Note : much of the hydrometric data featured in this report is provisional; the Foot and Mouth outbreak has also restricted the amount of data available.

Hydrological summary for the United Kingdom

March 2001

General

March rainfall was close to the long term average for the UK as a whole, but regional variations were large; much of southern England was again very wet. Provisional figures indicate that rainfall for EW over the last seven months closely matches the wettest seven-month period on record. River flows during March were mostly within in the normal range in northern and western catchments but spate conditions continued in southern Britain. Runoff was outstanding in many spring-fed rivers and the protracted episode of 'clear-water' flooding in permeable catchments continued as groundwater levels remained close to term maxima over wide areas. Reservoir stocks and overall groundwater resources are exceptionally healthy for the early spring but the flood risk will continue until accelerating evaporation rates help dry-out the soils across what remains a largely saturated landscape. The chance of further floodplain inundations is of particular concern to the agricultural community given the current restrictions on livestock movement.

Rainfall

As with much of the preceding autumn and winter, March rainfall patterns served to moderate the normal NW-SE rainfall gradient across the UK. In a zone extending from the western Highlands to Northern Ireland some localities recorded less than 35% of the average monthly rainfall. By contrast, parts of the South-East reported more than 200%; March rainfall in Sussex was higher than in much of the Highland Region. Substantial parts of the English lowlands reported their seventh successive wet month, and rainfall accumulations in the 3-7 month timeframes are remarkable. Whilst provisional figures suggest that Northern Ireland had its driest start to the year (Jan-Mar) for 36 years, and Scotland its second driest in the last 31 years, rainfall records continue to be broken for England and Wales. Rainfall over the last six months substantially exceeds the previous highest (that for 1929/30) for the winter half-year (Oct-Mar) in the Climate Research Unit's 235-year E&W rainfall series and the September-March total closely matches the maximum seven-month total for any start month (1852/53). In the modern era, only in 1960/61 have half-year rainfall totals approaching those recently experienced. Over the winter half-year large parts of the English Lowlands have received well over 150% of average rainfall. More notably, throughout much of the South-East, the 6-month total exceeds the annual average, by a wide margin in parts of the Southern and Thames regions; for the Thames catchment (above Kingston) rainfall accumulations since last August are unprecedented (for any start month) in a series from 1883.

River Flows

March river flows in most maritime western and northern catchments were generally within the normal early spring range but rainfall and snowmelt produced some significant spates (e.g. on the 6th in north-east England). Generally however monthly runoff totals were below average – the River Luss (draining from the Scottish Highlands) reported its lowest March flow on record and in NI the River Bush recorded its lowest flow for 28 years. Throughout most of southern England however, exceptional runoff rates continued. Many southern rivers (including the Blackwater, Lymington and Otter, each with records > 38 yrs) established new maximum March runoff totals. Abundant spring outflows continued and the outstanding baseflow contributions made for record discharge rates in a number of groundwater-fed streams (e.g. the Ewelme Brook in the Chilterns). Mean March flows in the Mimram (like those for February also) exceeded the previous maximum - for any month - in a record from 1952. The recent redefinition of high flow regimes- in permeable catchments especially - is most evident in runoff accumulations spanning up to six months. For the year thus far, runoff in the Itchen exceeds the previous maximum by more than 25% and the singular nature of recent hydrological conditions is underlined by the winter half-year runoff totals. In records of 116 and 118 years respectively, new 6-month runoff maxima have been established on the Lee and Thames. For gauging stations with shorter records, previous maxima have been eclipsed by very wide margins (e.g. around 60% for the Mole). With catchments still saturated at month end the risk of further flooding remained very real, across southern Britain in particular.

Groundwater

Foot and Mouth restrictions severely affected the collection of groundwater level data during March. Nonetheless, the impact of the historically outstanding recharge totals (over four times the average in some eastern areas) over the winter half-year remains very evident – in terms of exceptionally high groundwater levels, record spring outflows, the migration of stream sources high into the headwaters, and very protracted clear-water flooding. Although there has been some decline from record December peaks (e.g. at Compton) in the more responsive aquifer units, further heavy pulses of recharge have maintained exceptionally high groundwater levels in the Chalk. Levels continued to rise through March in many eastern outcrop areas (and in the Chilterns) where the commonly exceed previous maxima by significant margins (e.g. at Redlands and Stonor). There is no close parallel - in a 118-year record - for the recent rapid recovery in the deep Therfield well; levels now stand at their highest since the First World War. Pumping is being used to help reduce groundwater levels in areas subject to significant flooding (e.g. in the upper Pang catchment). Recessions were apparent in some northern aquifers (e.g. the Carboniferous limestone at Alstonfield) but unprecedented levels still characterise many Permo-Triassic sandstones outcrops. Across England as a whole, there is no close modern precedent to the scale and duration of the 2000/2001 groundwater flooding.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall . . . Rainfall . . . Rainfall.

Rainfall accumulations and return period estimates

Area	Rainfall	Mar 2001	Jan 01-Mar 01	RP	Oct 00-Mar 01	RP	Jul 00-Mar 01	RP	Apr 00-Mar 01	RP
England & Wales	**mm**	**87**	**246**		**715**		**960**		**1214**	
	%	**121**	**110**	**2-5**	**145**	**60-90**	**136**	**60-90**	**135**	**150-250**
North West	mm	61	243		885		1240		1523	
	%	64	83	2-5	132	15-25	127	15-25	127	30-40
Northumbrian	mm	52	199		586		825		1089	
	%	74	93	2-5	129	10-20	122	10-15	128	30-50
Severn Trent	mm	65	187		574		796		1037	
	%	107	101	2-5	144	35-50	137	40-60	138	110-150
Yorkshire	mm	52	188		603		852		1134	
	%	76	92	2-5	137	20-35	133	30-50	138	120-170
Anglian	mm	74	197		486		667		869	
	%	158	147	15-25	163	>200	148	>200	146	>>200
Thames	mm	95	250		641		829		1073	
	%	170	152	15-25	177	>>200	157	>>200	156	>>200
Southern	mm	122	328		852		1056		1315	
	%	194	166	35-50	192	>>200	171	>>200	169	>>200
Wessex	mm	115	286		766		988		1250	
	%	164	129	5-10	161	150-250	148	120-170	149	>>200
South West	mm	141	347		964		1244		1516	
	%	142	103	2-5	134	15-25	129	15-25	129	30-50
Welsh	mm	118	322		1026		1373		1683	
	%	110	93	2-5	132	10-20	128	20-30	128	30-50
Scotland	**mm**	**72**	**260**		**838**		**1144**		**1379**	
	%	**58**	**69**	**10-20**	**100**	**< 2**	**96**	**2-5**	**96**	**2-5**
Highland	mm	75	273		949		1211		1477	
	%	46	57	35-50	88	2-5	82	10-15	84	10-15
North East	mm	83	242		687		933		1196	
	%	107	100	< 2	129	20-30	120	10-20	123	30-40
Tay	mm	84	316		847		1173		1404	
	%	77	91	2-5	117	5-10	116	5-10	114	5-10
Forth	mm	70	240		667		992		1217	
	%	74	82	2-5	106	2-5	109	2-5	110	2-5
Tweed	mm	64	217		617		930		1165	
	%	81	88	2-5	117	5-10	120	5-15	120	10-20
Solway	mm	75	277		997		1414		1654	
	%	64	74	5-10	121	5-10	120	10-15	116	5-10
Clyde	mm	81	306		993		1412		1634	
	%	55	67	10-20	99	2-5	99	2-5	96	2-5
Northern Ireland	**mm**	**61**	**182**		**647**		**905**		**1118**	
	%	**69**	**66**	**5-15**	**108**	**2-5**	**106**	**2-5**	**106**	**2-5**

RP = Return period

The monthly rainfall figures* are copyright of The Met. Office and may not be passed on to any unauthorised person or organisation. **All monthly totals since December 1998 are provisional (see page 12).** 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 England & Wales and Scotland rainfall series can exaggerate the relative wetness of the recent past. *See page 12. The rainfall figures presented here are derived from different raingauge networks to those used to derive the CRU data series (now updated by the Hadley Centre).

Rainfall . . . Rainfall . . . Rainfall

Key

00% Percentage of 1961-90 average

Very wet

Substantially above average

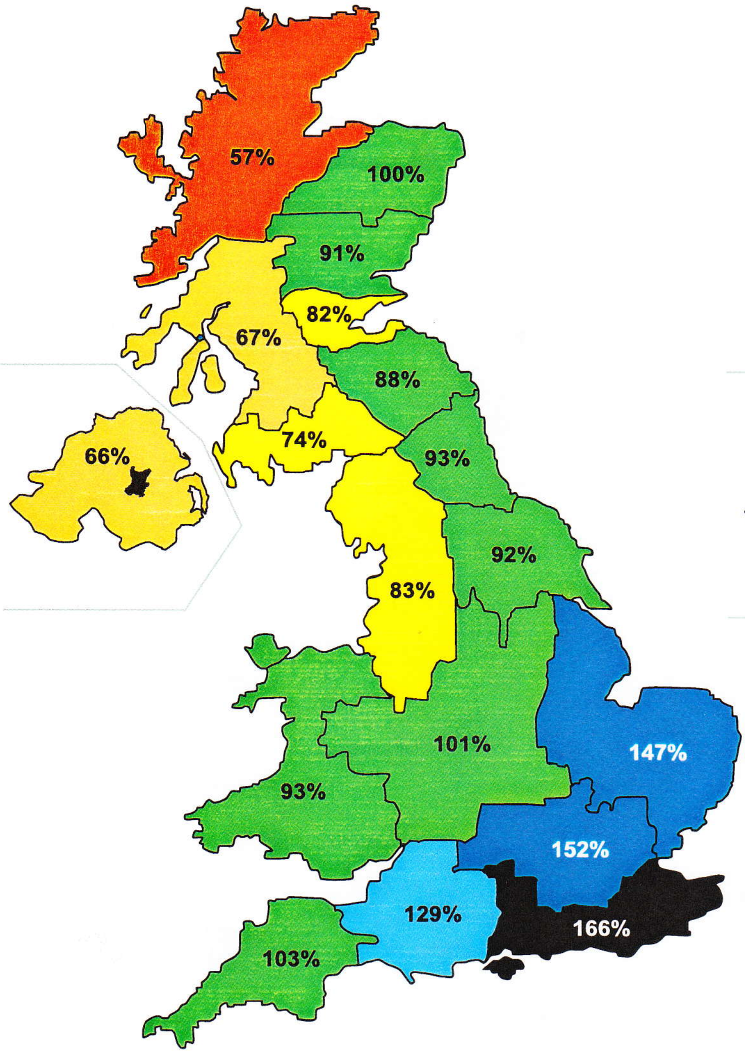
Above average

Normal range

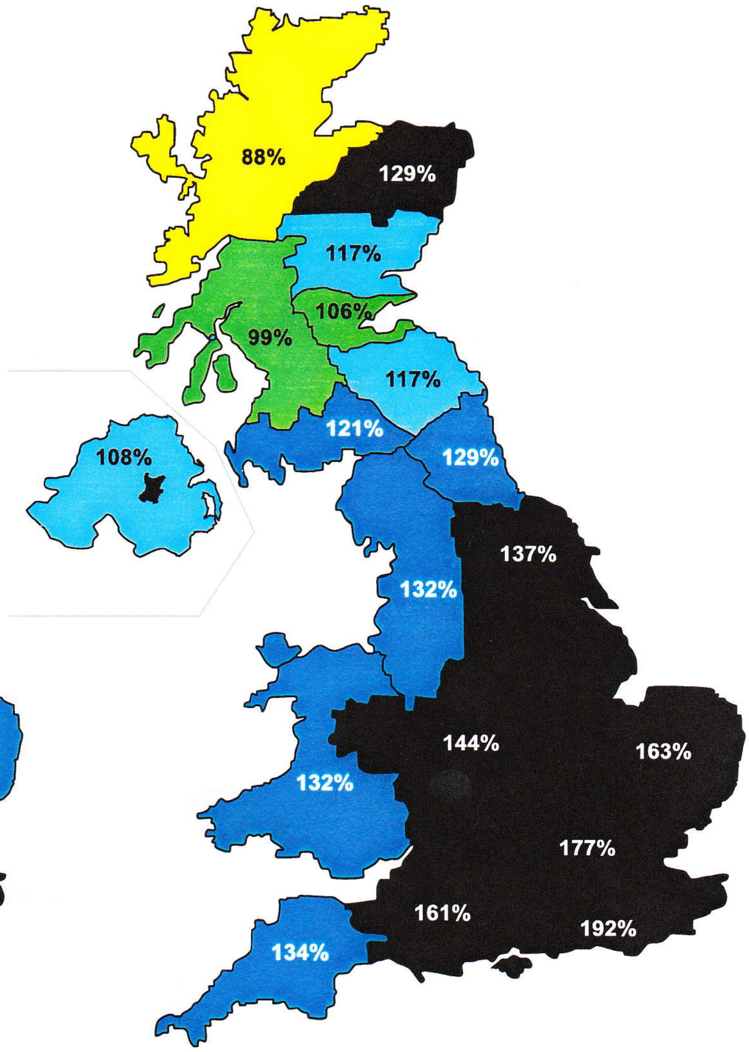
Below average

Substantially below average

Exceptionally low rainfall



January 2001 - March 2001

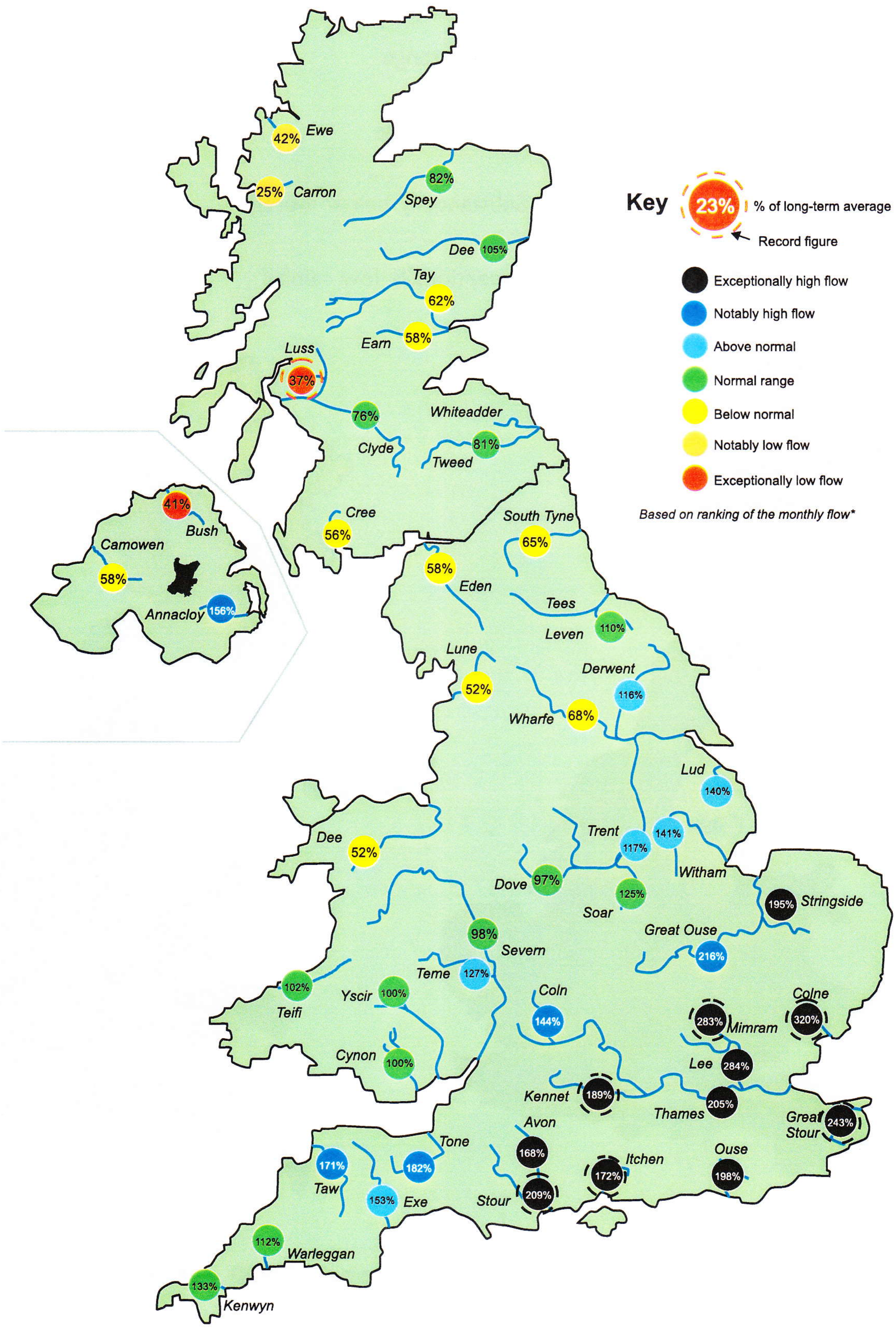


October 2000 - March 2001

Rainfall accumulation maps

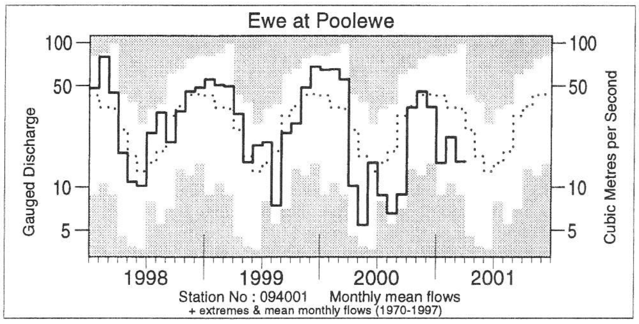
The moderation in the north-west to south-east rainfall gradient across the UK is particularly evident in the January-March rainfall patterns. Return periods associated with the winter half-year rainfall totals exceed 200 years throughout much of the English Lowlands; these help to explain the remarkable increase in groundwater levels over the period since September 2000.

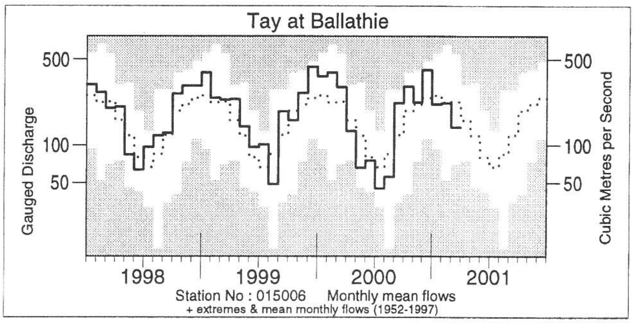
River flow . . . River flow . . .

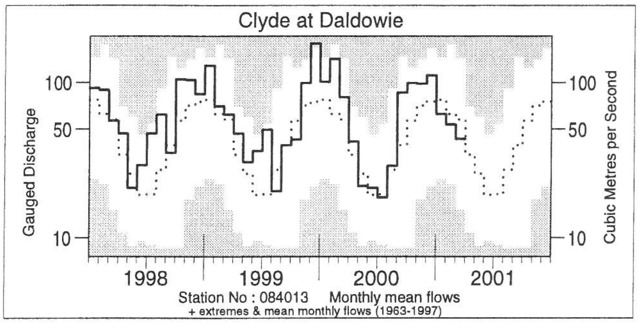


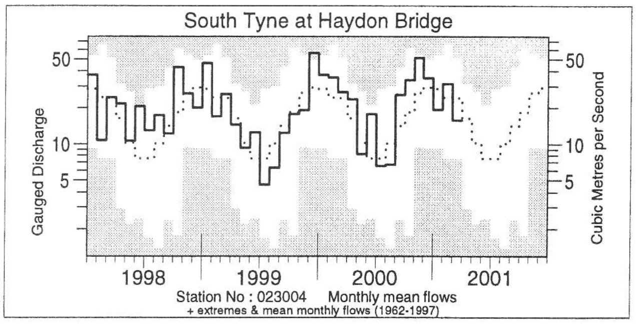
River flows - March 2001

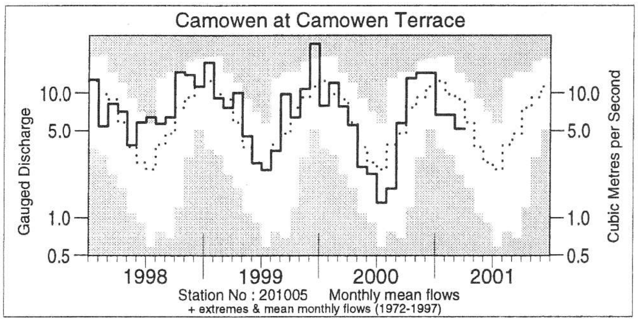
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

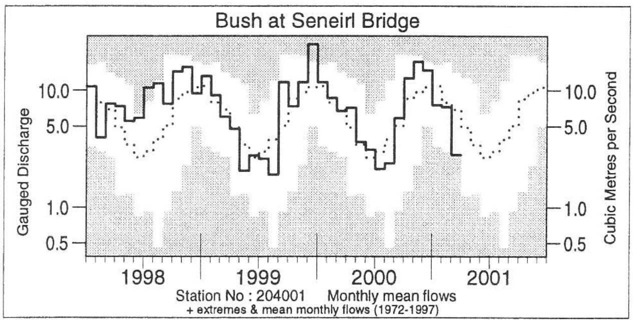


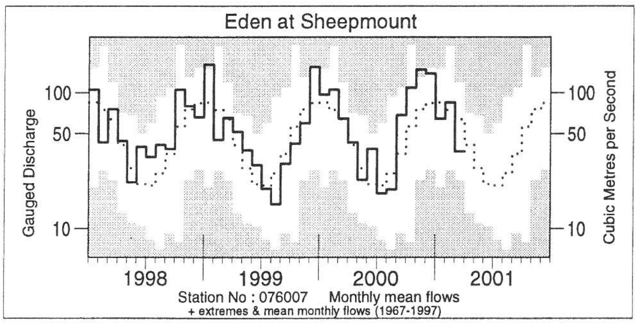


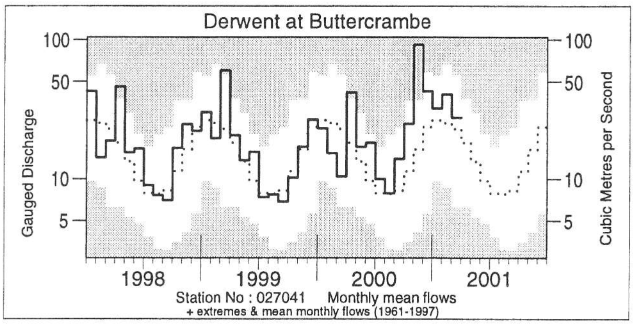


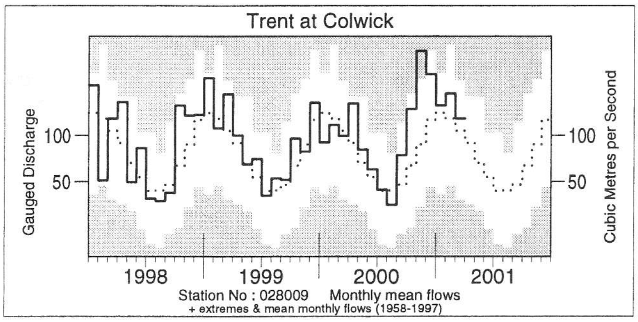


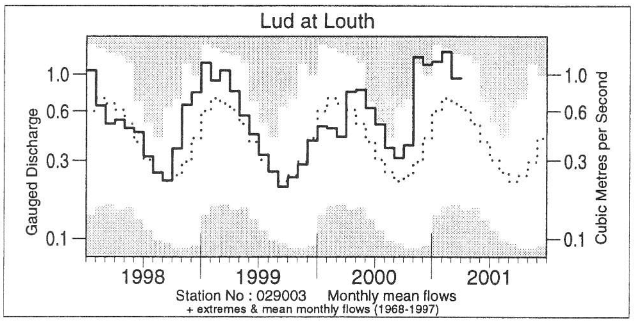








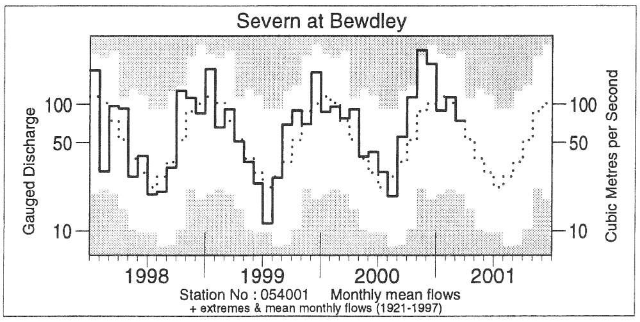


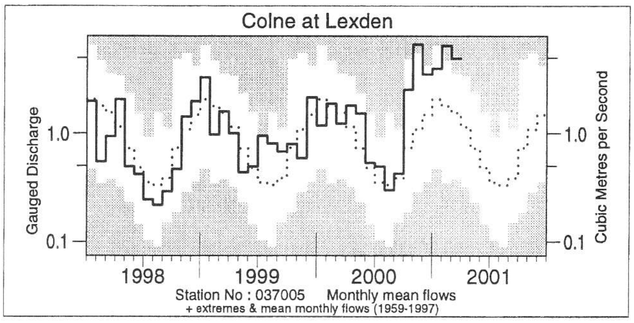


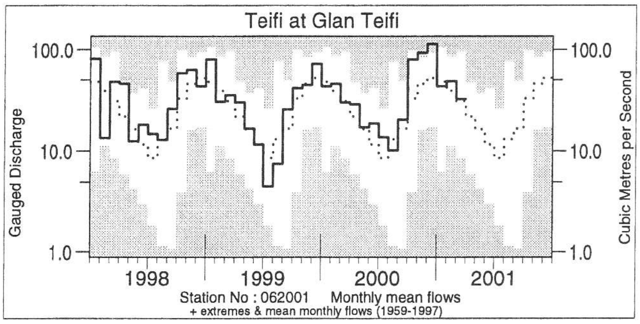
Monthly river flow hydrographs

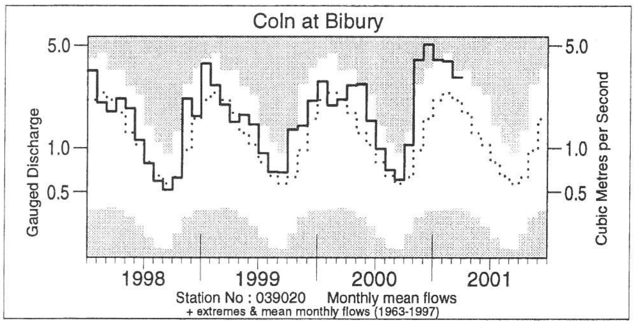
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1998 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

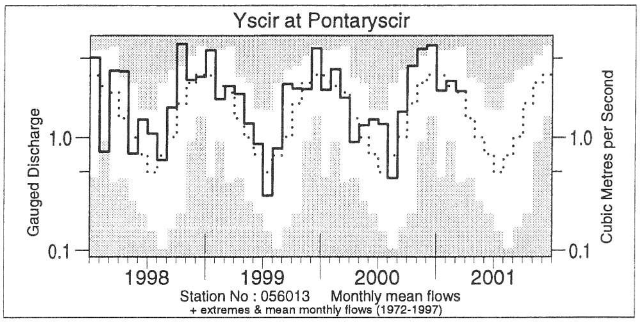
River flow . . . River flow . . .

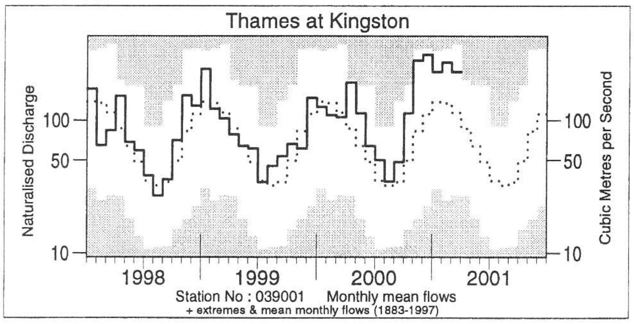


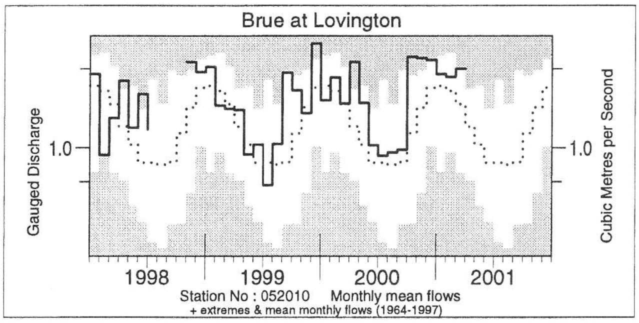


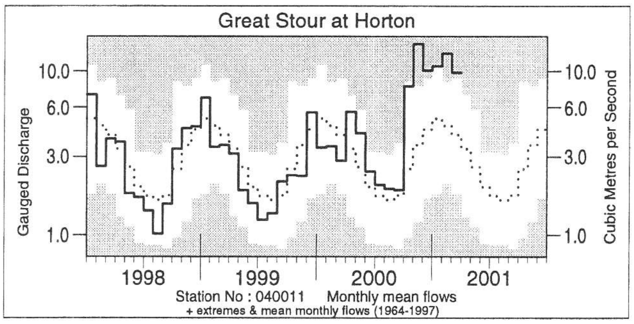


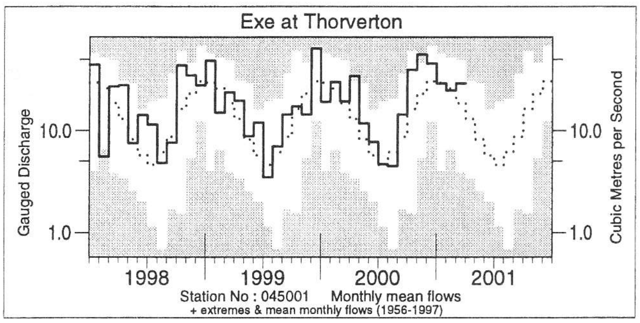


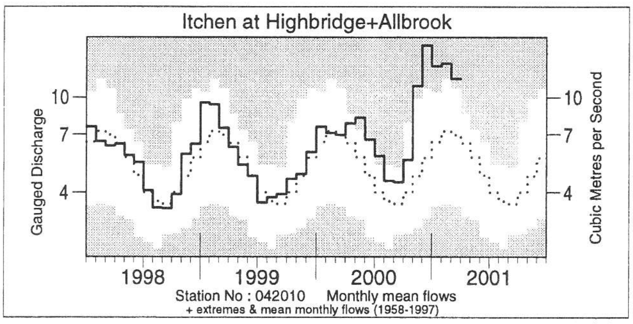










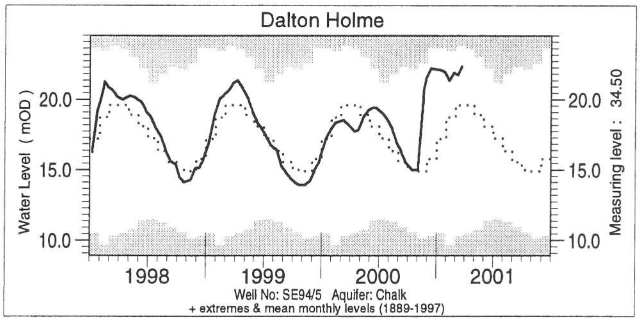


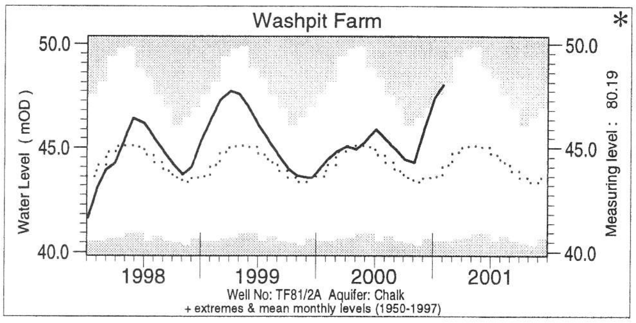
Notable runoff accumulations (a) January 2001 - March 2001, (b) October 2000 - March 2001

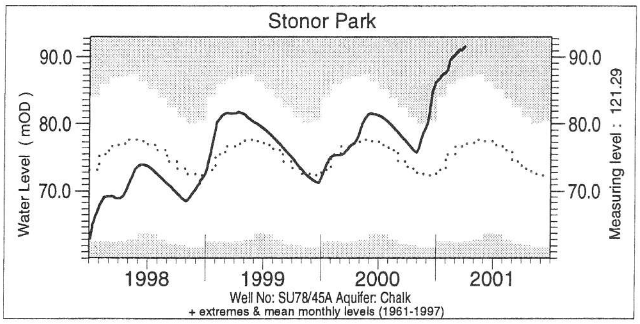
	River	%lta	Rank	River	%lta	Rank	River	%lta	Rank
(a)	Luss	59	1/24	Ouse	227	68/68	Great Stour	257	36/36
	Naver	58	1/24	Colne	308	41/41	Itchen	201	43/43
	Camowen	60	1/28	Lee	289	116/116	Severn	170	80/80
(b)	Trent	180	43/43	Thames	226	118/118	Dee	151	64/64
							Annacloy	171	21/21

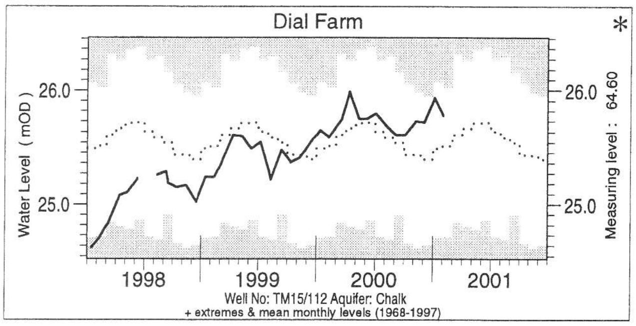
lta = long term average
Rank 1 = lowest on record

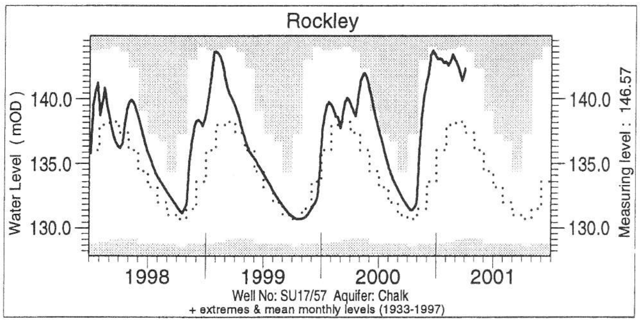
Groundwater . . . Groundwater

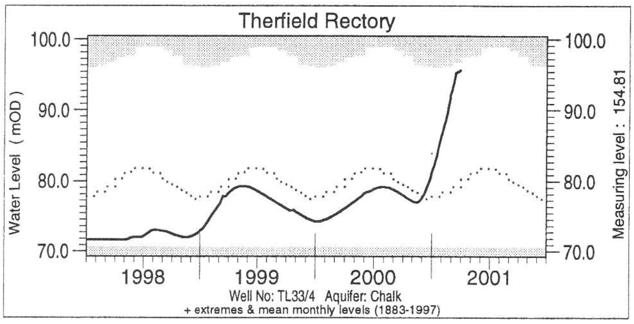


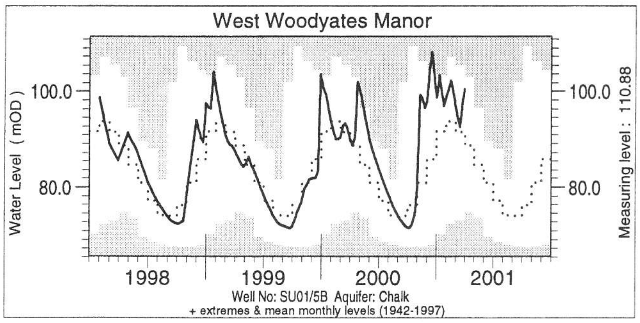


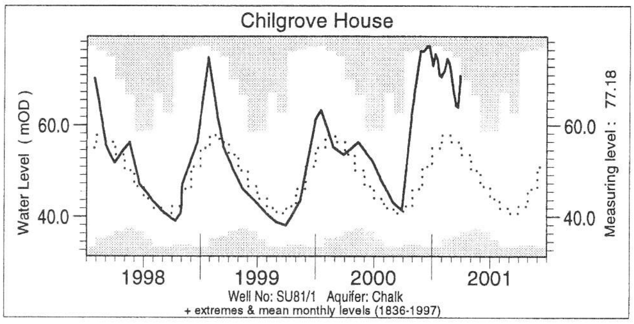


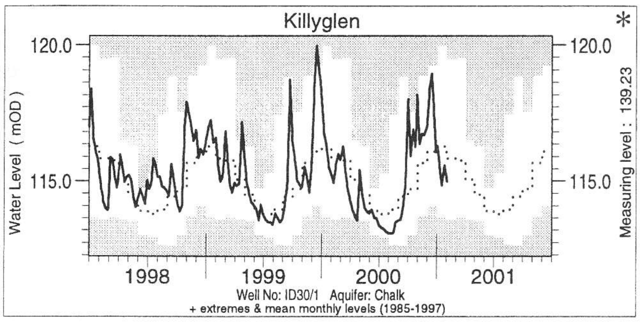


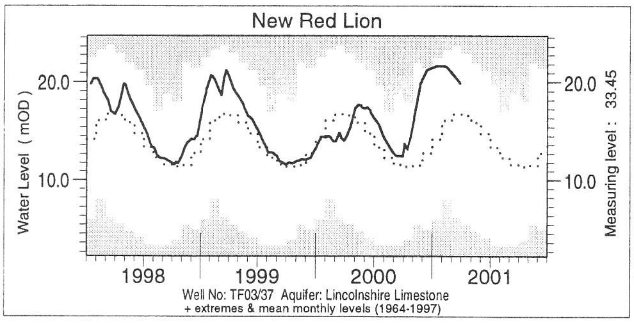








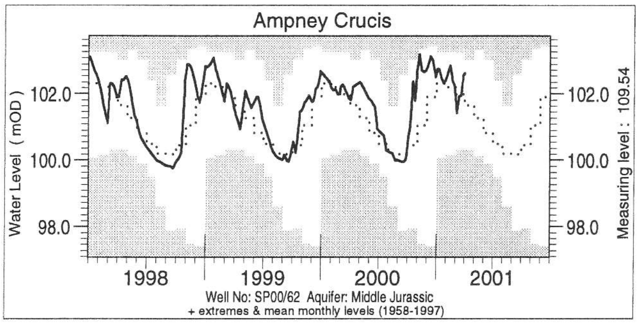


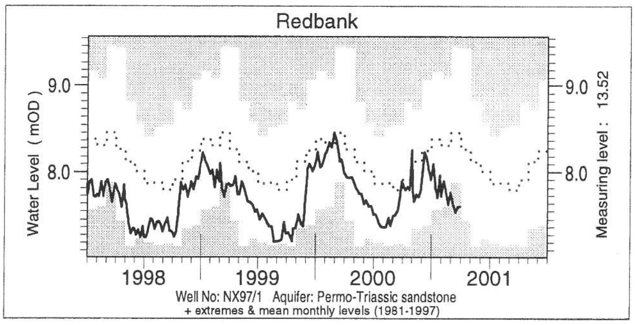


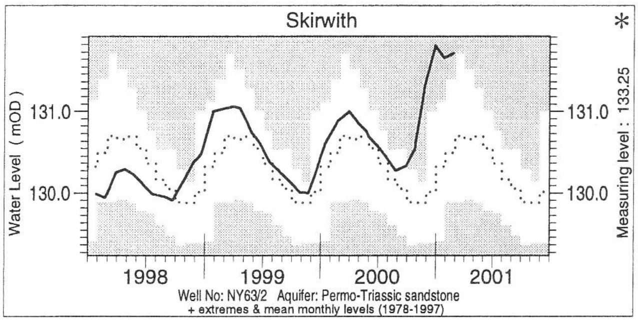
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

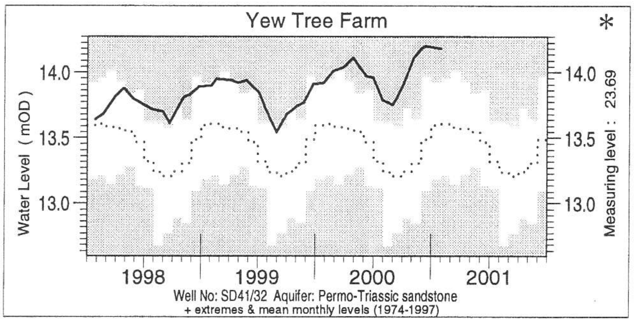
* No March/ April groundwater levels available.

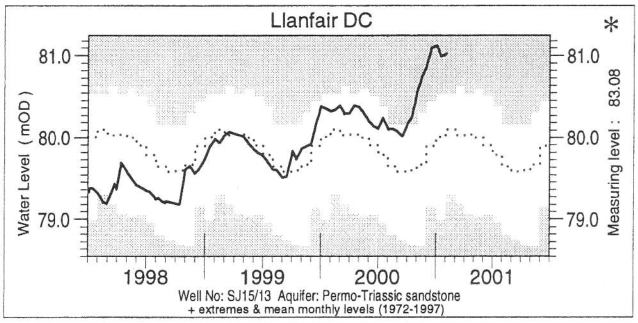
Groundwater . . . Groundwater

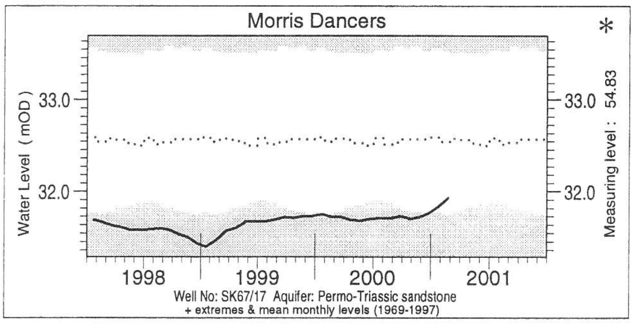


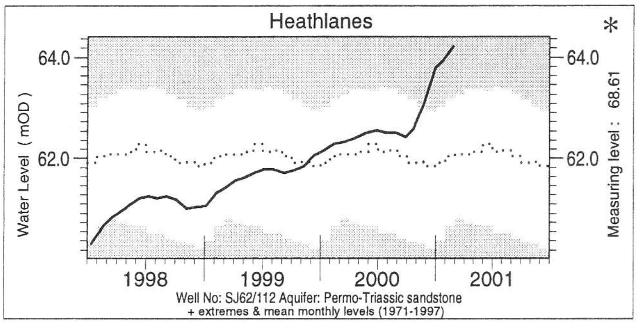


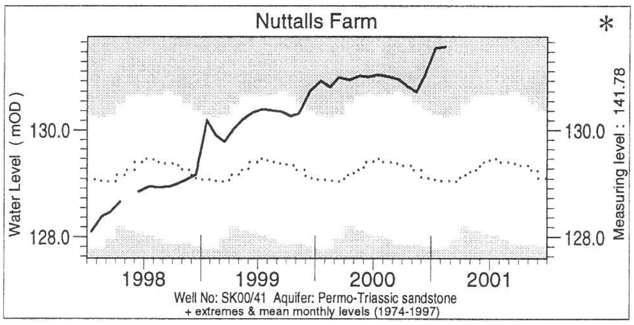


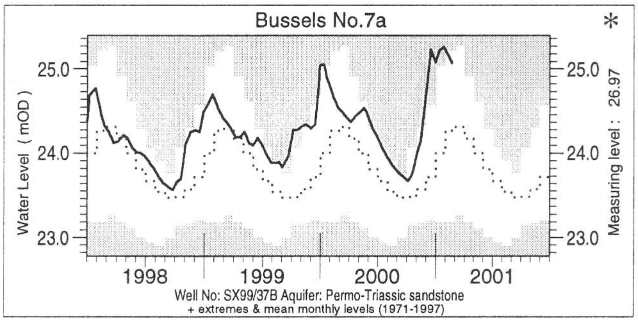


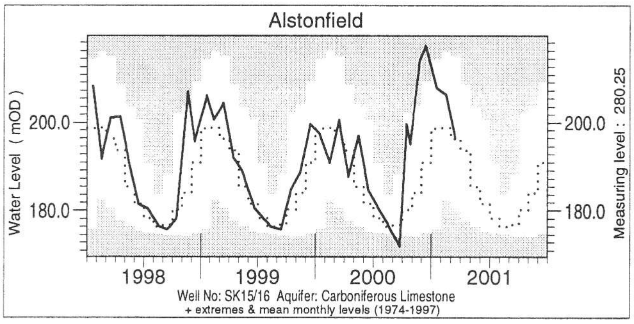












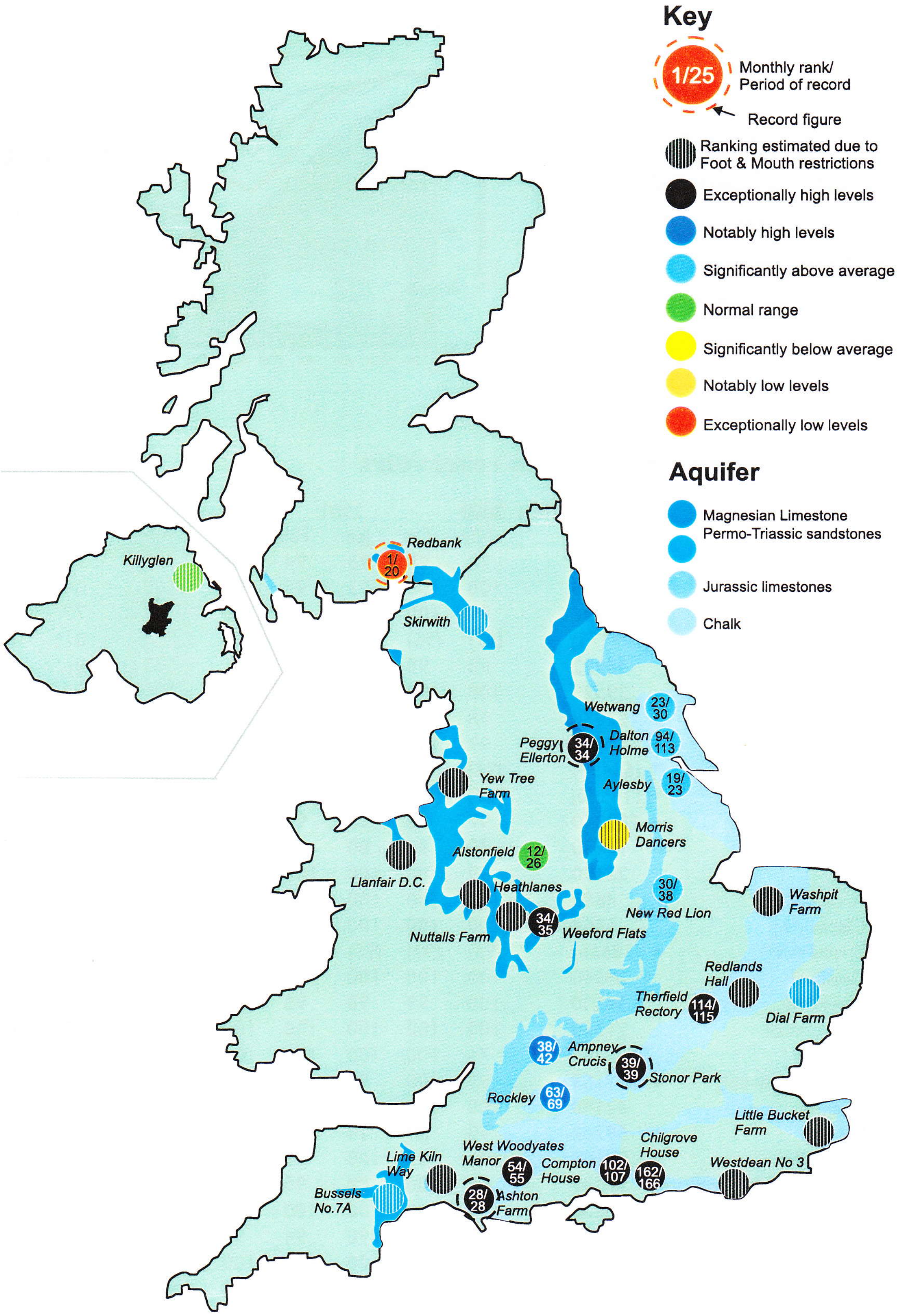
Groundwater levels March / April 2001

Borehole	Level	Date	Mar. av.	Borehole	Level	Date	Mar. av.
Dalton Holme	22.34	22/03	19.50	Chilgrove	70.82	28/03	55.44
Wetwang	27.17	22/03	25.05	Weeford Flats	91.24	14/03	89.75
Therfield Rectory	95.70	29/03	79.07	New Red Lion	19.89	27/03	16.58
Ashton Farm	71.06	31/03	69.56	Ampney Crucis	102.63	02/04	102.03
Aylesby	20.35	26/03	15.69	Redbank	7.60	30/03	8.41
Peggy Ellerton	37.66	27/03	34.54	Alstonfield	196.40	27/03	196.23
West Woodyates	100.42	31/03	90.64				

Data Missing due to Foot & Mouth restrictions

Levels in metres above Ordnance Datum

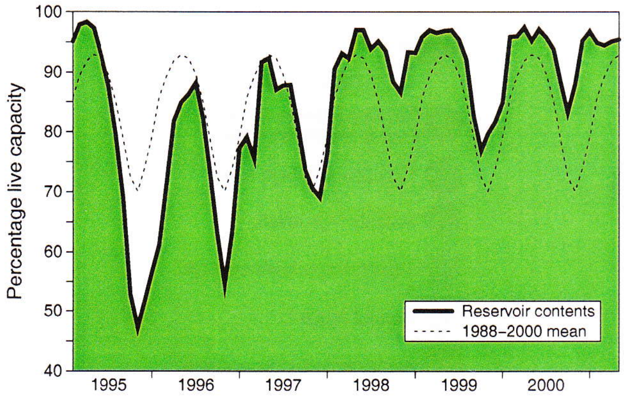
Groundwater . . . Groundwater



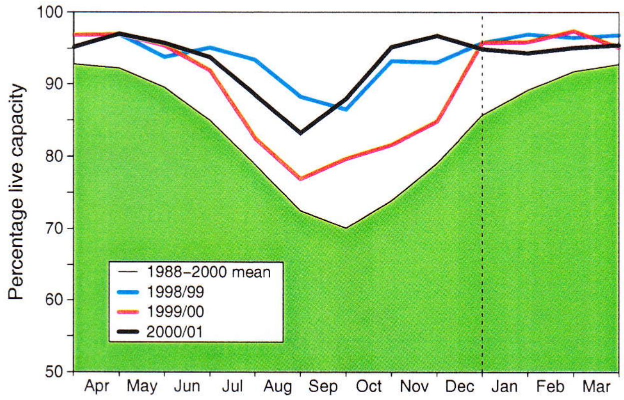
Groundwater levels - March 2001

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.

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

Area	Reservoir	Capacity (Ml)	2000 Nov	Dec	2001 Jan	Feb	Mar	Apr	Min. Apr	Year* of min
North West	N Command Zone	• 124929	78	96	95	94	94	85	77	1993
	Vyrnwy	55146	100	100	93	93	98	100	64	1996
Northumbrian	Teesdale	• 87936	99	100	99	97	91	92	77	1996
	Kielder	(199175)	(97)	(95)	(93)	(91)	(92)	(92)	81	1993
Severn Trent	Clywedog	44922	98	98	82	82	91	99	86	1996
	Derwent Valley	• 39525	100	100	100	94	98	100	54	1996
Yorkshire	Washburn	• 22035	98	97	89	95	97	99	70	1996
	Bradford supply	• 41407	99	100	99	99	97	99	59	1996
Anglian	Grafham	** (55490)	(94)	(89)	(88)	(88)	(88)	(92)	77	1997
	Rutland	**(116580)	(89)	(89)	(89)	(86)	(92)	(95)	74	1992
Thames	London	• 202340	97	98	98	97	96	95	88	1990
	Farmoor	• 13830	90	90	80	72	81	90	84	1992
Southern	Bewl	28170	89	98	100	100	100	100	58	1989
	Ardingly	4685	100	100	100	100	100	100		
Wessex	Clatworthy	5364	100	100	100	97	100	100	82	1992
	Bristol WW	• (38666)	(95)	(99)	(95)	(100)	(98)	(98)	71	1992
South West	Colliford	28540	100	100	100	100	100	100	58	1997
	Roadford	34500	100	99	98	98	97	100	37	1996
	Wimbleball	21320	100	100	100	100	100	100	78	1996
	Stithians	5205	76	100	100	100	100	100	52	1992
Welsh	Celyn and Brenig	• 131155	99	100	95	97	99	100	72	1996
	Brianne	62140	100	100	94	97	95	97	90	1993
	Big Five	• 69762	90	89	94	100	97	98	78	1993
	Elan Valley	• 99106	100	100	100	99	98	99	89	1993
East of Scotland	Edinburgh/Mid Lothian	• 97639	99	100	99	99	99	97	71	1998
	East Lothian	• 10206	100	100	100	100	100	100	95	1990
West of Scotland	Loch Katrine	• 111363	97	98	90	94	95	88	88	2001
	Daer	22412	100	100	100	100	100	93	93	2001
	Loch Thom	• 11840	100	100	100	100	98	93	93	2001
Northern Ireland	Silent Valley	• 20634	65	85	100	95	96	100	57	2000

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

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 where data commence in 1994). 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; the Hydrological Summaries for the autumn and early winter of 2000/2001, in particular, stand as a testimony to the assistance provided by many hydrometric personnel working in exceptionally challenging circumstances.

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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