Hydrological Summary

for the United Kingdom

October 2016

General

With high pressure dominating for most of the month, October was notably dry for most of the UK. Although there were warm spells, easterly winds brought temperatures close to the seasonal average. There was a good deal of autumn sunshine, although there were regional variations: it was exceptionally sunny in north-west Scotland, while sunshine was near-average in the east. The dry October extends appreciable rainfall deficiencies which have developed since July in southern England. With significant soil moisture deficits (SMDs) persisting in many areas, river flows and groundwater levels generally continued to recede. October river flows were below normal across much of the country, and exceptionally low in some western index catchments. Groundwater levels generally remained in the normal range or moderately below. With depressed autumn runoff, reservoir stocks declined – steeply in many impoundments – but at the national scale stocks are generally near-average (although 7% below average for Northern Ireland). Stocks were substantially below-average in some areas, particularly in some impoundments in south-west England where stocks have declined steeply since the spring; for example, Clatworthy registered 34% below average, its third lowest October stocks (after the drought years of 2003 and 1989). Overall, the water resources situation is favourable at the national scale. However, the delay in commencement of substantial aquifer recharge or reservoir replenishment suggests continuing vigilance will be required through the winter half-year, particularly in areas where current levels or stocks imply recovery will begin from a below-normal baseline. Current seasonal outlooks slightly favour drier rather than wetter conditions for the winter, albeit with a substantial range of possible outcomes.

Rainfall

October was dominated by anticyclonic conditions, with blocking high pressure stationed over Scandinavia deflecting most rain-bearing Atlantic systems to the north. The first day was showery in England and Wales, with thunderstorms bringing heavy rain to some areas, with localised disruption reported in Cambridgeshire. Thereafter, high pressure became established and most areas received little appreciable rainfall for nearly the next fortnight; Wallingford (Oxfordshire) saw no days of rainfall over 1mm from 2nd – 13th. A brief cyclonic interlude around mid-month brought heavy rainfall to many areas (with 74mm in 24h on the 13th/14th at Killylane, Antrim), with transport disruption reported in eastern Scotland and localised urban flooding in Northern Ireland. Blocking high pressure conditions were then re-established, with the remainder of the month being largely dry and settled, although there were heavy showers in south-west England on the 23rd/24th (with 49mm at Slapton, Devon) and unsettled conditions in the final days in north-west Britain. October was a notably dry month at the national scale, with the UK as a whole receiving 43% of the typical October rainfall. It was the sixth driest October for the UK, and the fourth driest for Scotland (in records from 1910). While localised parts of the east coast received moderately above-average rainfall (reflecting the easterly onshore winds associated with high pressure over Scandinavia), the majority of the UK received less than half the October average. The lowest rainfall was in the far west: Wales, north-west England and Solway regions all received 32% of the October average, with parts of the west coast receiving less than 30%, along with pockets of the Midlands and south-east. Moderate rainfall deficiencies are apparent across much of the country for the last four months, particularly in southern and central England; Southern region received 50% of its typical July-October rainfall, the third lowest on record for this period (from 1910).

River flows

Following moderately elevated flows resulting from unsettled weather at the turn of the month, many responsive index rivers were in recession for the first two weeks of October. Brief flow increases occurred following the cyclonic episode mid-month, although flows remained in the typical seasonal range. Recessions then became re-established and generally continued until month-end, although with occasional interruptions, e.g. around the 24th in south-west England, while rapid flow increases were also seen on the last day in Scotland. October average river flows were below normal across much of the country, although many eastward-flowing catchments remained in the normal range. Across western Britain, many catchments registered notably or exceptionally low October flows, with new October minima established in several catchments, from south-west England (the Tone) to western Scotland (the Cree, Carron and Nevis) and Northern Ireland (the Mourne). The Soar in the Midlands also registered an October minimum. Correspondingly, October outflows were notably low: it was the fourth lowest October flow in the Northern Ireland outflow series (from 1980), and the sixth lowest October flow in the England and Wales series (from 1961). Low flows for the autumn so far characterise many western catchments; some catchments in south-west England registered less than 40% of their typical September-October flows. Substantial runoff deficiencies extend back to July for the Soar and parts of south-west England, while moderate deficiencies over this timeframe can be seen in some northern catchments and the far south-east of England. In some catchments (the Soar, Tone, Exe, Naver) notable deficiencies can be traced back to the spring.

Groundwater

As a result of the dry October, SMDs decreased only marginally across the main aquifer areas, at a time of year when SMDs typically begin to decrease significantly. End-of-month SMDs were therefore substantially above average across much of the English Lowlands, for the third successive month. For Southern region, SMDs were over twice the average for the time of year (the fifth highest for end of October, in a series from 1961). For the Chalk as a whole, end-of-October SMDs were the third highest since 1980 – while lower than the drought years of 1996 and 2011, they were higher than at the equivalent time in 2003. Given the persistence of such deficits, unsurprisingly groundwater levels continued to recede across the Chalk apart from modest increases at Westdean No. 3 and Killyglen. All indicator sites were within the normal range or below, with notably low levels at Killyglen. In the Permo-Triassic sandstones, levels also continued to recede, falling from exceptionally high to above normal at Newbridge, into the normal range at Skirwith and Llanfair DC and to below normal at Bussells No. 7a. In the Jurassic and Magnesian limestone aquifers, levels fell and are in the normal range. Levels in the Carboniferous Limestone were in the normal range at Alstonefield in the Peak District and below normal across south Wales.

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.

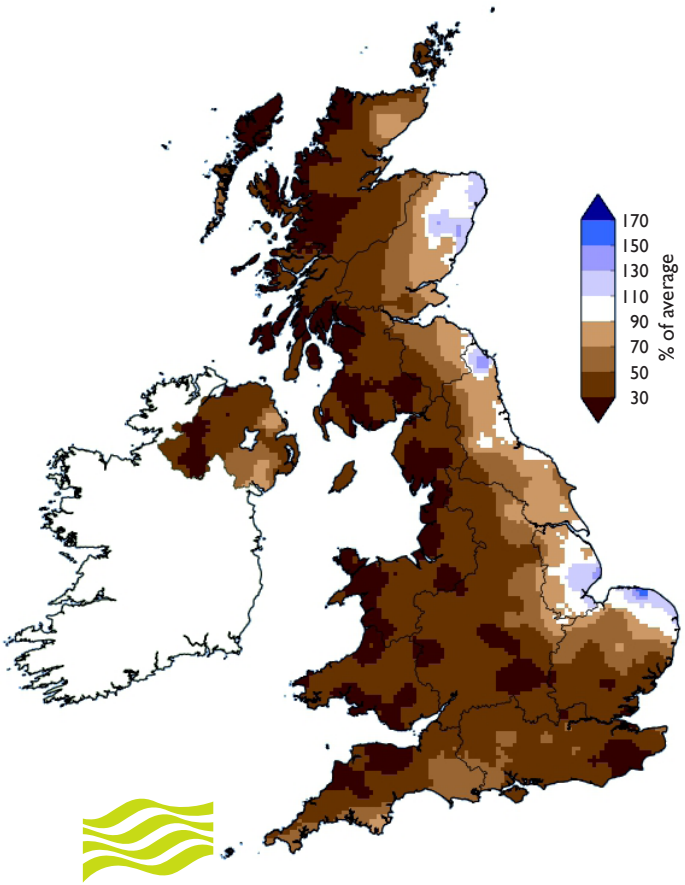
Area	Rainfall	Oct 2016	Sep16 – Oct16	RP	Jul16 – Oct16	RP	May16 – Oct16	RP	Nov15 – Oct16	RP
United Kingdom	mm	**49**	148		317		484		1338	
	%	**43**	71	5-10	89	2-5	99	2-5	124	60-90
England	mm	**39**	103		212		365		964	
	%	**48**	67	5-10	78	5-10	94	2-5	118	5-10
Scotland	mm	**66**	210		474		647		1833	
	%	**43**	73	5-10	100	2-5	104	2-5	128	>100
Wales	mm	**47**	192		384		612		1799	
	%	**32**	73	2-5	87	2-5	102	2-5	132	40-60
Northern Ireland	mm	**50**	154		326		483		1333	
	%	**43**	74	2-5	87	2-5	94	2-5	120	40-60
England & Wales	mm	**40**	115		235		399		1080	
	%	**44**	68	5-10	80	5-10	96	2-5	121	10-15
North West	mm	**40**	149		394		572		1680	
	%	**32**	65	5-10	98	2-5	105	2-5	143	>100
Northumbrian	mm	**60**	125		293		404		1162	
	%	**79**	86	2-5	107	2-5	103	2-5	140	>100
Severn-Trent	mm	**28**	86		187		351		879	
	%	**40**	63	5-10	75	8-12	96	2-5	116	5-10
Yorkshire	mm	**46**	99		239		367		1061	
	%	**60**	68	5-10	90	2-5	96	2-5	131	25-40
Anglian	mm	**40**	89		161		312		666	
	%	**70**	80	2-5	77	5-10	101	2-5	110	2-5
Thames	mm	**27**	82		140		300		741	
	%	**38**	61	5-10	61	10-20	88	2-5	106	2-5
Southern	mm	**33**	73		130		285		784	
	%	**37**	46	8-12	50	30-50	78	5-10	101	2-5
Wessex	mm	**42**	112		186		354		909	
	%	**48**	68	2-5	67	10-20	90	2-5	105	2-5
South West	mm	**51**	149		257		412		1256	
	%	**40**	66	5-10	70	10-15	81	5-10	104	2-5
Welsh	mm	**45**	186		367		588		1715	
	%	**32**	73	2-5	86	2-5	101	2-5	130	30-50
Highland	mm	**66**	242		551		740		2039	
	%	**36**	71	5-10	101	2-5	104	2-5	119	15-25
North East	mm	**87**	149		336		503		1252	
	%	**86**	79	2-5	103	2-5	111	2-5	132	25-40
Tay	mm	**79**	190		383		559		1761	
	%	**59**	77	2-5	95	2-5	102	2-5	139	>100
Forth	mm	**59**	159		341		492		1517	
	%	**50**	71	2-5	91	2-5	96	2-5	134	80-120
Tweed	mm	**58**	130		331		450		1402	
	%	**61**	74	5-10	105	2-5	101	2-5	147	>100
Solway	mm	**49**	191		443		600		1910	
	%	**32**	69	5-10	94	2-5	96	2-5	136	>100
Clyde	mm	**60**	258		574		770		2213	
	%	**32**	73	2-5	98	2-5	102	2-5	128	50-80

% = 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. Note that precipitation totals in winter months may be underestimated due to snowfall undercatch. All monthly rainfall totals from February 2016 (inclusive) are provisional.

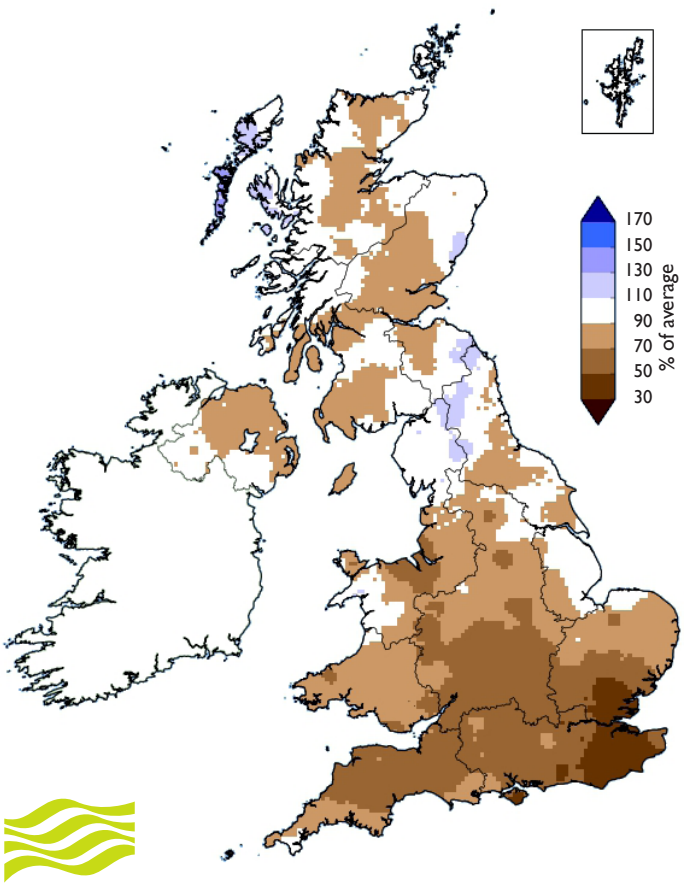
Rainfall . . . Rainfall . . .

October 2016 rainfall
as % of 1971-2000 average



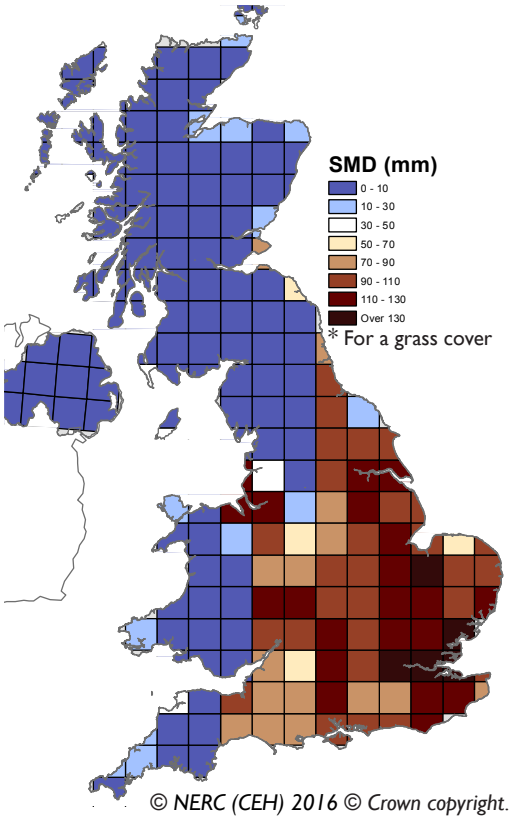
Met Office

July 2016 - October 2016 rainfall
as % of 1971-2000 average



Met Office

MORECS Soil Moisture Deficits*
October 2016



Met Office

Met Office
3-month outlook
Updated: October 2016

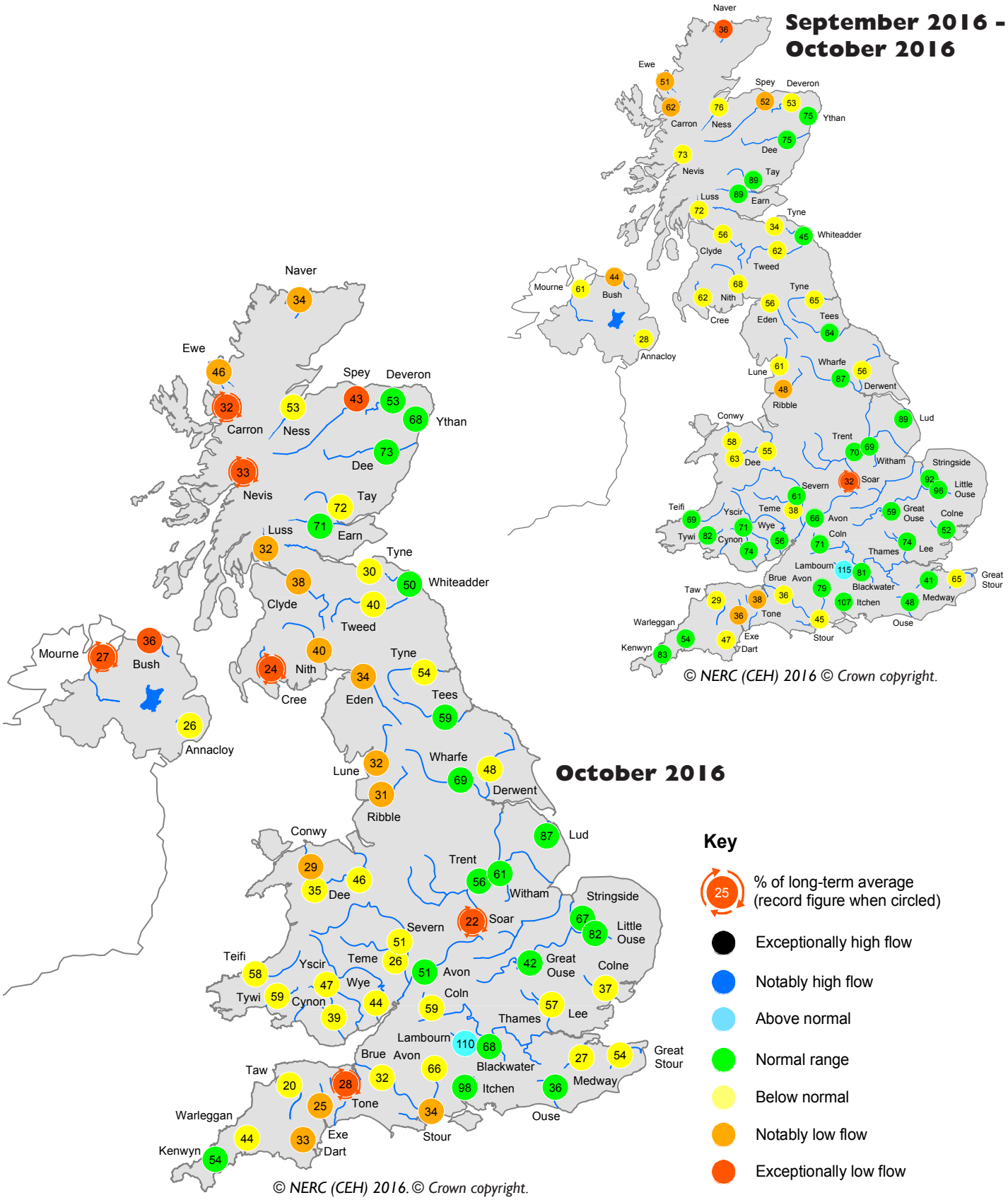
For November, below-average precipitation is more probable than above-average values. For the period November-December-January as a whole, the chances of below-average precipitation are also higher than those of above-average values.

The probability that UK precipitation for November-December-January will fall into the driest of our five categories is between 20 and 25% and the probability that it will fall into the wettest of our five categories is around 15% (the 1981-2010 probability for each of these categories is 20%).

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.

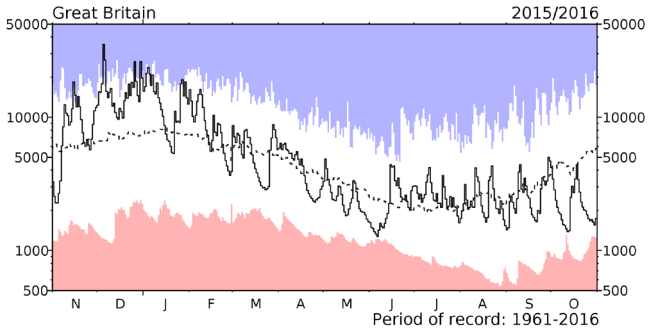
River flow . . . River flow . . .

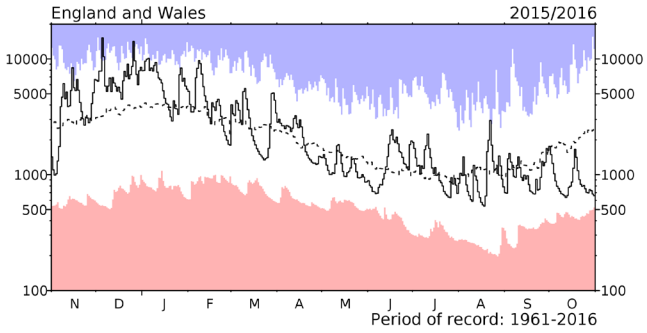


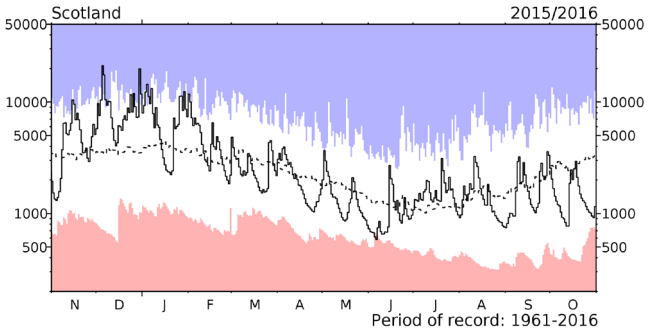
River flows

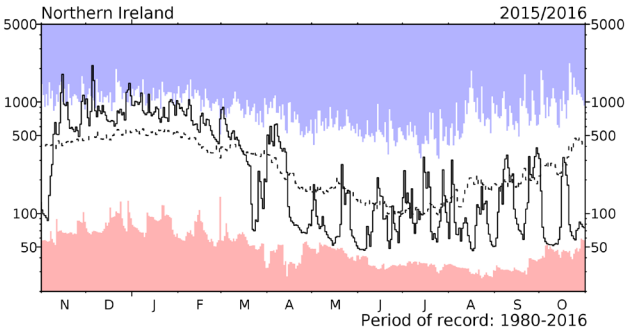
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much 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.

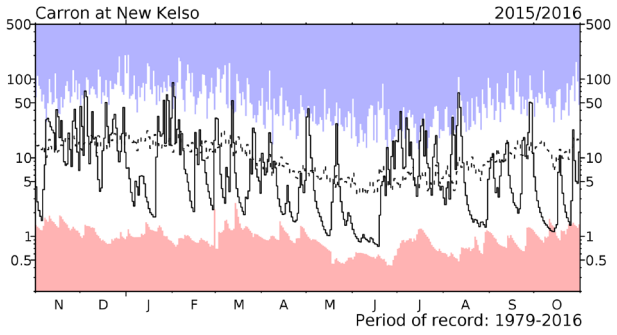
River flow . . . River flow . . .

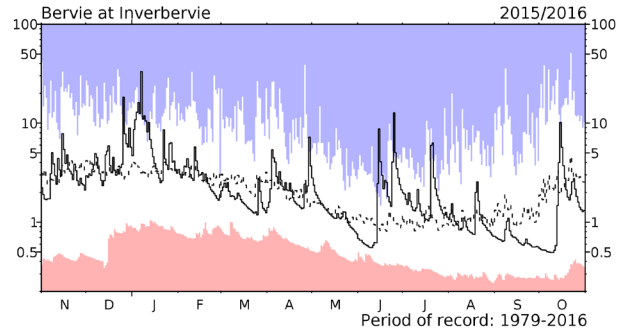


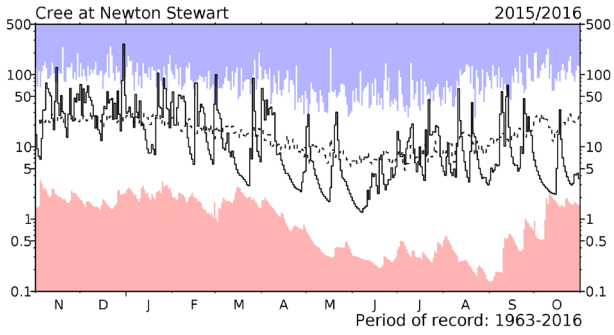


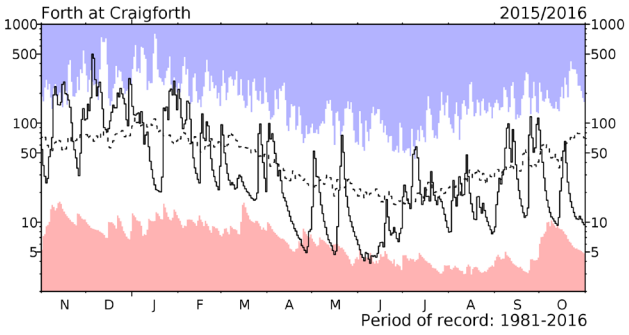


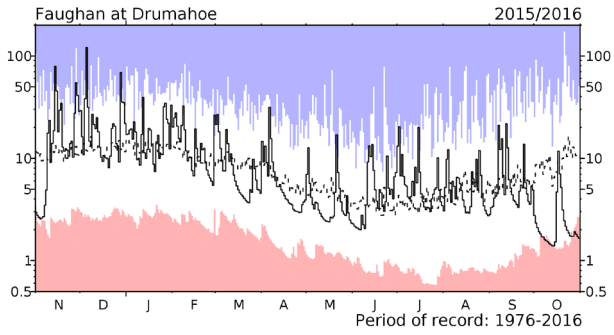


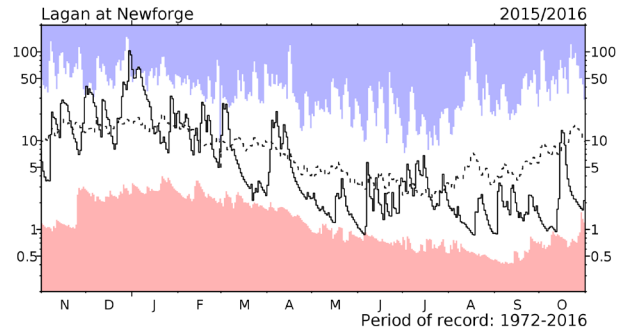








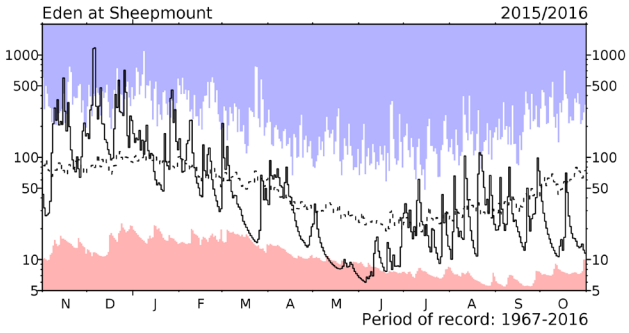


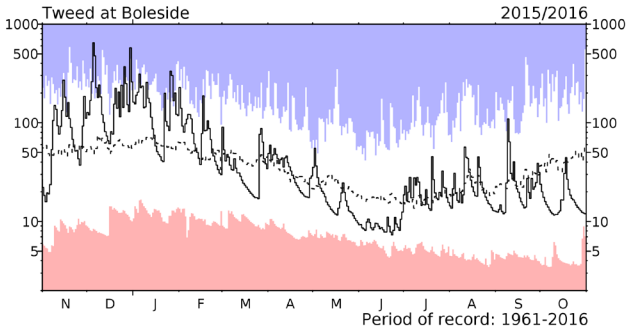


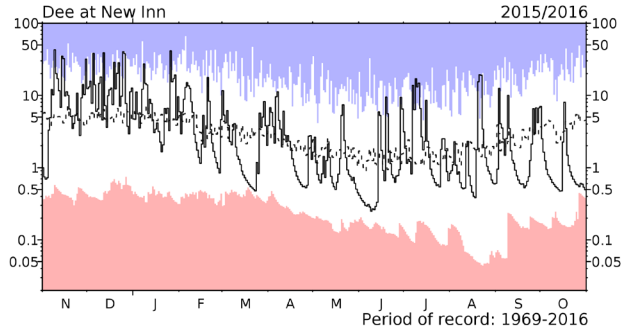
River flow hydrographs

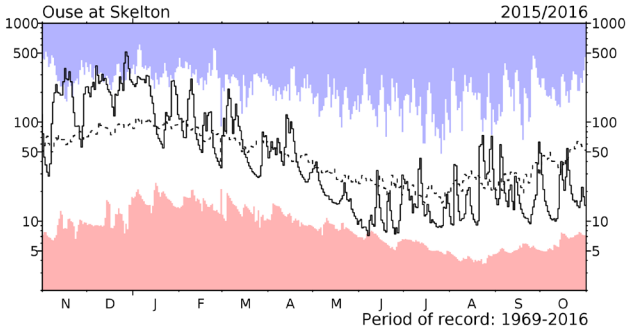
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to Novemer 2015 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the dashed line.

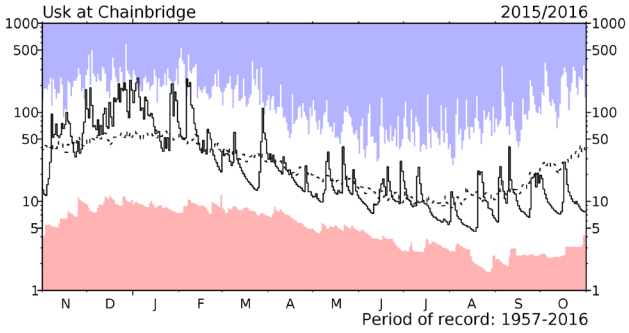
River flow . . . River flow . . .

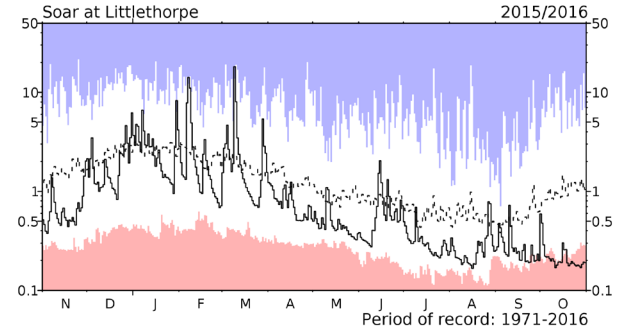


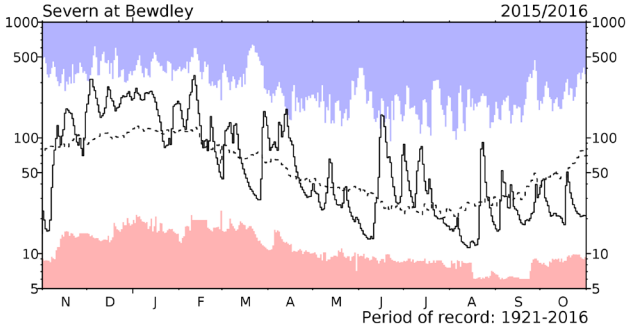


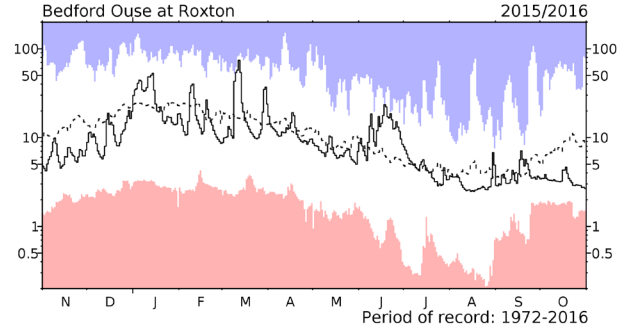


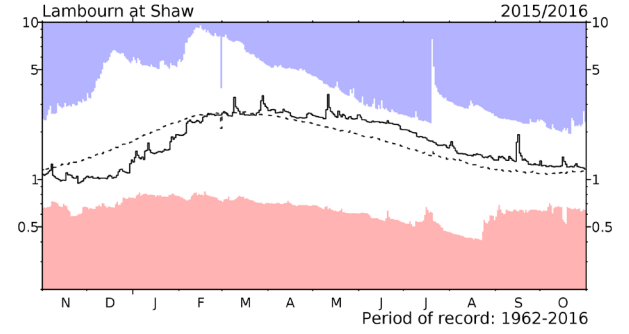


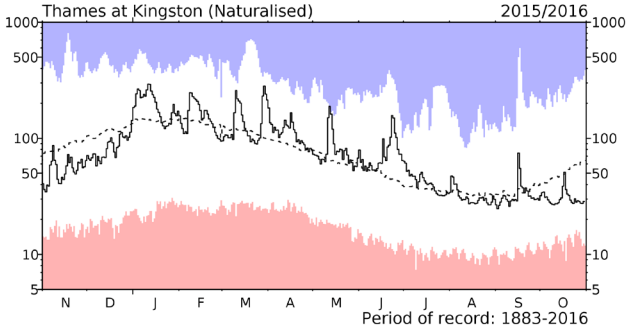


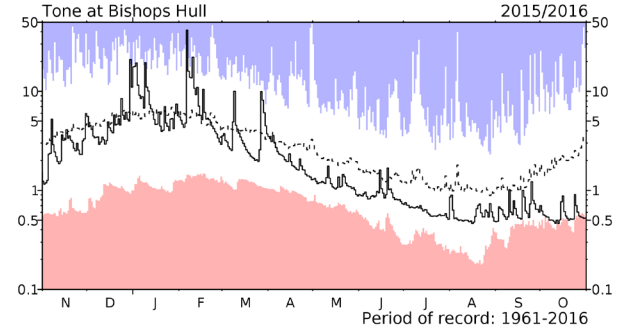


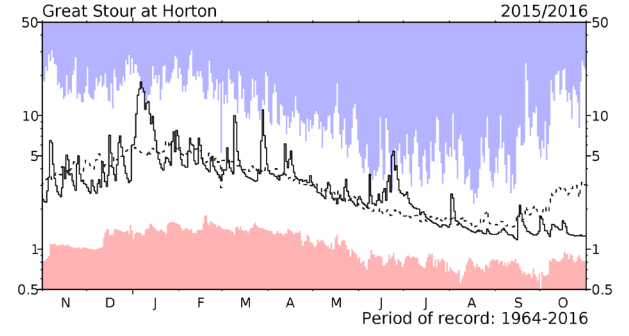




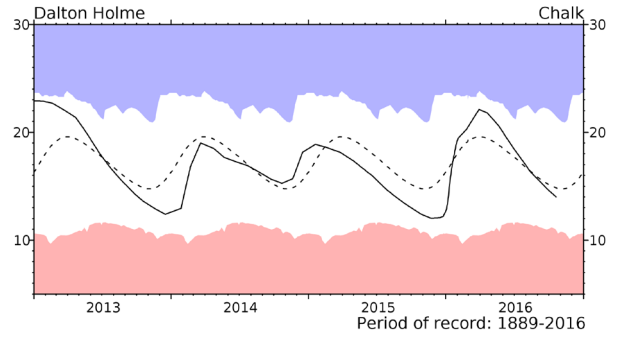


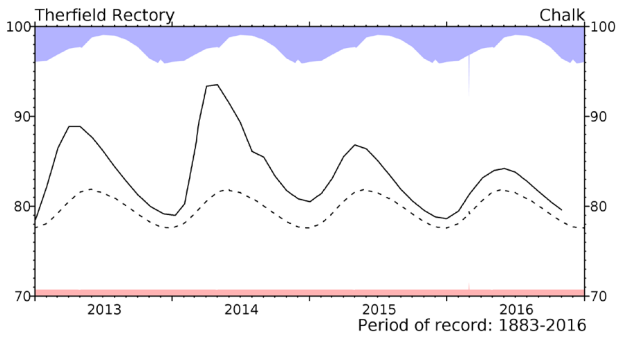


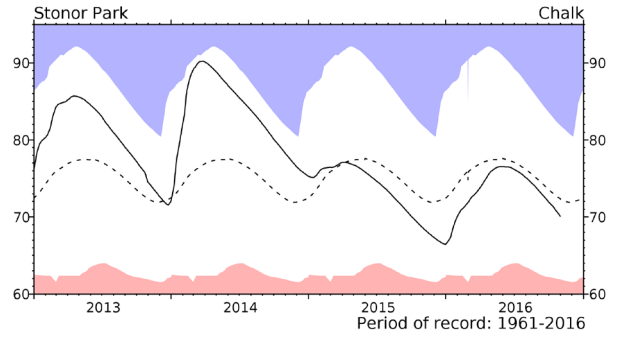


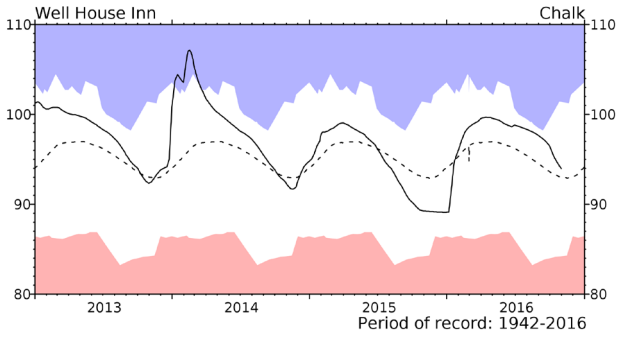


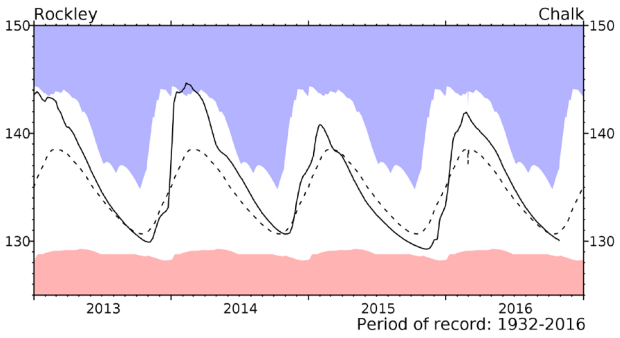
Groundwater…Groundwater

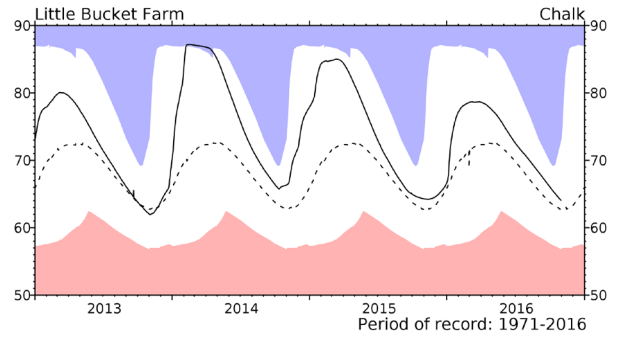


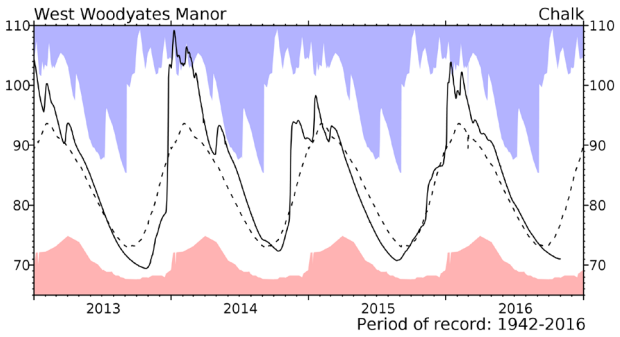


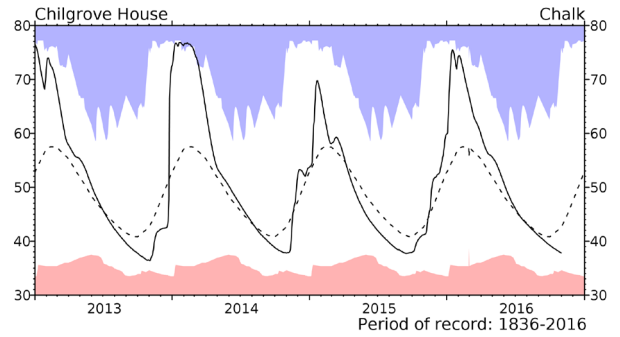


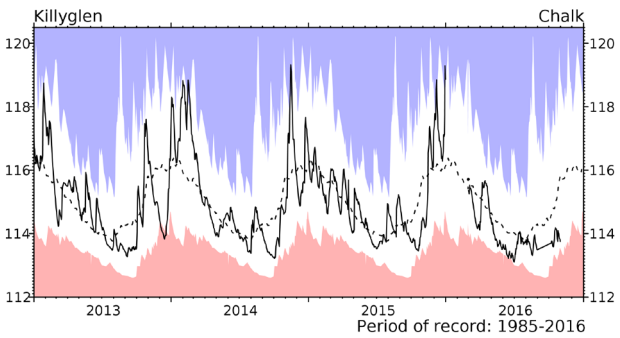


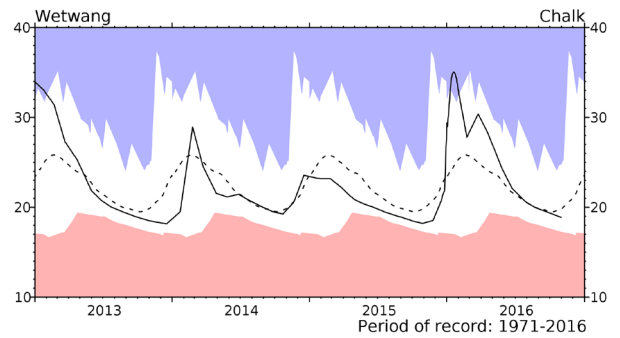






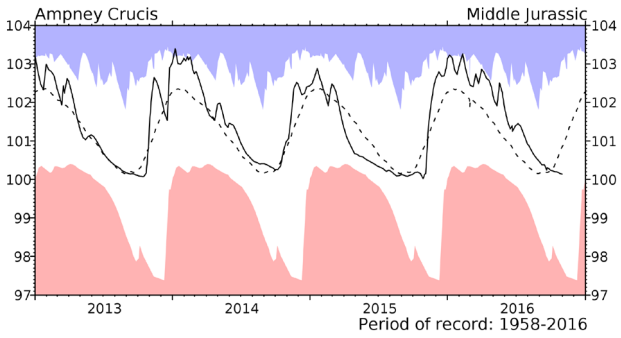


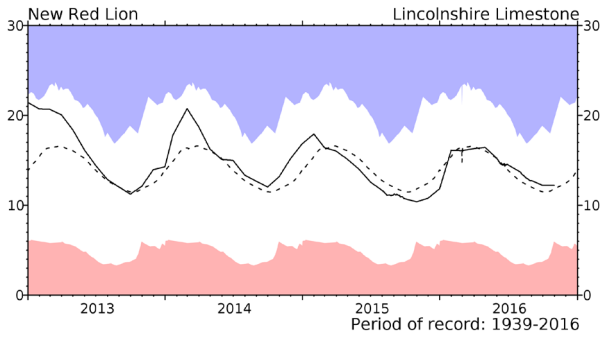


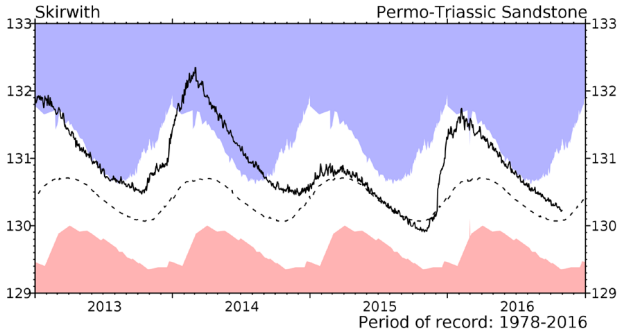


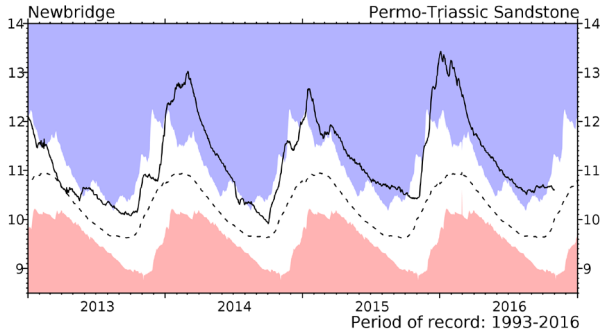
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

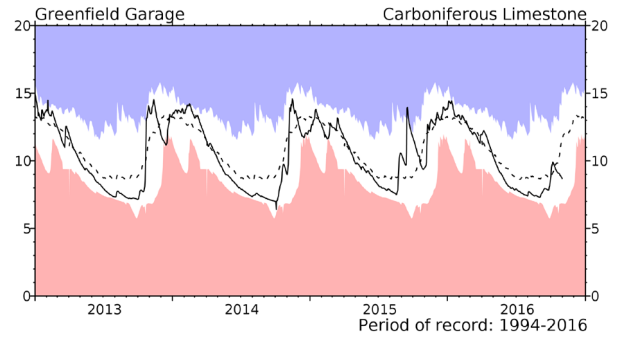
Groundwater ... Groundwater

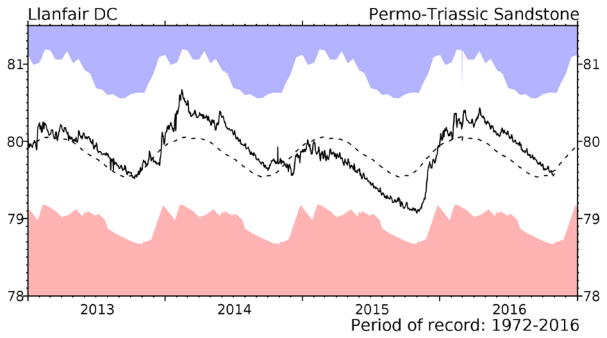


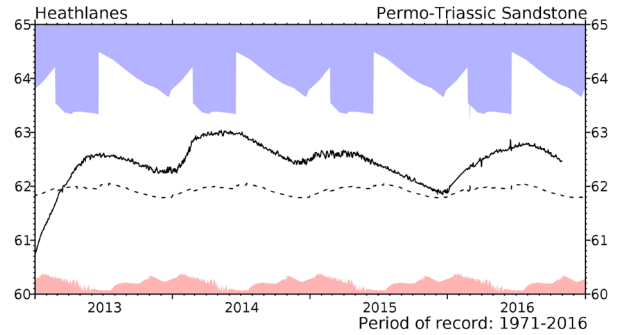


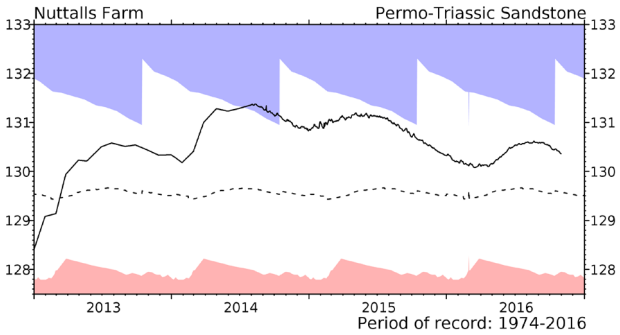


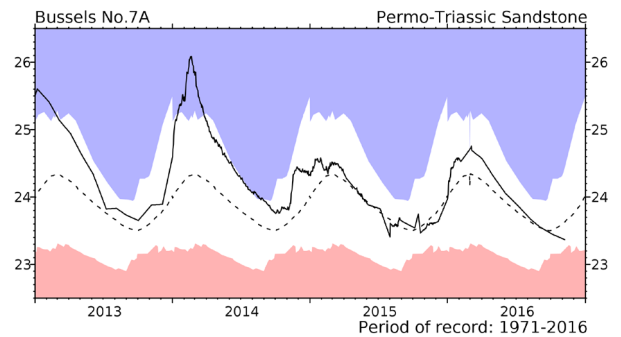


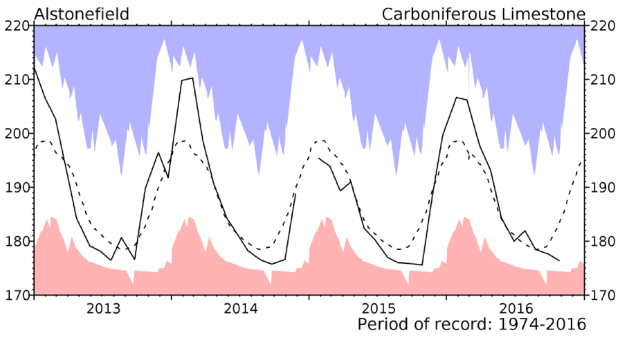








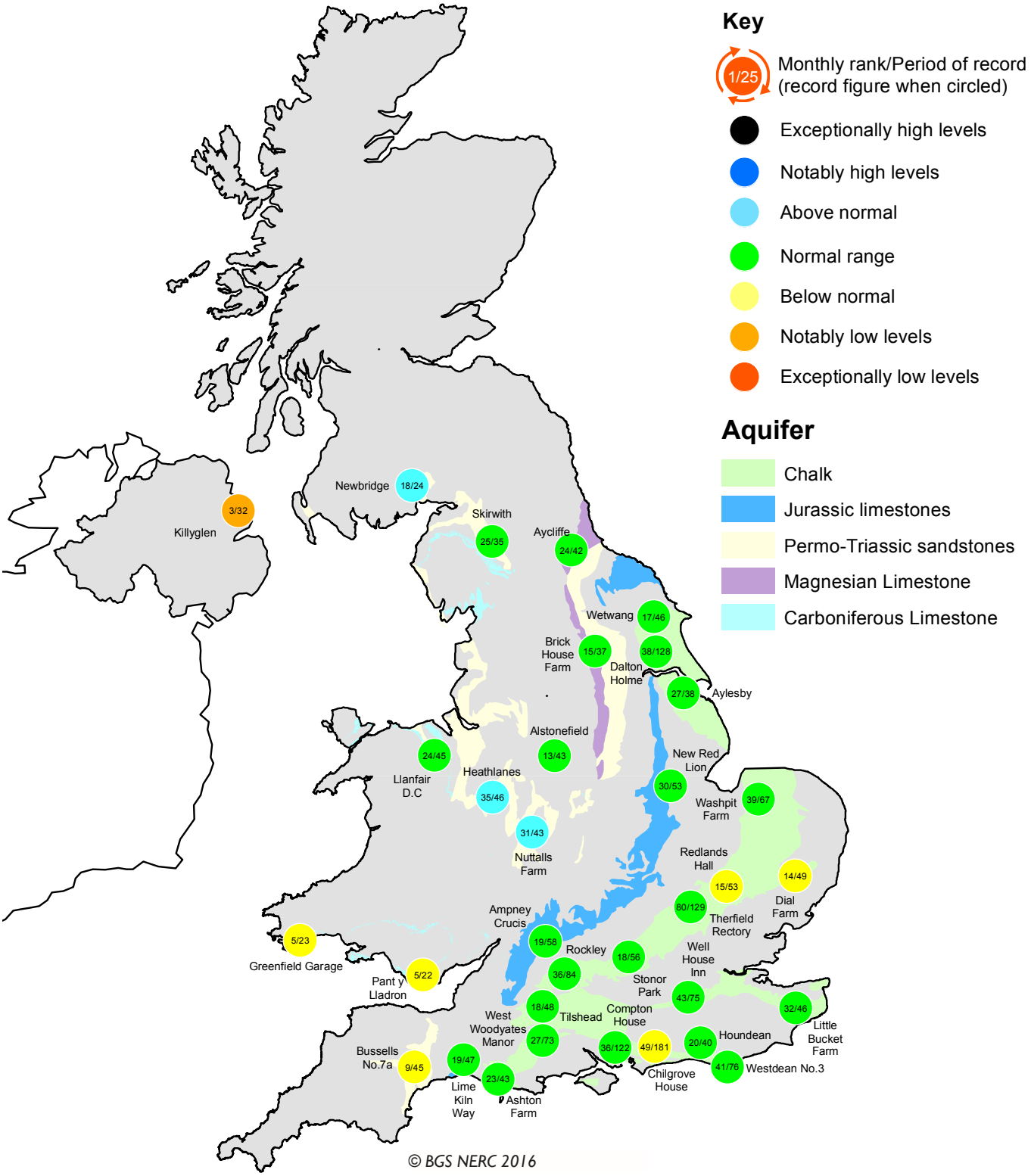




Groundwater levels October / November 2016

Borehole	Level	Date	Oct av.	Borehole	Level	Date	Oct av.	Borehole	Level	Date	Oct av.
Dalton Holme	14.00	20/10	14.88	Chilgrove House	37.77	31/10	42.22	Brick House Farm	12.17	25/10	12.31
Therfield Rectory	79.57	01/11	79.13	Killyglen (NI)	113.75	31/10	114.85	Llanfair DC	79.58	31/10	79.55
Stonor Park	70.08	31/10	72.98	Wetwang	18.95	25/10	19.41	Heathlanes	62.46	30/10	61.89
Tilshead	79.82	31/10	80.79	Ampney Crucis	100.14	31/10	100.46	Nuttalls Farm	130.36	31/10	129.69
Rockley	130.03	28/10	130.70	New Red Lion	12.20	31/10	11.58	Bussells No.7a	23.37	7/11	23.53
Well House Inn	93.95	31/10	93.00	Skirwith	130.22	31/10	130.09	Alstonefield	176.36	26/10	181.45
West Woodyates	71.01	31/10	74.90	Newbridge	10.60	31/10	9.84				

Levels in metres above Ordnance Datum

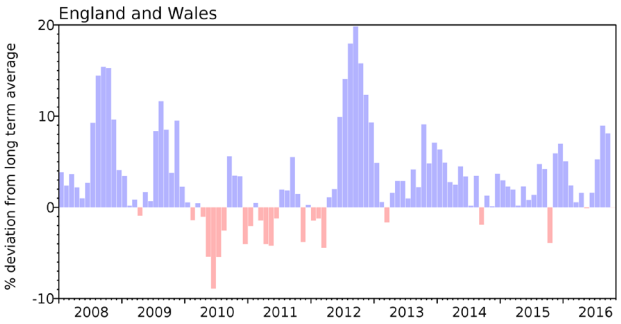


Groundwater levels - October 2016

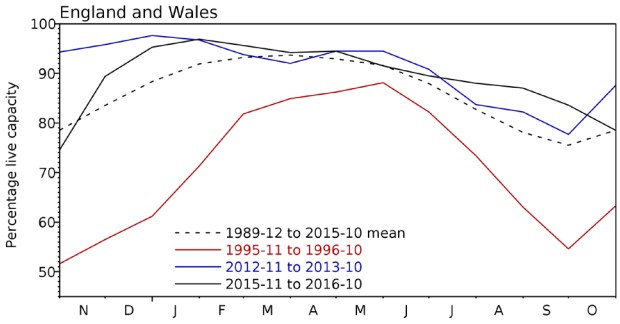
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. The rankings are designed as a qualitative indicator, and ranks at extreme levels, and when levels are changing rapidly, need to be interpreted with caution.

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



Percentage live capacity of selected reservoirs at end of month

Area	Reservoir		Capacity (Ml)	2016 Aug	2016 Sep	2016 Oct	Oct Anom.	Min Oct	Year* of min	2015 Oct	Diff 16-15
North West	N Command Zone	•	124929	72	72	68	0	33	2003	50	18
	Vyrnwy		55146	98	99	79	5	25	1995	75	5
Northumbrian	Teesdale	•	87936	88	83	80	4	33	1995	68	11
	Kielder		(199175)	96	92	88	1	63	1989	81	7
Severn-Trent	Clywedog		44922	98	89	83	6	38	1995	80	3
	Derwent Valley	•	39525	90	82	74	5	15	1995	50	25
Yorkshire	Washburn	•	22035	68	65	58	-12	15	1995	69	-11
	Bradford Supply	•	41407	75	70	66	-7	16	1995	59	7
Anglian	Grafham		(55490)	91	90	88	5	44	1997	96	-8
	Rutland		(116580)	90	89	87	9	59	1995	81	6
Thames	London	•	202828	84	81	76	-2	46	1996	81	-5
	Farmoor	•	13822	97	98	90	2	43	2003	93	-3
Southern	Bewl		28170	81	69	61	0	33	1990	59	2
	Ardingly		4685	80	62	47	-20	15	2003	57	-11
Wessex	Clatworthy		5364	53	40	29	-34	14	2003	61	-32
	Bristol	•	(38666)	71	64	55	-7	24	1990	66	-11
South West	Colliford		28540	76	69	65	-5	38	2006	77	-12
	Roadford		34500	77	68	65	-6	18	1995	80	-15
	Wimbleball		21320	60	50	43	-24	26	1995	65	-22
	Stithians		4967	61	60	62	4	18	1990	64	-2
Welsh	Celyn & Brenig	•	131155	99	95	90	6	48	1989	79	11
	Brianne		62140	99	100	98	6	57	1995	96	2
	Big Five	•	69762	85	81	72	-5	38	2003	76	-4
	Elan Valley	•	99106	86	85	82	-3	37	1995	68	14
Scotland(E)	Edinburgh/Mid-Lothian	•	96518	86	87	82	2	48	2003	68	14
	East Lothian	•	9374	96	92	98	14	38	2003	83	15
Scotland(W)	Loch Katrine	•	110326	79	95	89	3	40	2003	80	9
	Daer		22412	86	93	80	-10	42	2003	83	-3
	Loch Thom		10798	100	100	93	4	66	2007	100	-7
Northern Ireland	Total+	•	56800	77	75	74	-7	39	1995	87	-13
	Silent Valley	•	20634	75	72	68	-8	34	1995	89	-21

( ) figures in parentheses relate to gross storage

• denotes reservoir groups

*last occurrence

+ excludes Lough Neagh

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 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes. Monthly figures may be artificially low due to routine maintenance or turbidity effects in feeder rivers.

Location map…Location map

NHMP

The National Hydrological Monitoring Programme (NHMP) was started in 1988 and is undertaken jointly by the Centre for Ecology & Hydrology (CEH) and the British Geological Survey (BGS). The NHMP aims to provide an authoritative voice on hydrological conditions throughout the UK, to place them in a historical context and, over time, identify and interpret any emerging hydrological trends. Hydrological analysis and interpretation within the Programme is based on the data holdings of the National River Flow Archive (NRFA; maintained by CEH) and National Groundwater Level Archive (NGLA; maintained by BGS), including rainfall, river flows, borehole levels, and reservoir stocks.

Data Sources

The NHMP depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged. River flow and groundwater level data are provided by the Environment Agency (EA), Natural Resources Wales - Cyfoeth Naturiol Cymru (NRW), the Scottish Environment Protection Agency (SEPA) and, for Northern Ireland, the Rivers Agency and the Northern Ireland Environment Agency. In all cases the data are subject to revision following validation (high flow and low flow data in particular may be subject to significant revision).

Details of reservoir stocks are provided by the Water Service Companies, the EA, Scottish Water and Northern Ireland Water.

The Hydrological Summary and other NHMP outputs may also refer to and/or map soil moisture data for the UK. These data are provided by the Meteorological Office Rainfall and Evaporation Calculation System (MORECS). MORECS provides estimates of monthly soil moisture deficit in the form of averages over 40 x 40 km grid squares over Great Britain and Northern Ireland. The monthly time series of data extends back to 1961.

Rainfall data are provided by the Met Office. To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA, NRW and SEPA. The areal rainfall figures have been produced by the Met Office National Climate Information Centre (NCIC), and are based on 5km resolution gridded data from rain gauges. The majority of the full rain gauge network across the UK is operated by the EA, NRW, SEPA and Northern Ireland Water; supplementary rain gauges are operated by the Met Office. The Met Office NCIC monthly rainfall series extend back to 1910 and form the official source of UK areal rainfall statistics which have been adopted by the NHMP. The gridding technique used is described in Perry MC and Hollis DM (2005) available at http://www.metoffice.gov.uk/climate/uk/about/methods

Long-term averages are based on the period 1971-2000 and are derived from the monthly areal series.

The regional figures for the current month in the hydrological summaries are based on a limited rain gauge network so these (and the associated return periods) should be regarded as a guide only.

The monthly rainfall figures are provided by the Met Office NCIC and are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

For further details on rainfall or MORECS data, please contact the Met Office:

Tel: 0870 900 0100
Email: enquiries@metoffice.gov.uk

Enquiries

Enquiries should be directed to the NHMP:

Tel: 01491 692599
Email: nhmp@ceh.ac.uk

A full catalogue of past Hydrological Summaries can be accessed and downloaded at:

http://nrfa.ceh.ac.uk/monthly-hydrological-summary-uk

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