Hydrological Summary
for the United Kingdom

March 2016

General

March was a typically changeable spring month featuring interludes of heavy rainfall, gale-force winds, long settled spells and periodic snow over upland areas. The majority of rainfall was delivered in intense stormy episodes during the first and last weeks (including storm 'Katie' at Easter which caused disruption to transport and power networks), bookending a sustained period of dry weather mid-month. Although the UK registered near average rainfall in March, there was a distinct gradient in rainfall anomalies. Much of central, southern and eastern England bore the brunt of stormy conditions and received substantially above average rainfall, whereas Scotland, Northern Ireland and parts of Wales were relatively dry. Nevertheless, soils were saturated throughout the country as a result of the predominantly unsettled conditions of recent months. Reflecting the rainfall patterns in March, river flows were generally above normal in the English Lowlands and parts of northern England, and within the normal range elsewhere. Groundwater levels were generally near or slightly above average, except in northern England and southern Scotland where they remained notably or exceptionally high. Overall reservoir stocks for England & Wales were near average for the time of year. With reservoir stocks plentiful and groundwater levels in the normal range or higher towards the end of the recharge season, the water resources situation is healthy entering the summer half-year.

Rainfall

After an unsettled start, persistent blocking anticyclonic conditions became established across the middle of the month before stormy weather returned in the last week. A sequence of Atlantic low pressure systems in the first week heralded substantial rainfall, strong winds and snow in upland areas. On the 1st/2nd, storm 'Jake' brought heavy rainfall (e.g. 57mm at Capel Curig) and strong winds. On the 3rd/4th, snow (e.g. 17cm at Malham Tarn, North Yorkshire) closed roads and schools in northern England, and Leeds-Bradford airport temporarily. On the 8th/9th, gale-force winds and heavy rainfall (e.g. 40mm at Bedford) impacted southern England & Wales; flash flooding affected the West Coast mainline and Birmingham-London train routes, and more than 6,000 properties were left without power. After two weeks of dry but often cloudy and cool weather, Easter weekend heralded changing conditions. Following 46mm at Cluanie Inn (Highlands) on the 26th, storm 'Katie' traversed England & Wales on the 27th/28th. The strongest winds affected southern England, diverting London-bound flights, closing major road bridges and ports, and leaving more than 200,000 properties without power. For March overall, most of Scotland, the Lake District and Northumberland received less than 70% of average rainfall, with a large part of central Scotland registering less than half the average. Conversely, many parts of central, southern and eastern England received more than 150% of average, and the Midlands registered its wettest March since 1982. Rainfall totals over the first three months of 2016 were substantially above average for the majority of the country, exceptionally so in parts of coastal eastern Britain. Most areas in the north and west of the UK established new maximum winter half-year (October-March) rainfall accumulations in 2015/16 (in series from 1910), many by wide margins.

River flows

River flows were highest during the unsettled first and last weeks of the month, bookending long and often steep recessions around mid-month. On the 8th/9th, roads were inundated with floodwater in Warwickshire and the Lymington registered a new maximum March flow. Thereafter, whilst flows in a few baseflow dominated catchments of south-eastern England remained seasonally high (e.g. the Coln and Itchen), recessions in northern and western areas were particularly steep although national outflows indicate the widespread nature of declining river flows. Daily flow minima were closely approached prior to Easter weekend in some catchments in Wales (e.g. the Conwy and Dee), northern England (e.g. the Tyne and Eden) and north-western Scotland (e.g. the Naver and Carron). By the 18th there were no flood warnings or alerts anywhere in Great Britain, an unusual occurrence in an unsettled winter half-year. Heavy rainfall across Easter weekend culminating in storm 'Katie' on the 27th/28th saw recessions broken in fast responding catchments as well as contributing an additional surface runoff component to those with seasonally high baseflows. New March flow maxima were established for the Otter (27th) and Mole (28th) in series of at least 45 years, although reports of severe fluvial flooding were relatively limited. Average river flows for March were generally above normal in central, southern and eastern England, notably so for the Yorkshire Derwent. For the rest of the UK, flows were generally near average with below normal flows on the Tyne rivers in both England and Scotland. Average flows over the first three months of 2016 were generally above normal, and notably or exceptionally so for much of the north and west of the UK, reflecting the exceptional winter rainfall.

Groundwater

Following heavy winter rainfall in the north and west of the UK and substantial rainfall in the last week of March in the south and east, end of month soil moisture deficits were negligible throughout the country. In the Chalk, levels fell along the south coast and in Wiltshire but remained near average or above normal. Further north and east, levels rose and were generally in the normal range. In Yorkshire levels were above normal, and exceptionally high in the fast responding aquifer at Wetwang which received substantially above average rainfall over the last three months. Levels were below average in the slower responding parts of the Chalk at Stonor Park and Dial Farm, and notably low at Killyglen following below average March rainfall. Throughout the Permo-Triassic sandstones levels were stable or fell, and remained normal or just above except in the north-west where they remained notably high. In the Jurassic limestones, levels rose slightly and remained in the normal range at New Red Lion, but became exceptionally high at Ampney Crucis reflecting the wet conditions in March in this area. In the Magnesian Limestone, a record maximum monthly level was recorded at Brick House Farm. Levels in the Carboniferous Limestone fell during March but remained in the normal range in south Wales and fell to the normal range at Alstonefield.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
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Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

Area	Rainfall	Mar 2016	Jan15 – Mar16		Oct15 – Mar16		Jul15 – Mar16		Apr15 – Mar16	
				RP		*RP*		*RP*		*RP*
United Kingdom	mm	**87**	386		864		1135		1346	
	%	**94**	131	25-40	136	>>100	129	>100	125	>100
England	mm	**83**	286		603		836		976	
	%	**127**	138	15-25	133	15-25	131	15-25	121	8-12
Scotland	mm	**88**	516		1201		1520		1841	
	%	**66**	124	10-15	136	>100	126	70-100	128	>100
Wales	mm	**117**	537		1240		1563		1791	
	%	**102**	143	30-50	149	>100	139	>100	132	>100
Northern Ireland	mm	**73**	361		835		1117		1345	
	%	**78**	121	10-15	131	>>100	125	>>100	122	>100
England & Wales	mm	**88**	321		691		937		1089	
	%	**122**	139	20-35	137	30-50	133	25-40	123	10-20
North West	mm	**85**	425		1114		1389		1627	
	%	**85**	139	30-50	163	>>100	145	>>100	139	>>100
Northumbrian	mm	**53**	300		763		996		1157	
	%	**77**	143	25-40	170	>>100	154	>>100	141	>100
Severn-Trent	mm	**82**	255		524		708		848	
	%	**138**	136	10-20	130	10-15	122	5-10	113	2-5
Yorkshire	mm	**96**	305		727		956		1112	
	%	**142**	148	25-40	164	>>100	152	80-120	139	80-120
Anglian	mm	**72**	174		345		537		637	
	%	**158**	128	5-10	114	2-5	119	2-5	107	2-5
Thames	mm	**86**	241		445		650		754	
	%	**160**	143	10-15	120	2-5	122	2-5	109	2-5
Southern	mm	**82**	285		513		772		882	
	%	**138**	146	10-20	115	2-5	126	5-10	115	2-5
Wessex	mm	**99**	328		581		847		973	
	%	**143**	143	15-25	117	2-5	124	5-10	114	2-5
South West	mm	**105**	453		820		1185		1354	
	%	**109**	132	10-15	111	2-5	121	5-10	114	5-10
Welsh	mm	**115**	515		1179		1495		1714	
	%	**105**	143	30-50	148	>100	139	>100	131	>100
Highland	mm	**107**	560		1296		1618		2018	
	%	**66**	110	2-5	119	10-15	111	5-10	117	10-20
North East	mm	**56**	364		759		1046		1252	
	%	**73**	151	50-80	144	60-90	139	40-60	133	30-50
Tay	mm	**60**	490		1147		1468		1731	
	%	**51**	128	10-15	146	>>100	139	>100	137	>>100
Forth	mm	**49**	421		1036		1311		1553	
	%	**47**	131	10-20	154	>>100	141	>>100	138	>>100
Tweed	mm	**56**	400		963		1205		1399	
	%	**69**	159	>100	179	>>100	159	>>100	148	>>100
Solway	mm	**87**	579		1395		1726		2006	
	%	**71**	148	>100	165	>>100	148	>>100	144	>>100
Clyde	mm	**104**	630		1512		1887		2279	
	%	**65**	125	10-15	141	>>100	128	80-120	131	>100

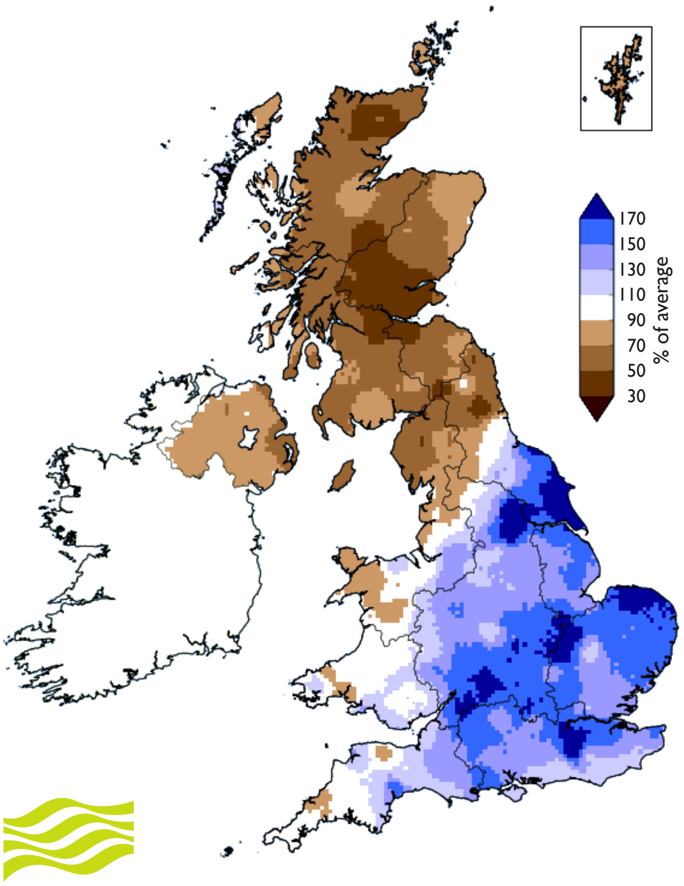
% = percentage of 1971-2000 average

RP = Return period

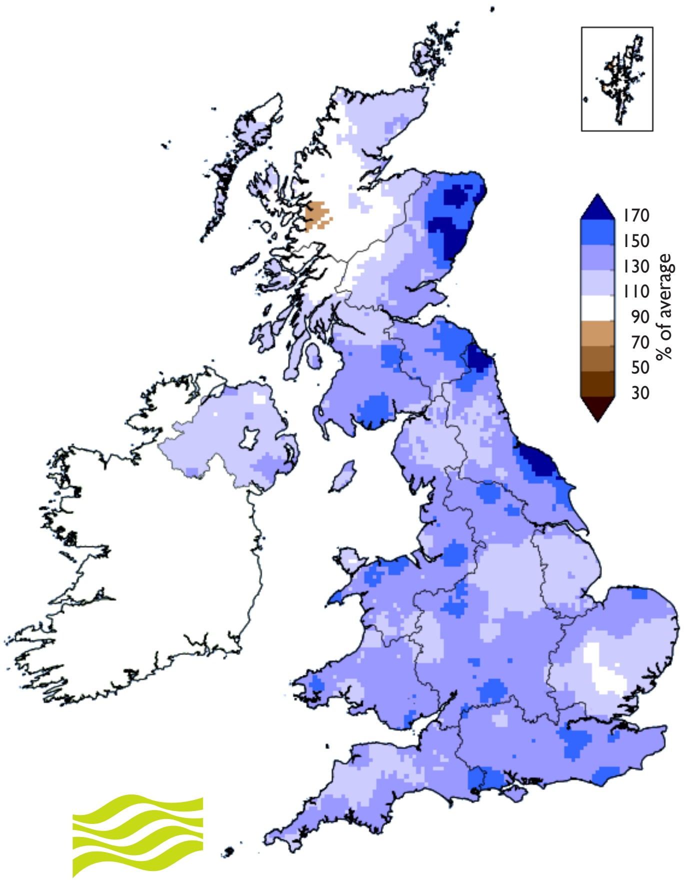
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic 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 June 2015 (inclusive) are provisional.

Rainfall . . . Rainfall . . .

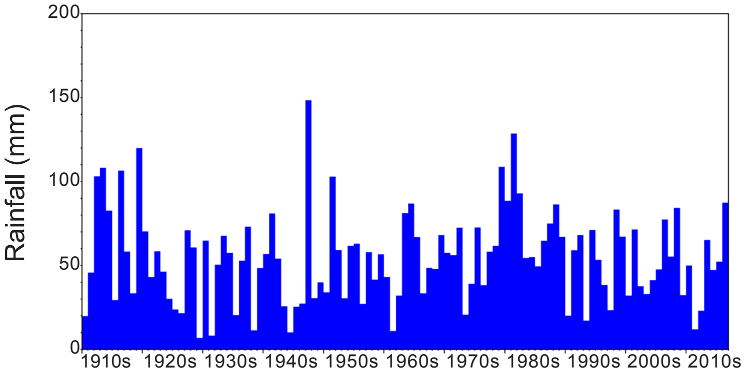
March 2016 rainfall as % of 1971-2000 average



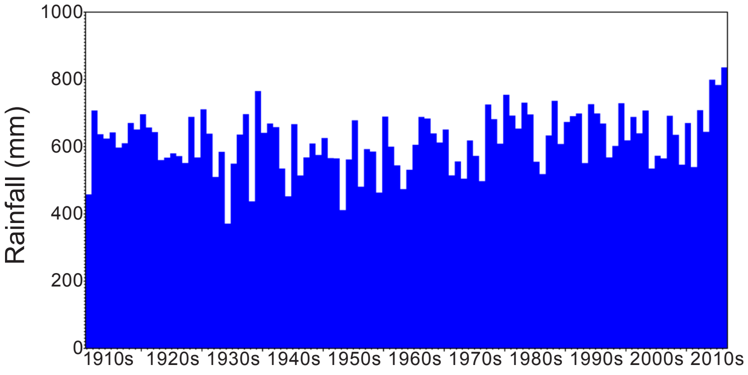
January 2016 - March 2016 rainfall as % of 1971-2000 average



March rainfall for Midlands region



October - March rainfall for Northern Ireland



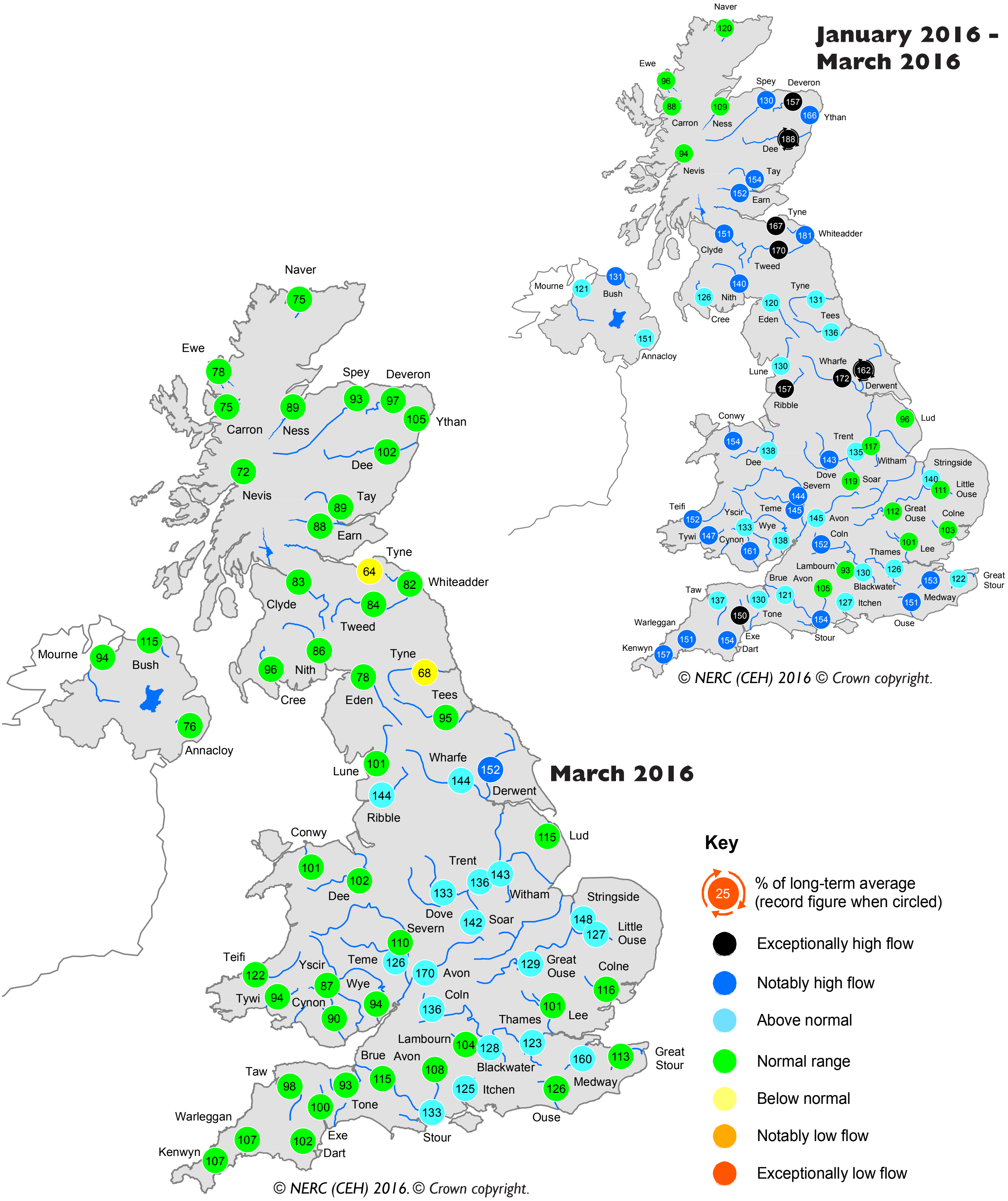
Met Office 3-month outlook
Updated: March 2016

For April, and April-May-June as a whole, above-average precipitation is considered more probable than below-average. Overall, the probability of the UK-average precipitation for April-May-June falling into the driest of our five categories is between 15 and 20%. The probability of UK-average precipitation falling into our wettest category is around 25% (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 . . .



January 2016 - March 2016

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March 2016

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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

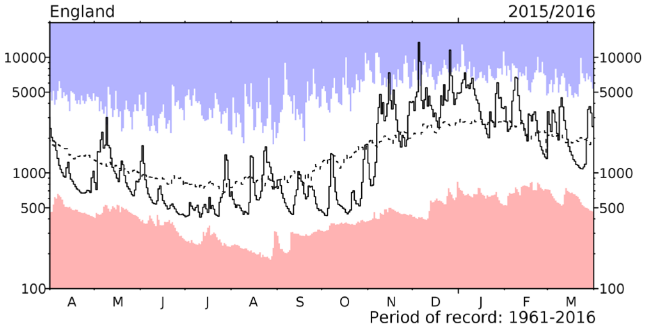
● Exceptionally low flow

*Based on ranking of the monthly flow**

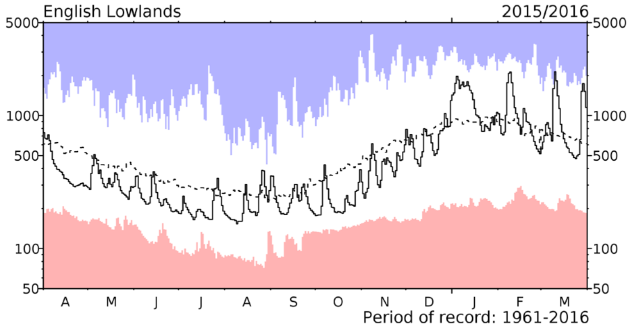
River flows

*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.

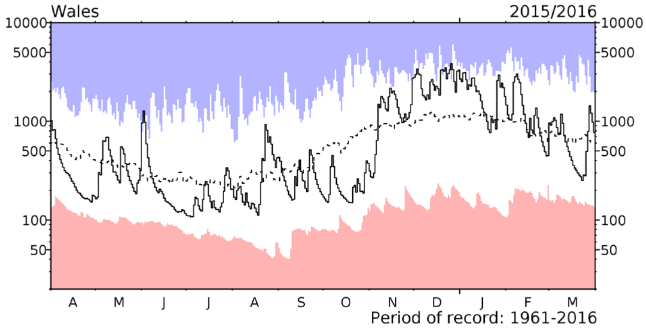
River flow . . . River flow . . .


England 2015/2016

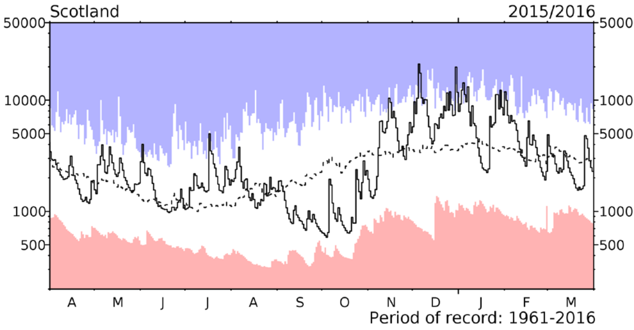
Period of record: 1961-2016


English Lowlands 2015/2016

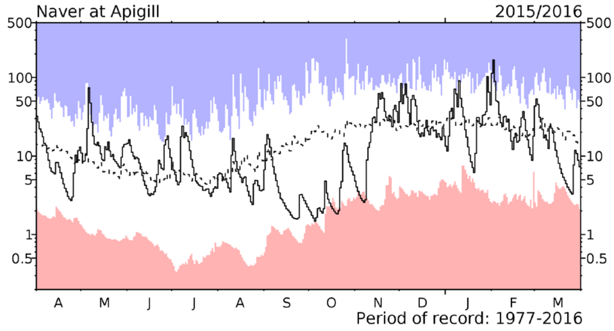
Period of record: 1961-2016


Wales 2015/2016

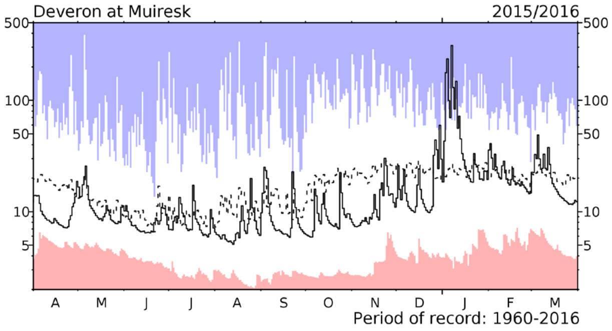
Period of record: 1961-2016


Scotland 2015/2016

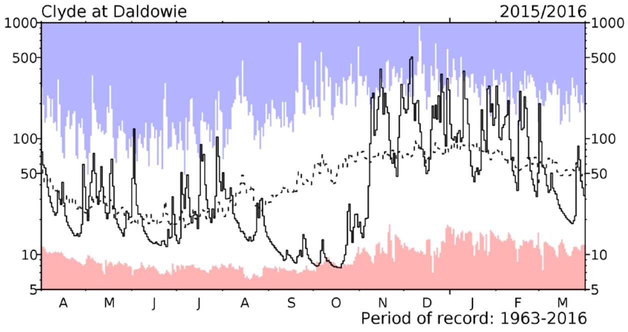
Period of record: 1961-2016


Naver at Apigill 2015/2016

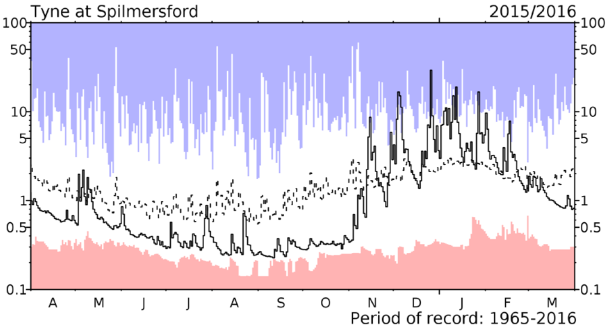
Period of record: 1977-2016


Deveron at Muiresk 2015/2016

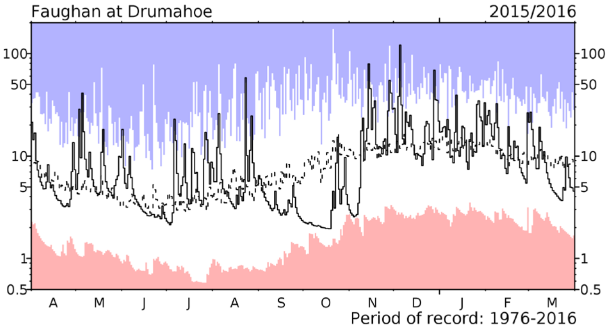
Period of record: 1960-2016


Clyde at Daldowie 2015/2016

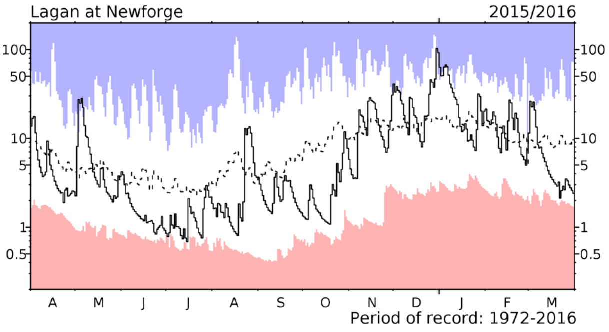
Period of record: 1963-2016


Tyne at Spilmersford 2015/2016

Period of record: 1965-2016


Faughan at Drumahoe 2015/2016

Period of record: 1976-2016


Lagan at Newforge 2015/2016

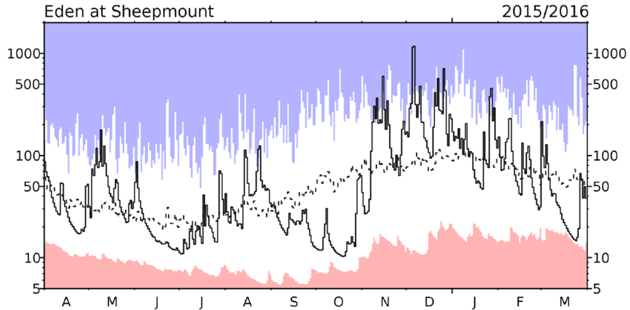
Period of record: 1972-2016

River flow hydrographs

The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to April 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.

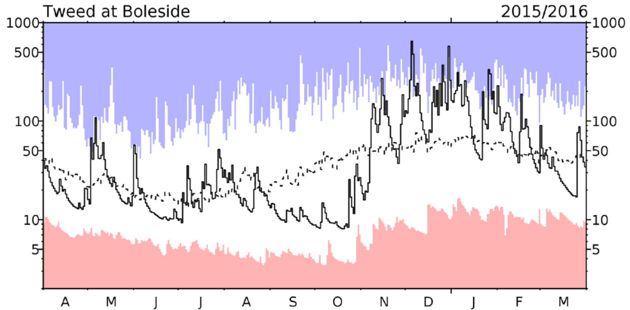
River flow . . . River flow . . .

Eden at Sheepmount 2015/2016



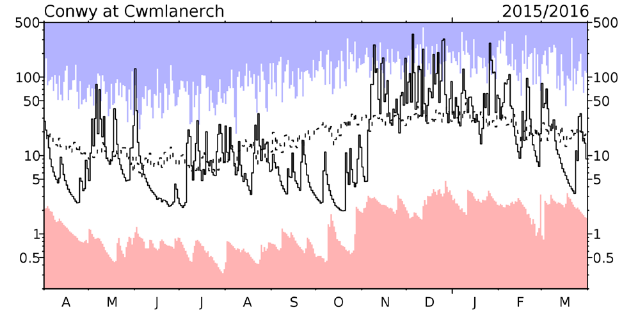
Period of record: 1967-2016

Tweed at Boleside 2015/2016



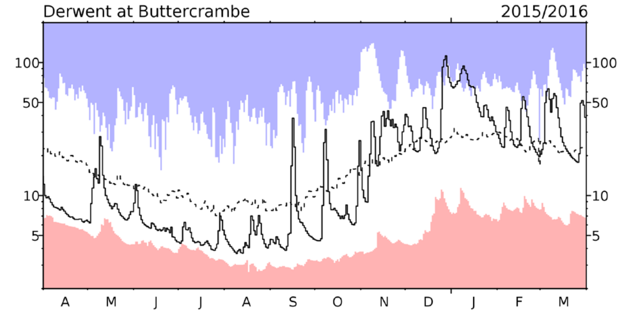
Period of record: 1961-2016

Conwy at Cwmlanerch 2015/2016



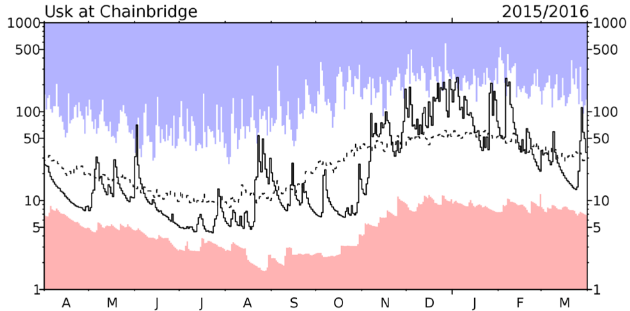
Period of record: 1964-2016

Derwent at Buttercrambe 2015/2016



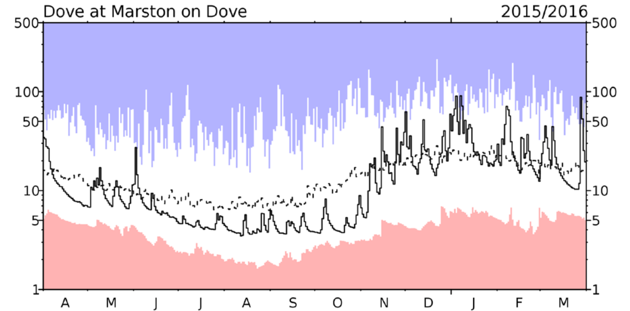
Period of record: 1973-2016

Usk at Chainbridge 2015/2016



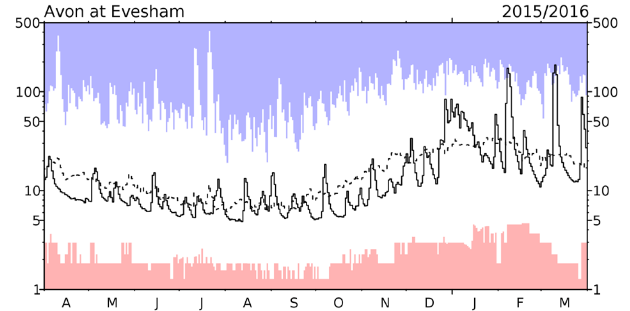
Period of record: 1957-2016

Dove at Marston on Dove 2015/2016



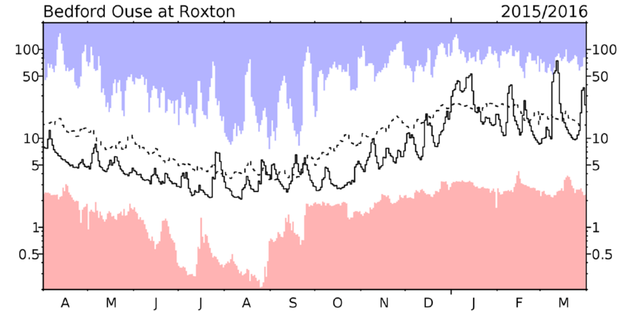
Period of record: 1961-2016

Avon at Evesham 2015/2016



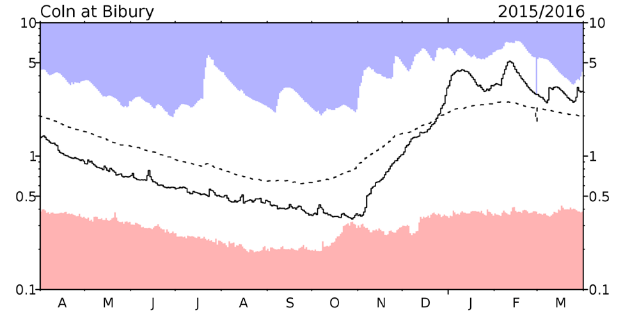
Period of record: 1936-2016

Bedford Ouse at Roxton 2015/2016



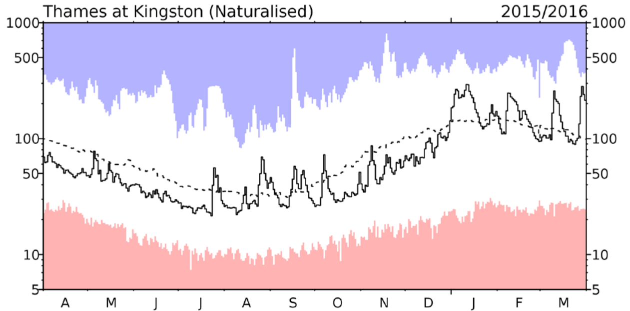
Period of record: 1972-2016

Coln at Bibury 2015/2016



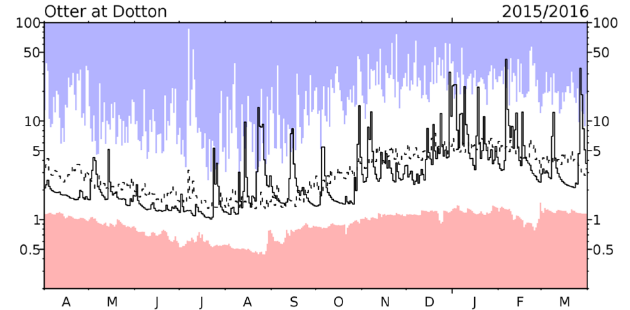
Period of record: 1963-2016

Thames at Kingston (Naturalised) 2015/2016



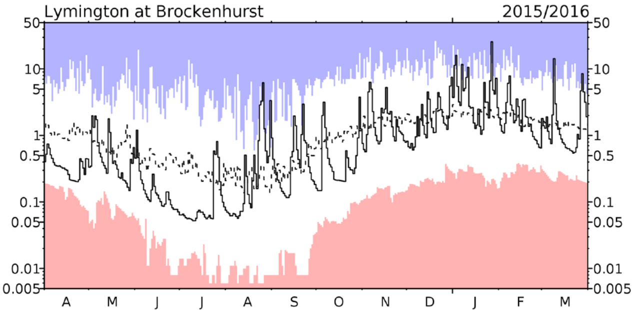
Period of record: 1883-2016

Otter at Dotton 2015/2016



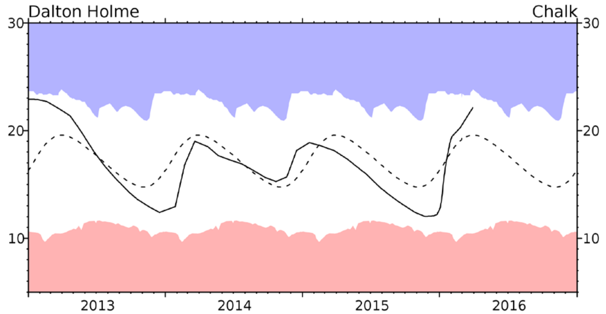
Period of record: 1962-2016

Lymington at Brockenhurst 2015/2016

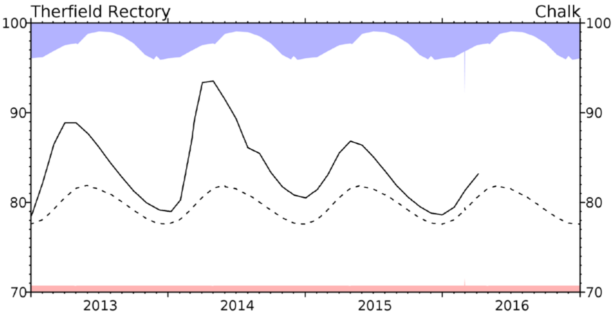


Period of record: 1960-2016

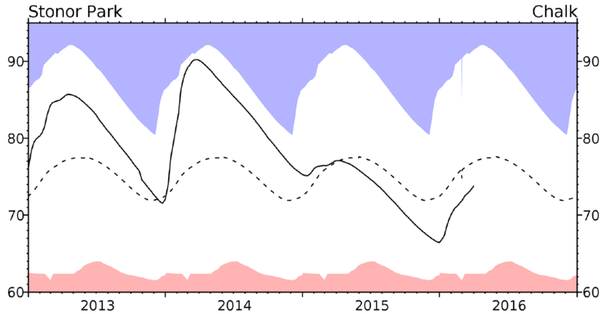
Groundwater . . . Groundwater



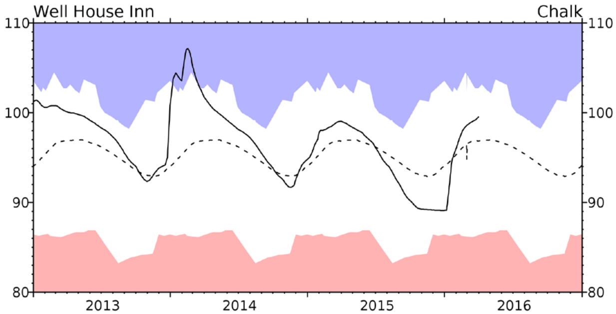
Period of record: 1889-2016



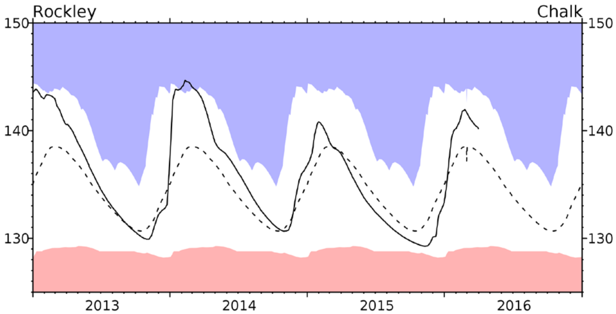
Period of record: 1883-2016



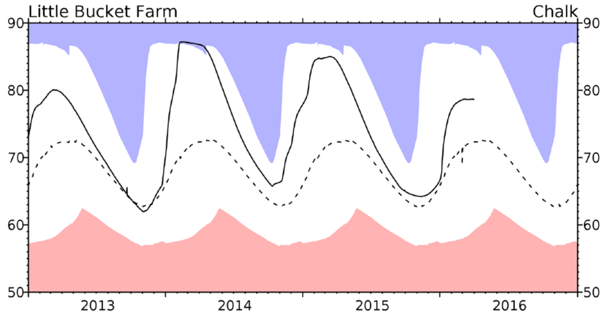
Period of record: 1961-2016



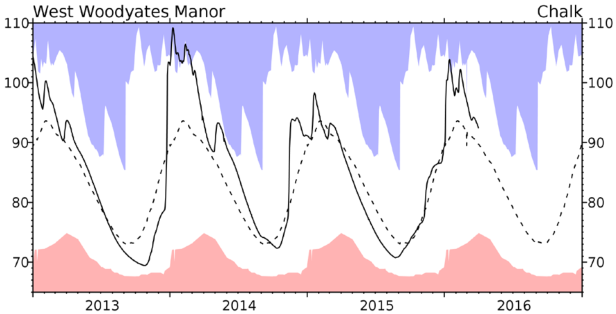
Period of record: 1942-2016



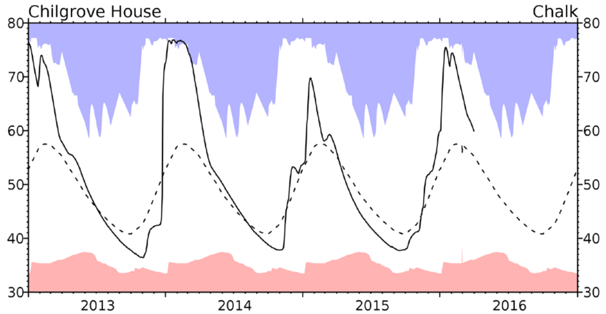
Period of record: 1932-2016



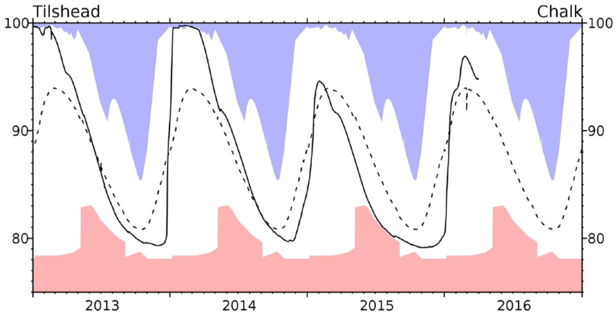
Period of record: 1971-2016



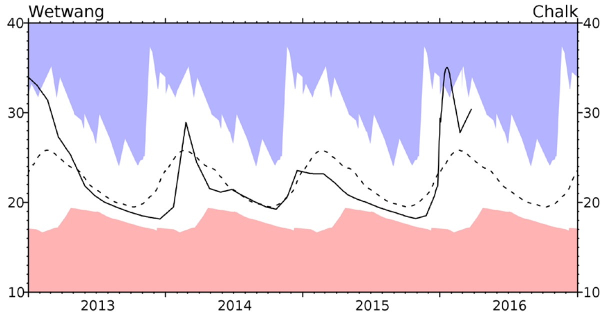
Period of record: 1942-2016



Period of record: 1836-2016



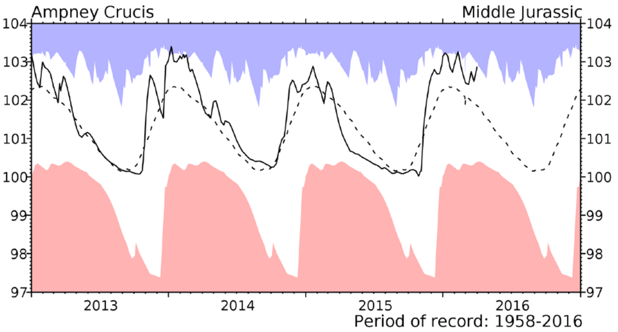
Period of record: 1966-2016

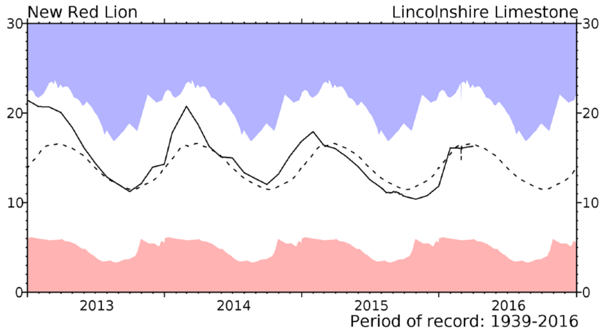


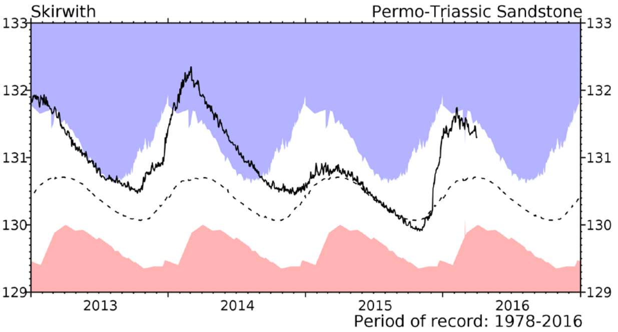
Period of record: 1971-2016

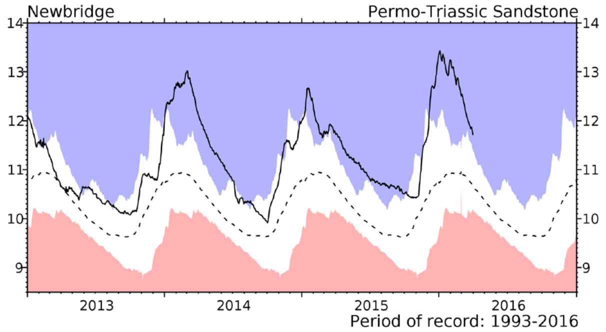
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

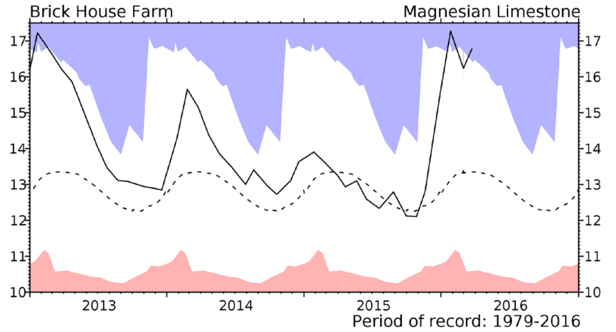
Groundwater ... Groundwater

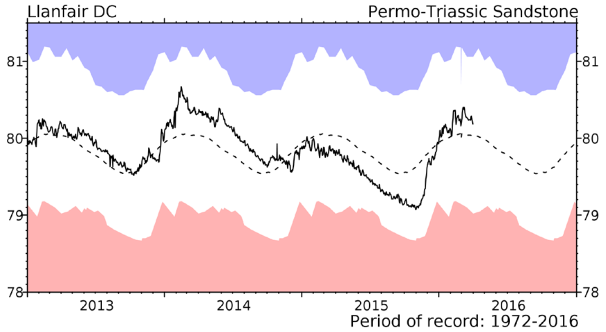


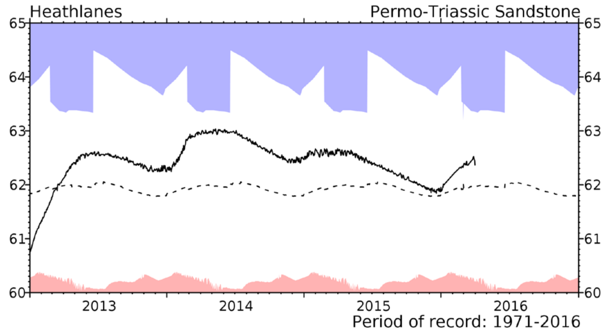


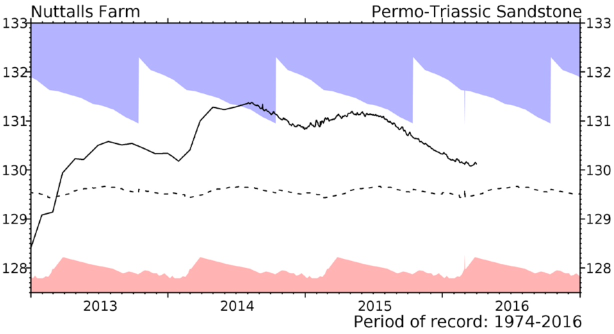


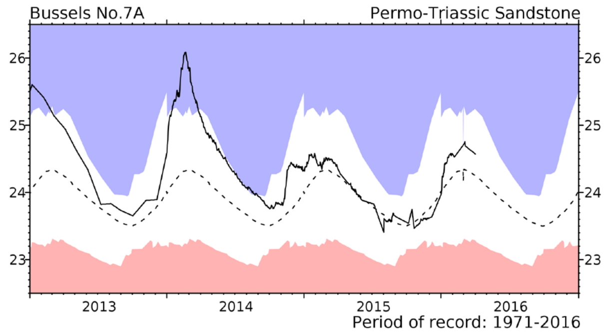


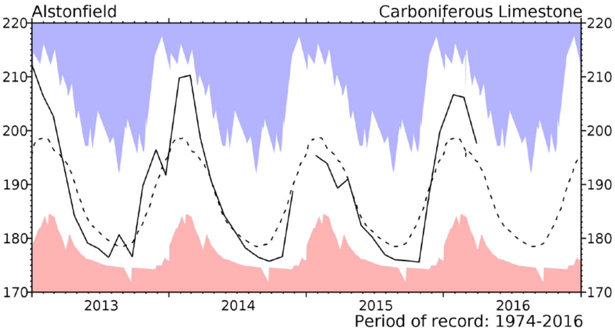








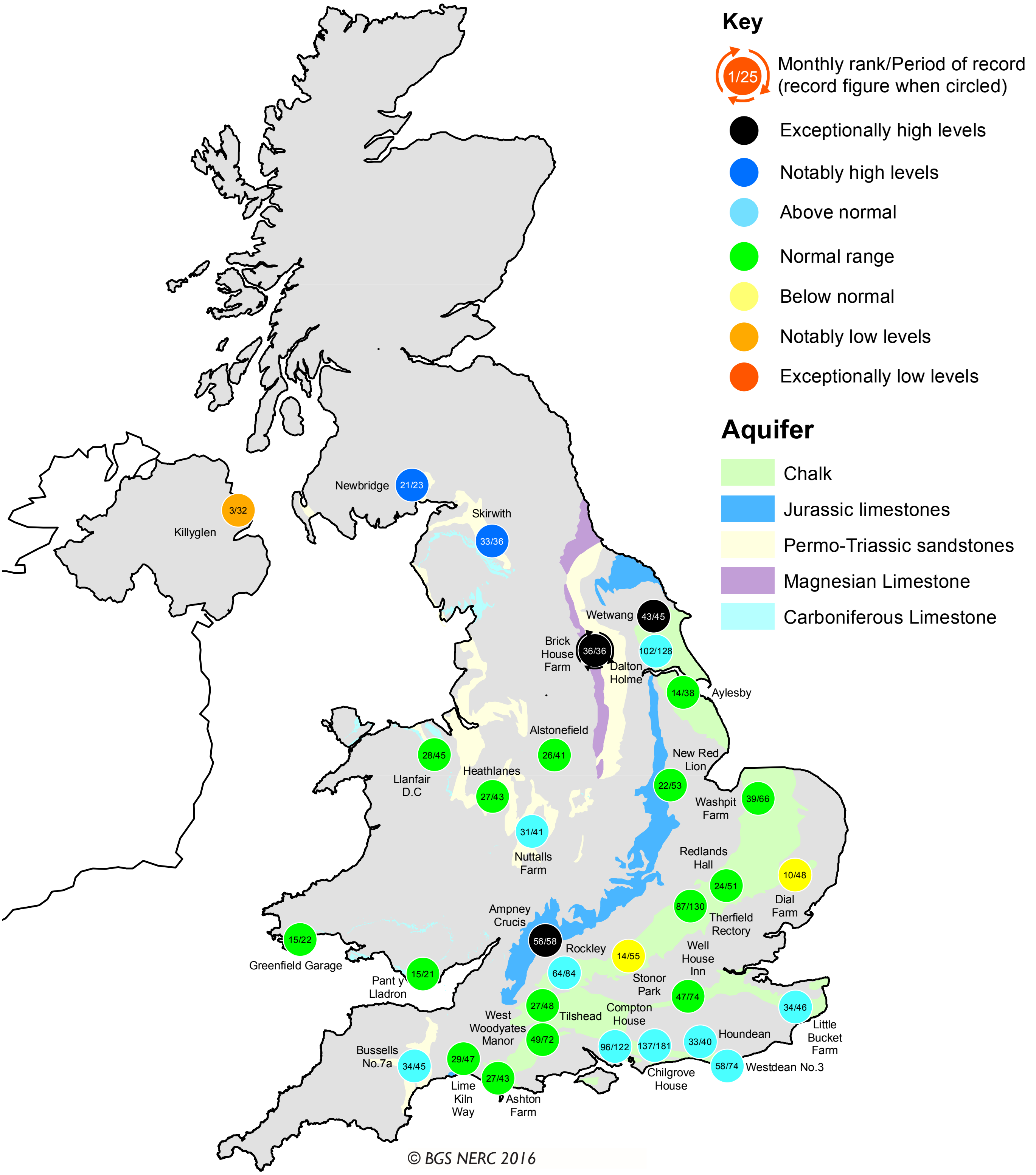




Groundwater levels March / April 2016

Borehole	Level	Date	Mar av.	Borehole	Level	Date	Mar av.	Borehole	Level	Date	Mar av.
Dalton Holme	22.11	29/03	19.47	Chilgrove House	59.75	31/03	55.66	Brick House Farm	16.78	23/03	13.45
Therfield Rectory	83.16	05/04	79.42	Killyglen (NI)	114.11	31/03	115.43	Llanfair DC	80.18	31/03	80.05
Stonor Park	73.75	31/03	76.83	Wetwang	30.36	24/03	25.29	Heathlanes	62.36	31/03	61.97
Tilshead	94.74	31/03	93.85	Ampney Crucis	102.86	31/03	102.00	Nuttalls Farm	130.12	31/03	129.53
Rockley	140.17	31/03	138.48	New Red Lion	16.28	31/03	16.57	Bussells No.7a	24.57	01/04	24.36
Well House Inn	99.52	31/03	96.99	Skirwith	131.30	31/03	130.79	Alstonefield	197.61	29/03	195.29
West Woodyates	92.43	31/03	90.82	Newbridge	11.72	31/03	10.95				

Levels in metres above Ordnance Datum

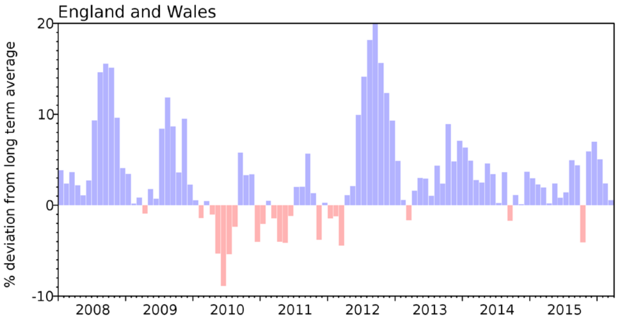


Groundwater levels - March 2016

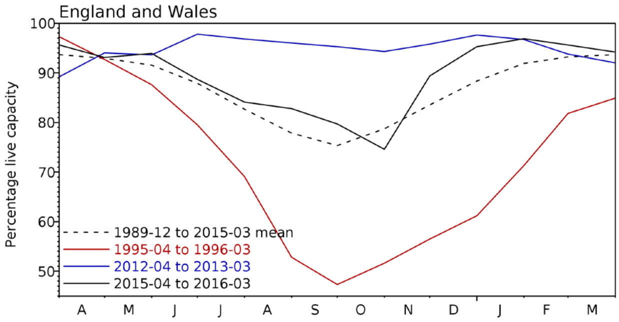
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Jan	2016 Feb	2016 Mar	Mar Anom.	Min Mar	Year* of min	2015 Mar	Diff 16-15
North West	N Command Zone	• 124929	100	98	90	-2	77	1993	96	-6
	Vyrnwy	55146	99	97	99	4	64	1996	100	-1
Northumbrian	Teesdale	• 87936	100	97	86	-7	77	2003	95	-9
	Kielder	(199175)	99	89	86	-6	81	1993	91	-5
Severn-Trent	Clywedog	44922	97	96	98	3	86	1996	99	-1
	Derwent Valley	• 39525	100	100	100	5	54	1996	100	-1
Yorkshire	Washburn	• 22035	96	95	95	2	70	1996	95	-1
	Bradford Supply	• 41407	97	98	95	1	59	1996	98	-3
Anglian	Grafham	(55490)	91	96	96	5	77	1997	92	4
	Rutland	(116580)	94	95	95	4	73	2012	96	-1
Thames	London	• 202828	97	96	93	-1	88	1990	92	1
	Farmoor	• 13822	79	88	82	-13	80	2013	99	-17
Southern	Bewl	28170	83	89	100	10	49	2012	92	8
	Ardingly	4685	100	100	95	-2	51	2012	100	-5
Wessex	Clatworthy	5364	100	100	100	3	82	1992	100	0
	Bristol	• (38666)	99	99	99	6	71	1992	99	0
South West	Colliford	28540	100	100	100	13	58	1997	93	7
	Roadford	34500	98	98	96	11	37	1996	95	1
	Wimbleball	21320	100	100	100	4	78	1996	100	0
	Stithians	4967	100	100	100	6	52	1992	88	12
Welsh	Celyn & Brenig	• 131155	100	99	100	2	72	1996	99	1
	Brianne	62140	100	96	98	1	90	1993	98	0
	Big Five	• 69762	84	92	97	1	78	1993	98	-1
	Elan Valley	• 99106	99	98	99	2	89	1993	99	0
Scotland(E)	Edinburgh/Mid-Lothian	• 96518	100	100	100	5	71	1998	95	5
	East Lothian	• 9374	100	100	100	1	95	2012	99	1
Scotland(W)	Loch Katrine	• 110326	98	95	95	3	74	2010	90	5
	Daer	22412	100	99	94	-3	77	2013	100	-6
	Loch Thom	• 10798	100	100	100	3	83	2010	100	0
Northern Ireland	Total$^+$	• 56800	100	99	95	5	83	2002	94	1
	Silent Valley	• 20634	100	98	94	8	57	2000	100	-5

( ) 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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