Hydrological Summary for the United Kingdom

November 2011

General

November was a remarkably mild month across most of the UK but synoptic patterns again conspired to produce a very substantial exaggeration in the NW/SE rainfall gradient across the UK. Northern Ireland and western Scotland were wet with flood warnings widespread across Scotland late in the month. However, with rainfall deficiencies now extending over two years, record late-autumn soil moisture deficits and depressed river flows, exceptional drought conditions now extend across large parts of central, southern and eastern England. Generally, reservoir stocks are healthy across most of Wales, Northern Ireland, and Scotland (where most large reservoirs are near to capacity). But the lack of any sustained seasonal recovery in runoff rates has left stocks well below average in the English Lowlands and parts of the South West. Stocks are particularly depressed at Ardingly, Bewl, Colliford and Wimbleball. The seasonally very dry November soil conditions caused continuing problems for farmers and further delayed the seasonal recovery in aquifer recharge rates. Consequently groundwater levels are depressed over wide areas with exceptionally low levels in the western Chalk. With the window of opportunity for winter replenishment of water resources narrowing, measures to augment and conserve water supplies have been introduced (for example: activating the North London Artificial Recharge scheme; the granting of drought permits to supplement reservoir stocks, e.g. at Pitsford; appeals to water users to moderate demand). In the drought-affected areas, above average winter rainfall will be required through into the spring to ensure an adequate surface water and groundwater resources outlook in 2012.

Rainfall

An unusually persistent continental high pressure cell continued to divert most Atlantic low pressure systems away from the English Lowlands throughout almost all of November. North western parts of the country experienced wet and windy weather with some notable storm totals associated with the passage of Atlantic frontal systems (Benmore, Argyll, reported 81mm on the 17th). Snow, particularly late in the month, contributed to precipitation totals which exceeded 150% of the November average in parts of western and central Scotland (and the Sperrin Hills in Northern Ireland). In contrast, much of eastern and central England (including the core areas of the drought) recorded <60% of average contributing to exceptional rainfall deficiencies across a range of timeframes. Whilst Scotland (provisionally) registered its 2nd wettest autumn since 1984, England recorded its 2nd driest since 1985; the Anglian Region reporting its 3rd driest autumn in a series from 1910. In England & Wales, accumulated rainfall deficiencies are exceptional in the March-November timeframe. For the Midlands region, the previous minimum (in 1995) in a series from 1910 has been clearly eclipsed and extreme deficiencies characterise parts of Cambridgeshire, Bedfordshire and Northants (see map on page 3). Longer term deficiencies are of particular relevance to the current status of groundwater resources (see below): for E&W, the last 24 months were the driest (for accumulations ending in November) since 1974-76, whilst the total for the Midlands Region is vying with 1933/34 as the driest in a 100-year series.

River Flows

November runoff rates spanned a very wide range across the UK. In Scotland, floodplain inundations were common during the final week (when the Forth recorded its highest autumn daily mean flow in a 30-year series); local flash flooding was also very disruptive (e.g. in Glasgow). Some significant spates occurred in southern England (e.g. on the 4th) but the month was dominated by continuing recessions with very depressed flows in many catchments across the English Lowlands. In the last 50 years, comparable November outflows for the English Lowlands have been registered only in 1964 and 1978. The Rivers Coln, Kennet and Avon, each with records of around 50 years, eclipsed previous November minimum mean flows and autumn (Sept-Nov) runoff totals were depressed throughout much of central, southern and eastern England. The dramatic regional contrast in river flow patterns is well captured by runoff accumulations since March. Whilst mean flows for many Scottish rivers (including the Ness, Tay and Nevis) exceeded previous maxima – mean flows were in the 30-55% range across much of the English Lowlands where the Medway, Little Ouse and Soar are among a significant proportion of index rivers which have registered new period-of-record minima. For the Trent, runoff over this timeframe is below that recorded during the exceptional drought of 1959. The depressed runoff rates in the English Lowlands have been accompanied by a continuing contraction in the stream network (exacerbated by the failure of headwater, and lower level, springs) and an associated loss of aquatic habitat.

Groundwater

The exceptionally warm conditions (provisionally, November was the 2nd warmest in at least the last 100 years), together with limited rainfall over aquifer outcrop areas resulted in exceptionally high end-of-autumn soil moisture deficits; the highest in a 50-year series for the Anglian Region. Thus while seasonal groundwater level recoveries are gathering momentum in some western and northern index wells (e.g. in the responsive Carboniferous Limestone outcrops in South Wales and at Newbridge in the Permo-Triassic sandstones of southern Scotland) the very dry soils continue to preclude any appreciable recharge to most of the major aquifers. Very protracted recessions have left depressed groundwater levels across much of eastern, central and southern England. In the Chalk, Chilgrove, Compton and Lime Kiln Way are among those wells and boreholes where levels are close to natural base levels. Only during the severe groundwater droughts of the early 1990s, 1976 and 1964/65 have levels declined as far as in 2011 in the western Chalk (e.g. at Rockley); the Tilshead well is effectively dry – for the first time since 1976. Generally, only in the deeper, slowest responding wells (e.g. Therfield) are levels still within the normal range. With soil moisture deficits still the equivalent of around 6-8 weeks of average winter rainfall in many eastern and central areas, a wet winter is required to initiate and sustain a recovery in groundwater resources in the drought-affected outcrop areas.

Centre for Ecology & Hydrology
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Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

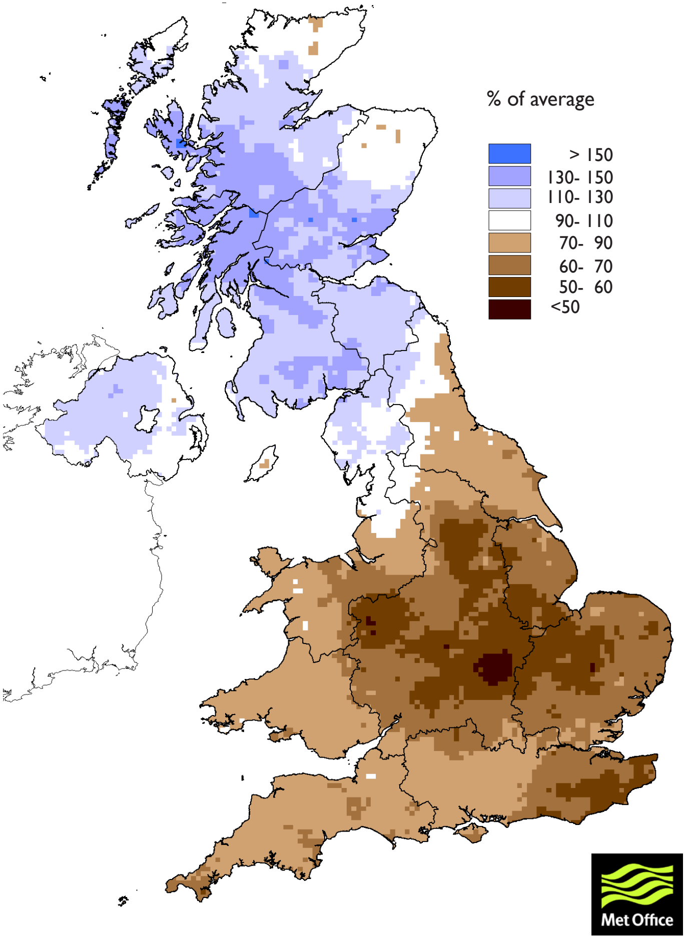
Area	Rainfall	Nov 2011	Sep11 - Nov11		Mar11 - Nov11		Oct10 - Nov11		Dec09 - Nov11	
				RP		*RP*		*RP*		*RP*
United	mm	**101**	330		785		1274		2054	
Kingdom	%	**88**	102	2-5	103	2-5	97	2-5	95	2-5
England	mm	**49**	165		453		809		1430	
	%	**59**	70	8-12	77	20-30	82	15-25	87	15-20
Scotland	mm	**183**	578		1317		1999		2979	
	%	**115**	130	15-20	132	>100	114	10-20	103	2-5
Wales	mm	**96**	340		780		1371		2341	
	%	**63**	81	2-5	82	10-15	82	15-25	85	15-25
Northern	mm	**131**	459		898		1382		2225	
Ireland	%	**119**	144	50-80	114	2-5	103	2-5	100	<2
England &	mm	**55**	189		498		886		1556	
Wales	%	**60**	73	5-10	78	20-30	82	20-30	87	15-25
North West	mm	**84**	356		864		1427		2242	
	%	**68**	101	2-5	103	2-5	100	<2	95	2-5
Northumbria	mm	**52**	199		618		1079		1762	
	%	**63**	87	2-5	102	2-5	109	2-5	106	2-5
Midlands	mm	**44**	128		349		629		1175	
	%	**62**	61	15-20	63	>100	70	>100	77	>100
Yorkshire	mm	**43**	169		460		850		1448	
	%	**54**	76	5-10	79	10-20	88	5-10	89	8-12
Anglian	mm	**26**	79		279		514		1040	
	%	**46**	47	40-60	61	80-120	72	40-60	86	10-15
Thames	mm	**40**	108		350		631		1179	
	%	**61**	54	10-20	68	25-40	75	20-35	84	10-20
Southern	mm	**47**	126		374		763		1401	
	%	**57**	52	10-20	67	40-60	80	10-15	90	5-10
Wessex	mm	**58**	173		472		821		1424	
	%	**67**	69	5-10	78	10-20	79	20-30	82	30-40
South West	mm	**76**	281		620		1136		1978	
	%	**57**	78	2-5	76	20-30	77	40-60	82	30-40
Welsh	mm	**93**	326		748		1309		2254	
	%	**64**	81	2-5	82	10-15	81	20-30	85	15-25
Highland	mm	**218**	690		1544		2260		3333	
	%	**107**	128	12-16	132	60-90	108	5-10	97	2-5
North East	mm	**75**	259		828		1306		2231	
	%	**75**	90	2-5	119	2-5	114	2-5	118	5-10
Tay	mm	**183**	497		1234		1911		2807	
	%	**139**	131	5-10	143	>100	125	30-40	111	5-10
Forth	mm	**145**	421		1071		1693		2515	
	%	**127**	124	5-10	135	40-60	124	40-60	111	5-10
Tweed	mm	**101**	326		891		1430		2214	
	%	**107**	121	2-5	131	10-15	125	15-25	116	5-10
Solway	mm	**185**	599		1307		2059		3038	
	%	**124**	140	15-25	134	30-40	120	20-30	108	5-10
Clyde	mm	**246**	809		1646		2492		3558	
	%	**132**	150	80-120	138	>100	118	20-35	103	2-5

% = percentage of 1971-2000 average *RP = Return period*

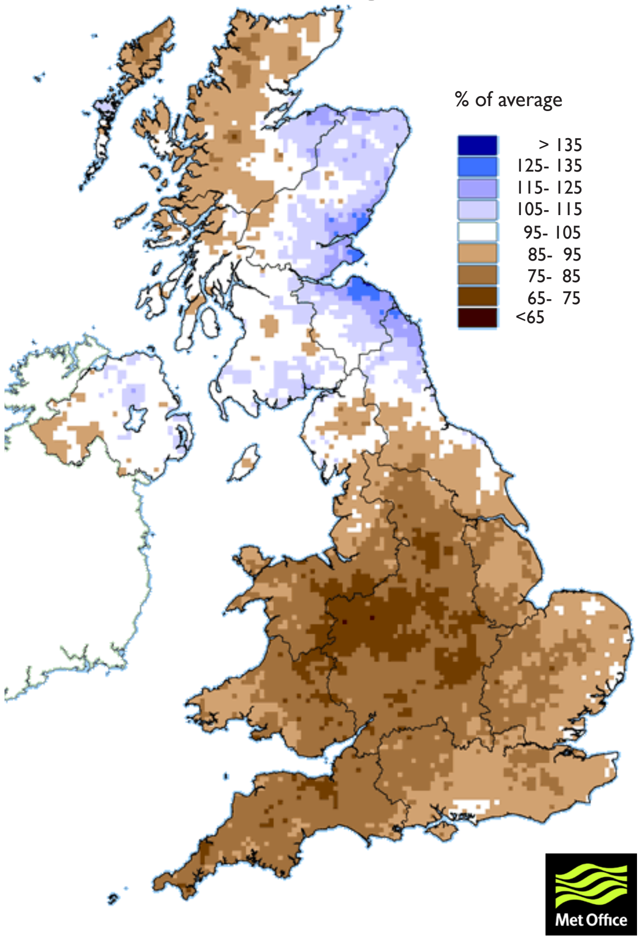
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1910; they also assume a stable climate. The quoted RPs relate to the specific timespans only; for the same timespans, but beginning in any month the RPs would be substantially shorter. The timespans featured do not purport to represent the critical periods for any particular water resource management zone. For hydrological or water resources assessments of drought severity, river flows and/or groundwater levels normally provide a better guide than return periods based on regional rainfall totals. All monthly rainfall totals since July 2011 are provisional.

Rainfall . . . Rainfall . . .

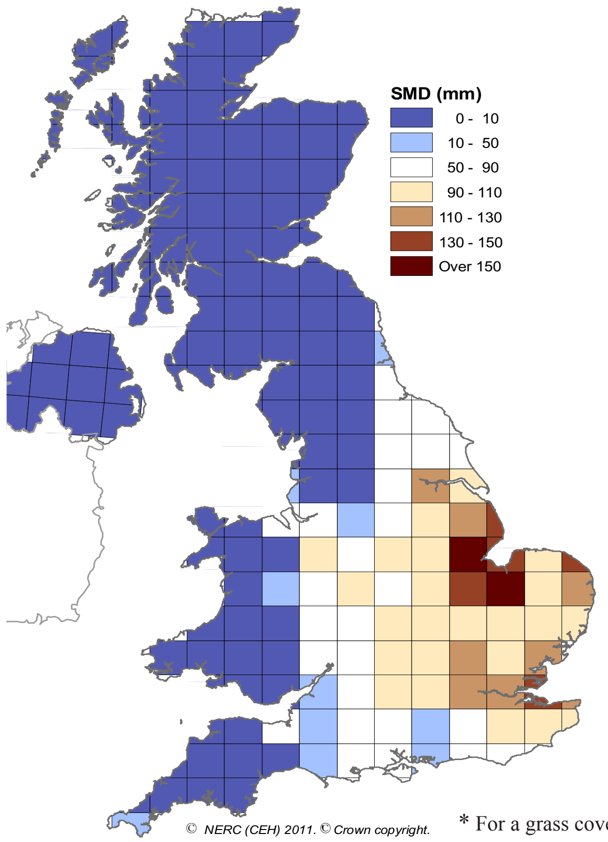
March - November 2011 rainfall as % of 1971-2000 average



December 2009 - November 2011 rainfall as % of 1971-2000 average



Soil Moisture Deficits*
November 2011



* For a grass cover

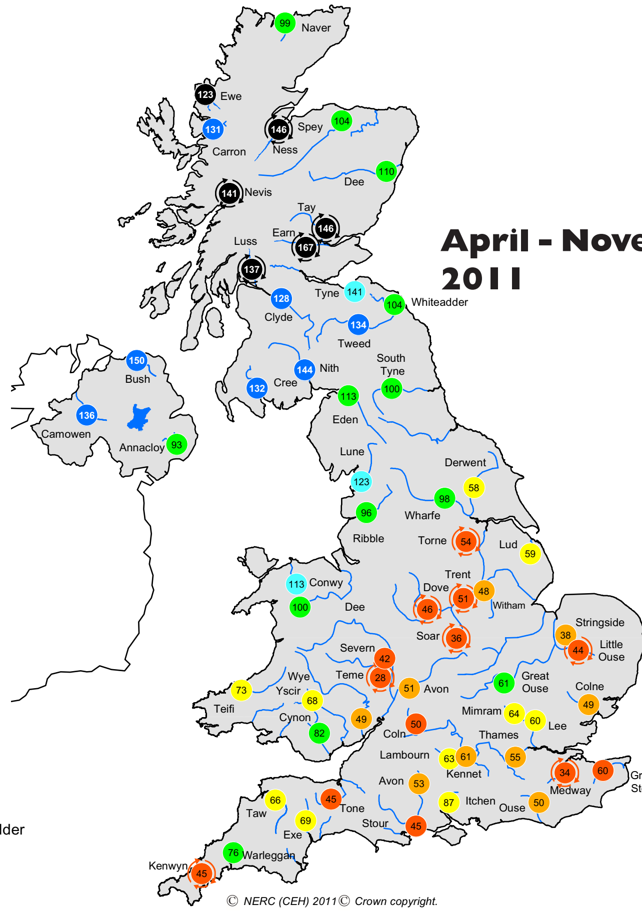
Met Office 3-month outlook

The probability that UK precipitation for December-January-February will fall into the driest of our five categories is about 15%, whilst the probability that it will fall into the wettest of our five categories is 20-25%, each of these categories has occurred in 20% of the years between 1971-2000.

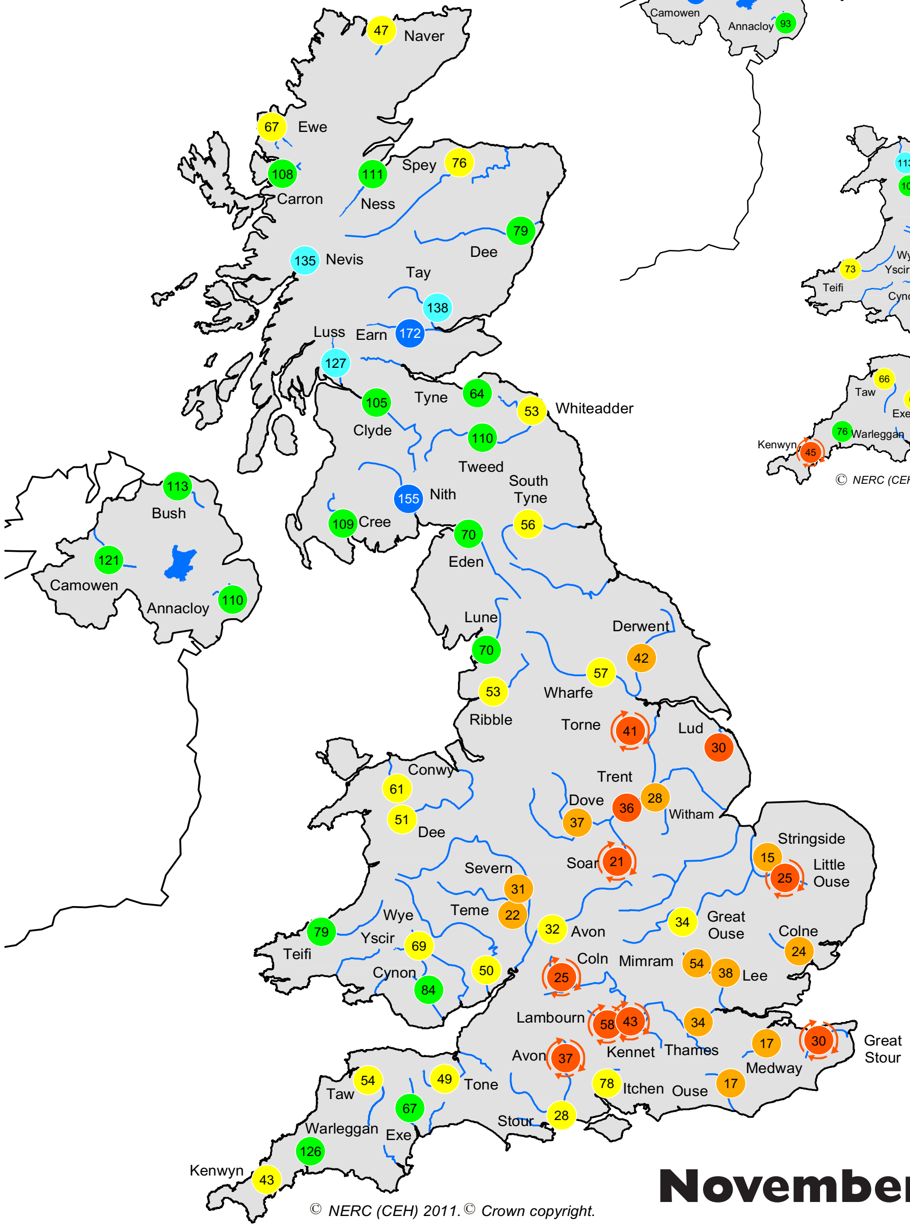
The complete version of the 3-month outlook may be found at:
http://www.metoffice.gov.uk/publicsector/contingency-planners
This outlook is updated towards the end of each calendar month.

The latest shorter-range forecasts, covering the upcoming 30 days, can be accessed via:
http://www.metoffice.gov.uk/weather/uk/uk_forecast_weather.html
These forecasts are updated very frequently.

River flow . . . River flow . . .



April - November 2011



Key

25 — % of long-term average (record figure when circled)

- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

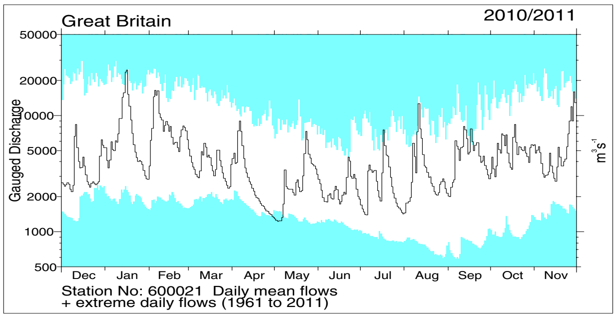
*Based on ranking of the monthly flow**

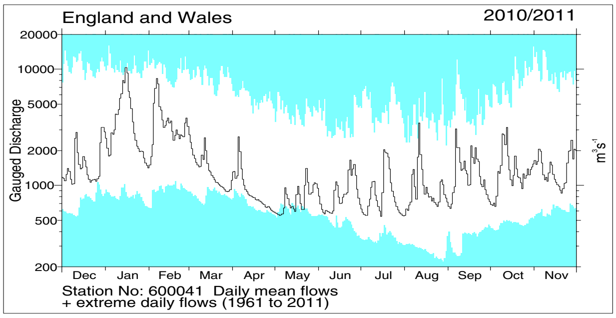
November 2011

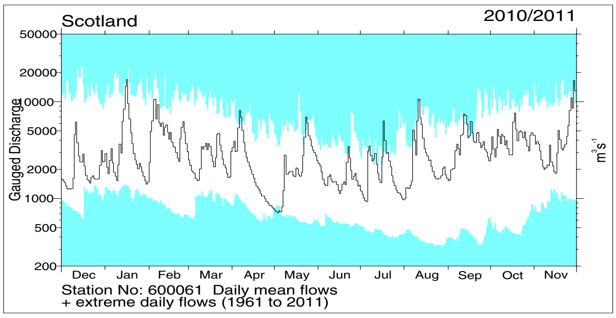
River flows

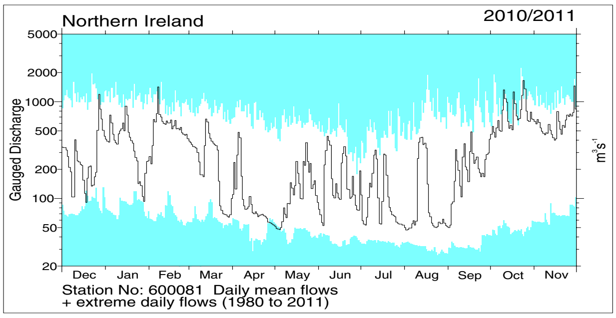
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

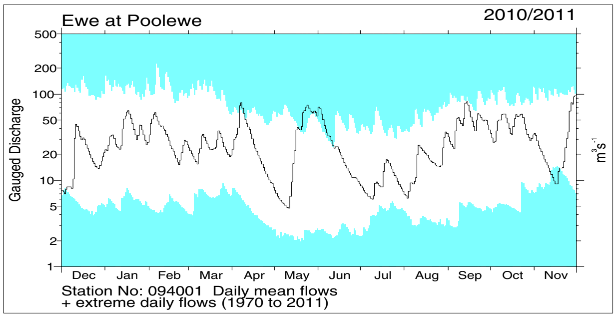
River flow . . . River flow . . .

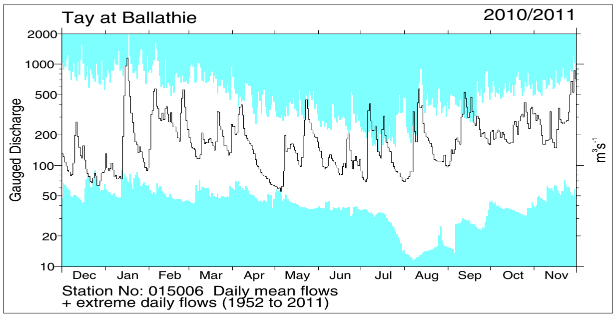


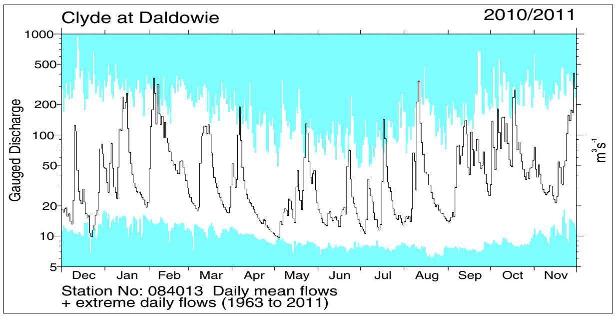


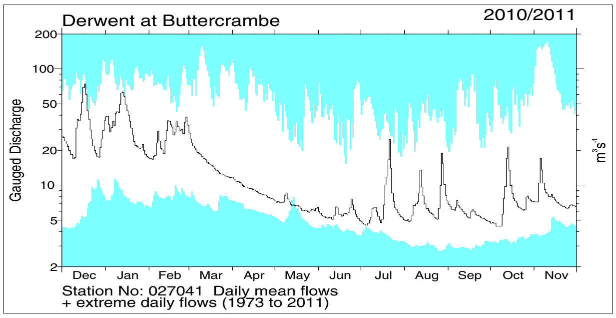


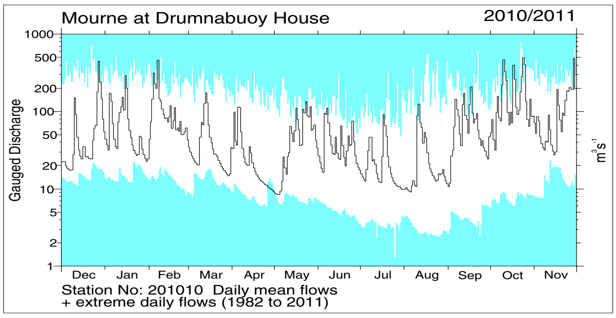


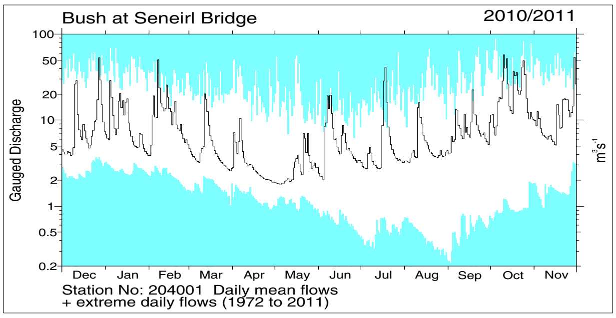








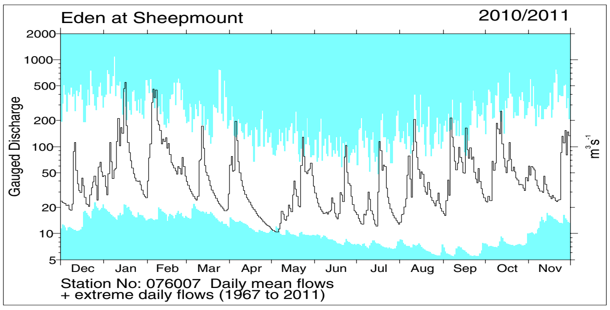




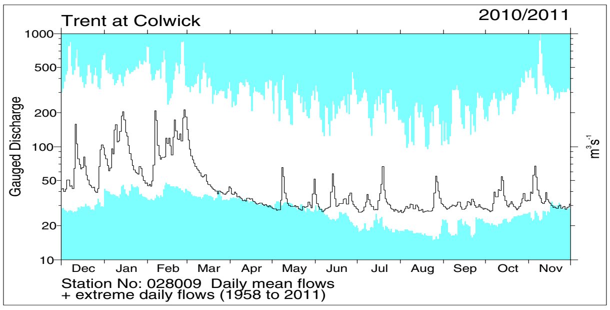
River flow hydrographs

The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to December 2010 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

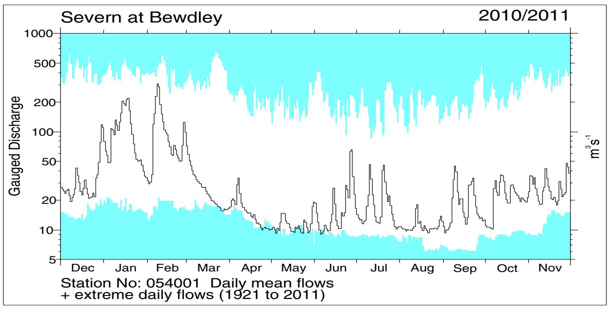
River flow . . . River flow . . .



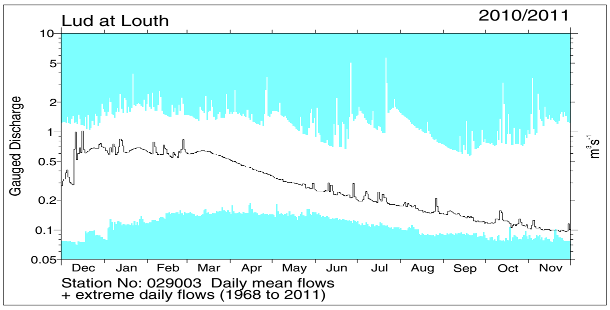
Station No: 076007 Daily mean flows
+ extreme daily flows (1967 to 2011)



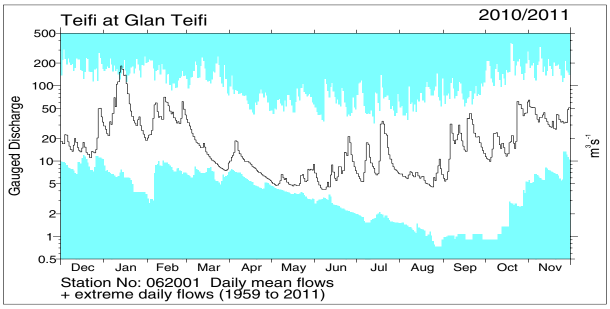
Station No: 028009 Daily mean flows
+ extreme daily flows (1958 to 2011)



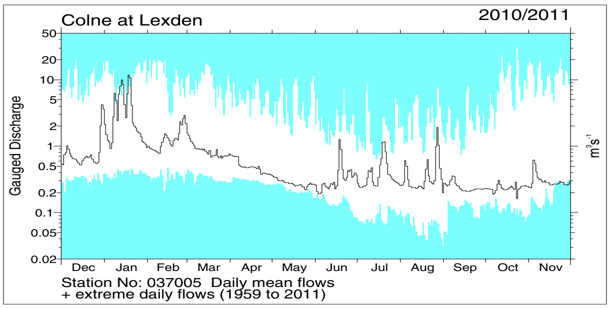
Station No: 054001 Daily mean flows
+ extreme daily flows (1921 to 2011)



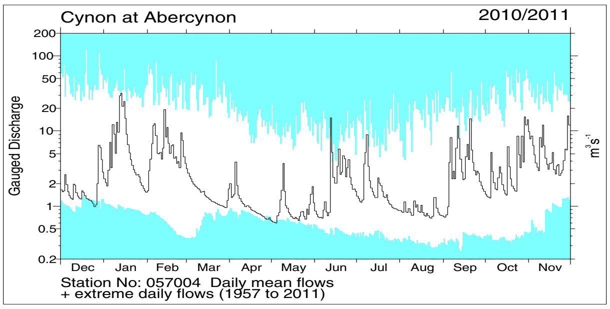
Station No: 029003 Daily mean flows
+ extreme daily flows (1968 to 2011)



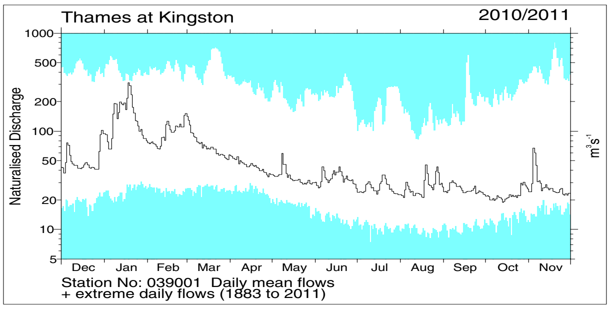
Station No: 062001 Daily mean flows
+ extreme daily flows (1959 to 2011)



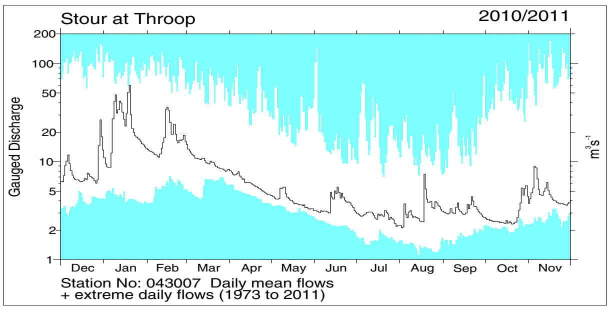
Station No: 037005 Daily mean flows
+ extreme daily flows (1959 to 2011)



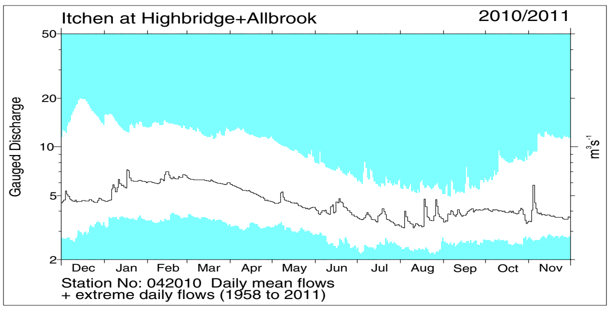
Station No: 057004 Daily mean flows
+ extreme daily flows (1957 to 2011)



Station No: 039001 Daily mean flows
+ extreme daily flows (1883 to 2011)



Station No: 043007 Daily mean flows
+ extreme daily flows (1973 to 2011)



Station No: 042010 Daily mean flows
+ extreme daily flows (1958 to 2011)

Notable runoff accumulations (a) September - November 2011, (b) April - November 2011

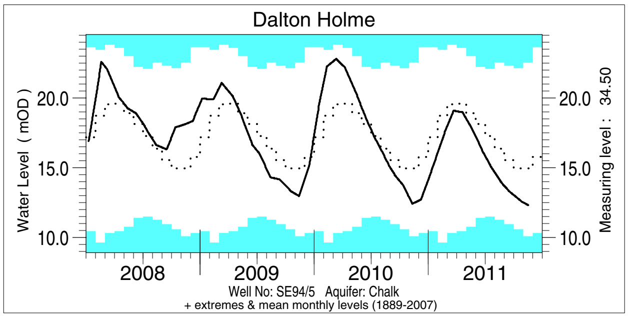
	River	%lta	Rank
a)	Lud	44	3/44
	Colne	32	3/52
	Kennet	55	1/50
	Lambourn	64	3/49
	Coln	39	1/48
	Gt Stour	44	2/47
	Avon (Amesbury)	46	1/46
	Nith	159	54/54
	Camowen	187	40/40
	Mourne	172	30/30
	Bush	170	37/38

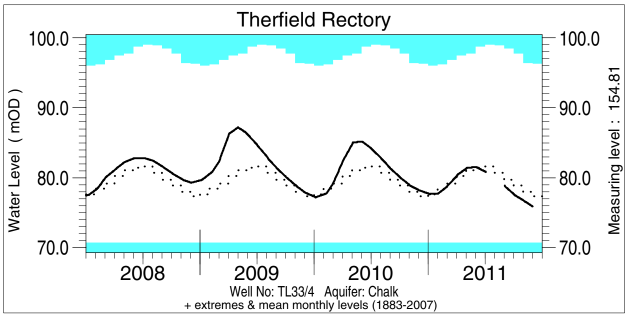
	River	%lta	Rank
b)	Ness	146	39/39
	Tay	146	59/59
	Earn	167	64/64
	Forth	159	30/30
	Trent	151	1/53
	Dove	46	1/50
	Torne	54	1/40
	Soar	36	1/40

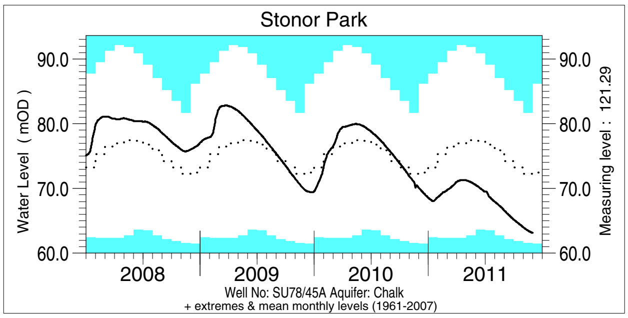
	River	%lta	Rank
b)	Little Ouse	44	1/41
	Medway	34	1/49
	Wallington	29	1/56
	Kenwyn	45	1/43
	Teme	28	1/42
	Luss Water	137	33/33
	Nevis	141	29/29

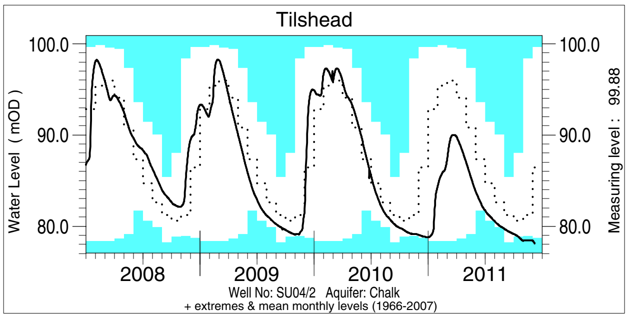
lta = long term average
Rank 1 = lowest on record

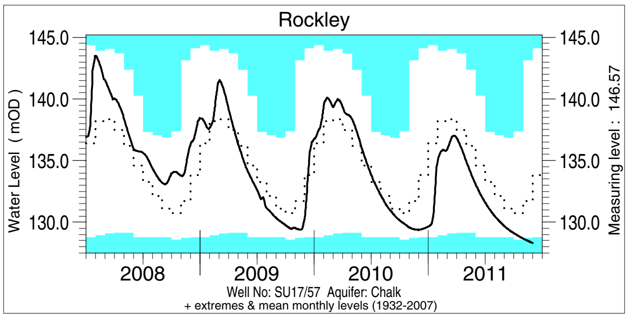
Groundwater . . . Groundwater

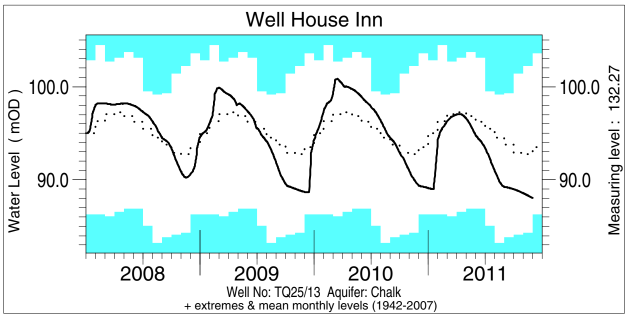


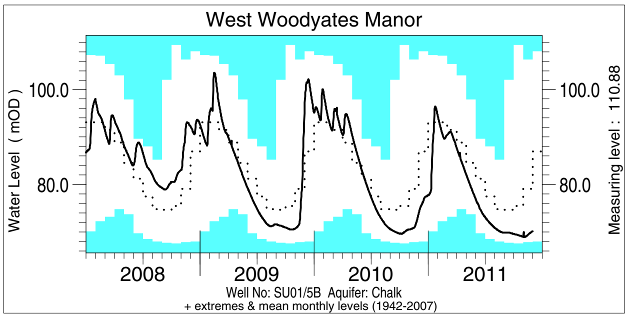


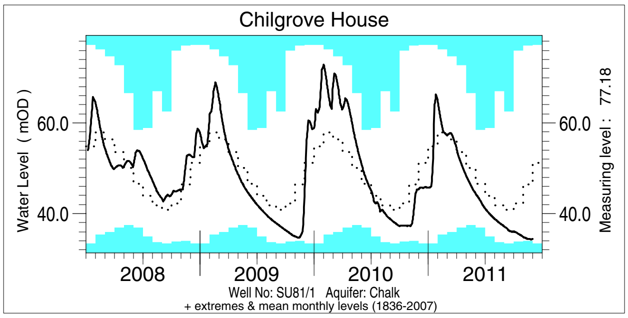


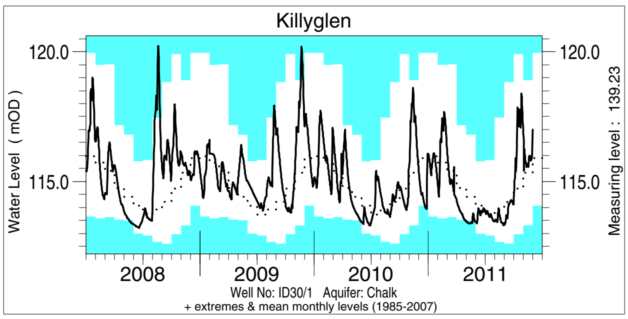


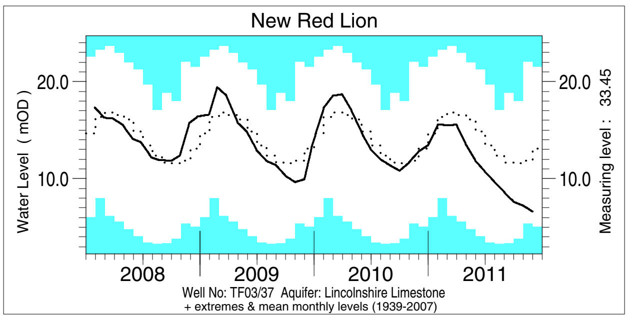






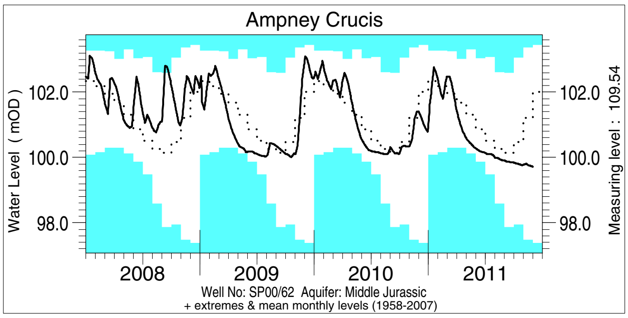


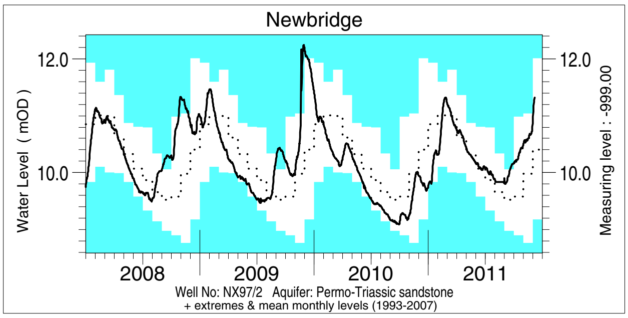


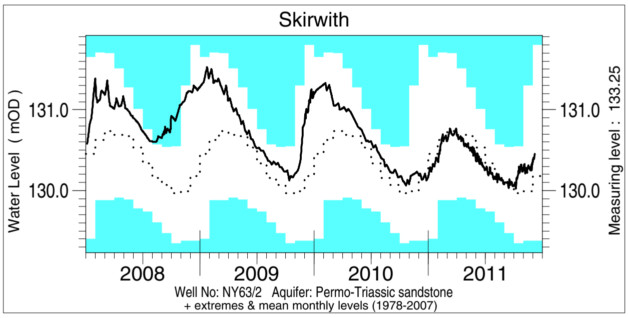


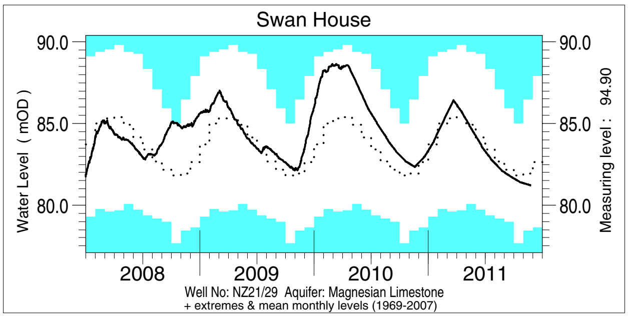
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly mean and the highest and lowest levels recorded for each month are displayed in a similar style to the river flow hydrographs. Note that most groundwater levels are not measured continuously and, for some index wells, the greater frequency of contemporary measurements may, in itself, contribute to an increased range of variation. The latest recorded levels are listed overleaf.

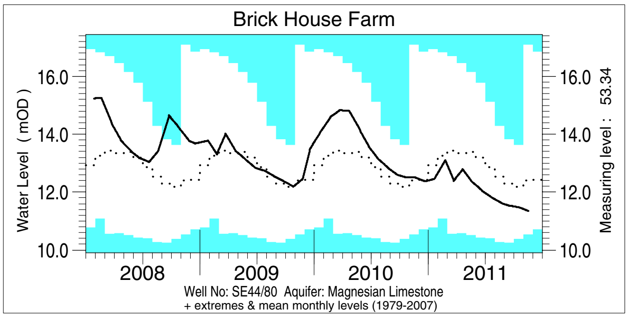
Groundwater . . . Groundwater

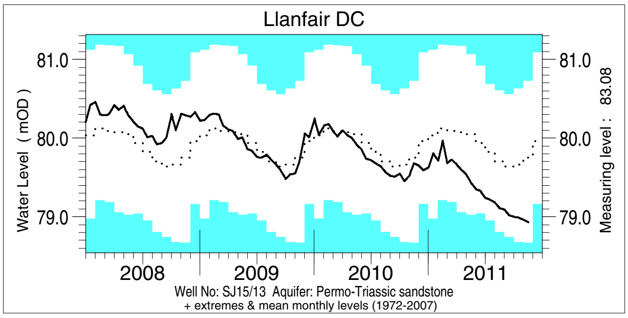


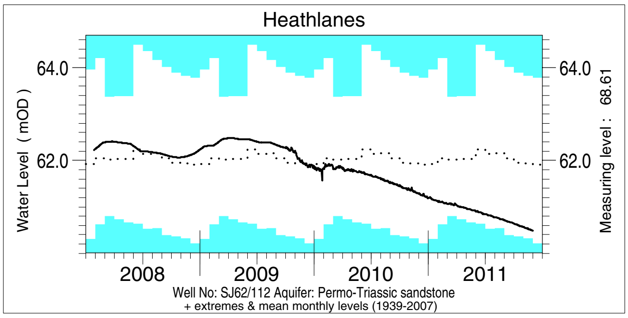


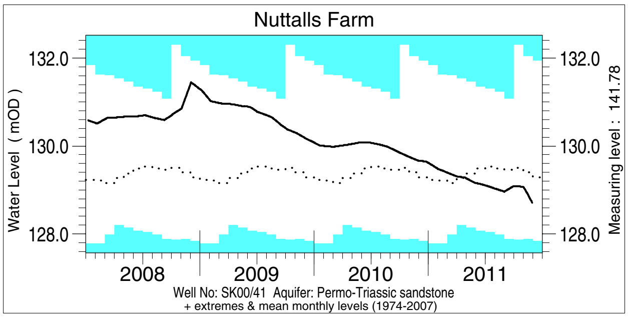


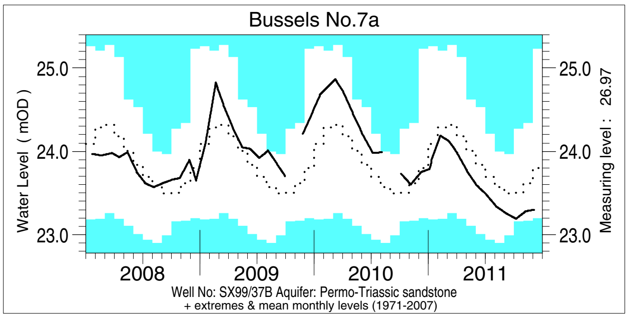


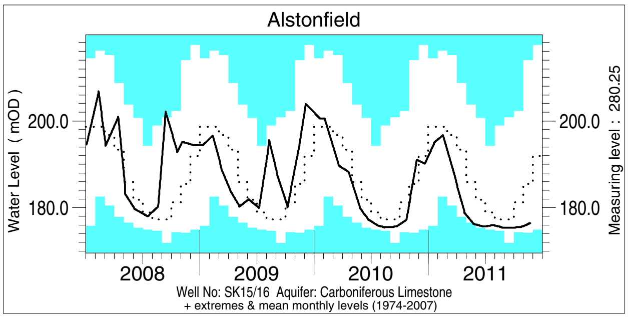








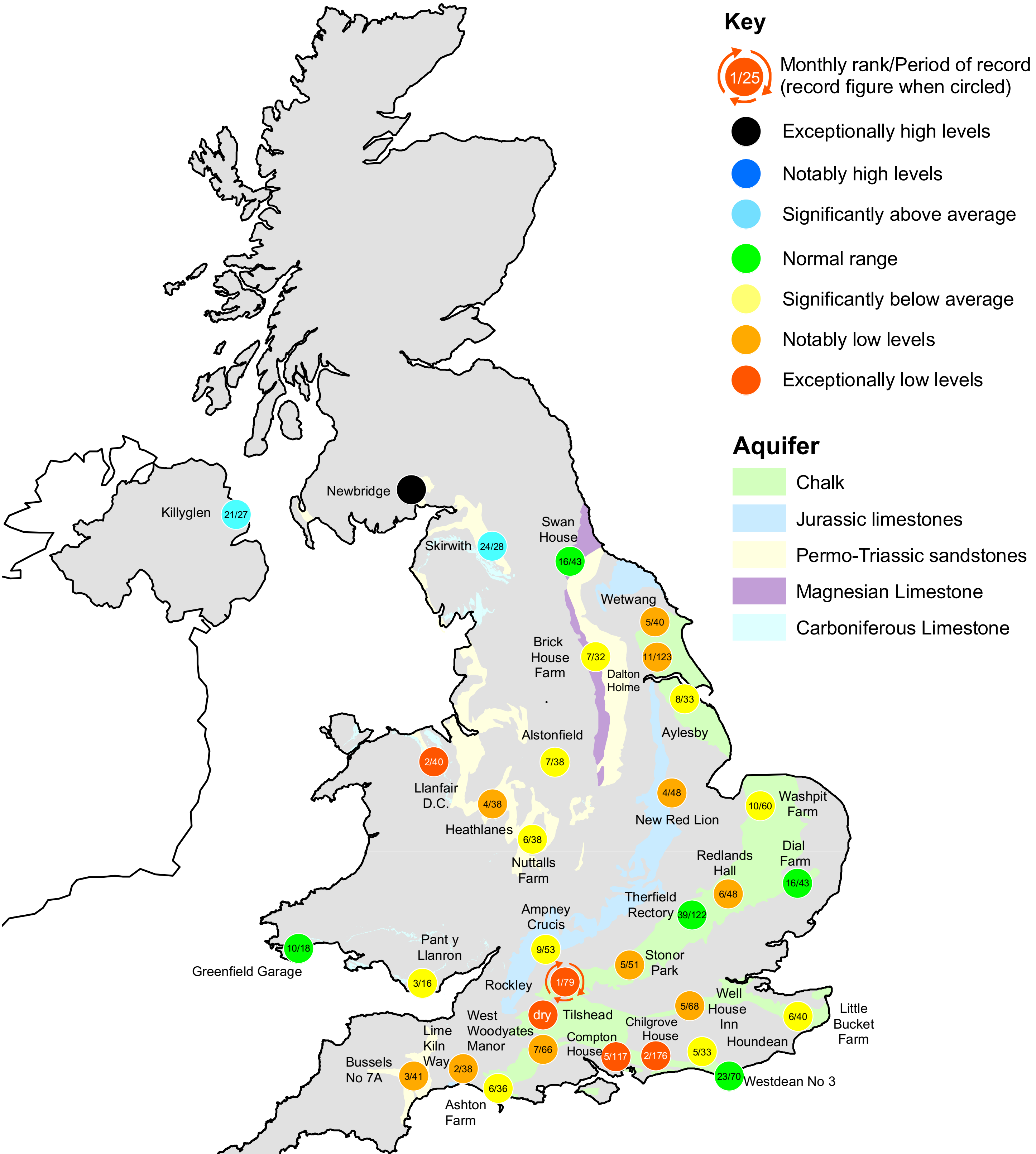




Groundwater levels November / December 2011

Borehole	Level	Date	Nov av.	Borehole	Level	Date	Nov av.	Borehole	Level	Date	Nov av.
Dalton Holme	12.32	16/11	14.79	Chilgrove House	34.37	30/11	46.44	Brick House Farm	11.34	17/11	12.34
Therfield Rectory	75.84	01/12	78.24	Killyglen (NI)	117.01	30/11	115.97	Llanfair DC	78.93	15/11	79.69
Stonor Park	63.12	30/11	72.25	New Red Lion	6.60	30/11	12.27	Heathlanes	60.49	30/11	61.88
Tilshead	78.11	07/12	82.55	Ampney Crucis	99.72	30/11	101.21	Nuttalls Farm	128.71	28/11	129.61
Rockley	128.31	30/11	131.62	Newbridge	11.32	06/12	10.13	Bussels No.7a	23.30	05/12	23.64
Well House Inn	88.04	30/11	92.89	Skirwith	130.45	6/12	130.07	Alstonfield	176.45	22/11	187.08
West Woodyates	70.14	30/11	80.65	Swan House	81.21	23/11	82.07				

Levels in metres above Ordnance Datum



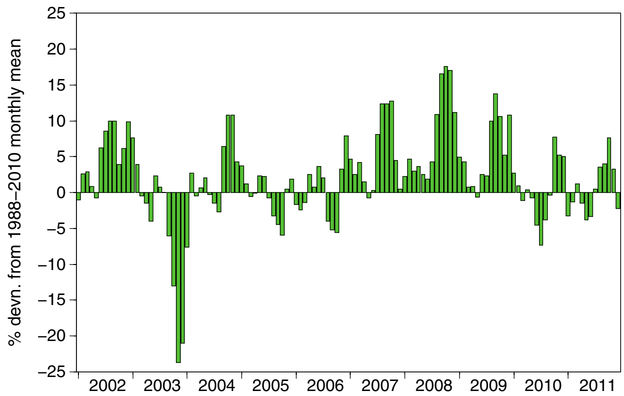
Groundwater levels - November 2011

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.

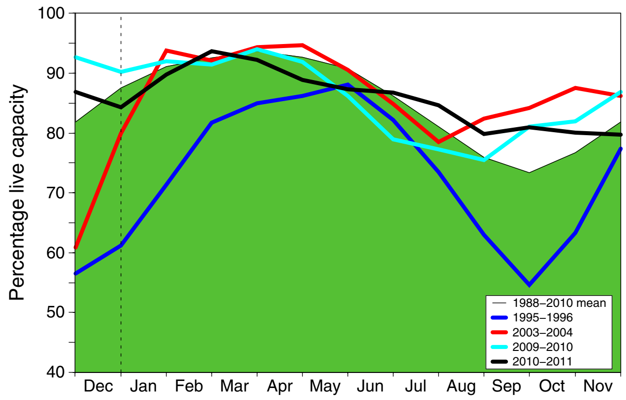
Notes:
i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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)	2011 Oct	Nov	Dec	Dec Anom.	Min Dec	Year* of min	2010 Dec	Diff 11-10
North West	N Command Zone	•	124929	78	80	**81**	4	44	1993	83	-2
	Vyrnwy		55146	86	75	**80**	-2	33	1995	96	-16
Northumbrian	Teesdale	•	87936	93	91	**90**	10	39	1995	90	0
	Kielder		(199175)	(91)	(90)	**(89)**	4	(55)	2007	(88)	1
Severn Trent	Clywedog		44922	87	86	**88**	8	43	1995	86	2
	Derwent Valley	•	39525	53	75	**72**	-8	9	1995	85	-13
Yorkshire	Washburn	•	22035	71	81	**86**	12	16	1995	89	-3
	Bradford supply	•	41407	76	86	**90**	8	20	1995	92	-2
Anglian	Grafham		(55490)	(89)	(84)	**(82)**	-1	(47)	1997	(95)	-13
	Rutland		(116580)	(70)	(66)	**(63)**	-16	(57)	1995	(75)	-12
Thames	London	•	202828	80	69	**66**	-16	52	1990	89	-23
	Farmoor	•	13822	93	85	**86**	-3	52	1990	87	-1
Southern	Bewl		28170	50	43	**35**	-28	34	1990	51	-16
	Ardingly		4685	48	34	**14***	-61	**14***	**2011**	75	-61
Wessex	Clatworthy		5364	37	33	**65**	-13	16	2003	60	5
	Bristol WW	•	(38666)	(57)	(53)	**(53)**	-14	(27)	1990	(54)	-1
South West	Colliford		28540	48	49	**51**	-22	42	1995	79	-28
	Roadford		34500	54	56	**58**	-16	19	1995	72	-14
	Wimbleball		21320	44	44	**49**	-26	34	1995	62	-13
	Stithians		4967	44	39	**50**	-15	29	2001	64	-14
Welsh	Celyn and Brenig	•	131155	96	93	**95**	8	50	1995	97	-2
	Brianne		62140	98	100	**92**	-3	72	1995	92	0
	Big Five	•	69762	85	93	**97**	15	49	1990	100	-3
	Elan Valley	•	99106	90	100	**100**	6	47	1995	99	1
Scotland(E)	Edinburgh/Mid Lothian	•	97639	97	100	**100**	15	45	2003	90	10
	East Lothian	•	10206	100	100	**100**	12	38	2003	100	0
Scotland(W)	Loch Katrine	•	111363	96	95	**97**	7	65	2007	90	7
	Daer		22412	99	100	**99**	2	73	2003	99	0
	Loch Thom	•	11840	95	100	**100**	7	72	2003	96	4
Northern Ireland	Total+	•	56920	78	93	**91**	6	59	2003	92	-1
	Silent Valley	•	20634	73	88	**91**	13	43	2001	93	-2

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

Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2010 period except for West of Scotland and Northern Ireland where data commence in the mid-1990's. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.

*** The monthly record of Ardingly reservoir stocks is under review.**

Location map . . . Location map

National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme (NHMP)[#] is undertaken jointly by the Centre for Ecology & Hydrology (CEH) 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 Environment Agency, the Environment Agency Wales, the Scottish Environment Protection Agency and, for Northern Ireland, the Rivers Agency and the Northern Ireland Environment Agency. 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 Northern Ireland Water.

The National River Flow Archive (maintained by CEH) 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 (see 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. A significant number of additional monthly raingauge totals are provided by the EA and SEPA to help derive the contemporary regional rainfalls. Revised monthly national and regional rainfall totals for the post-1960 period were made available by the Met Office in 2004; these have been adopted by the NHMP. As with all regional figures based on limited raingauge networks the monthly tables and accumulations (and the return periods associated with them) should be regarded as a guide only.

The monthly rainfall figures are provided by the Met Office (National Climate Information Centre) and are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

[#] Instigated in 1988

[*]MORECS is the generic name for the Met 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.

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Selected text and maps are available on the WWW at http://www.ceh.ac.uk/data/nrfa/nhmp/nhmp.html
Navigate via Hydrological Summary for the UK.

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