Hydrological summary
for the United Kingdom

October 2002

General

During October the main focus of hydrological concern switched decisively from incipient drought conditions to the widespread threat of flooding. This is not a particularly rare circumstance in the late autumn, in southern Britain especially, but the hydrological contrast between early and late October was dramatic. A succession of active frontal systems produced a rapid upturn in runoff rates across most of the UK and exceptional flows were reported from many catchments over the latter half of the month – in eastern Scotland especially. Moderate flooding and severe transport disruption was common in late October. The steep early autumn declines in reservoir stocks was reversed and early November stocks for England and Wales as a whole are well above average for the time of year. The very dry early October soil conditions made for a more sluggish onset in the recovery of groundwater levels but infiltration was widespread by early November and levels were rising in many index boreholes. The water resources outlook has improved substantially over the last five weeks but, by early November catchments across much of the country were close to saturation and very vulnerable to further significant rainfall.

Rainfall

October began dry with high pressure continuing to dominate weather patterns. From the 9th however, active frontal systems began crossing the British Isles, heralding a very unsettled episode with damaging gales towards month-end. Sustained rainfall produced a number of notable 2, 3 and 4-day totals: up to 90 mm in parts of Grampian Region (22-23rd), 120 mm at Dunkeswell, Devon (11-15th) and > 130 mm in parts of the Mourne Mountains (20-22nd). Rainfall totals for October displayed wide regional and local variations. The NW and SE extremities of Britain reported <50% - the Outer Hebrides were particularly dry. By contrast, much of England and Wales reported >150% and parts of eastern Scotland (e.g. the lower Tweed basin) exceeded three times the 1961-90 average. Provisional data indicate that October was among the five wettest on record for Northern Ireland (in a series since 1900). Britain experienced it third notably wet October in successive years. Over the nine weeks to October 10th significant rainfall deficiencies had developed across much of the country - some areas reporting less than 25% of average rainfall - triggering moderate drought stress. The ensuing wet period has seen these deficiencies largely made up, but parts of western Scotland have had their driest August-October for more than 25 years. Regional rainfall totals for the year thus far are however above average throughout the UK.

River Flows

Early October river flows were substantially below average in most parts of the UK. The continuation of late summer recessions produced particularly depressed runoff rates in many western and northern rivers; on the 10th the Tawe (S. Wales) recorded its lowest October flow since the 1959 drought. Thereafter recoveries were dramatic (echoing 1959). Within three days many rivers draining impermeable catchments were in high spate, with moderate flooding in some areas (e.g. South Wales and the South West). Exceptional flow rates characterised much of the Tweed basin on the 22nd – at the Sprouston gauging station,a new maximum flow in a 33-year series was established; significant flooding affected Eyemouth. To the north, flows in all three gauging stations on the River Don eclipsed previous maxima. Flooding of agricultural land was substantial and transport disruption severe (exacerbated, in the south, by the damaging storm on the 22nd). Some rivers in eastern Scotland (including the Whiteadder) registered new October runoff maxima; by contrast, in western Scotland – away from the paths of most frontal systems - new monthly minima were being established (e.g on the Carron). In England and Wales October runoff totals were generally within the normal range but even in the English Lowlands many rivers were approaching bankfull by month end, and the high flood risk continued into November. For the year thus far, runoff totals for most rivers are above average – unprecedented for some northern rivers (including the Clyde, Earn and Camowen).

Groundwater

Exceptionally dry soils in early October appeared to foreshadow a much delayed seasonal onset of recharge to the major aquifers. In the event, rainfall over the five weeks from the 9th was typically 200-400% of the average, producing a steep decline in soil moisture deficits across most outcrop areas - allowing infiltration to commence by early November in all but the most easterly areas. This infiltration is not reflected in most of the groundwater hydrographs (most boreholes reported in early October); these indicate around average mid-autumn levels across much of the Chalk outcrop – but upturns did occur to the west (e.g. at Rockley and West Woodyates). In the more responsive limestone aquifers most current levels are also in the normal range with evidence of brisk recoveries in those index wells measured sufficiently late in the month (e.g. Ampney Crucis). In parts of the Permo-Triassic sandstones (e.g. at Bussels), levels are also rising and overall groundwater resources are significantly above the late-autumn average. Recoveries are awaited in most of the minor aquifers in eastern England - where early October soil moisture deficits were large and recoveries normally do not gather momentum until the late autumn. The sustained rainfall over the last five weeks has seen a substantial improvement in the groundwater resources outlook.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Area	Rainfall	Oct 2002	Aug 02-Oct 02	RP	May 02-Oct 02	RP	Jan 02-Oct 02	RP	Nov 01-Oct 02	RP
England & Wales	**mm**	**143**	**260**		**490**		**787**		**894**	
	%	**164**	**107**	**2-5**	**113**	**2-5**	**109**	**2-5**	**98**	**2-5**
North West	mm	169	324		647		1144		1306	
	%	132	93	2-5	110	2-5	120	5-15	109	2-5
Northumbrian	mm	134	252		477		788		912	
	%	176	110	2-5	114	2-5	115	5-10	107	2-5
Severn Trent	mm	124	209		408		660		743	
	%	193	107	2-5	112	2-5	109	2-5	99	2-5
Yorkshire	mm	120	269		478		738		832	
	%	164	125	5-10	121	5-10	112	2-5	101	2-5
Anglian	mm	91	180		358		523		598	
	%	179	116	2-5	118	5-10	108	2-5	100	<2
Thames	mm	97	164		372		614		681	
	%	156	92	2-5	110	2-5	111	2-5	99	2-5
Southern	mm	84	166		378		639		707	
	%	105	81	2-5	104	2-5	104	2-5	91	2-5
Wessex	mm	150	228		441		751		833	
	%	189	105	2-5	114	2-5	113	2-5	99	2-5
South West	mm	171	247		513		969		1118	
	%	148	84	2-5	102	2-5	106	2-5	95	2-5
Welsh	mm	209	328		600		1136		1331	
	%	152	93	2-5	102	2-5	112	2-5	101	2-5
Scotland	**mm**	**173**	**308**		**669**		**1324**		**1590**	
	%	**111**	**74**	**5-15**	**98**	**2-5**	**117**	**10-20**	**111**	**5-10**
Highland	mm	153	269		638		1455		1790	
	%	77	54	40-60	81	5-15	107	2-5	102	2-5
North East	mm	197	332		617		948		1106	
	%	203	122	5-10	129	15-25	121	10-20	114	5-10
Tay	mm	194	332		721		1323		1471	
	%	149	98	2-5	126	10-20	135	60-90	120	10-20
Forth	mm	186	329		668		1180		1317	
	%	162	103	2-5	124	10-20	133	70-100	119	10-20
Tweed	mm	184	303		576		999		1122	
	%	194	111	2-5	120	5-10	127	30-40	116	5-10
Solway	mm	220	395		802		1454		1642	
	%	140	94	2-5	118	5-10	129	30-45	116	5-10
Clyde	mm	190	354		791		1604		1866	
	%	99	70	5-15	99	2-5	120	10-20	110	2-5
Northern Ireland	**mm**	**189**	**285**		**634**		**1087**		**1244**	
	%	**167**	**94**	**2-5**	**124**	**5-15**	**128**	**20-35**	**117**	**5-15**

RP = Return period

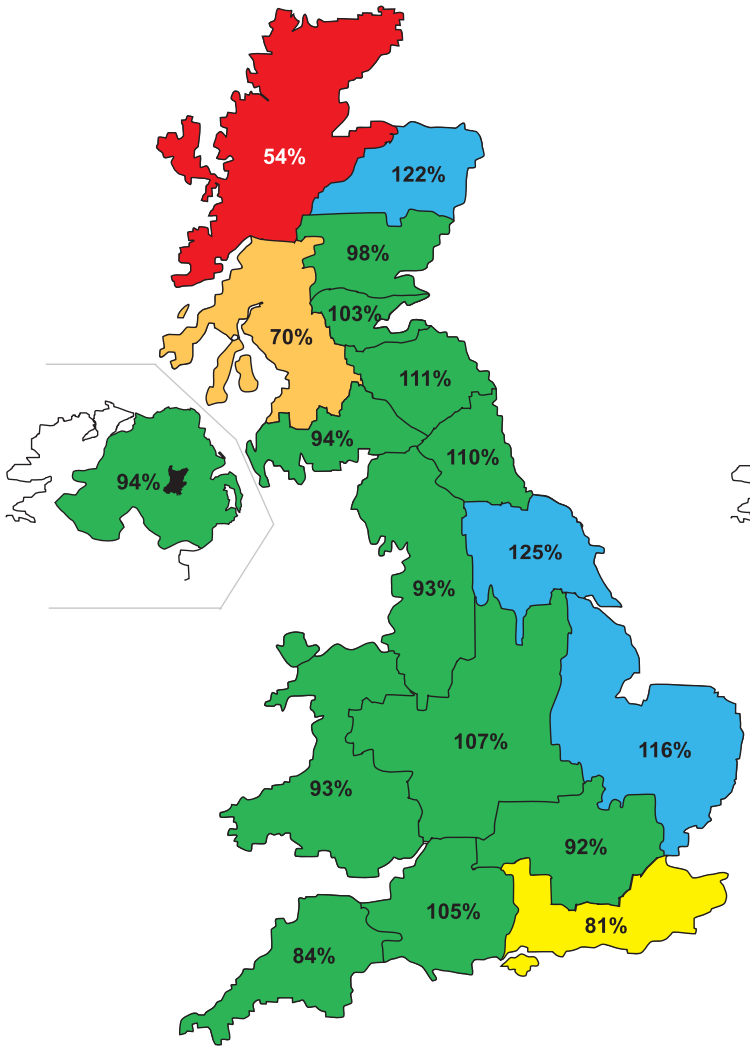
 All monthly totals since December 1998 are provisional (see page 12). The figures for England & Wales are derived by the Hadley Centre and are updates of the homogenised series developed by the Climate Research Unit; the other national figures are derived from different raingauge networks to those used to derive the CRU data series. The return period estimates are based on tables provided by the Meteorological Office (see Tabony, R.C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37) and relate to the specified span of months only (return periods may be up to an order of magnitude less if n-month periods beginning in any month are considered); RP estimates for Northern Ireland are based on the tables for north-west England. The tables reflect rainfall over the period 1911-70 and assume a stable climate. Artifacts, in the Scottish rainfall series in particular, can exaggerate the relative wetness of the recent past.

*See page 12.

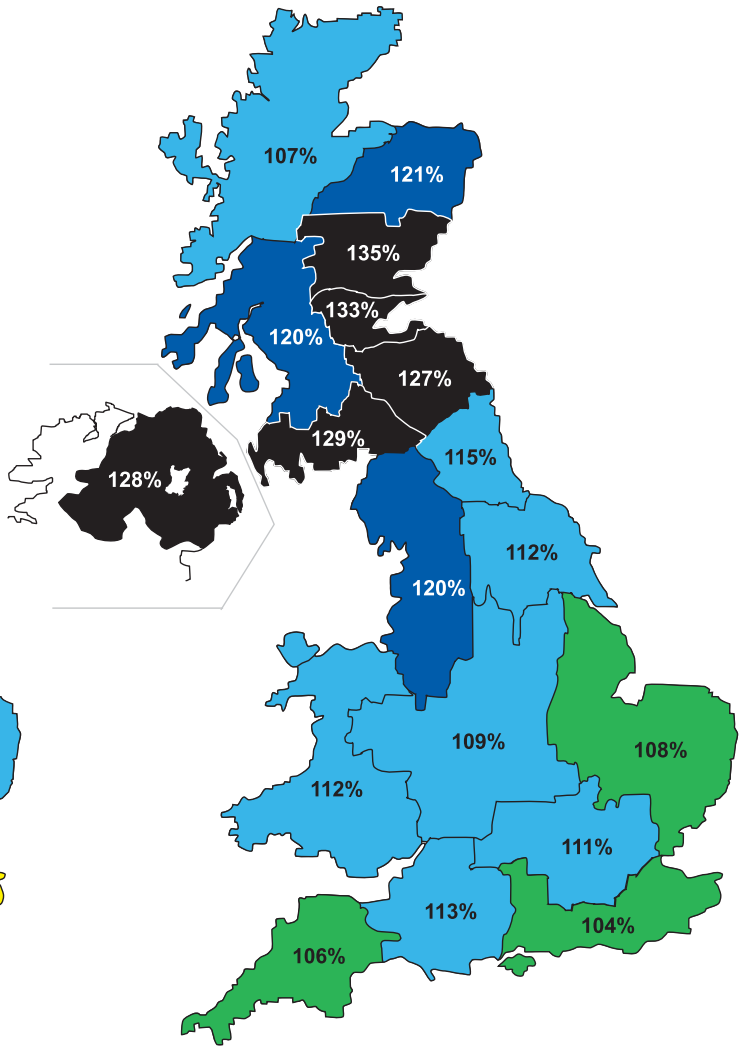
Rainfall . . . Rainfall . .

Key

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



August 2002 - October 2002

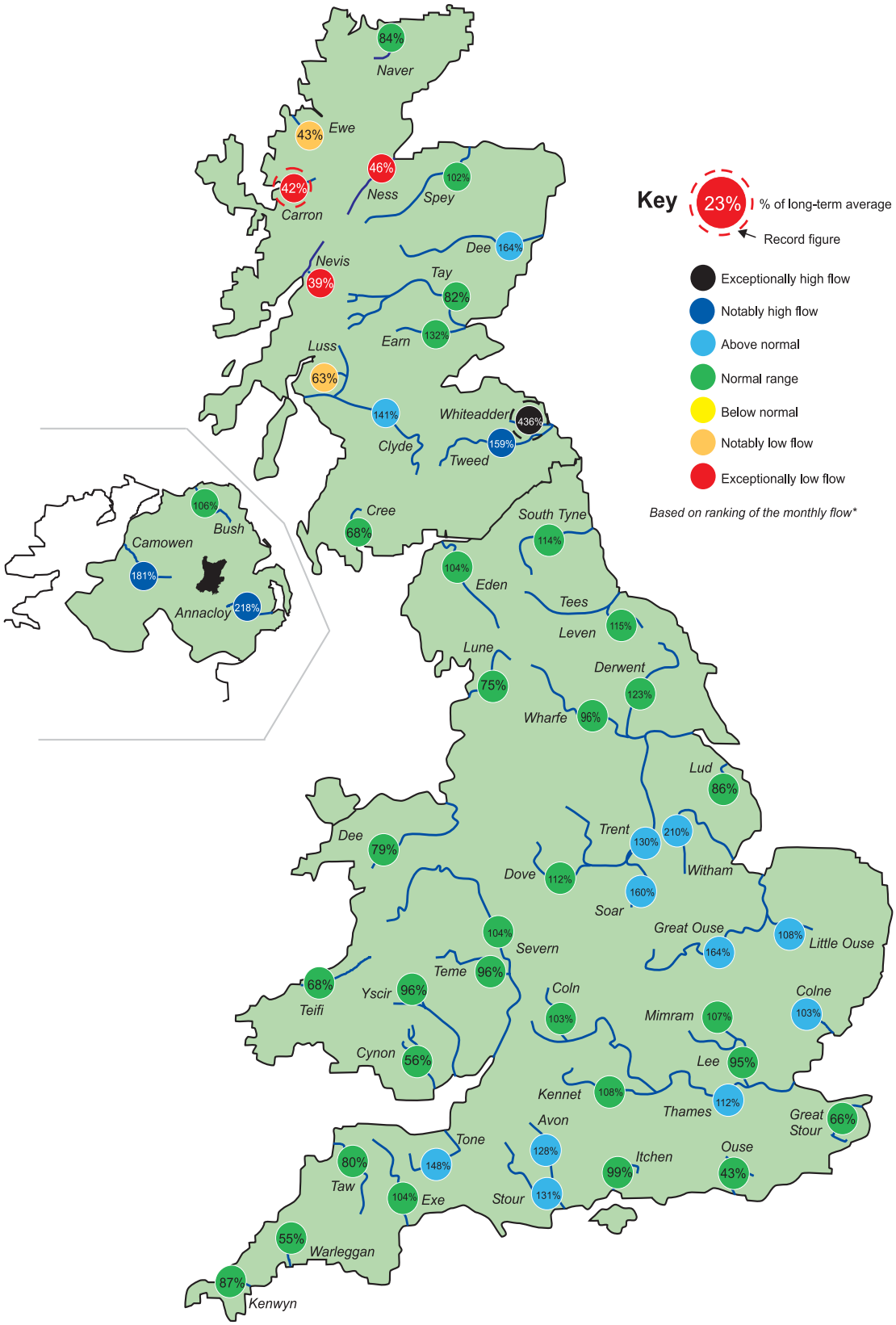


January 2002 - October 2002

Rainfall accumulation maps

Despite the wetness of the last three weeks of October, regional rainfall totals for the last three months were generally below average - notably so in Highland Region (where the west was especially dry). For Britain as a whole the August-October period was the driest since 1997. By contrast the corresponding January-October ranks among the wettest dozen in the last 100 years - with above average rainfall characterising all regions

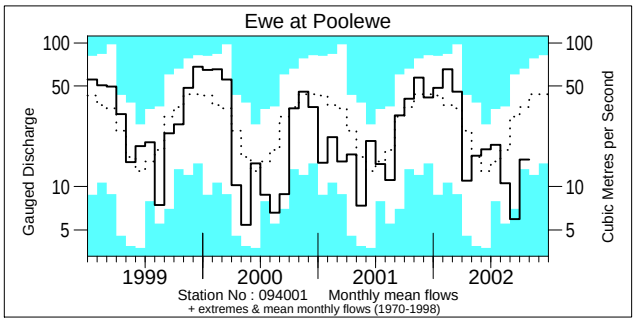
River flow . . . River flow . . .

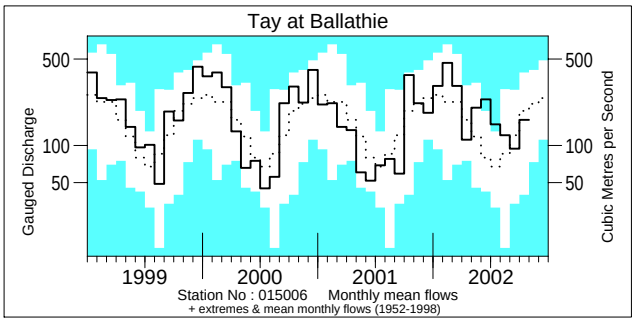


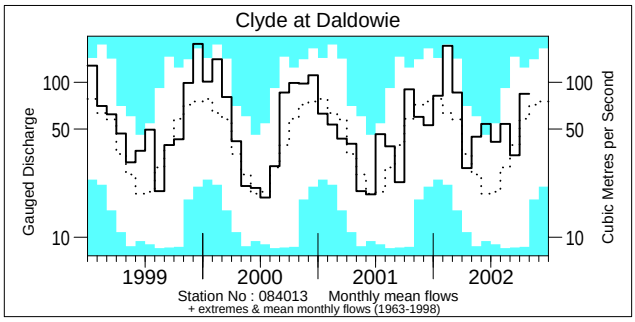
River flows - October 2002

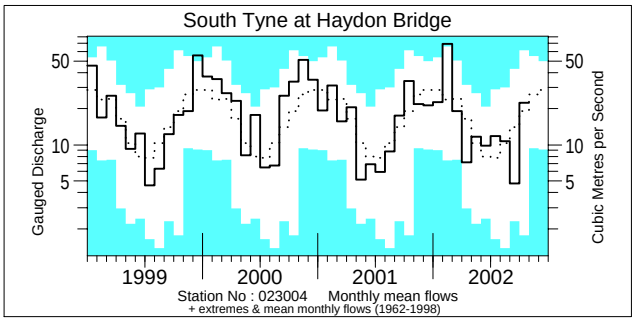
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

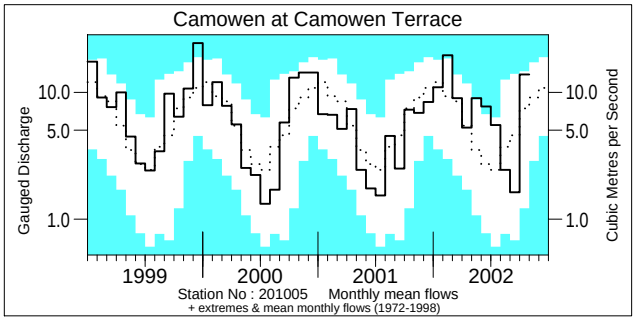
River flow . . . River flow . . .

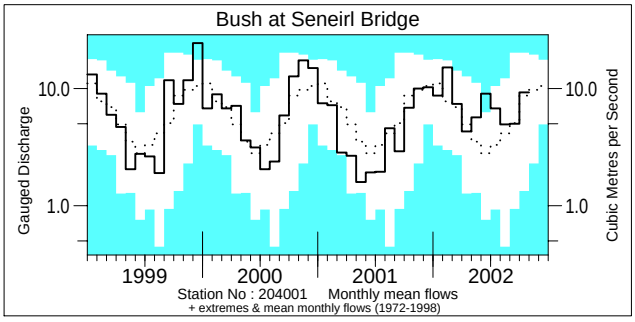


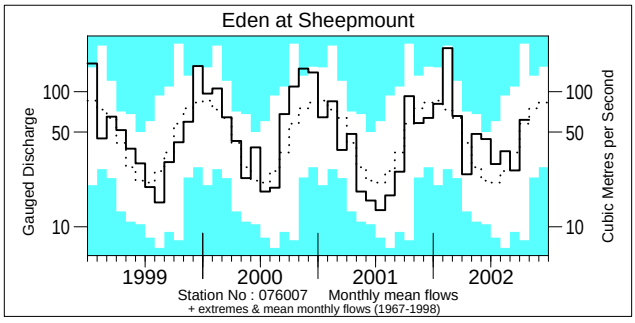


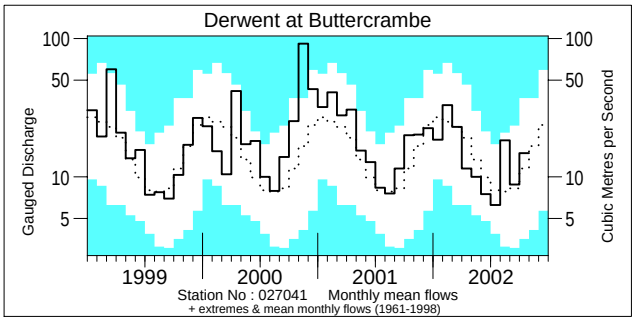


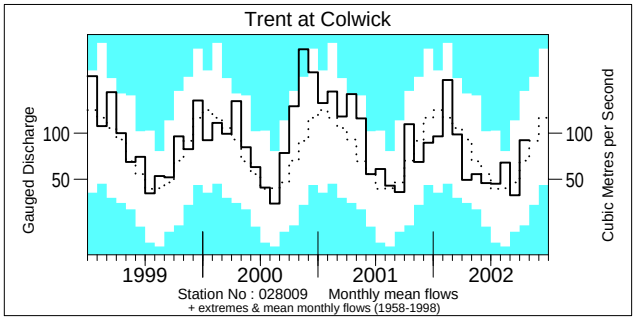


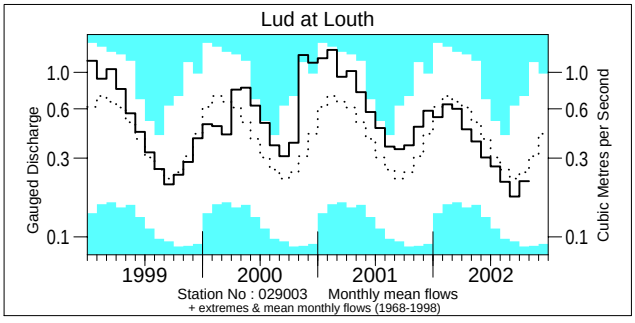








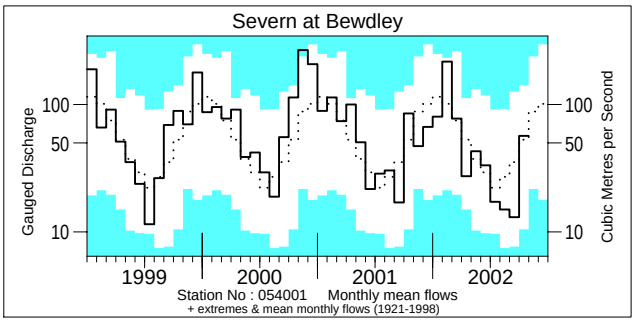


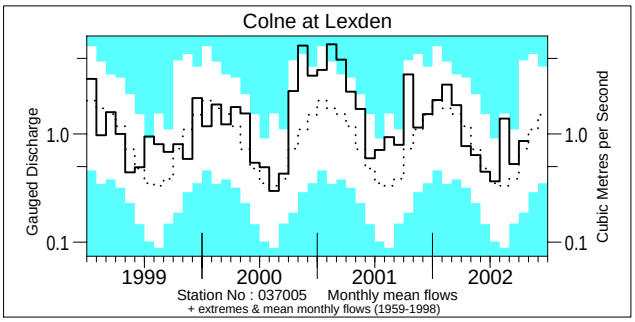


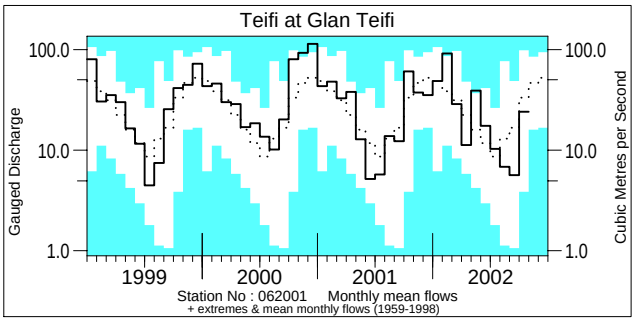
Monthly river flow hydrographs

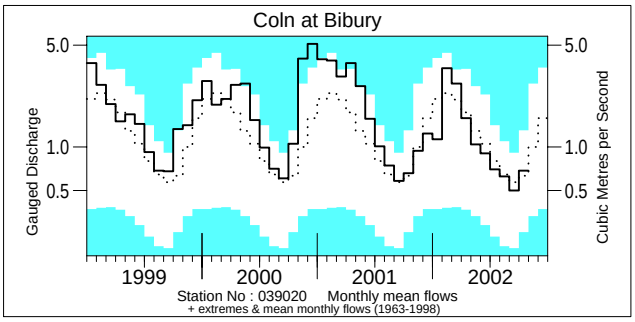
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1999 (shown by the shaded areas). Monthly flows falling outside the maximum/ minimum range are indicated where the bold trace enters the shaded areas.

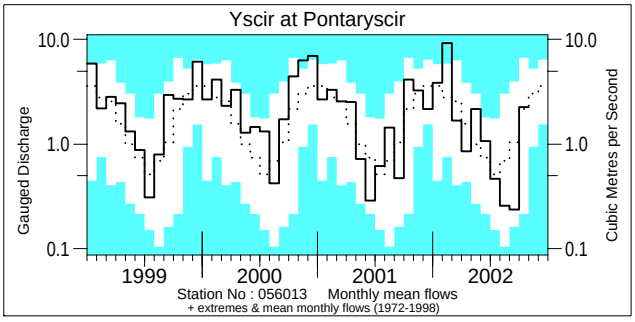
River flow . . . River flow . . .

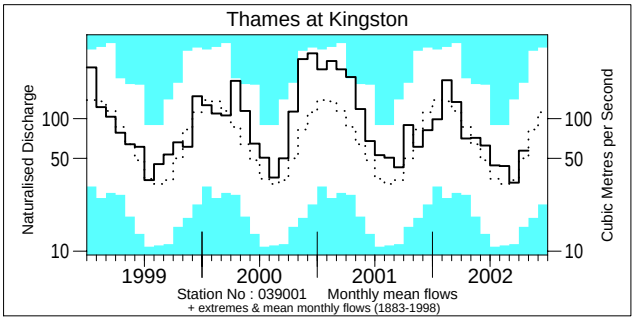


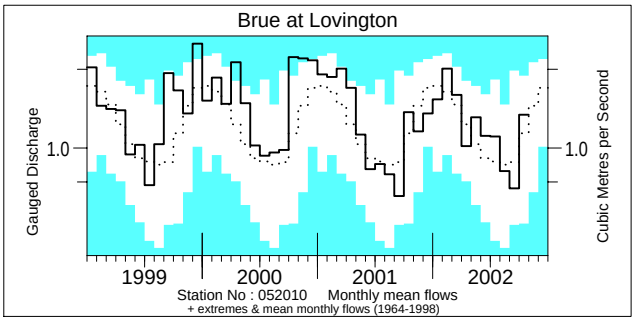


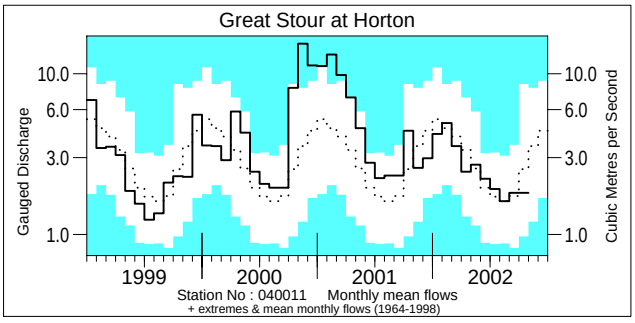


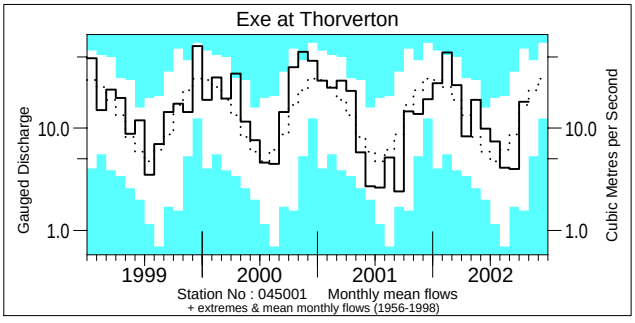


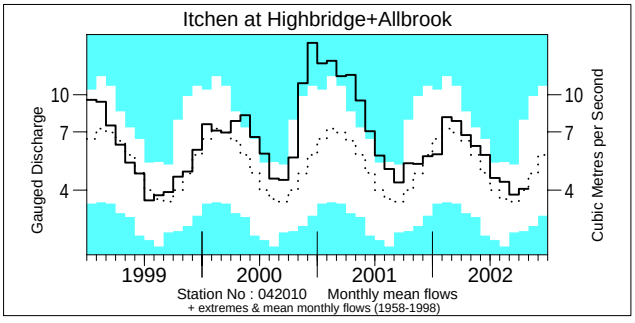












Notable runoff accumulations (a) August 2002 - October 2002, (b) January 2002 - October 2002

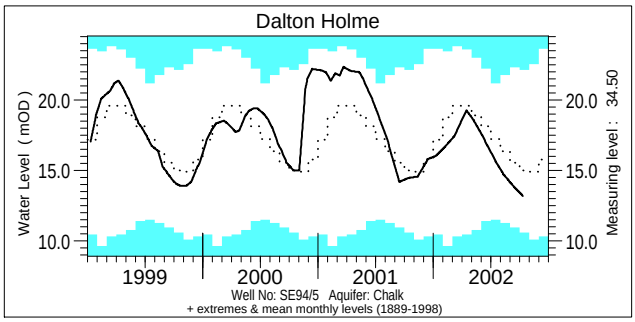
	River	%lta	Rank
a)	Ness	54	1/30
	Deveron	162	39/41
	Whiteadder	253	33/33
	Torne	193	31/32
	Luss	50	2/24
	Nevis	38	1/20
	Carron	30	1/24
	Ewe	40	1/32

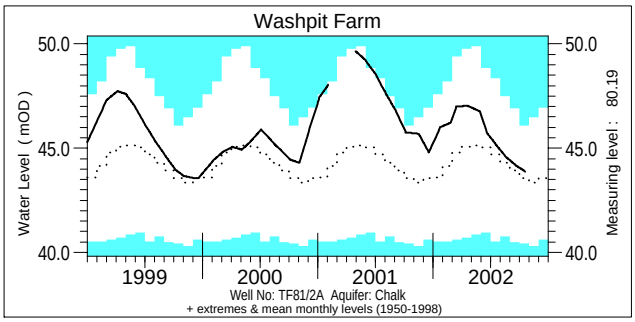
	River	%lta	Rank
b)	Tay	137	48/50
	Earn	151	55/55
	Tyne	133	35/37
	Tweed	134	42/42
	Mole	127	25/27
	Lune	129	38/42
	Eden	134	35/35

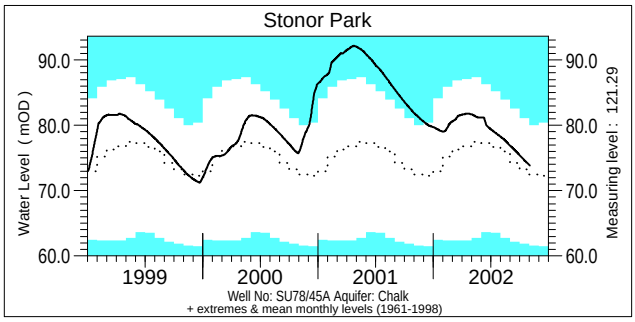
River	%lta	Rank
Nith	130	43/45
Clyde	154	39/39
Leven (Glasgow)	137	37/38
Camowen	139	29/29
Bush	129	26/29
Annacloy	140	22/23

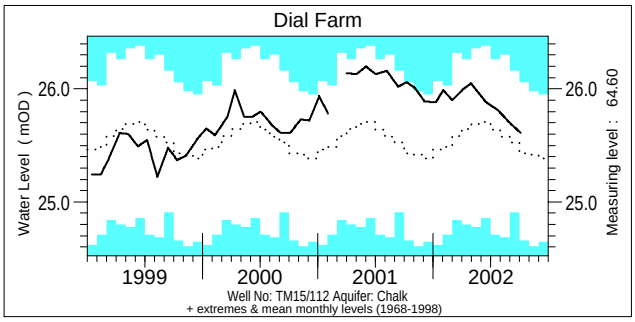
lta = long term average
Rank 1 = lowest on record

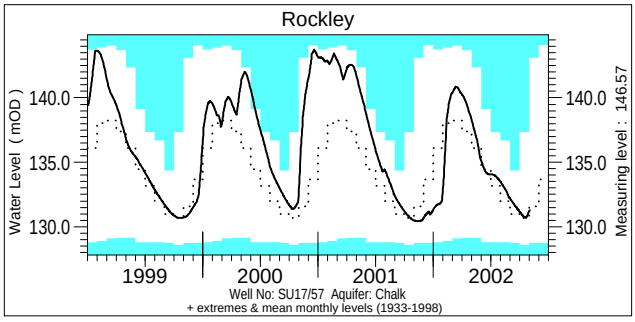
Groundwater . . . Groundwater

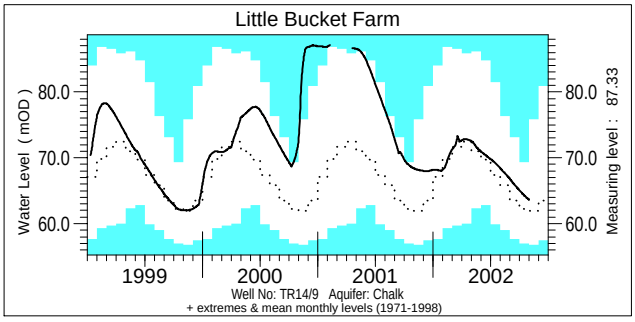


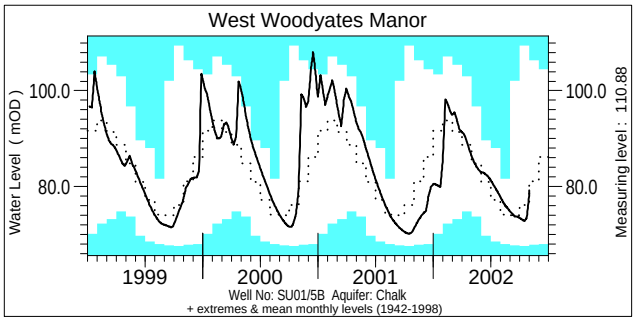


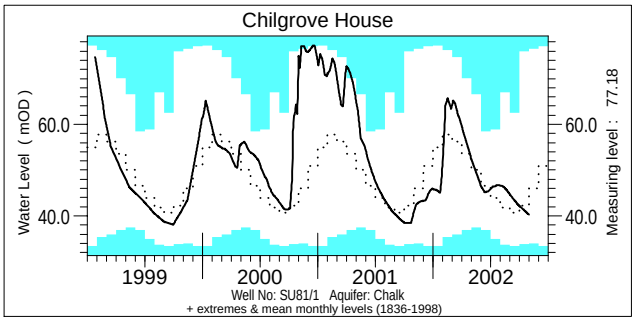


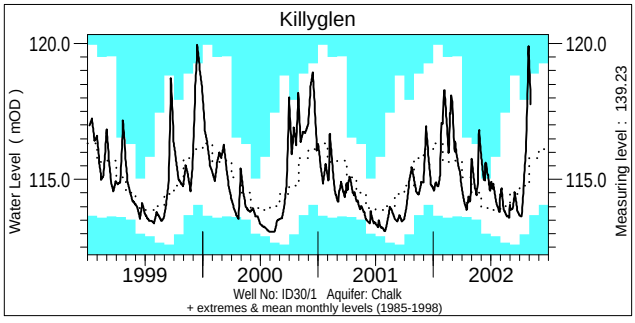


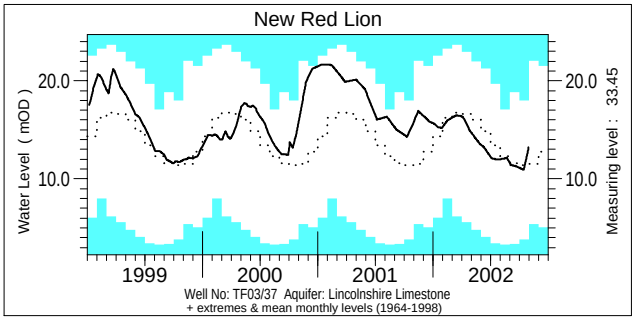






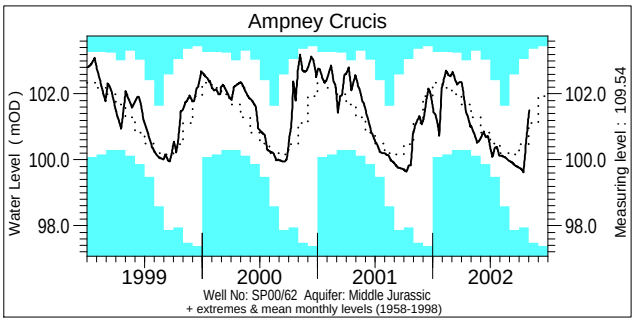


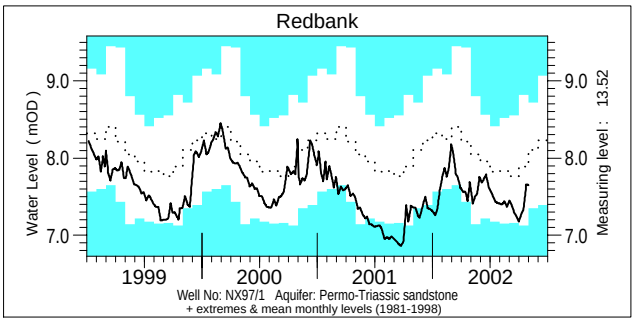


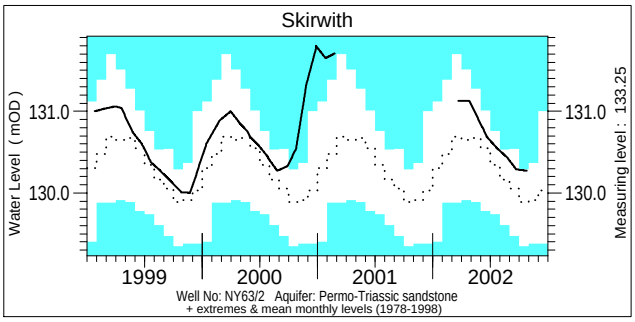


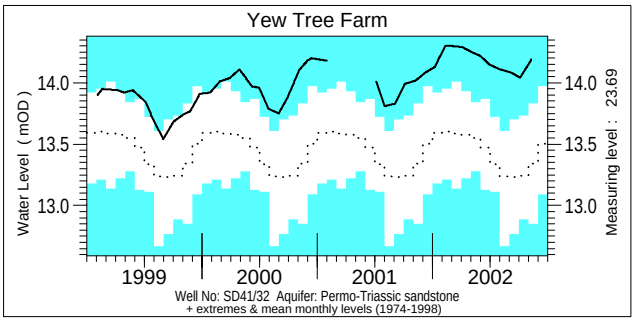
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly max., min. and mean levels are displayed in a similar style to the river flow hydrographs. Note that most groundwater levels are not measured continuously – the latest recorded levels are listed overleaf.

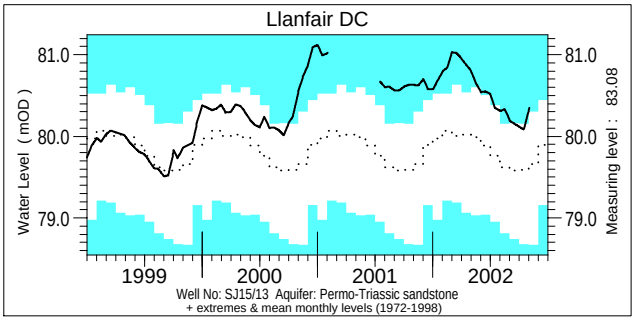
Groundwater . . . Groundwater

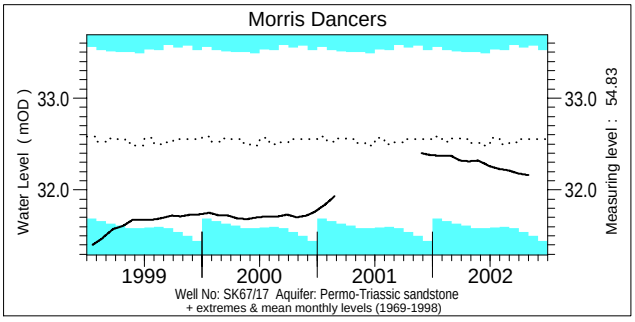


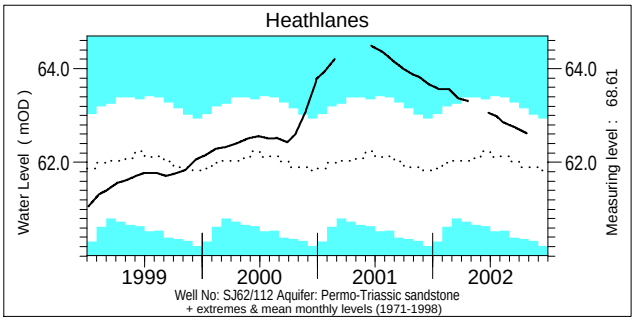


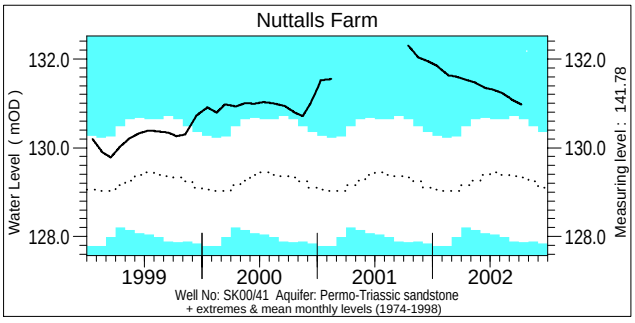


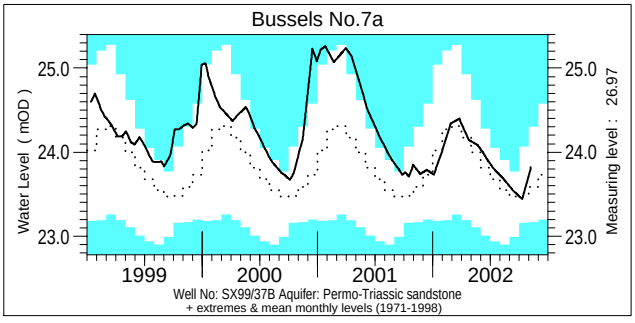


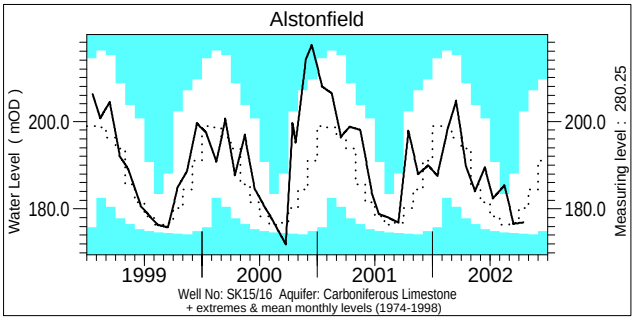










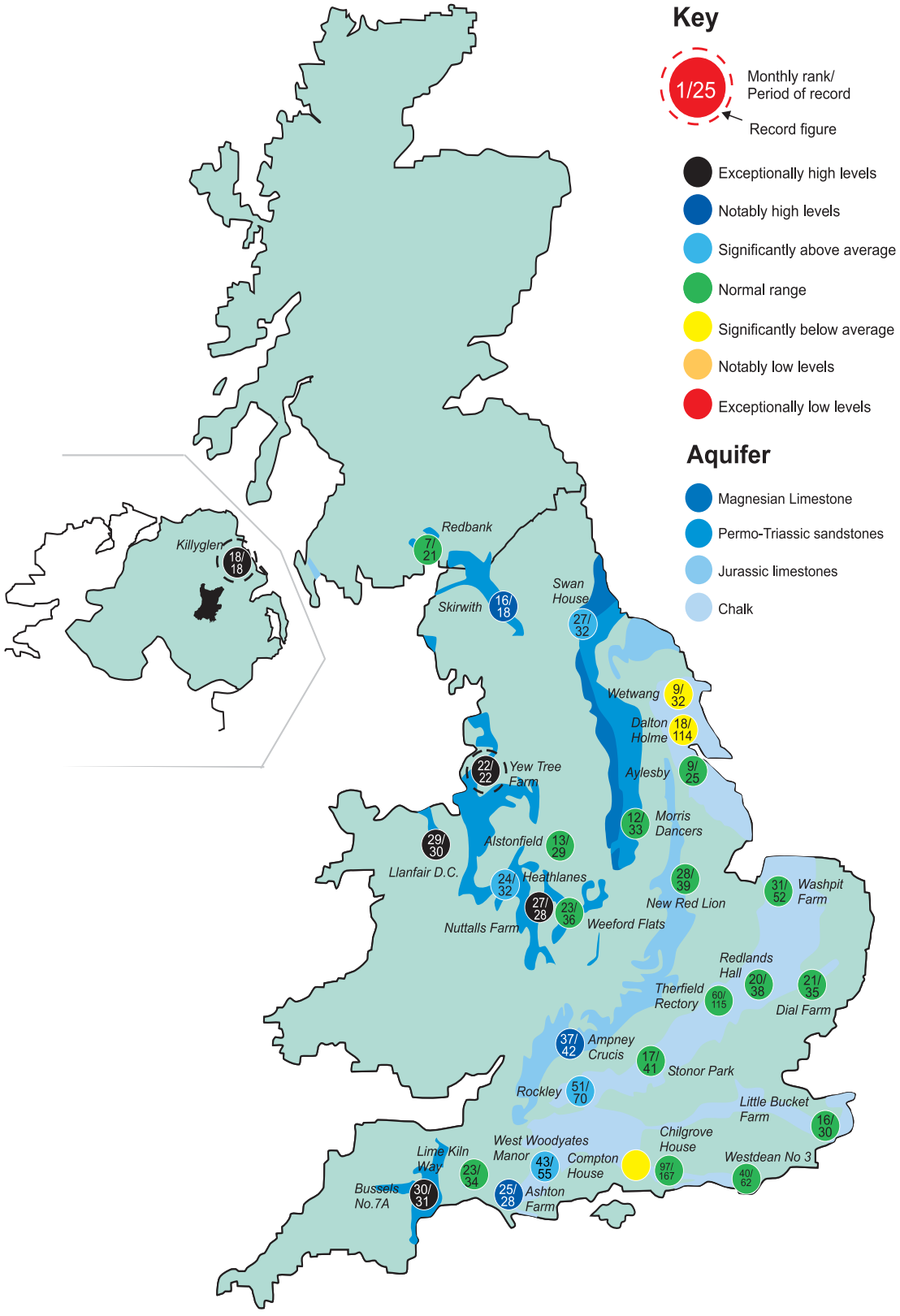


Groundwater levels October 2002 / November 2002

Borehole	Level	Date	Oct. av.	Borehole	Level	Date	Oct. av.	Borehole	Level	Date	Oct. av.
Dalton Holme	13.20	10/10	14.89	Chilgrove House	40.20	31/10	42.49	Llanfair DC	80.35	01/11	79.52
Washpit Farm	43.88	18/10	43.51	Killyglen	117.77	04/11	114.76	Morris Dancers	32.16	30/10	32.41
Stonor Park	73.85	01/11	73.48	New Red Lion	13.25	29/10	11.57	Heathlanes	62.62	24/10	61.95
Dial Farm	25.61	04/10	25.46	Ampney Crucis	101.50	01/11	100.44	Nuttalls Farm	130.97	09/10	129.56
Rockley	131.30	01/11	130.68	Redbank	7.65	31/10	7.88	Bussels No.7a	23.82	06/11	23.54
Little Bucket Farm	63.59	31/10	63.57	Skirwith	130.27	25/10	129.92	Alstonfield	176.92	14/10	181.32
West Woodyates	79.20	31/10	75.16	Yew Tree Farm	14.19	08/11	13.33				

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater



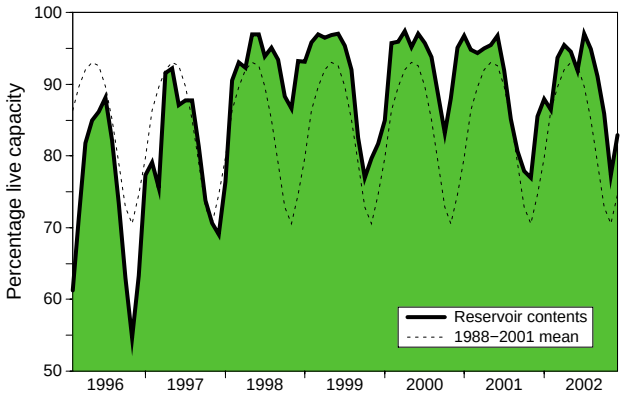
Groundwater levels - October 2002

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.

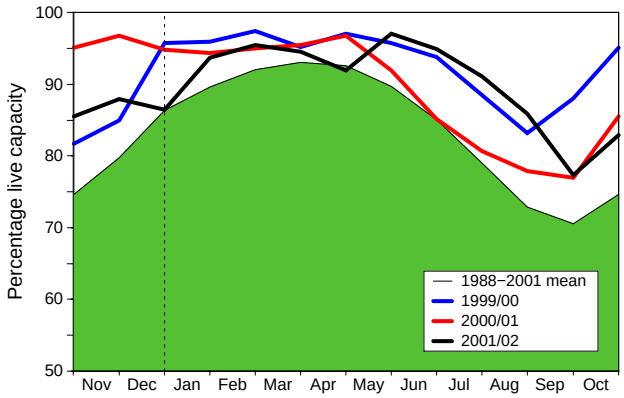
(Note: Redbank is affected by groundwater abstraction.)

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.

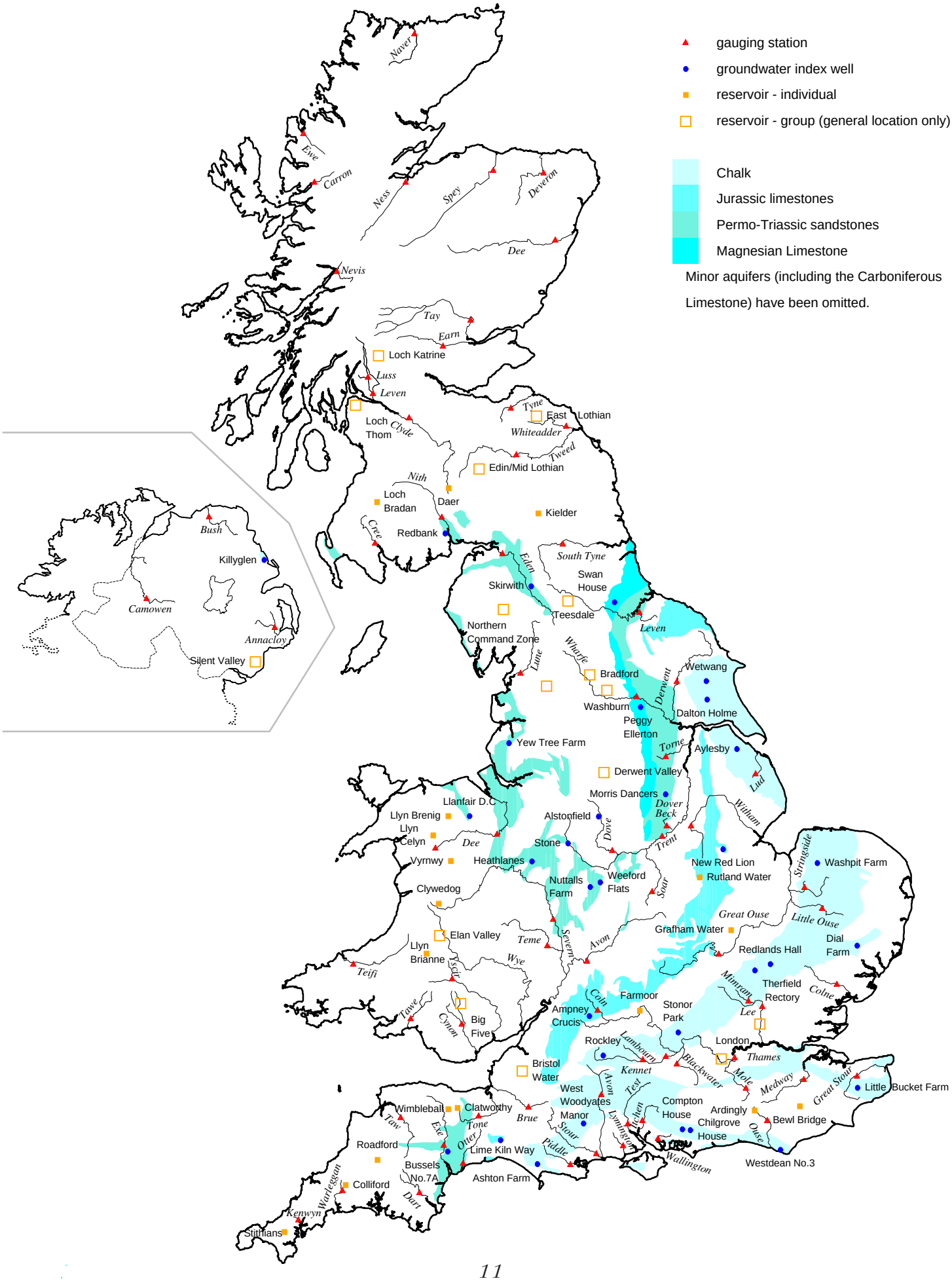
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2002 Jun	Jul	Aug	Sep	Oct	Nov	Min. Nov	Year* of min
North West	N Command Zone	• 124929	100	97	88	78	68	**66**	38	1993
	Vyrnwy	55146	99	95	90	77	62	**86**	25	1995
Northumbrian	Teesdale	• 87936	98	95	88	87	77	**89**	33	1995
	Kielder	(199175)	(98)	(94)	(90)	(91)	(86)	**(94)**	(63)	1989
Severn Trent	Clywedog	44922	99	98	92	85	71	**86**	38	1995
	Derwent Valley	• 39525	85	81	80	84	78	**95**	15	1995
Yorkshire	Washburn	• 22035	91	89	81	84	75	**89**	15	1995
	Bradford supply	• 41407	95	95	93	92	83	**95**	16	1995
Anglian	Grafham	(55490)	(94)	(96)	(95)	(94)	(89)	**(88)**	(44)	1997
	Rutland	(116580)	(95)	(92)	(90)	(88)	(85)	**(89)**	(59)	1995
Thames	London	• 202340	97	97	94	92	81	**84**	46	1996
	Farmoor	• 13830	90	96	95	95	91	**83**	53	1990
Southern	Bewl	28170	95	93	89	85	78	**73**	33	1990
	Ardingly	4685	100	99	99	98	92	**88**	33	1996
Wessex	Clatworthy	5364	100	97	91	76	62	**73**	19	1989
	Bristol WW	• (38666)	(95)	(93)	(89)	(78)	(71)	**(78)**	(24)	1990
South West	Colliford	28540	84	84	80	74	63	**63**	42	1996
	Roadford	34500	94	93	97	90	83	**82**	18	1995
	Wimbleball	21320	100	97	94	86	73	**80**	26	1995
	Stithians	5205	86	83	76	68	54	**55**	18	1990
Welsh	Celyn and Brenig	• 131155	100	99	98	93	88	**90**	48	1989
	Brianne	62140	100	99	96	89	80	**83**	57	1995
	Big Five	• 69762	98	94	89	69	53	**62**	41	1995
	Elan Valley	• 99106	100	95	90	75	64	**68**	37	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	99	100	94	92	88	**89**	50	1998
	East Lothian	• 10206	96	98	89	96	92	**100**	48	1989
West of Scotland	Loch Katrine	• 111363	100	99	96	83	74	**77**	76	1997
	Daer	22412	100	99	99	97	94	**100**	70	1997
	Loch Thom	• 11840	100	100	95	94	87	**100**	73	1999
Northern Ireland	Silent Valley	• 20634	81	90	81	79	69	**93**	34	1995

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

Details of the individual reservoirs in each of the groupings listed above are available on request. The featured reservoirs may not be representative of the storage conditions across each region; this can be particularly important during droughts. The minimum storage figures relate to the 1988-2002 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 for Environment, Food and Rural Affairs (DEFRA), the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA), the Rivers Agency (RA) in Northern Ireland, and the Office of Water Services (OFWAT).

Data Sources

River flow and groundwater level data are provided by the 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, Scottish Water and the Northern Ireland Water Service.

The National River Flow Archive (maintained by CEH Wallingford) and the National Groundwater Level Archive (maintained by BGS) provide the historical perspective within which to examine contemporary hydrological conditions.

Rainfall

Most rainfall data are provided by The Met Office (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.

The Met Office
Johnson House
London Road
Bracknell
RG12 2SY
Tel.: 01344 856849
Fax: 01344 854906

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:

Hydrological Summaries
National Water Archive
CEH Wallingford
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB
Tel.: 01491 838800
Fax: 01491 692424

Selected text and maps are available on the WWW at
http://www.nerc-wallingford.ac.uk/ih/nrfa/index.htm
Navigate via Water Watch

NATURAL ENVIRONMENT RESEARCH COUNCIL

10/02