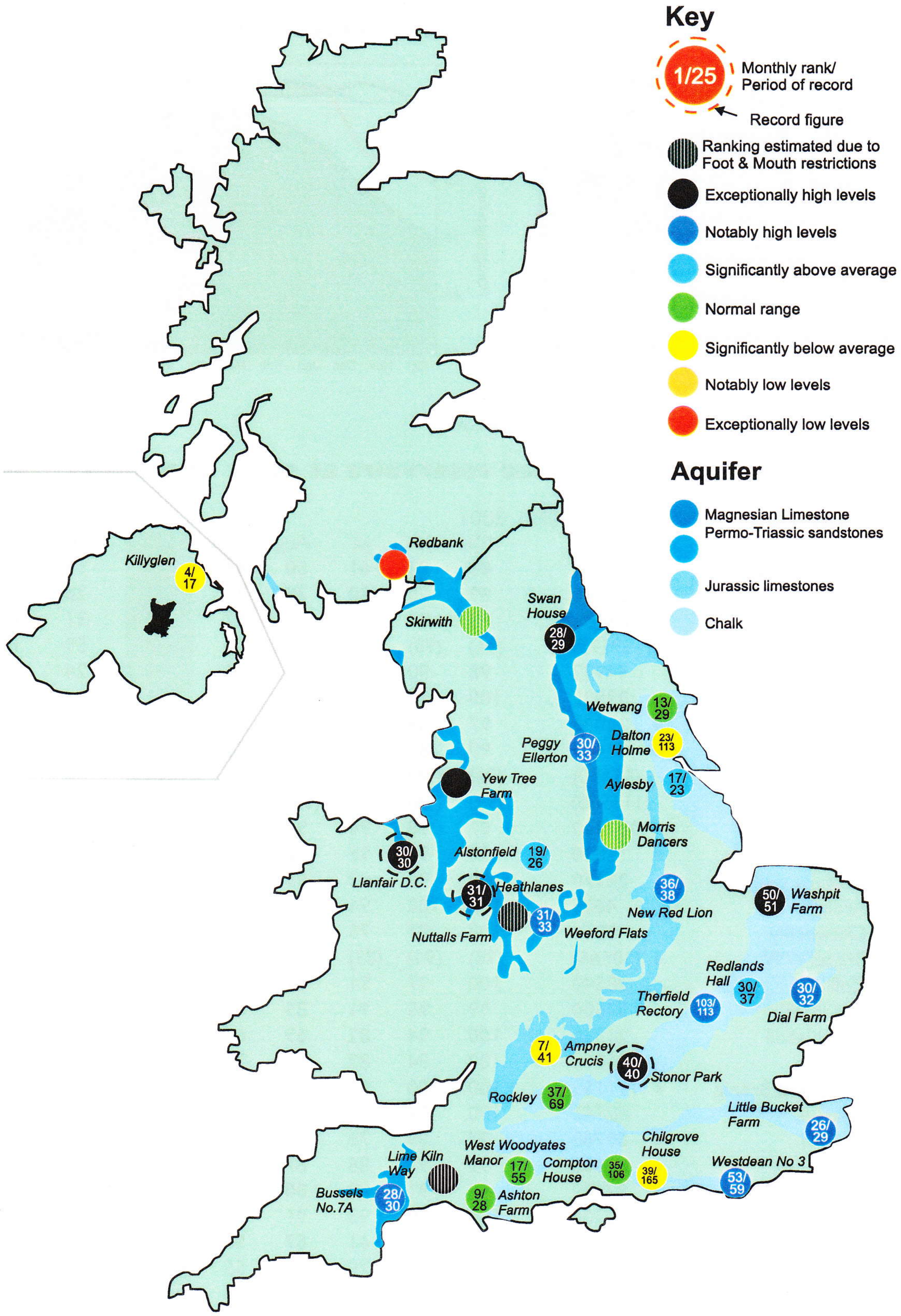
Borehole	Level	Date	Sep. av.
Chilgrove House	38.58	29/09	40.80
Killyglen	113.55	30/09	114.54
New Red Lion	15.05	05/09	11.57
Ampney Crucis	99.70	01/10	100.09
Redbank	6.93	30/09	7.77
Yew Tree Farm	13.99	03/10	13.26
Llanfair DC	80.61	01/10	79.48

Borehole	Level	Date	Sep. av.
Heathlanes	64.01	26/09	61.97
Bussels No.7a	23.73	25/09	23.51
Alstonfield	176.87	14/09	176.76

Data missing due to Foot & Mouth restrictions

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater



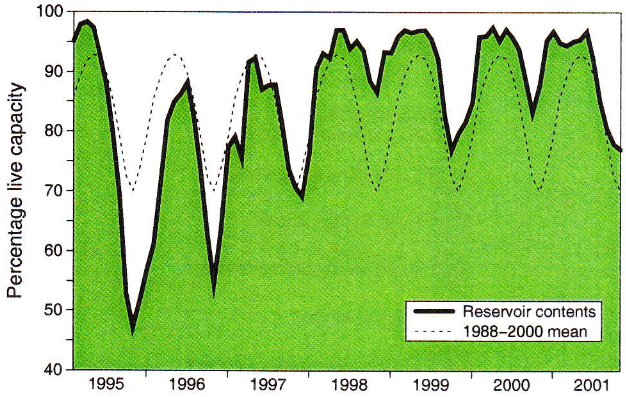
Groundwater levels - September 2001

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.

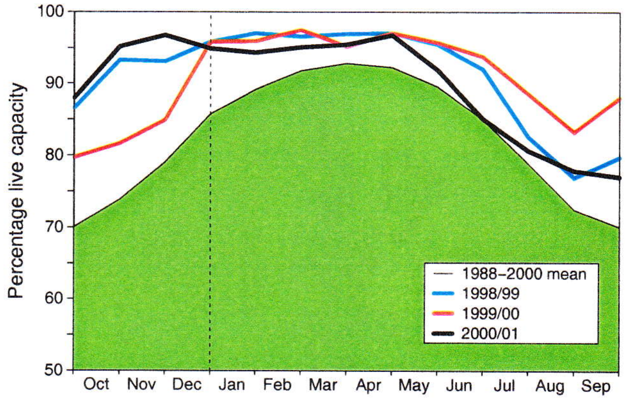
(Note: Redbank is affected by groundwater abstraction)

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)	2001 May	Jun	Jul	Aug	Sep	Oct	Min. Oct	Year* of min
North West	N Command Zone	• 124929	89	73	61	50	44	44	13	1995
	Vyrnwy	55146	99	90	80	79	74	71	26	1995
Northumbrian	Teesdale	• 87936	98	84	76	65	57	63	31	1995
	Kielder	(199175)	(91)	(90)	(88)	(89)	(87)	(86)	59	1989
Severn Trent	Clywedog	44922	98	90	80	61	46	49	24	1989
	Derwent Valley	• 39525	100	97	80	71	69	81	24	1989
Yorkshire	Washburn	• 22035	97	89	81	75	69	69	24	1995
	Bradford supply	• 41407	99	85	77	64	61	64	15	1995
Anglian	Grafham	(55490)	(96)	(96)	(95)	(94)	(95)	(95)	46	1997
	Rutland	(116580)	(99)	(96)	(90)	(85)	(80)	(78)	61	1995
Thames	London	• 202340	97	98	94	91	91	90	53	1997
	Farmoor	• 13830	98	98	98	96	92	94	60	1990
Southern	Bewl	28170	100	98	93	85	79	72	32	1990
	Ardingly	4685	100	100	96	91	70	67	37	1996
Wessex	Clatworthy	5364	100	87	75	64	54	44	30	1995
	Bristol WW	• (38666)	(98)	(94)	(83)	(75)	(69)	(60)	31	1990
South West	Colliford	28540	100	97	91	82	72	62	43	1997
	Roadford	34500	99	95	91	85	80	73	26	1995
	Wimbleball	21320	100	94	82	69	61	50	30	1995
	Stithians	5205	100	94	83	66	51	37	22	1990
Welsh	Celyn and Brenig	• 131155	100	100	96	96	92	92	39	1989
	Brianne	62140	100	94	85	81	86	86	48	1995
	Big Five	• 69762	97	89	76	78	82	77	19	1995
	Elan Valley	• 99106	99	94	86	87	93	93	34	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	97	91	82	80	75	70	43	1998
	East Lothian	• 10206	100	100	93	91	90	84	52	1989
West of Scotland	Loch Katrine	• 111363	83	66	61	57	58	55	43	1995
	Daer	22412	96	81	70	64	55	48	32	1995
	Loch Thom	• 11840	89	74	70	66	66	62	56	1995
Northern Ireland	Silent Valley	• 20634	93	83	72	59	59	47	27	1995

() figures in parentheses relate to gross storage • denotes reservoir groups * last occurrence

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 minimum storage figures relate to the 1988-2000 period only (except for West of Scotland and Northern Ireland where data commence in 1994 and 1993 respectively). 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 of the Environment, Transport and the Regions, 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 regional divisions of the EA (England and Wales) and SEPA (Scotland), data for Northern Ireland are provided by 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, the West of Scotland and East of Scotland Water Authorities, 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 (address 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; over the coming months further monthly raingauge totals will be included for selected regions. Until the access to these additional data has stabilised the regional figures (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.nwl.ac.uk/ih

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