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

Hydrological summary

for the United Kingdom

October 2000

General

The remarkably widespread and protracted flooding in October and early November has served to underline our continuing vulnerability to exceptional climatic conditions. Following a wet September, the October rainfall total - for England and Wales - ranks second wettest in a series from 1767. As catchments became saturated, the area at risk from substantial flooding increased rapidly. By early November more than 50 Severe Flood Warnings were in force across England and Wales; notable spates were reported from Scotland and Northern Ireland also. At the national scale, it is the most severe (widespread) flood episode since the snowmelt induced flooding of March 1947. Unsurprisingly, current reservoir stocks and groundwater resources are very healthy but there is a high risk of further substantial flooding. The very extensive flooding has focussed attention on the possible roles of floodplain development and climate change. Whilst the hydrological volatility of the recent past may reflect changing climatic conditions, there is a need to strengthen our capability to identify climate-driven trends in the magnitude and frequency of fluvial flooding.

Rainfall

A sequence of very vigorous frontal systems crossed the British Isles during October – the unusual position of the Polar Front encouraged a more southerly track than normal. The 9-12th was extraordinarily wet: on the 9th storm totals exceeded 80 mm in parts of Antrim and Down; a 48-hour total of 125 mm was reported for West Freugh (Dumfries and Galloway); In Sussex, Barcombe reported 175 mm in less than 72 hrs (return period: c 400 years), Plumpton 144 mm in 24 hours and Uckfield 150 mm in 12 hours (on the 12th). Thereafter, significant pulses of rain occurred on most days culminating on the 29/30th when many catchments reported > 40 mm (Andover recorded 62.2 mm in 16 hrs); in northern England, blizzard conditions produced significant snow accumulations on the Pennines. Over the six days to Nov. 2nd Linton-on-Ouse (North Yorkshire) recorded more than twice the average October rainfall. Throughout most of England October rainfall totals exceeded twice the average, a few areas in Sussex and Kent registering >350%. Many new October rainfall records were established – Baronscourt in NI recorded its second highest total (for any month) in a record from 1892. In parts of Kent and Sussex (e.g. Crowborough and Barcombe) the October rainfall equates to 40-50% of the average annual rainfall – catchments receiving more than 35% were widely distributed. For E&W, it was the wettest month since November 1970, closely matching March 1947. Exceptionally unsettled conditions continued into November, and by the second week the autumn (Sept-Nov) rainfall total was already the third highest since 1852.

River Flows

Generally, soil moisture deficits had been satisfied by the second week of October and most rivers were very responsive to further rainfall. In the South-East a considerable number of rivers draining impermeable catchments (e.g. the Uck and Ouse in Sussex, and Teise in Kent) registered new maximum flows around the 11/12th. Flooding also occurred across the South-West, in parts of Northern Ireland and in Dumfries and Galloway – where flows on the Cree were unprecedented in a record from 1963. In some coastal areas high tides and wind surges were exacerbating factors. Further rainfall prevented recessions gaining much momentum and the storms of the 29/30th triggered a second, more extensive, phase of flooding. A few areas in Sussex and Kent (e.g. Yalding) experienced three separate inundations over a four-week period. Existing October maximum flows were widely eclipsed across the UK and some peaks were without recorded precedent (e.g. on the Rivers Taw, Tone and Hampshire Avon). Locally, some drainage systems were overwhelmed (not helped by excessive leaf fall in the storms) – contributing to a miserable month for transport; excessive surface runoff from cultivated fields also caused local flooding (e.g. near Brighton). An outstanding peak on the River Wharfe, combined with very heavy runoff from other tributaries, produced massive washland inundation on the lower Ouse; unprotected areas of York were inundated. Further heavy rainfall in early November saw the flood threat extend to the North-East and parts of Scotland (e.g. Edinburgh). In most large catchments peak flows were appreciably lower than in March 1947 (when snowmelt, over frozen ground, was a major contributory factor) but the extent and protracted nature of the current event qualifies it as the most severe since. Nothwithstanding the low early October flows, monthly runoff totals were amongst the highest on record. Many new October maxima were established (e.g. on the Rivers Mole, Welsh Dee and Cree); autumn totals are likely to be even more outstanding.

Groundwater

The surge of infiltration over the six weeks from around the 9th October has few recent precedents (early 1994 in the South Downs would be one). Although the infiltration capacity of the soils was exceeded during a few intense storms, October infiltration totals were still exceptional. Approaching mid-November, estimated recharge for some eastern and southern Chalk outcrops exceeds the normal winter average. The monthly sampling employed for most index wells – together with the lag between infiltration and water-table response - means that the October groundwater level hydrographs are generally unrepresentative of the scale of the autumn recovery. Levels in most aquifer units are above average and rising briskly. High level springs are flowing remarkably early, flows in the Lavant (Sussex) -which is normally dry through the autumn - currently exceed the late-winter average. The prospect of a long recharge season underlines a healthy outlook for groundwater resources but further significant increases in groundwater levels will bring the risk of more sustained flooding.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall accumulations and return period estimates

Area	Rainfall	Oct 2000	Sep 00-Oct 00	RP	Jul 00-Oct 00	RP	Apr 00-Oct 00	RP	Jan 00-Oct 00	RP
England & Wales	mm	**177**	**296**		**423**		**676**		**851**	
	%	**208**	**183**	**>100**	**141**	**20-30**	**138**	**>50**	**120**	**10-15**
North West	mm	259	430		614		897		1193	
	%	202	177	>50	141	20-30	135	30-40	125	10-20
Northumbrian	mm	128	240		367		631		811	
	%	168	161	20-30	124	5-10	133	20-30	118	5-10
Severn Trent	mm	134	243		356		598		729	
	%	209	190	>50	144	20-30	142	>50	120	5-10
Yorkshire	mm	151	283		399		681		815	
	%	207	201	>100	146	20-35	150	>100	124	10-20
Anglian	mm	114	196		295		498		589	
	%	224	196	>100	145	20-30	143	>50	122	10-20
Thames	mm	157	251		344		588		701	
	%	253	208	>100	151	20-35	151	>100	127	10-20
Southern	mm	226	336		430		689		816	
	%	283	226	>200	169	>100	166	>200	133	30-40
Wessex	mm	175	283		397		659		818	
	%	222	187	>50	147	20-30	150	>50	124	10-20
South West	mm	223	361		503		775		999	
	%	192	173	30-40	139	10-20	135	20-30	110	2-5
Welsh	mm	254	412		601		912		1234	
	%	185	163	30-40	140	10-20	136	30-40	121	10-20
Scotland	mm	**227**	**372**		**533**		**768**		**1264**	
	%	**146**	**125**	**5-10**	**105**	**2-5**	**101**	**2-5**	**111**	**5-10**
Highland	mm	271	382		533		800		1522	
	%	137	104	2-5	89	2-5	91	2-5	112	5-10
North East	mm	155	265		401		664		901	
	%	160	144	10-20	117	2-5	123	10-20	115	5-10
Tay	mm	197	359		522		754		1159	
	%	152	147	10-20	126	5-10	119	5-10	118	5-10
Forth	mm	151	306		477		701		1053	
	%	131	136	5-10	121	5-10	118	5-10	119	10-20
Tweed	mm	126	257		439		674		912	
	%	133	140	5-10	127	5-10	125	10-20	116	5-10
Solway	mm	280	485		697		938		1364	
	%	178	162	30-40	137	10-20	124	10-20	121	5-10
Clyde	mm	282	504		701		923		1517	
	%	146	135	5-10	114	5-10	105	2-5	113	5-10
Northern Ireland	mm	**170**	**290**		**428**		**641**		**865**	
	%	**150**	**137**	**5-10**	**116**	**2-5**	**112**	**2-5**	**102**	**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.

Rainfall . . . Rainfall . . . Rainfall

Key

00% Percentage of 1961-90 average

Very wet

Substantially above average

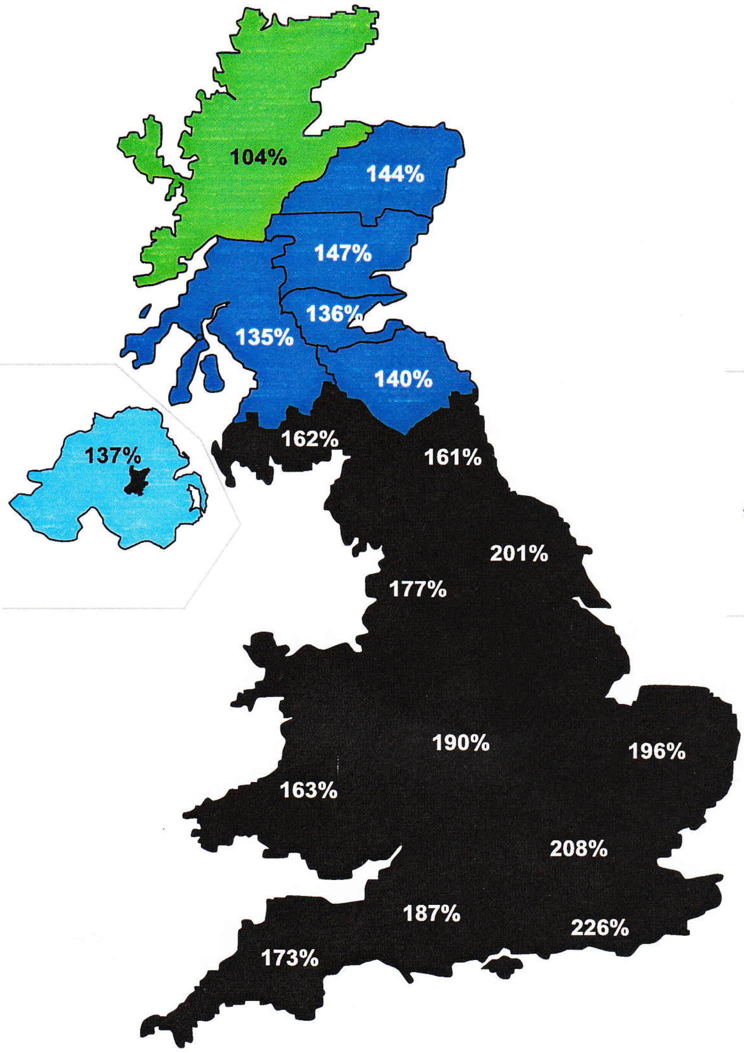
Above average

Normal range

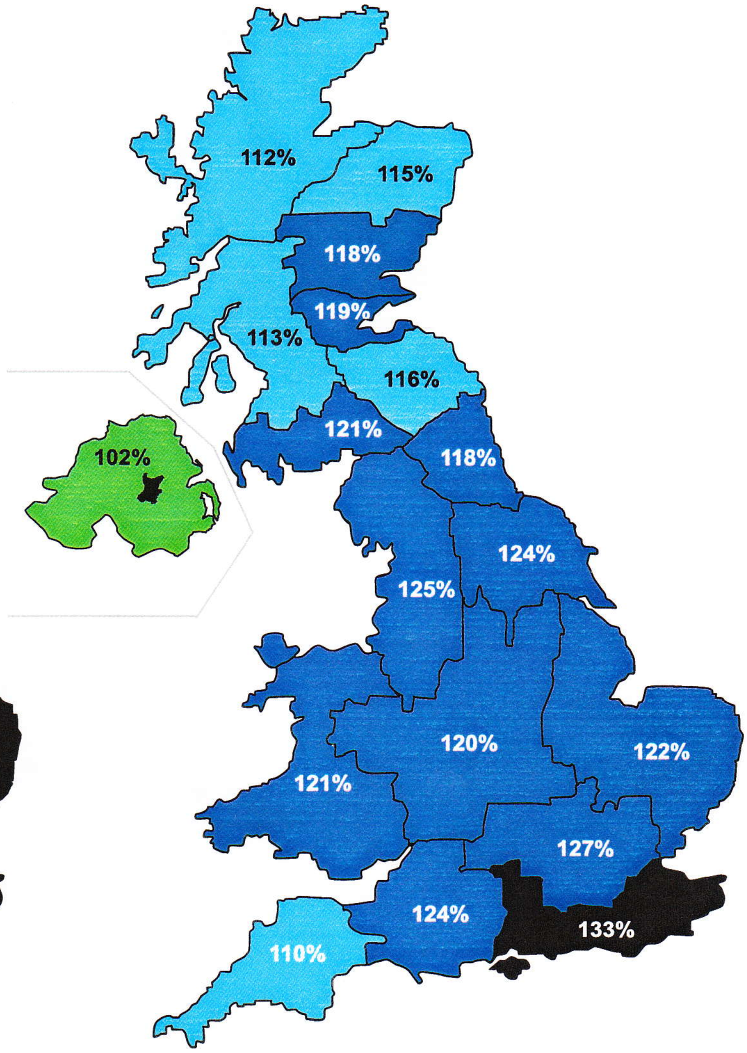
Below average

Substantially below average

Exceptionally low rainfall



September 2000 - October 2000

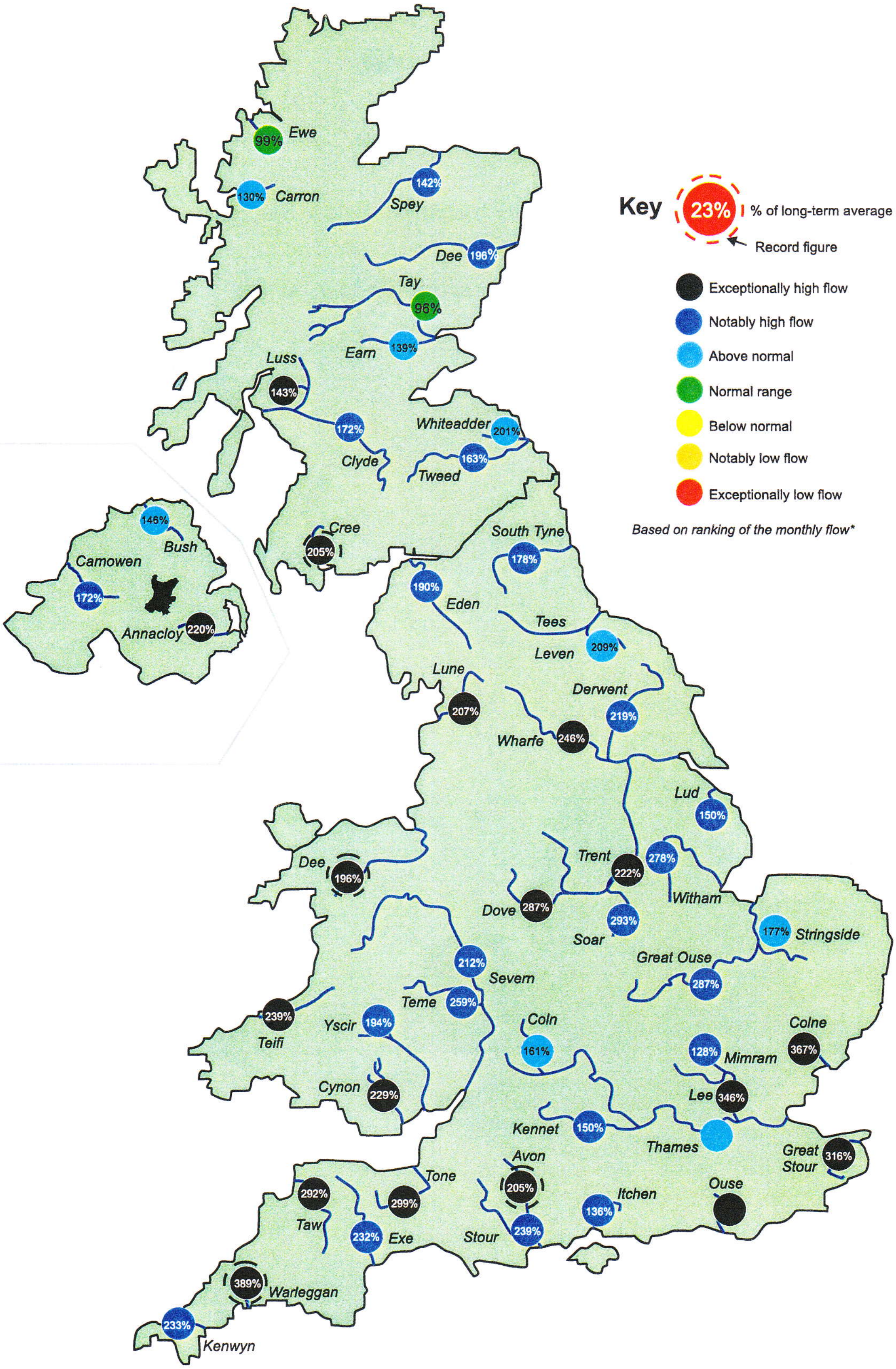


January 2000 - October 2000

Rainfall accumulation maps

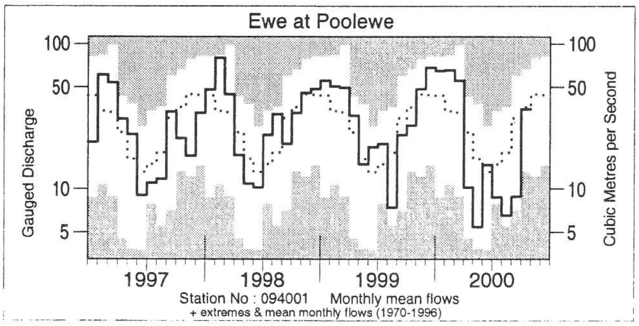
The provisional October rainfall total for the UK ranks equal second wettest on record in a series from 1900. Similarly, the combined September and October rainfall total ranks equal third wettest (1976 was comparable). Substantial parts of southern Britain recorded around twice the average rainfall for September/October and a continuation of unsettled conditions through November may see the highest UK autumn rainfall total (that for 1935) eclipsed.

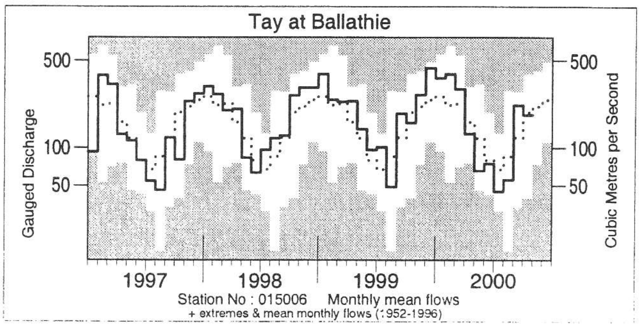
River flow . . . River flow . . .

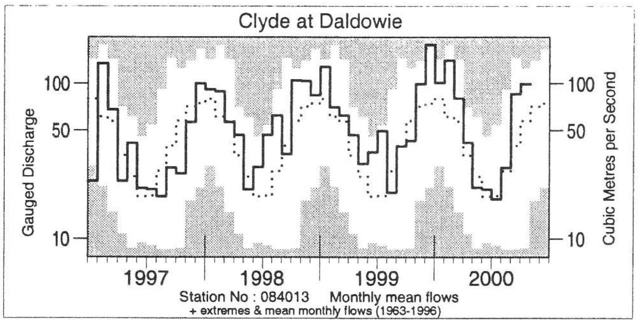


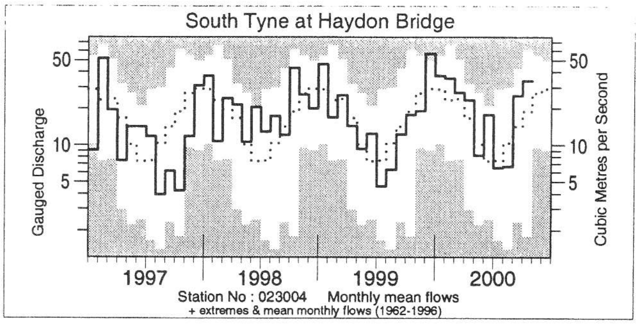
River flows - October 2000

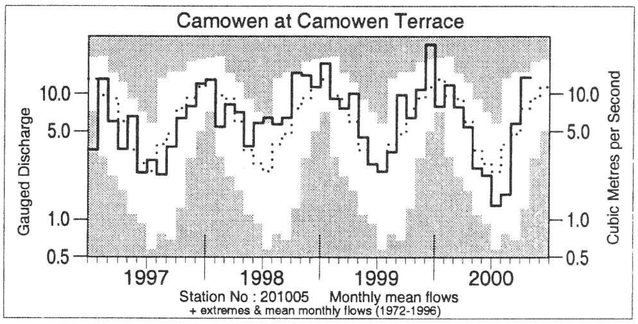
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

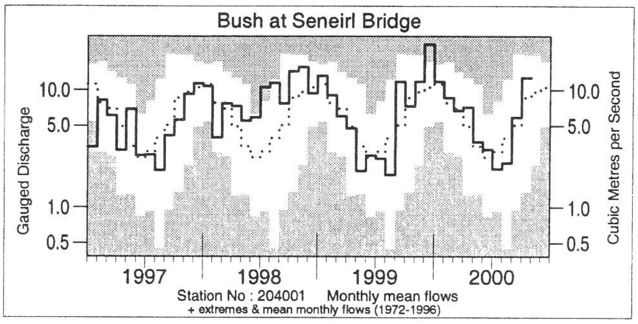


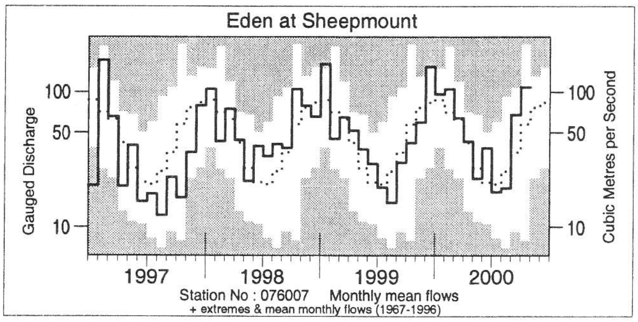


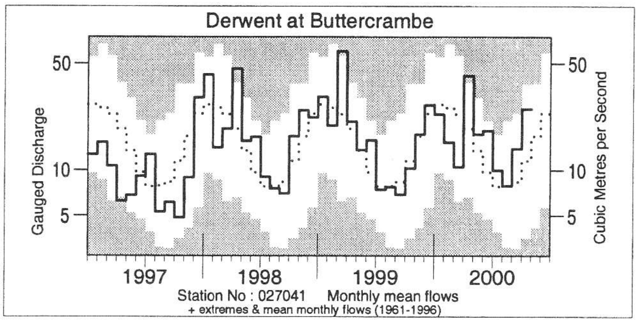


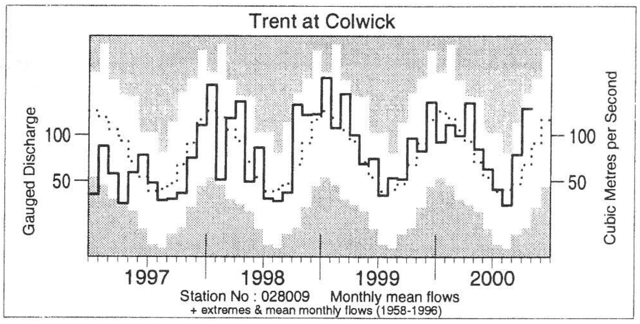


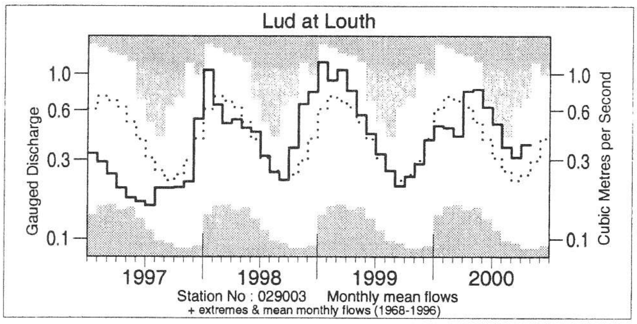








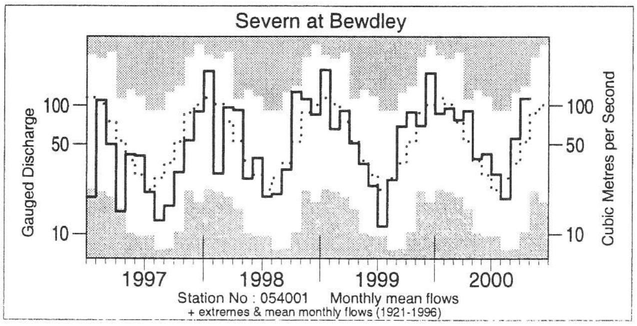


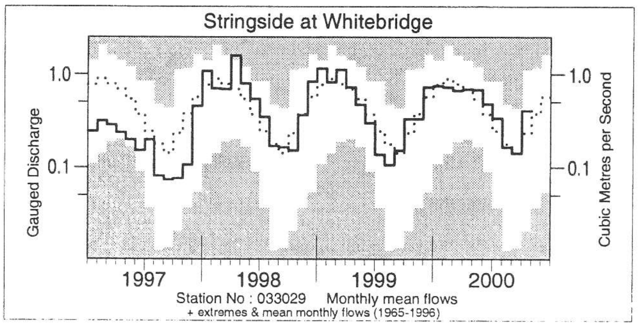


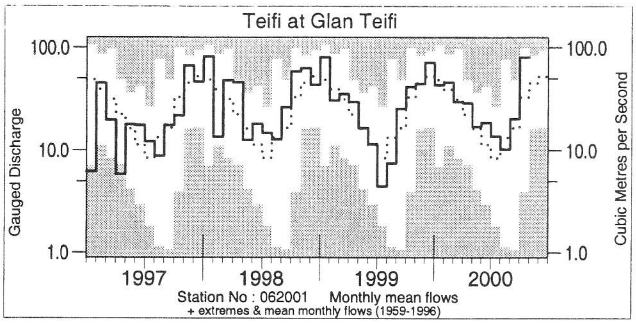
Monthly river flow hydrographs

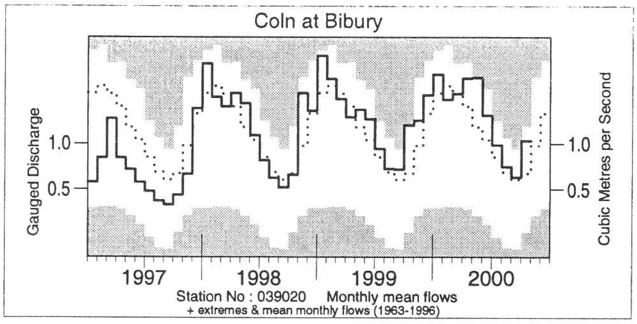
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1997 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded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

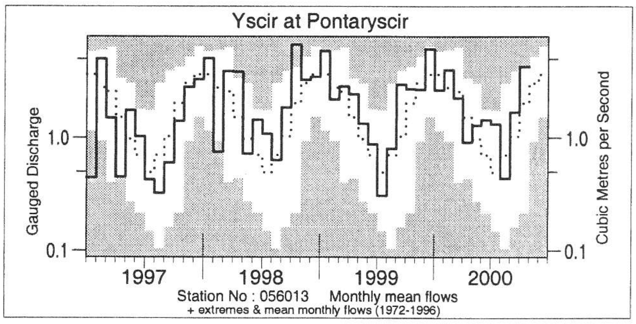
River flow . . . River flow . . .

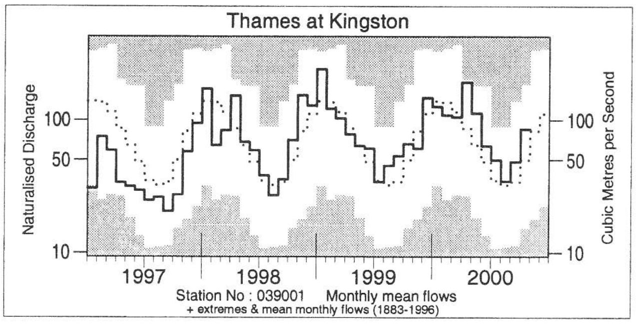


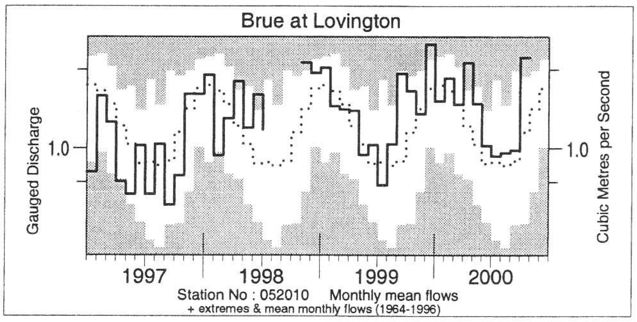


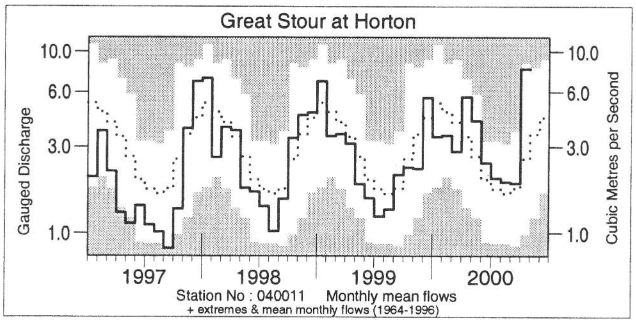


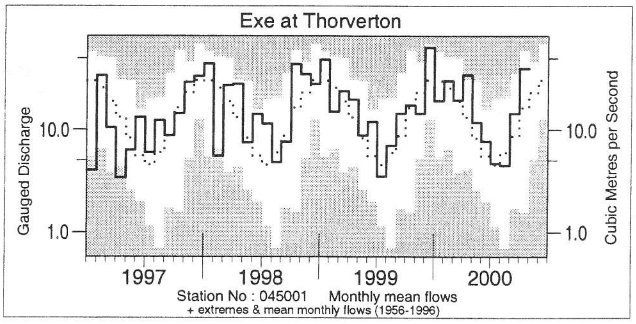


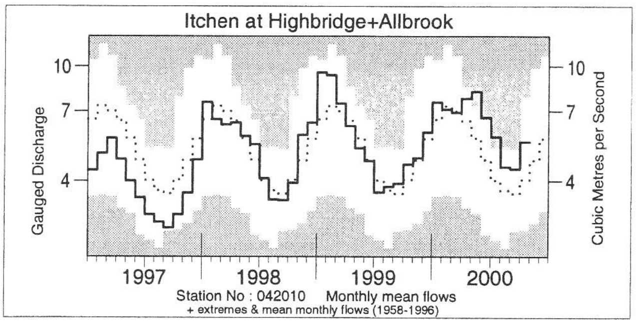










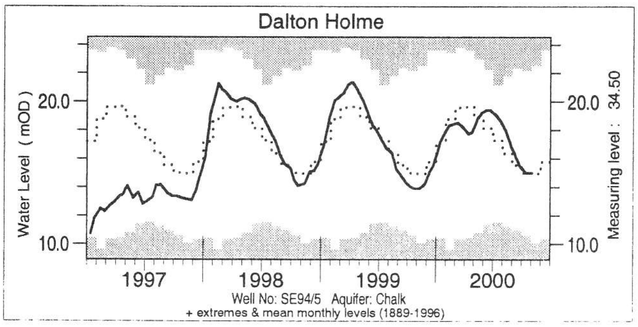


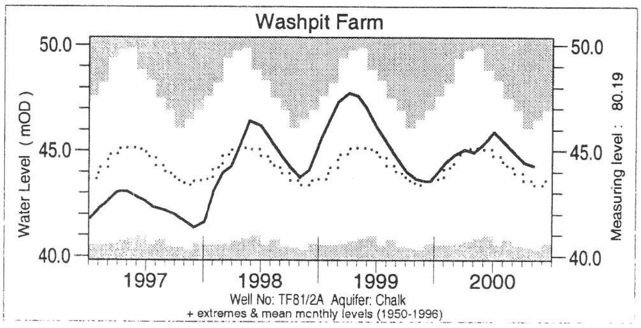
Notable runoff accumulations September - October 2000 (a); May 2000 - October 2000 (b)

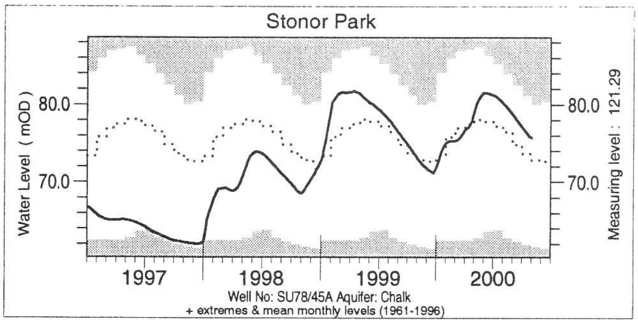
River	%lta	Rank	River	%lta	Rank	River	%lta	Rank
(a) Dover Beck	162	25/25	Warleggan	280	31/31	Mole	256	26/26
Lee	268	113/115	Nith	191	43/43	Avon	173	36/36
Mole	365	26/26	(b) Derwent	155	39/39	Tone	167	40/40
Avon	174	36/36	Witham	194	42/42	Dee	150	31/31
						Ewe	63	01/30

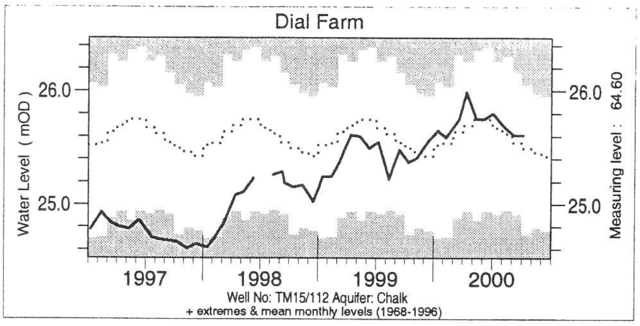
lta = long term average
Rank 1 = lowest on record

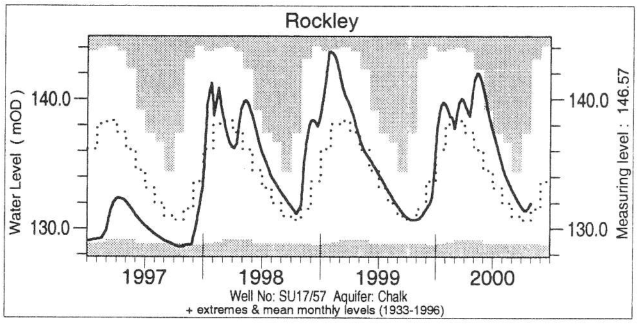
Groundwater . . . Groundwater

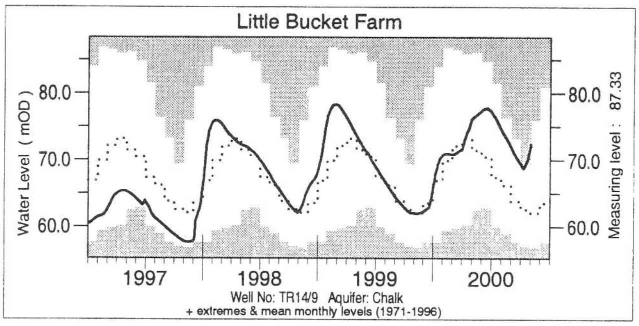


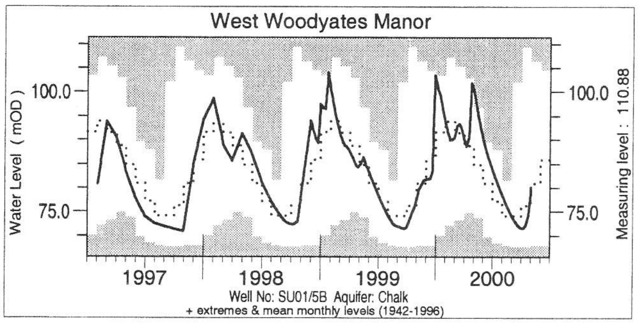


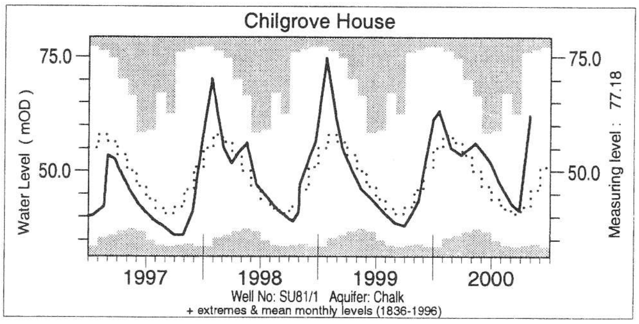


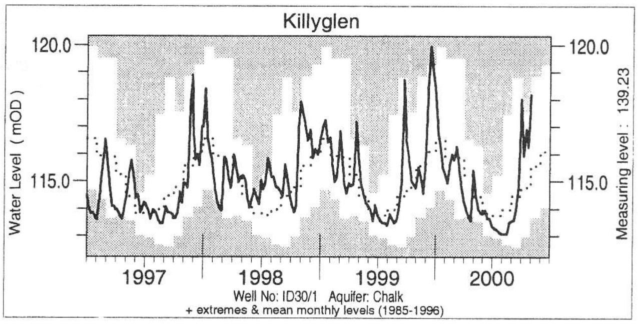


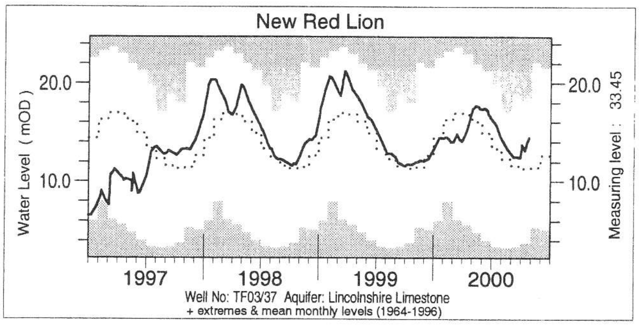










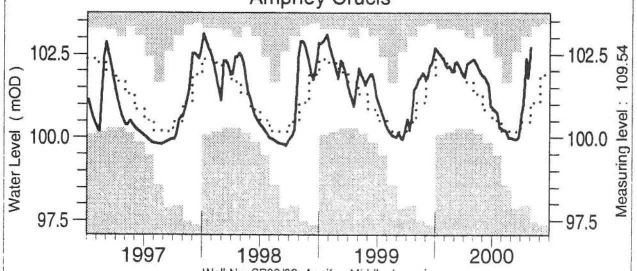


Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

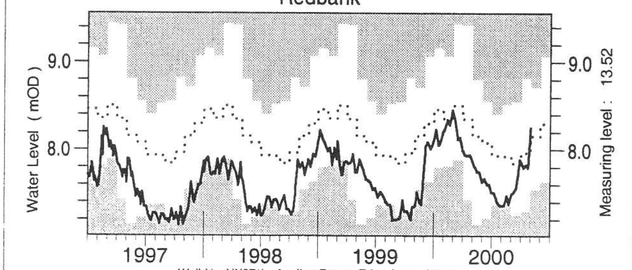
Groundwater . . . Groundwater

Ampney Crucis



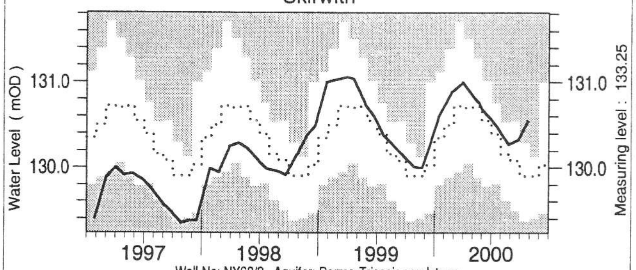
Well No: SP00/62 Aquifer: Middle Jurassic
+ extremes & mean monthly levels (1958-1996)

Redbank



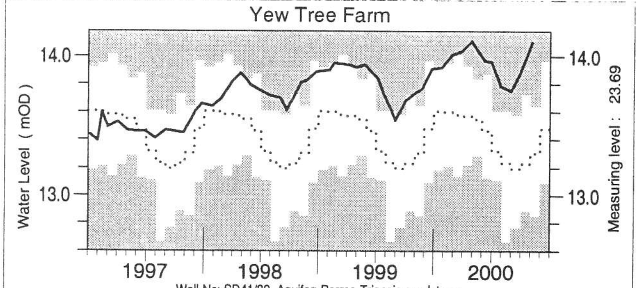
Well No: NX97/1 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1981-1996)

Skirwith



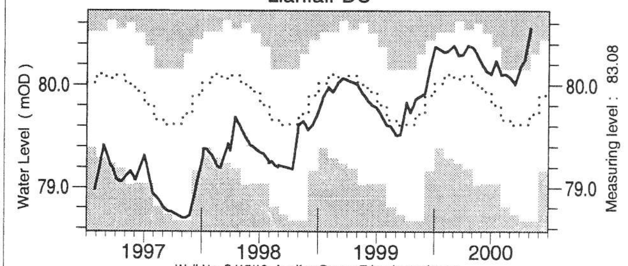
Well No: NY63/2 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1978-1996)

Yew Tree Farm



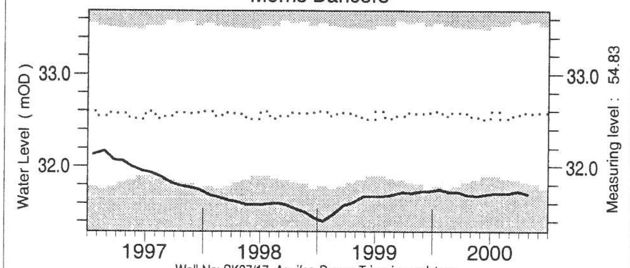
Well No: SD41/32 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1974-1996)

Llanfair DC



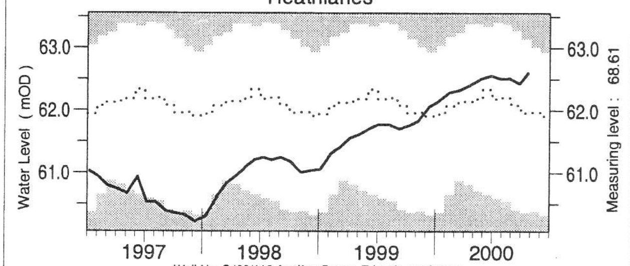
Well No: SJ15/13 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1972-1996)

Morris Dancers



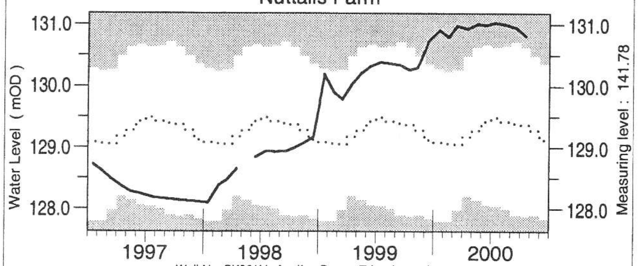
Well No: SK67/17 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1969-1996)

Heathlanes



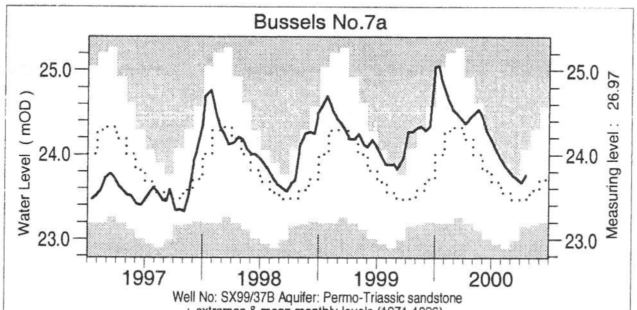
Well No: SJ62/112 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1971-1996)

Nuttalls Farm



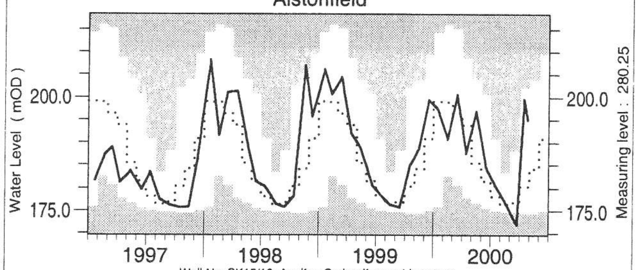
Well No: SK00/41 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1974-1996)

Bussels No.7a



Well No: SX99/37B Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1971-1996)

Alstonfield



Well No: SK15/16 Aquifer: Carboniferous Limestone
+ extremes & mean monthly levels (1974-1996)

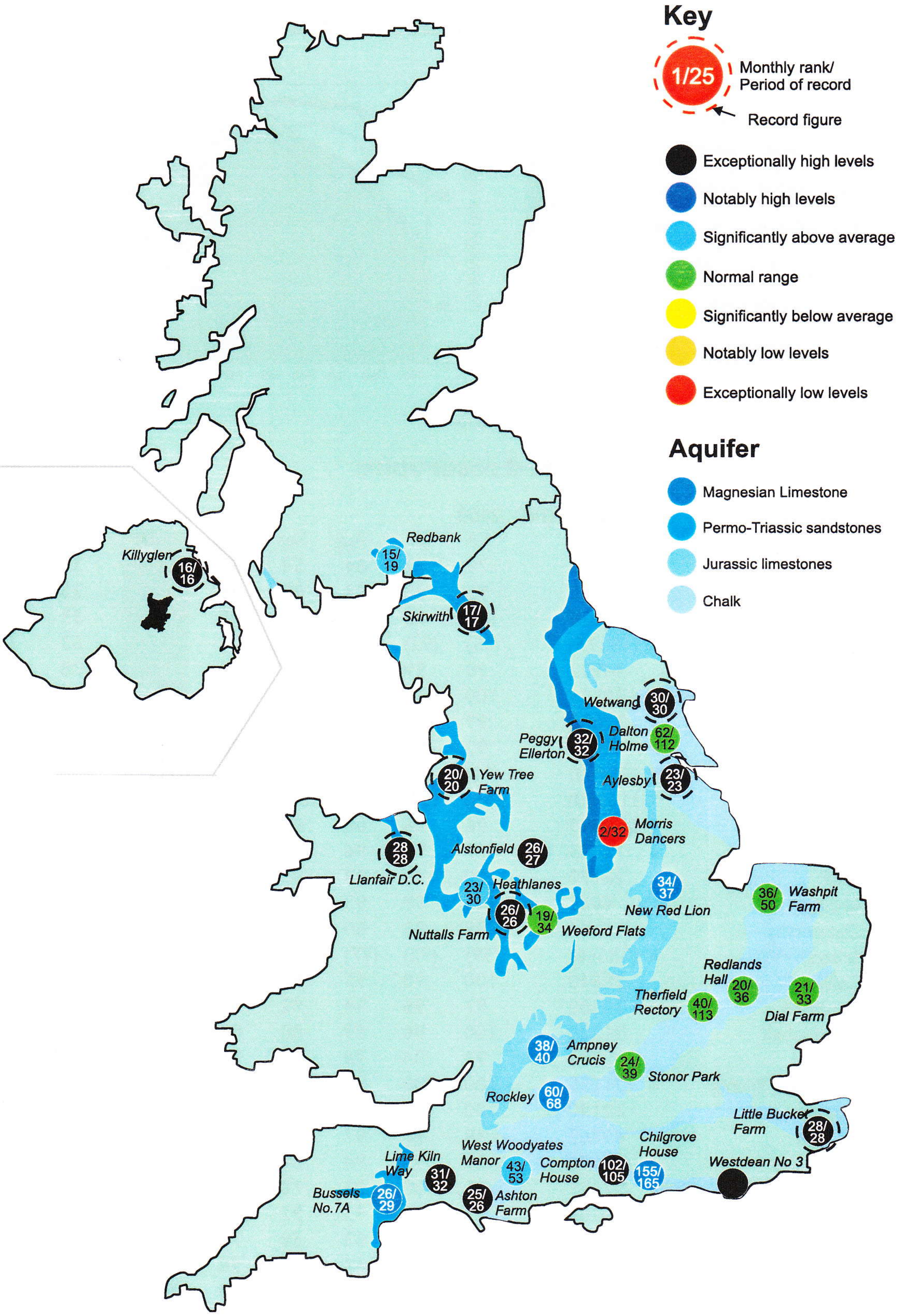
Groundwater levels October/ November 2000

Borehole	Level	Date	Oct. av.
Dalton Holme	15.01	02/11	14.90
Washpit Farm	44.29	03/11	43.46
Therfield Rectory	77.13	30/10	79.03
Dial Farm	25.61	04/10	25.44
Rockley	131.96	30/10	130.68
Little Bucket	72.39	31/10	63.38
West Woodyates	79.79	31/10	75.25

Borehole	Level	Date	Oct. av.
Chilgrove	62.26	27/10	42.53
Killyglen	118.18	30/10	114.75
New Red Lion	14.49	24/10	11.48
Ampney Crucis	102.71	30/10	100.45
Redbank	8.25	30/10	7.91
Skirwith	130.55	30/10	129.92
Yew Tree Farm	14.10	03/11	13.29

Borehole	Level	Date	Oct. av.
Llanfair D.C.	80.56	01/11	79.48
Morris Dancers	31.70	27/10	32.41
Heathlanes	62.61	23/10	61.89
Nuttalls Farm	130.81	16/10	129.46
Bussels No. 7A	23.76	18/10	23.53
Alstonfield	195.06	24/10	180.71

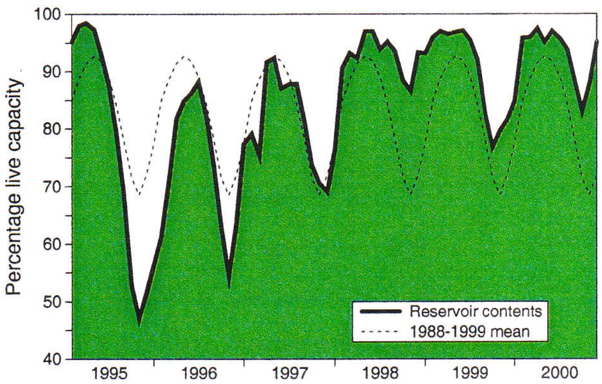
Levels in metres above Ordnance Datum



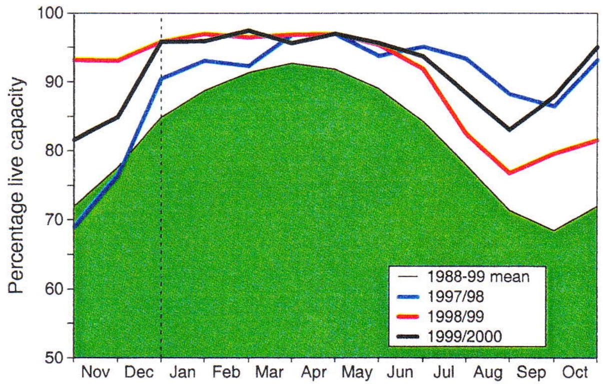
Groundwater levels - October 2000

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 Jun	Jul	Aug	Sep	Oct	Nov	Min. Nov	Year* of min
North West	N Command Zone	• 133375	79	77	64	54	62	78	38	1993
	Vyrnwy	55146	95	98	93	89	99	100	25	1995
Northumbrian	Teesdale	• 87936	100	93	87	78	95	99	33	1995
	Kielder	(199175)	(95)	(92)	(90)	(91)	(93)	(97)	63	1989
Severn Trent	Clywedog	44922	99	99	96	88	90	98	38	1995
	Derwent Valley	• 39525	100	92	86	75	87	100	15	1995
Yorkshire	Washburn	• 22035	99	90	83	76	85	98	15	1995
	Bradford supply	• 41407	92	90	76	67	83	99	16	1995
Anglian	Grafham	** (55490)	(91)	(92)	(93)	(92)	(94)	(94)	44	1997
	Rutland	**(116580)	(96)	(94)	(90)	(84)	(81)	(89)	59	1995
Thames	London	• 206399	96	96	88	83	88	97	46	1996
	Farmoor	• 13843	97	95	96	98	95	90	53	1990
Southern	Bewl	28170	100	100	93	85	80	89	33	1990
	Ardingly	4685	100	99	93	78	83	100	33	1996
Wessex	Clatworthy	5364	98	93	80	66	63	100	19	1989
	Bristol WW	• (38666)	(99)	(92)	(87)	(77)	(76)	(95)	24	1990
South West	Colliford	28540	100	98	95	90	92	100	42	1996
	Roadford	34500	97	96	94	92	97	100	18	1995
	Wimbleball	21320	100	96	89	80	83	100	26	1995
	Stithians	5205	92	84	74	58	56	76	18	1990
Welsh	Celyn and Brenig	• 131155	100	100	99	97	98	99	48	1989
	Brianne	62140	100	99	96	92	97	100	57	1995
	Big Five	• 69762	98	96	87	78	83	90	41	1995
	Elan Valley	• 99106	99	97	94	88	96	100	37	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	95	90	84	76	91	99	50	1998
	East Lothian	• 10206	99	96	93	93	100	100	48	1989
West of Scotland	Loch Katrine	• 111363	69	65	53	50	75	97	76	1997
	Daer	22412	90	80	66	68	98	100	70	1997
	Loch Thom	• 11840	79	69	59	60	80	100	73	1999
Northern Ireland	Silent Valley	• 20634	56	57	42	33	45	65	34	1995

() 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 October Hydrological Summary, in particular, stands 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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