Note : much of the hydrometric data featured in this report is provisional

Hydrological summary

for the United Kingdom

December 2000

General

A dry interlude in late December provided a much-needed respite following one of the most remarkable hydrological episodes of modern times. The Oct-Dec period for England & Wales was the second wettest three-month sequence in the last 200 years. Many new local and regional rainfall records have been established over the last four months. A further phase of extensive flooding during December confirmed the event as, overall, the most severe widespread flooding since 1947. As flows in many rivers declined from mid-month, groundwater levels continued a dramatic seasonal recovery - triggering groundwater flooding and exceptional outflows from high level springs. Some flood drawdown releases were made from reservoirs but overall stocks are still close to capacity. Entering 2001, catchments remained saturated and very vulnerable to further rainfall. Unusual though recent climate patterns have been, several broadly comparable wet episodes can be identified (e.g. the Oct-Jan periods of 1960/61, 1929/30 and 1852/53), and – as yet – most lengthy river flow and groundwater level series in E&W do not exhibit any compelling climate-driven trend.

Rainfall

December was the fourth successive month dominated by vigorous frontal systems. However, except for significant snowfall around the 27th, the final two weeks were relatively dry. Nonetheless, monthly rainfall totals comfortably exceeded the December average throughout most of the UK; parts of southern England again registered more than 200% and in Northern Ireland, Bangor registered a very notable 270%. A more appropriate measure of the singular conditions experienced since the early autumn is provided by the Sep-Dec and Oct-Dec rainfall totals. The UK registered its wettest Oct-Dec since 1930 and the three- and four-month totals are outstanding across much of the country - see Table 1. Locally, the Sep-Dec totals approach the annual average in a few parts of the South-East (e.g. south of London). In relation to the period over which the bulk of UK river flow and groundwater data have been collected, the recent rainfall is unprecedented. Longer term rainfall accumulations are also remarkable. E&W had its wettest nine-month period in 40 years and its second wettest year since 1903, as did the UK as a whole (1998 was marginally wetter).

River flow

The major flooding experienced through the autumn continued well into December. Flood warnings were again common and many rivers reported their third (or more in responsive lowland catchments) notable flood peak in eight weeks. On the Hampshire Avon, for example, the Oct, Nov, and Dec peaks each rank amongst the highest five in the last 20 years. The Thames, in its middle reaches, reported its highest flow since 1947. From mid-month, recessions became established in many western and northern rivers – and flows fell below average approaching year-end. By contrast, spates continued in permeable catchments as baseflows increased steeply - culminating in mid-Dec with a remarkable peak flow (return period >200 years) on the Itchen. Localised and more extensive groundwater flooding was common – in southern England particularly. Severe flooding was also reported for the Somerset Levels. The great majority of E&W index gauging stations reported new maximum Dec runoff totals, a few – including the Kennet, Itchen and Dorset Stour - were unprecedented for any month. An even more compelling testimony to the scale and duration of the flooding is provided by the Oct-Dec runoff totals. Catchments for which the accumulated runoff exceed previous maxima (for any start month) show a very wide distribution; they include the Tweed, Trent, Itchen, Brue and Welsh Dee – the latter in a record from 1937. Initial analyses suggest that the 50-day runoff total for E&W as a whole over the period to mid-Dec is the highest for at least 60 years (although peak runoff in March 1947 was higher, the flooding was of shorter duration). The outstanding flows since early Oct have ensured that runoff totals for 2000 are the highest on record for most index catchments in E&W.

Groundwater

Exceptionally high rates of infiltration continued until the third week of December, by which time recharge to most aquifer units had exceeded the full winter average – by a very wide margin in parts of the eastern Chalk. Steep recoveries have been a feature of several recent years (e.g. 89/90, 93/94 and 97/98) but none matches the current episode. In the Chalk of the South Downs, the Chilgrove borehole began overflowing in November – probably the earliest occurrence in a series from 1836 - and December levels at Compton reached a new recorded peak in a series from 1894. Water-tables are now rising rapidly in the deeper, slowest responding wells – levels at Therfield during December exceeded the monthly average for the first time since 1995. Record high levels were reported from many wells and boreholes across the country – examples in the Permo-Triassic sandstones include Skirwith, Llanfair DC and Heathlanes, in each case a dramatic contrast to late-1997 when levels were at, or below, previous mimima. Overall groundwater resources in December are likely to have been without modern precedent. The rapidly rising water-table caused high level springs to break remarkably early in the winter, extending the lowland stream network into the headwaters of many 'dry' valleys.

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	Dec 2000	Sep 00-Dec 00	RP	Jul 00-Dec 00	RP	Mar 00-Dec 00	RP	Dec 99-Dec 00	RP
England & Wales	**mm**	**124**	**588**		**715**		**968**		**1143**	
	%	**132**	**170**	**>>200**	**148**	**110-150**	**144**	**>200**	**128**	**30-50**
North West	mm	148	813		997		1280		1576	
	%	119	166	>200	146	60-90	141	110-150	131	50-80
Northumbrian	mm	96	499		626		890		1070	
	%	119	158	60-90	136	20-30	139	60-90	125	20-35
Severn Trent	mm	112	496		609		851		982	
	%	145	180	>>200	154	110-150	149	>200	130	30-45
Yorkshire	mm	103	547		663		945		1079	
	%	124	180	>>200	152	110-150	153	>>200	131	40-60
Anglian	mm	64	371		470		673		764	
	%	116	174	>200	148	60-90	146	120-170	128	30-40
Thames	mm	104	485		578		822		935	
	%	149	190	>>200	159	110-150	157	>>200	136	50-80
Southern	mm	122	634		728		987		1114	
	%	149	201	>>200	173	>>200	170	>>200	143	>200
Wessex	mm	150	588		702		964		1123	
	%	161	180	>200	158	110-150	156	>>200	134	40-60
South West	mm	184	755		897		1169		1393	
	%	132	160	50-80	143	30-45	140	50-80	119	5-15
Welsh	mm	204	862		1051		1362		1684	
	%	133	158	60-90	145	50-80	141	110-150	128	30-50
Scotland	**mm**	**179**	**723**		**884**		**1119**		**1615**	
	%	**119**	**121**	**5-10**	**109**	**2-5**	**106**	**2-5**	**112**	**5-10**
Highland	mm	195	787		938		1205		1927	
	%	99	102	2-5	94	2-5	94	2-5	109	2-5
North East	mm	123	555		691		954		1191	
	%	132	148	50-80	129	15-25	131	40-60	122	20-35
Tay	mm	182	693		856		1088		1493	
	%	143	141	20-30	129	10-20	123	10-20	121	10-20
Forth	mm	141	582		753		977		1329	
	%	128	130	10-15	122	5-15	119	10-15	120	10-20
Tweed	mm	123	531		713		948		1186	
	%	132	144	30-40	134	20-35	131	30-45	122	15-25
Solway	mm	233	925		1137		1378		1804	
	%	157	156	110-150	142	50-80	132	30-50	127	30-50
Clyde	mm	230	909		1106		1328		1922	
	%	128	124	5-10	114	2-5	107	2-5	113	5-10
Northern Ireland	**mm**	**141**	**585**		**723**		**936**		**1160**	
	%	**136**	**140**	**15-25**	**126**	**5-15**	**120**	**5-15**	**110**	**2-5**

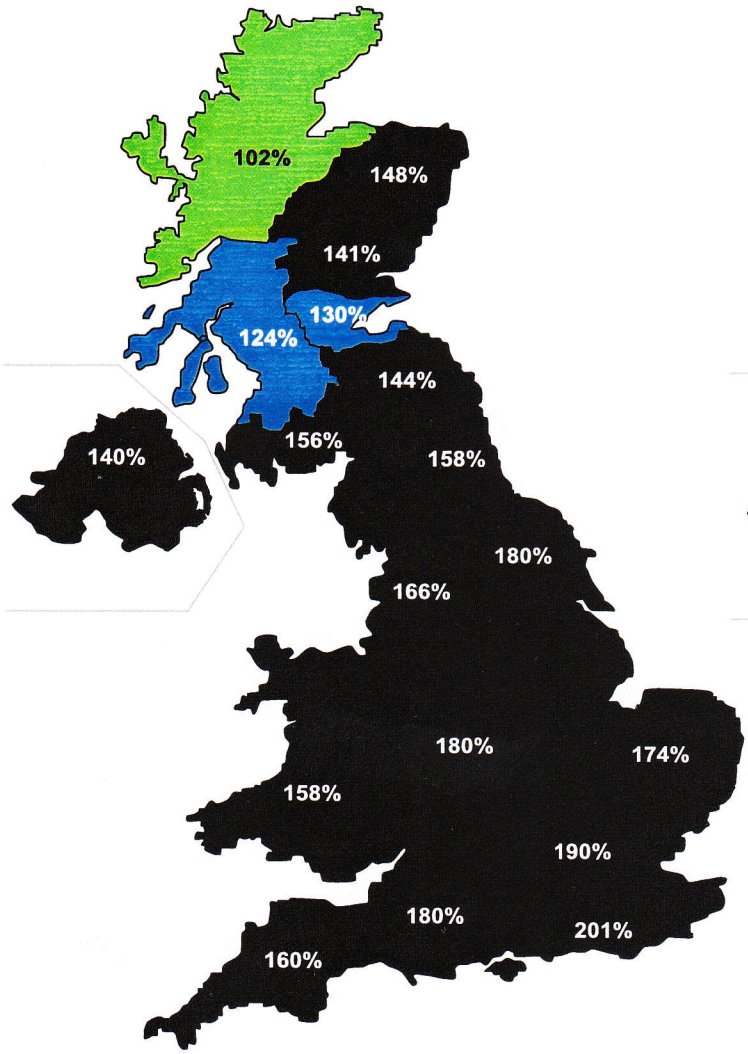
RP = Return period

 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.

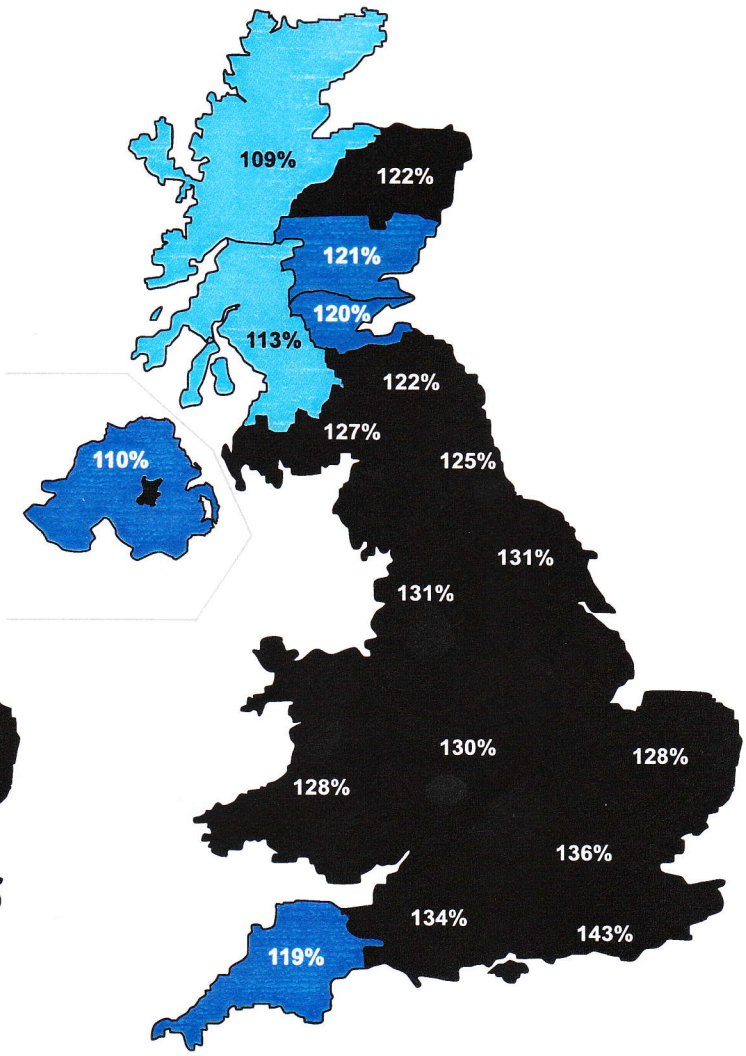
Rainfall . . . Rainfall . . . Rainfall

Key

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



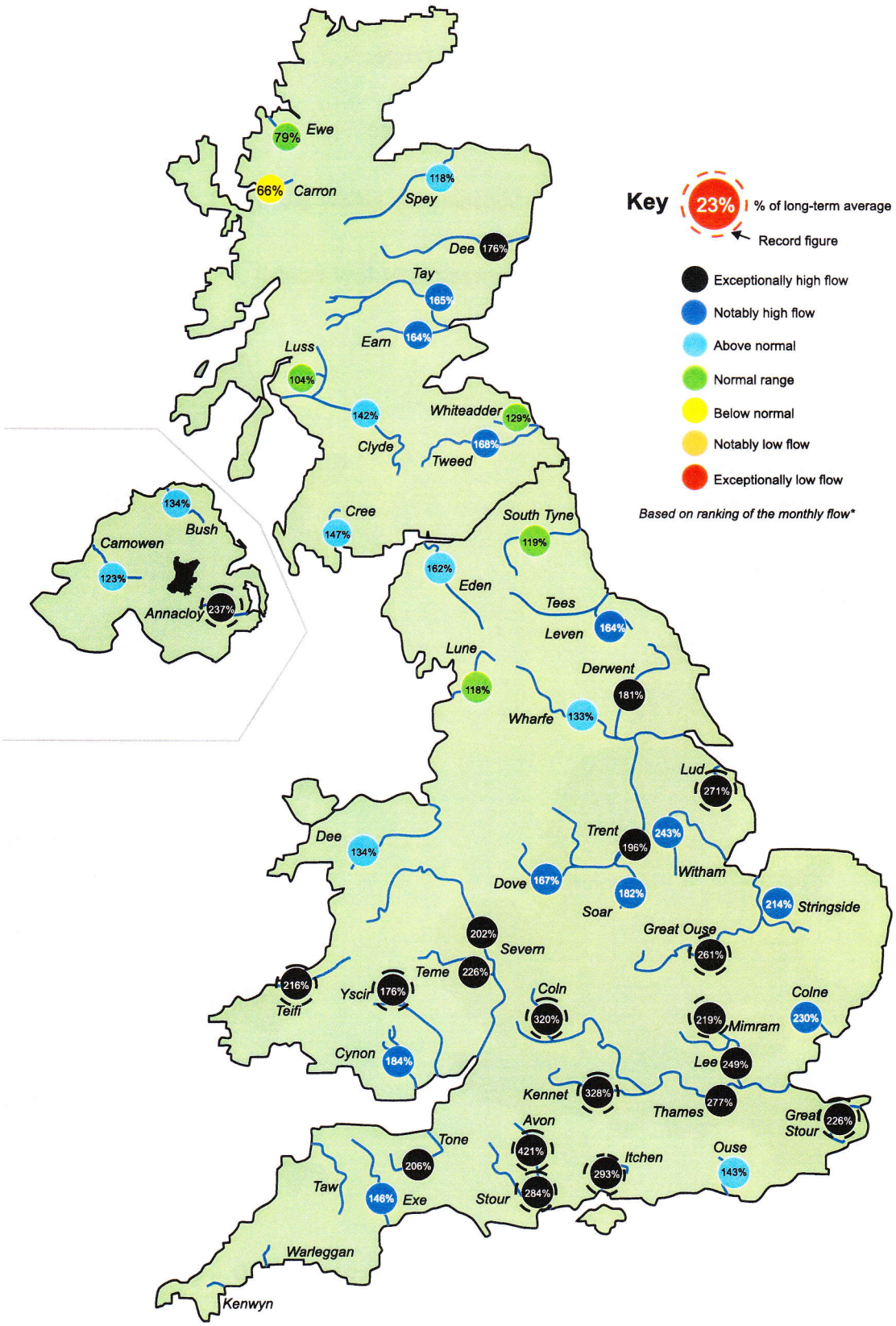
September 2000 - December 2000



January 2000 - December 2000

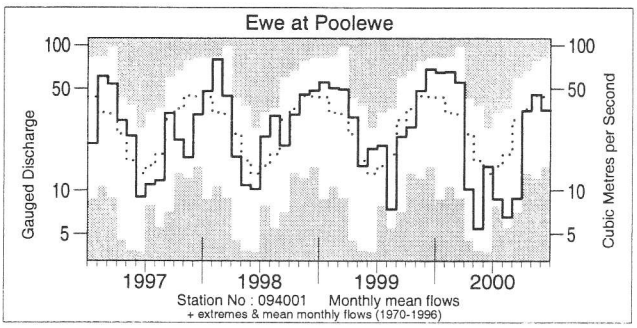
Rainfall accumulation maps

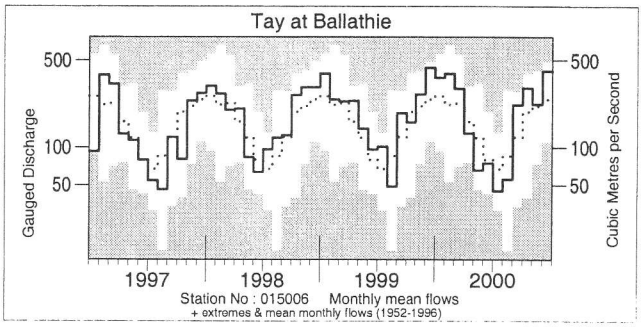
Provisional data indicate that the September-December period was the wettest on record for England and Wales (in a series from 1766) and for Northern Ireland (from 1900). On an annual basis, the 2000 rainfall totals rank 8th wettest for E&W, 11th wettest for Scotland (but a cluster of years over the last decade have been wetter), and 20th wettest for NI.

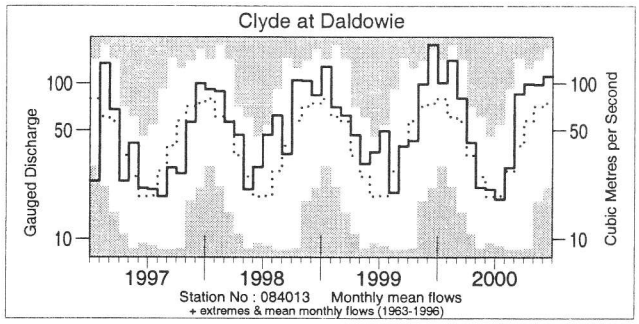


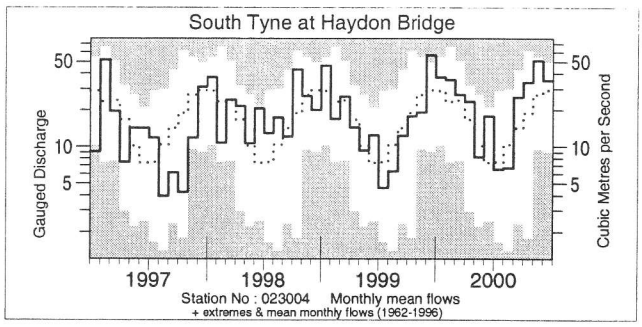
River flows - December 2000

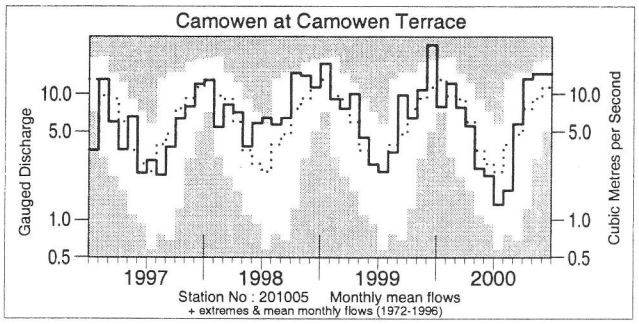
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

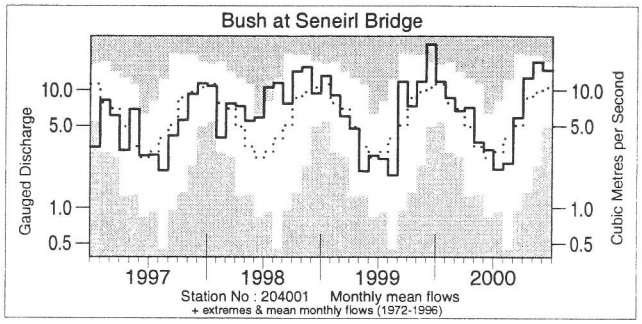


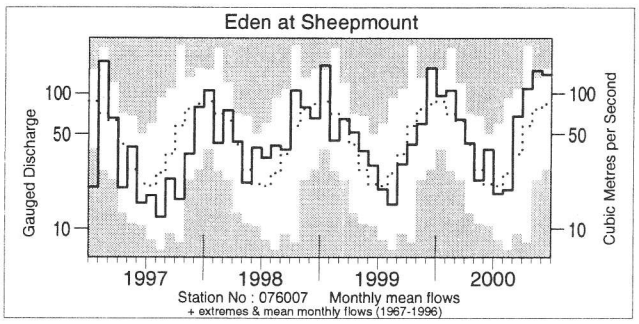


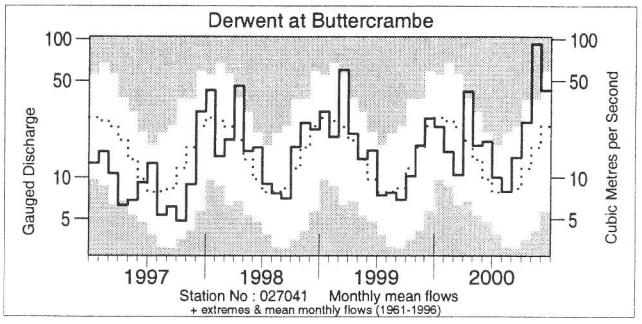


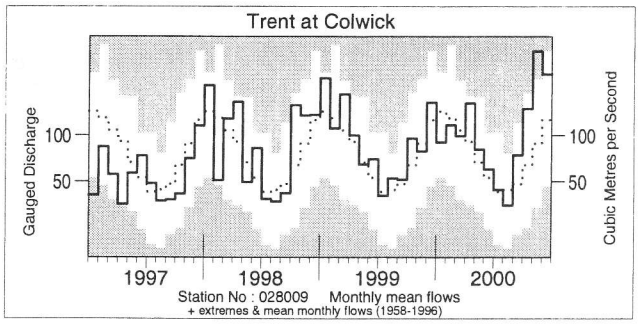


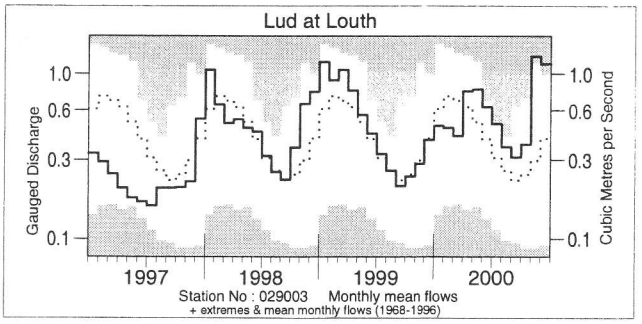








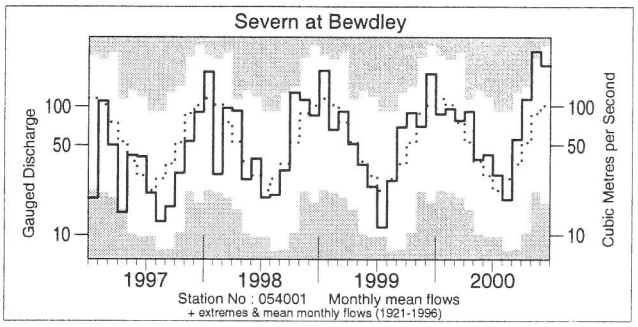


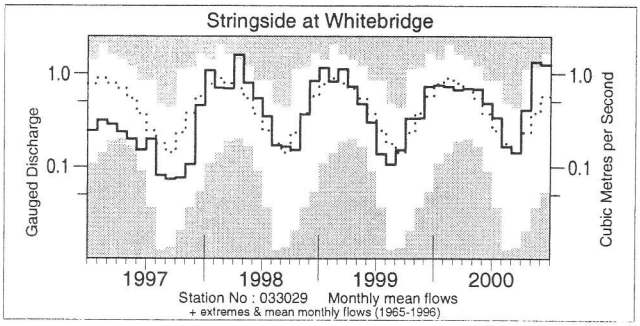


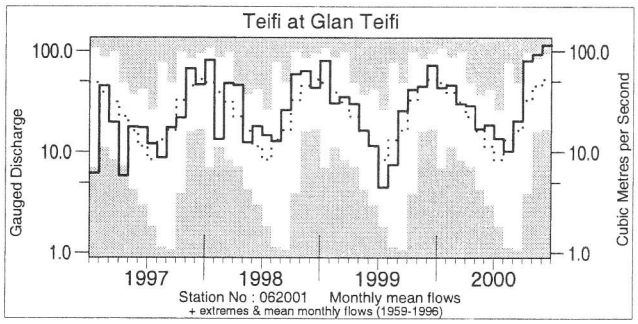
Monthly river flow hydrographs

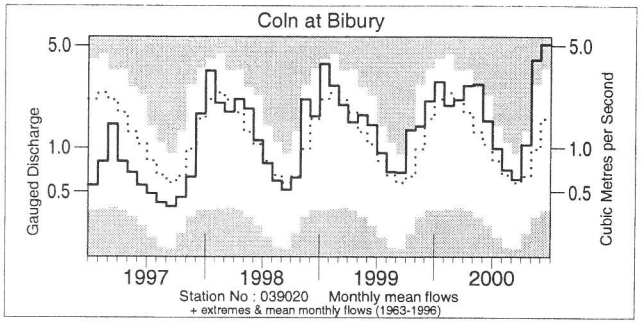
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1997 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

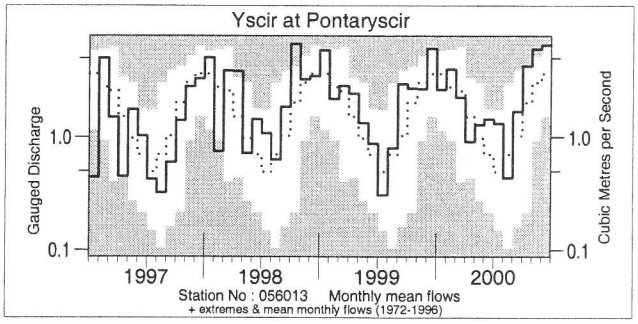
River flow . . . River flow . . .

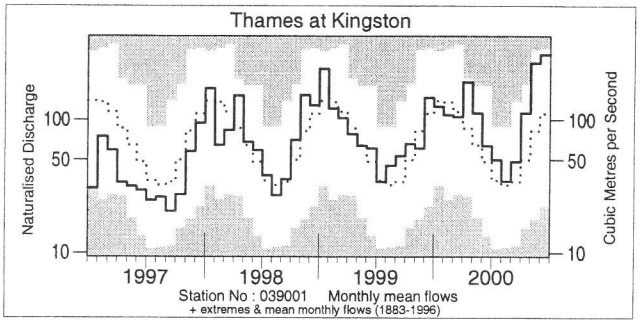


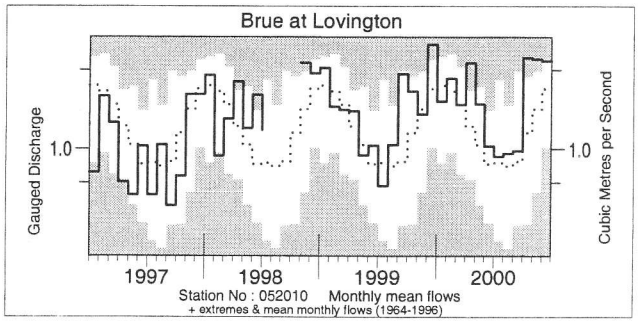


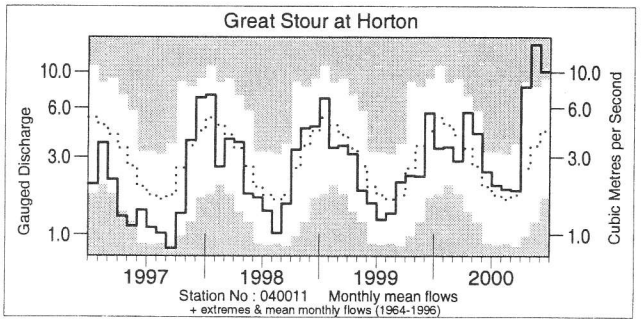


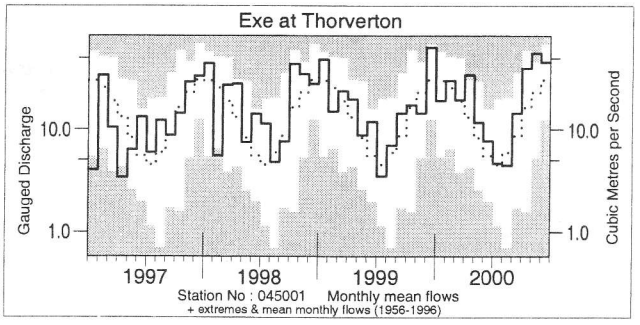


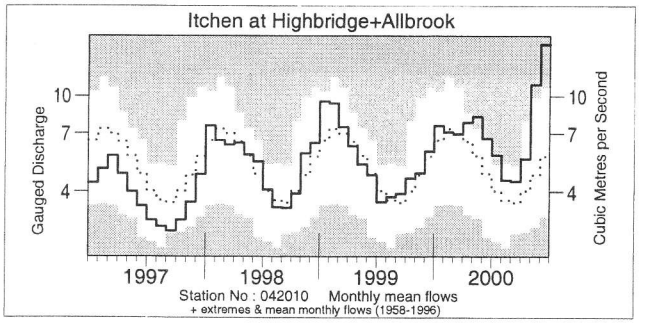










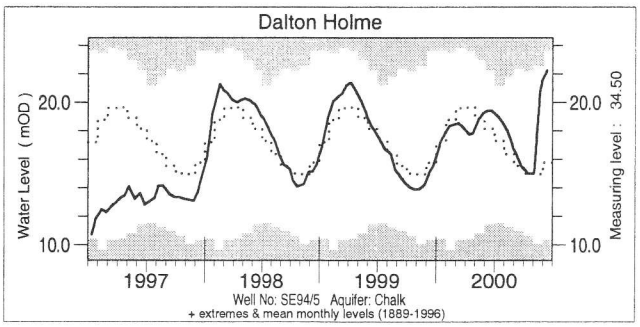


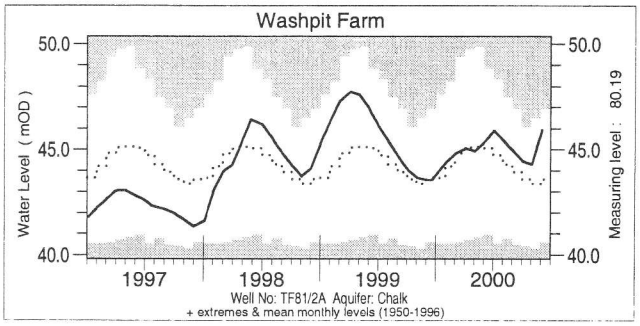
Notable runoff accumulations (a) October - December 2000, (b) January - December 2000

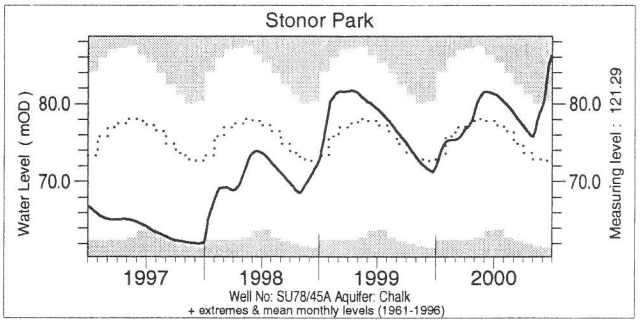
River	%lta	Rank	River	%lta	Rank	River	%lta	Rank
(a)Trent	254	43/43	Dee	213	64/64	Kennet	158	39/39
Lee	320	116/116	Camowen	143	29/29	Avon	181	35/35
Itchen	224	43/43	(b)Tweed	129	40/40	Tone	150	39/39
Severn	237	80/80	Witham	164	41/41	Clyde	145	37/37

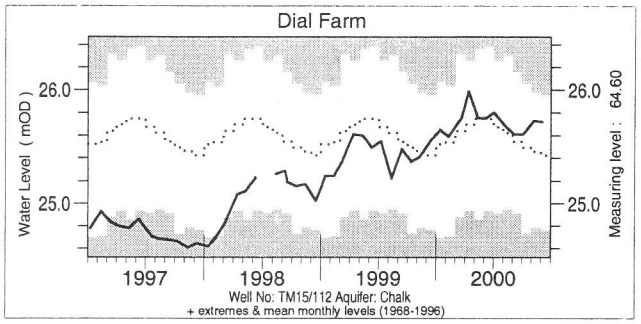
lta = long term average
Rank 1 = lowest on record

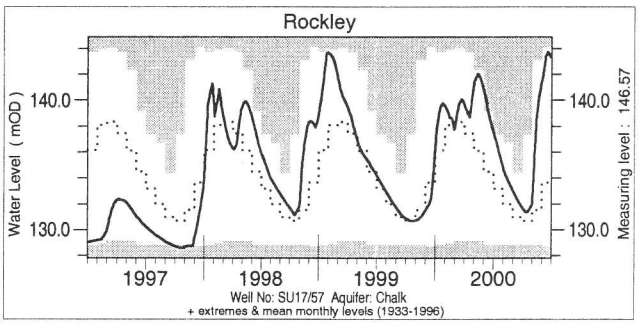
Groundwater . . . Groundwater

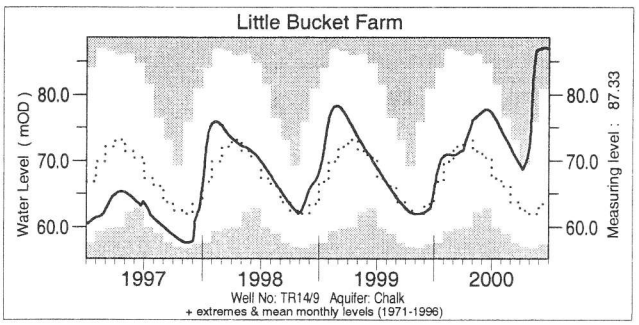


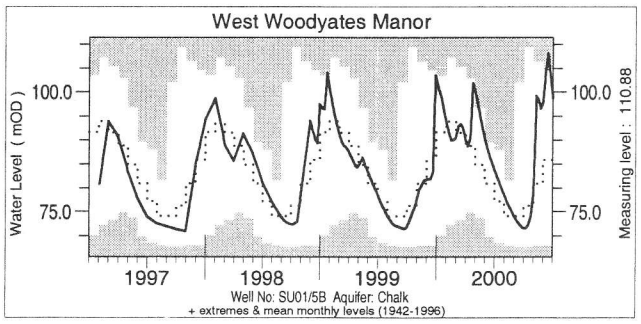


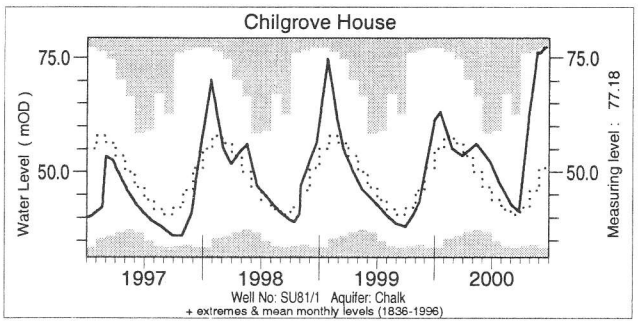


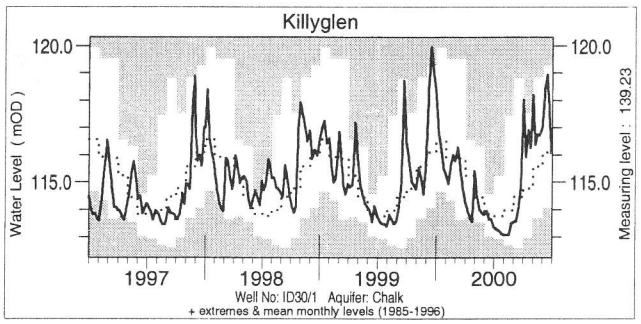


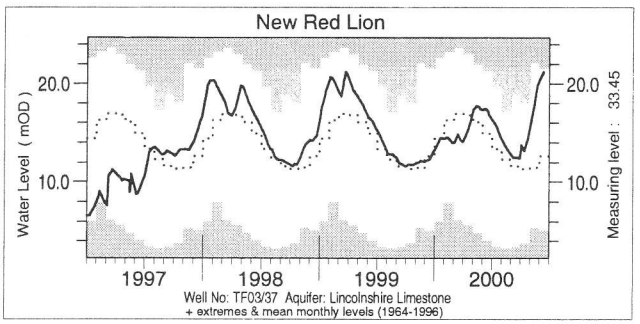








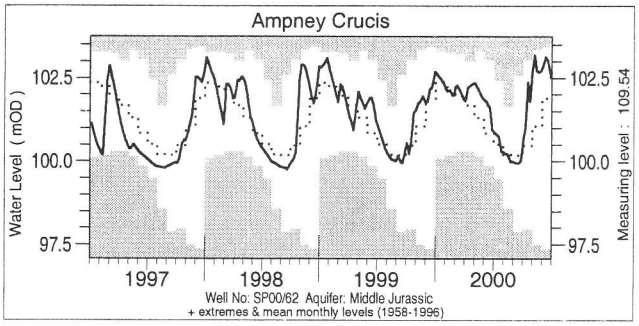


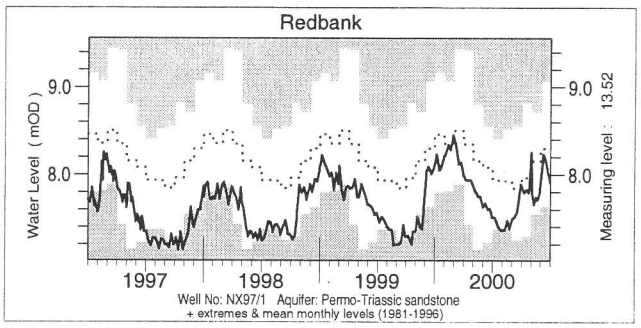


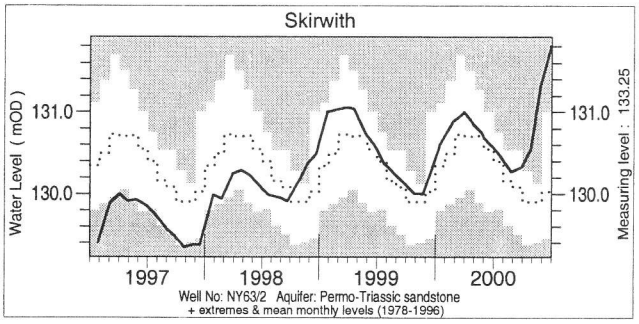
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

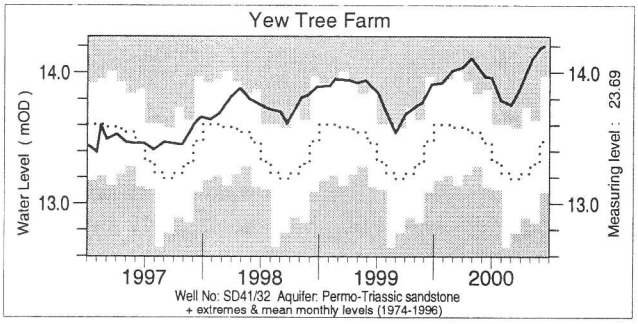
Note. Due to the impact of abstraction on groundwater levels at The Holt borehole, it has been replaced as an index site by the Stonor Park well.

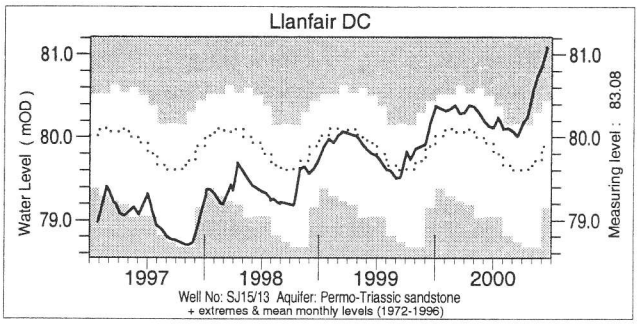
Groundwater . . . Groundwater

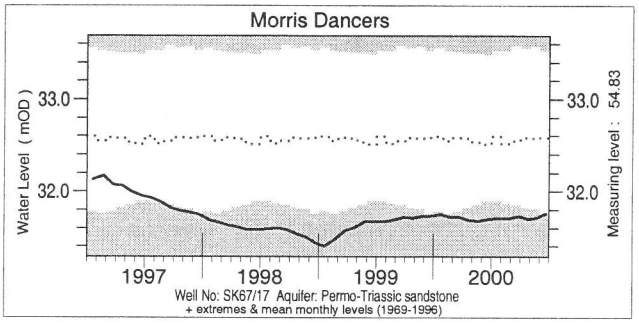


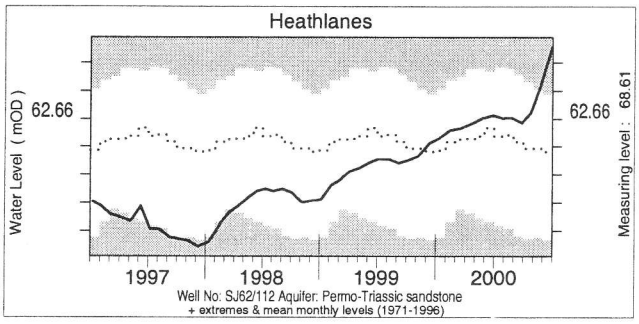


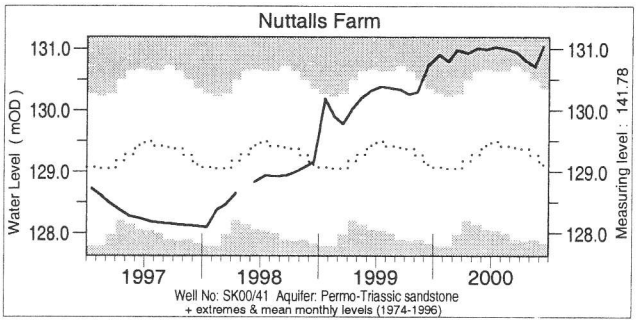


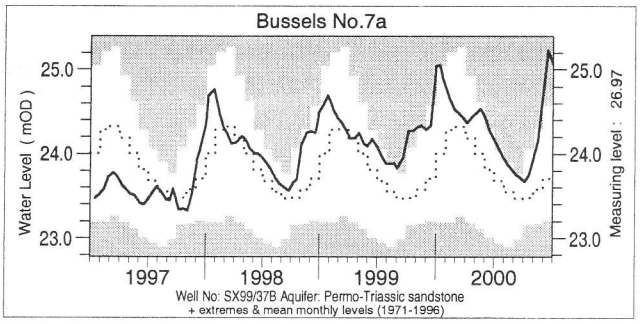


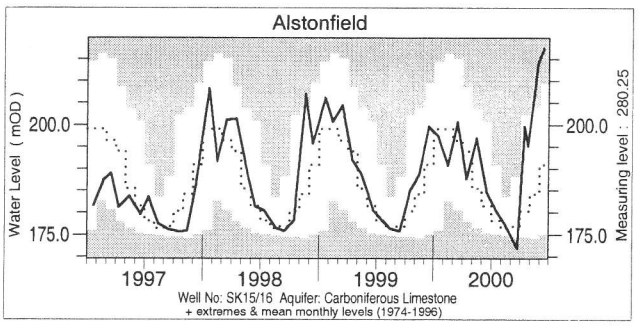












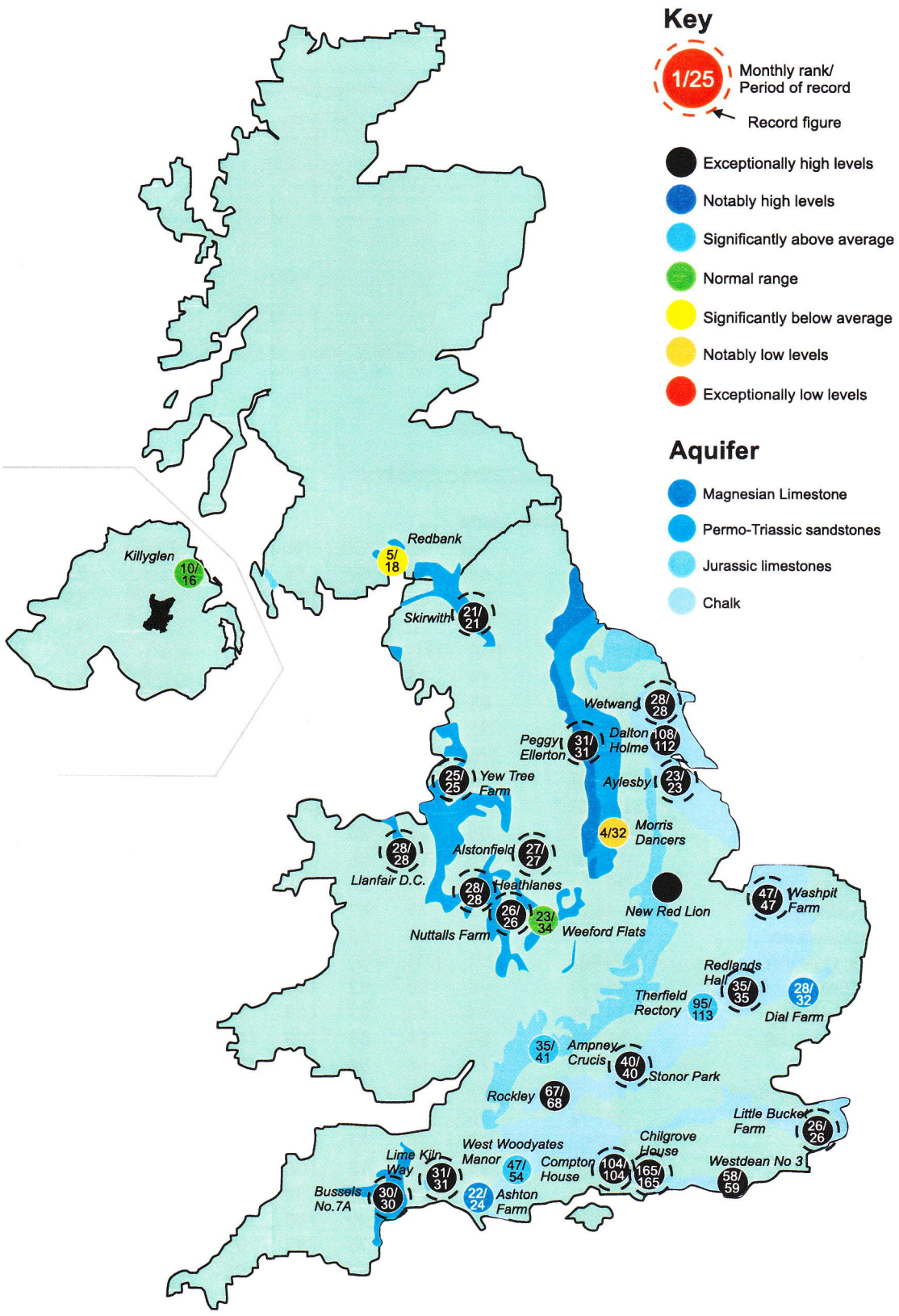
Groundwater levels December 2000/January 2001

Borehole	Level	Date	Dec. av.
Dalton Holme	22.20	12/12	15.53
Washpit Farm	47.41	04/01	43.23
Therfield Rectory	81.07	29/12	77.66
Dial Farm	25.72	04/12	25.38
Rockley	143.08	02/01	133.63
Little Bucket	86.94	31/12	63.77
West Woodyates	98.70	31/12	86.56

Borehole	Level	Date	Dec. av.
Chilgrove	77.18	21/12	51.83
Killyglen	116.30	01/01	116.26
New Red Lion	21.22	13/12	12.47
Ampney Crucis	102.77	02/01	101.88
Redbank	7.91	29/12	8.21
Skirwith	131.80	27/12	130.15
Yew Tree Farm	14.20	12/12	13.50

Borehole	Level	Date	Dec. av.
Llanfair D.C.	81.12	01/01	79.78
Morris Dancers	31.76	22/12	32.43
Heathlanes	63.78	28/12	61.79
Nuttalls Farm	131.04	12/12	129.27
Bussels No. 7A	25.08	29/12	23.79
Alstonfield	217.53	13/12	191.69

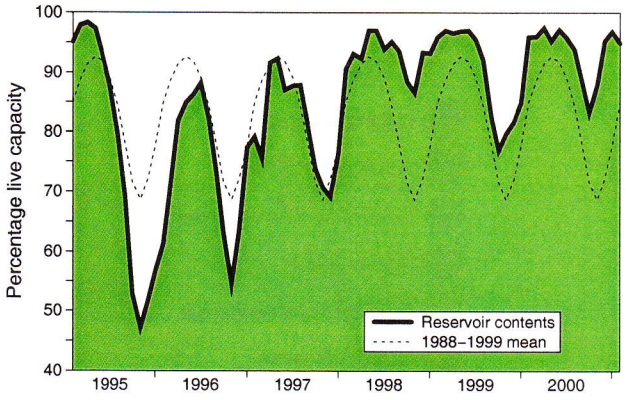
Levels in metres above Ordnance Datum



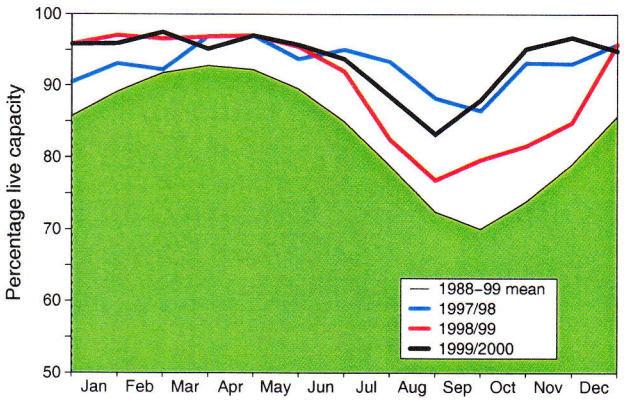
Groundwater levels - December 2000

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 Aug	Sep	Oct	Nov	Dec	2001 Jan	Min. Jan	Year* of min
North West	N Command Zone	• 124929	64	54	62	78	96	95	51	1996
	Vyrnwy	55146	93	89	99	100	100	93	35	1996
Northumbrian	Teesdale	• 87936	87	78	95	99	100	99	41	1996
	Kielder	(199175)	(90)	(91)	(93)	(97)	(95)	(93)	70	1990
Severn Trent	Clywedog	44922	96	88	90	98	98	82	54	1996
	Derwent Valley	• 39525	86	75	87	100	100	100	10	1996
Yorkshire	Washburn	• 22035	83	76	85	98	97	89	23	1996
	Bradford supply	• 41407	76	67	83	99	100	99	22	1996
Anglian	Grafham	** (55490)	(93)	(92)	(94)	(94)	(89)	(88)	57	1998
	Rutland	**(116580)	(90)	(84)	(81)	(89)	(89)	(89)	60	1991
Thames	London	• 202340	88	83	88	97	98	98	60	1991
	Farmoor	• 13830	96	98	95	90	90	80	71	1991
Southern	Bewl	28170	93	85	80	89	98	100	38	1991
	Ardingly	4685	93	78	83	100	100	100	61	1990
Wessex	Clatworthy	5364	80	66	63	100	100	100	59	1989
	Bristol WW	• (38666)	(87)	(77)	(76)	(95)	(99)	(95)	40	1991
South West	Colliford	28540	95	90	92	100	100	100	46	1996
	Roadford	34500	94	92	97	100	99	98	23	1996
	Wimbleball	21320	89	80	83	100	100	100	46	1996
	Stithians	5205	74	58	56	76	100	100	37	1992
Welsh	Celyn and Brenig	• 131155	99	97	98	99	100	95	54	1996
	Brianne	62140	96	92	97	100	100	94	76	1996
	Big Five	• 69762	87	78	83	90	89	94	67	1996
	Elan Valley	• 99106	94	88	96	100	100	100	56	1996
East of Scotland	Edinburgh/Mid Lothian	• 97639	84	76	91	99	100	99	60	1999
	East Lothian	• 10206	93	93	100	100	100	100	48	1990
West of Scotland	Loch Katrine	• 111363	53	50	75	97	98	90	80	1996
	Daer	22412	66	68	98	100	100	100	83	1996
	Loch Thom	• 11840	59	60	80	100	100	100	93	1998
Northern Ireland	Silent Valley	• 20634	42	33	45	65	85	100	61	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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RG12 2SY
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Fax: 01344 854906

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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CEH Wallingford
Maclean Building
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Oxfordshire
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Selected text and maps are available on the WWW at http://www.nwl.ac.uk/ih

NATURAL ENVIRONMENT RESEARCH COUNCIL

12/00