Hydrological Summary for the United Kingdom

September 2017

General

September was a predominantly unsettled month with Atlantic low pressure systems bringing persistent and sometimes heavy rainfall, particularly to the west. Rainfall was moderately above average at the national scale, with only parts of northern Scotland and south-east England registering below average rainfall. It was particularly wet in Northern Ireland and western Britain, with large swathes registering more than 150% of average. Soil Moisture Deficits (SMDs) generally decreased during September and soils mostly remained wetter than average for the time of year. River flows were generally in the normal range or above across the UK, with some western catchments registering more than twice the September average. Flows in the less responsive rivers in southern England were below normal, and in some cases were notably low. Reservoir stocks generally increased relative to average and were substantially above average in some impoundments in northern England and Northern Ireland. Following the wet summer and early autumn, the short-term water resources outlook is healthy with above average reservoir stocks and SMDs across much of the UK. However, groundwater levels generally continued their seasonal recession and remained below normal or notably low across much of the Chalk in south-east England, reflecting longer-term rainfall deficiencies. The long-term outlook is very dependent on recharge over the winter half-year, which will commence from a below-normal baseline in these areas.

Rainfall

September began settled under a ridge of high pressure, while the rest of the month was generally unsettled with weather patterns dominated by a westerly airflow bringing low pressure systems from the Atlantic. The persistence of the unsettled weather is illustrated by the average number of rain days (≥ 1mm): 17.9 were recorded in the UK compared to the 1981-2010 average of 12.1. Notable rainfall totals included 48mm at Plymouth on the 3rd, 44mm at Tibenham (Norfolk) on the 8th and 41mm at Shap (Cumbria) on the 30th. The first named storm of the winter 2017/2018 season, 'Aileen', tracked across the UK on the 12th/13th, bringing heavy rain (64mm was recorded at Cullen Bay, north-east Scotland) and strong winds that caused transport disruption and power cuts to thousands of homes in northern England. Although parts of northern Scotland and southern England received moderately below average rainfall, at the national scale the UK received 127% of the September average. More than 170% was registered in parts of Northern Ireland, north-east England and western Britain. For the summer half-year (April-September), rainfall was average or moderately above for the majority of the UK, with some parts of coastal Britain receiving more than 130% of average. It was the seventh wettest April-September for the Solway region where four of the seven wettest summer half-years have occurred since 2009 (in a series from 1910).

River flows

The persistent frontal rainfall in September triggered several rapid recoveries in the more responsive catchments, with new daily flow maxima set at more than twenty catchments and for eight consecutive days on the Ythan. Flood alerts were issued in Cornwall on the 3rd, though there were no reports of fluvial flooding; the Warleggan recorded its second highest September daily flow in a record from 1969. On the 16th, new September daily flow and peak flow maxima were registered on the Teifi (in a series from 1959). In the more slowly responding catchments, flows generally continued to recede and approached September minima on the Coln and Lambourn. September monthly mean flows were normal or above across most of the UK, notably so in parts of Northern Ireland, western Britain and north-east Scotland. The Mourne, Bush, Conwy, Taw, Spey and Ythan recorded more than twice their monthly average flow. Flows were exceptionally high on the Warleggan and Teifi, the latter recording a new maximum September average flow (in a series from 1959). In contrast, flows in some groundwater-fed streams in southern England remain below normal, exceptionally so on the Coln where average flows are the second lowest (behind 1976) in a series from 1963. Average flows were also second lowest for the summer half-year (April-September) on the Coln. More generally long-term runoff deficiencies are still evident across the English Lowlands over the last six to twelve months, reflecting the drier conditions from summer 2016 to spring 2017.

Groundwater

Following the wet June-September, SMDs continued to decline across most of the UK and were almost eliminated in Northern Ireland, parts of Scotland and western Britain. Across the major aquifer areas, SMDs were wetter than average for the time of year, with the exception of East Anglia where soils are moderately drier than average. In the Chalk, groundwater levels generally continued to fall, but small rises were recorded at Wetwang and West Woodyates Manor where levels are now above average for the time of year. Across East Anglia and southern England levels remained low to notably low at the majority of sites; September levels at Little Bucket Farm were the third lowest (behind 1976 and 1996) in a series from 1972. Levels fell in the more rapidly responding Jurassic and Magnesian limestones, following the usual seasonal recession, and remained within the normal range. In the Permo-Triassic sandstones, groundwater levels stabilised and are in the normal range, with the exception of Llanfair DC where levels rose to below normal. Despite no overall change in level at Newbridge, a new record high level was recorded for a fourth consecutive month, reflecting the above average rainfall in south-west Scotland over the last three to six months. Levels in the Carboniferous Limestone rose at Greenfield Garage and Alstonfield rose during September and are now above normal, whilst at Pant y Lladron levels fell but remained in the normal range. Levels continued to fall at Royalty Observatory in the Fell Sandstone, but remained notably high.

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 1981-2010 average.

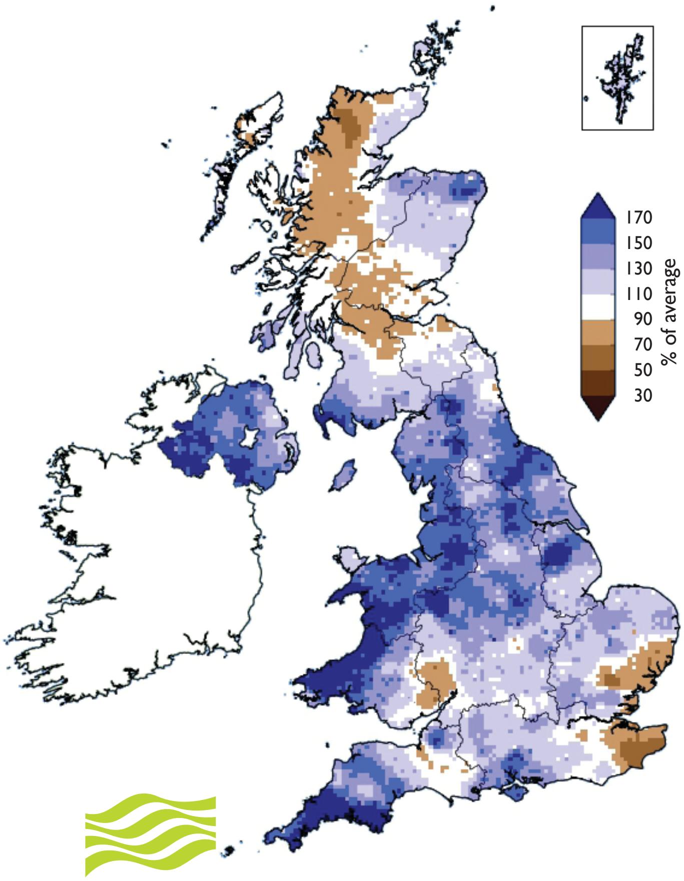
Region	Rainfall	Sep 2017	Jul17 – Sep17	RP	Apr17 – Sep17	RP	Jan17 – Sep17	RP	Oct16 – Sep17	RP
United	mm	**119**	330		537		805		1035	
Kingdom	%	**127**	129	5-10	115	5-10	105	2-5	92	2-5
England	mm	**95**	265		427		623		794	
	%	**138**	134	5-10	114	2-5	108	2-5	94	2-5
Scotland	mm	**139**	399		675		1038		1365	
	%	**106**	119	2-5	115	5-10	101	2-5	90	2-5
Wales	mm	**182**	434		667		1051		1297	
	%	**162**	142	5-10	120	5-10	113	5-10	91	2-5
Northern	mm	**145**	398		594		828		1034	
Ireland	%	**159**	147	10-20	120	5-10	105	2-5	91	2-5
England &	mm	**107**	289		460		682		864	
Wales	%	**143**	135	5-10	115	2-5	109	2-5	94	2-5
North West	mm	**165**	411		636		951		1192	
	%	**161**	142	5-10	124	5-10	115	5-10	97	2-5
Northumbria	mm	**101**	261		454		674		887	
	%	**142**	122	2-5	115	2-5	111	2-5	102	2-5
Severn-Trent	mm	**93**	244		386		572		723	
	%	**144**	128	2-5	105	2-5	104	2-5	93	2-5
Yorkshire	mm	**102**	278		462		647		839	
	%	**150**	139	5-10	121	5-10	110	2-5	100	2-5
Anglian	mm	**65**	202		351		478		605	
	%	**121**	123	2-5	112	2-5	106	2-5	97	2-5
Thames	mm	**69**	235		361		521		657	
	%	**119**	142	5-10	111	2-5	106	2-5	92	2-5
Southern	mm	**70**	242		383		566		713	
	%	**112**	144	5-10	118	2-5	109	2-5	90	2-5
Wessex	mm	**83**	254		396		607		788	
	%	**121**	133	2-5	109	2-5	104	2-5	89	2-5
South West	mm	**145**	363		548		839		1072	
	%	**161**	145	5-10	116	2-5	104	2-5	87	2-5
Welsh	mm	**170**	412		638		1006		1245	
	%	**157**	139	5-10	118	2-5	112	2-5	91	2-5
Highland	mm	**144**	429		742		1151		1555	
	%	**92**	112	2-5	112	2-5	95	2-5	86	2-5
North East	mm	**115**	292		519		736		981	
	%	**131**	122	2-5	118	2-5	106	2-5	97	2-5
Tay	mm	**114**	319		564		866		1130	
	%	**101**	109	2-5	108	2-5	95	2-5	84	5-10
Forth	mm	**95**	308		564		836		1063	
	%	**90**	110	2-5	114	2-5	100	2-5	88	2-5
Tweed	mm	**96**	296		515		790		1027	
	%	**116**	122	2-5	116	2-5	112	5-10	100	2-5
Solway	mm	**170**	469		765		1174		1428	
	%	**140**	139	8-12	129	15-25	118	15-25	96	2-5
Clyde	mm	**174**	502		807		1272		1649	
	%	**109**	121	5-10	115	5-10	104	2-5	91	2-5

% = percentage of 1981-2010 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 since January 2017 are provisional.

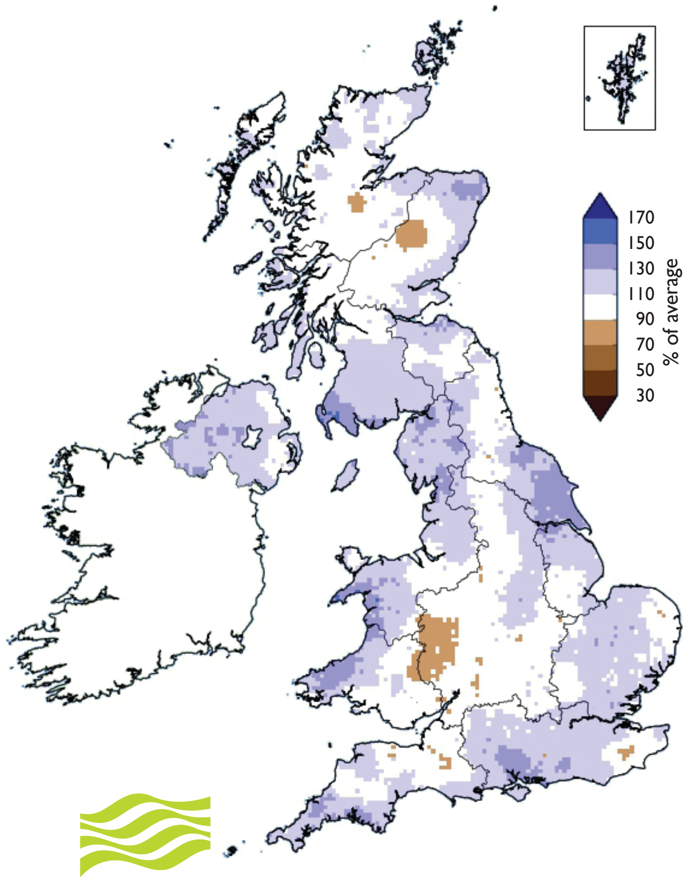
Rainfall . . . Rainfall . . .

September 2017 rainfall as % of 1981-2010 average



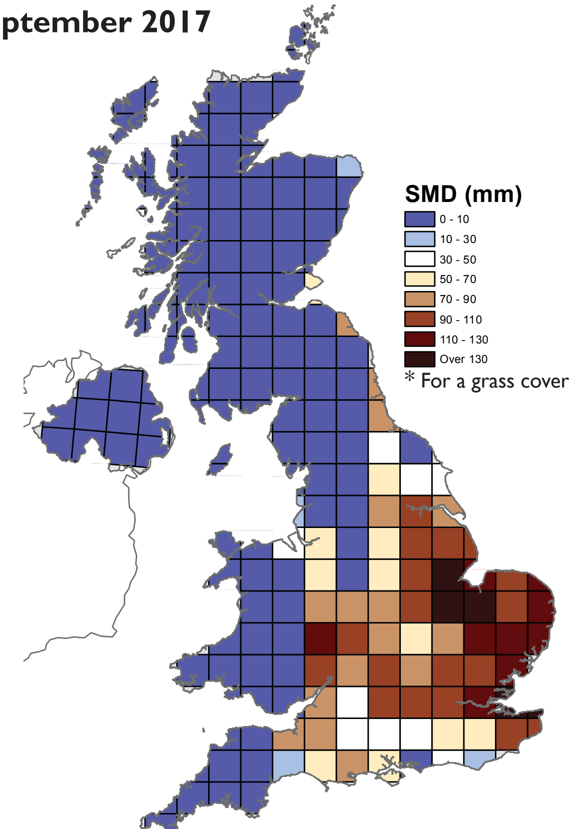
Met Office

April 2017 - September 2017 rainfall as % of 1981-2010 average



Met Office

MORECS Soil Moisture Deficits* September 2017



Hydrological Outlook UK

The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

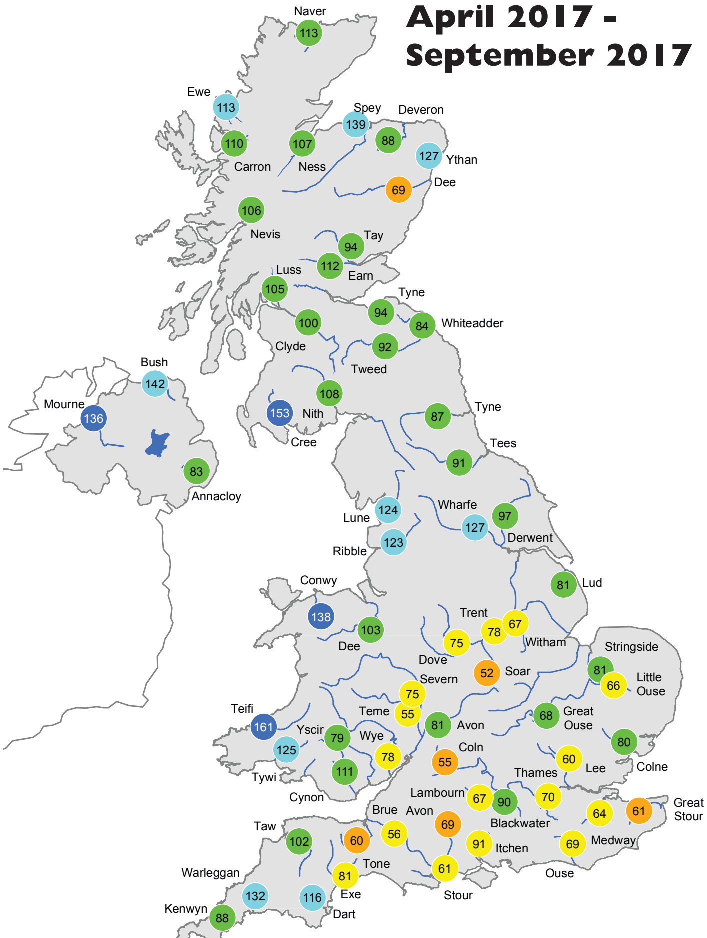
The complete version of the Hydrological Outlook UK can be found at: www.hydoutuk.net/latest-outlook/

Period: **from October 2017**
Issued: **09.10.2017**
using data to the end of September 2017

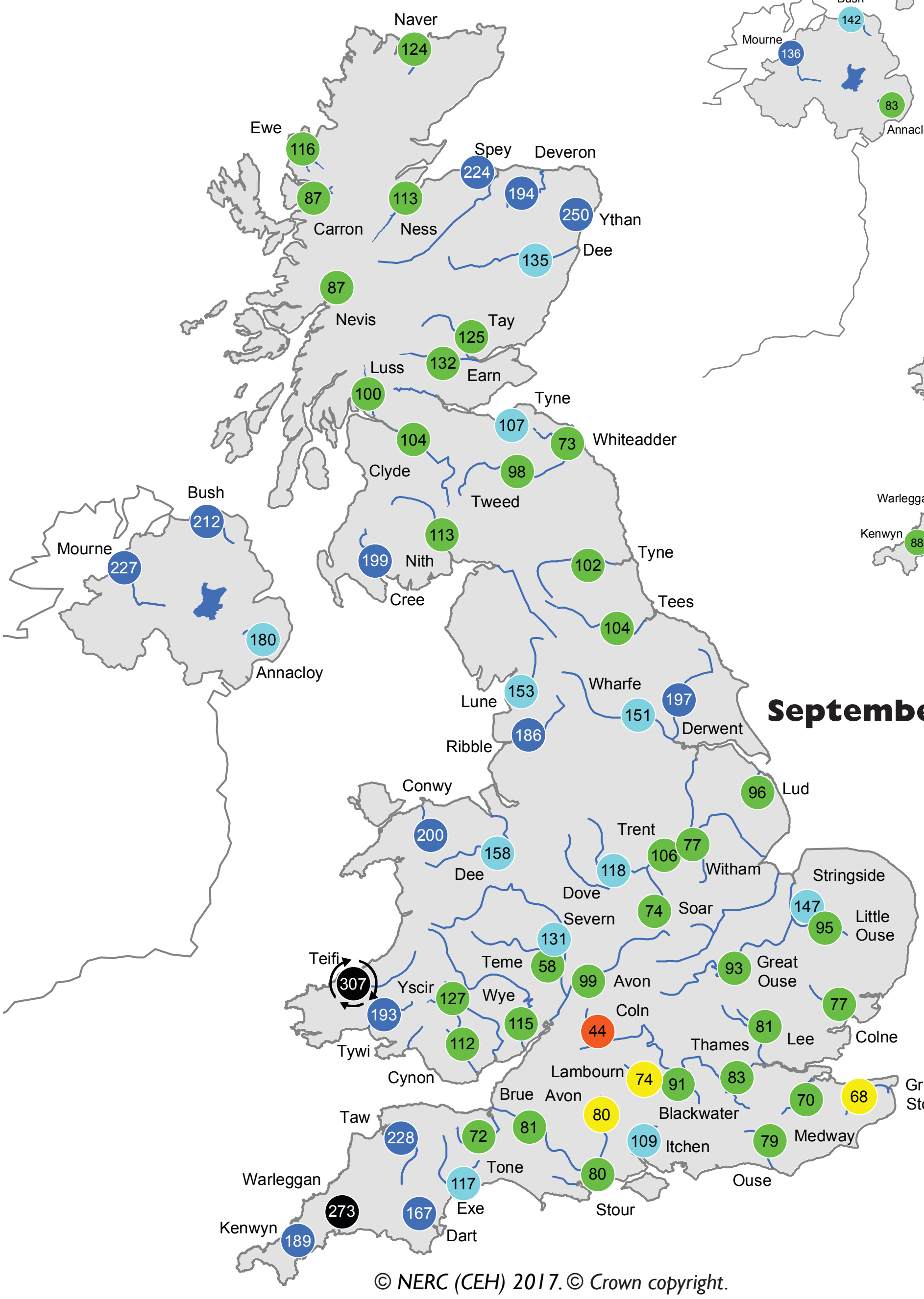
River flows are likely to be normal to above normal across most of the UK during October, with above normal flows most likely in the north-west of the UK. Only in parts of south-east England are flows likely to be normal to below normal in October, and in this area flows are likely to remain in this range for the next three months. Elsewhere there is considerable uncertainty concerning river flows over the next three months. Groundwater levels are likely to be normal during October with the exception of parts of south-east England, in which below normal levels are most likely, and in southern Scotland, where above normal levels are likely to continue in October.

River flow . . . River flow . . .

April 2017 - September 2017



September 2017



Key

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

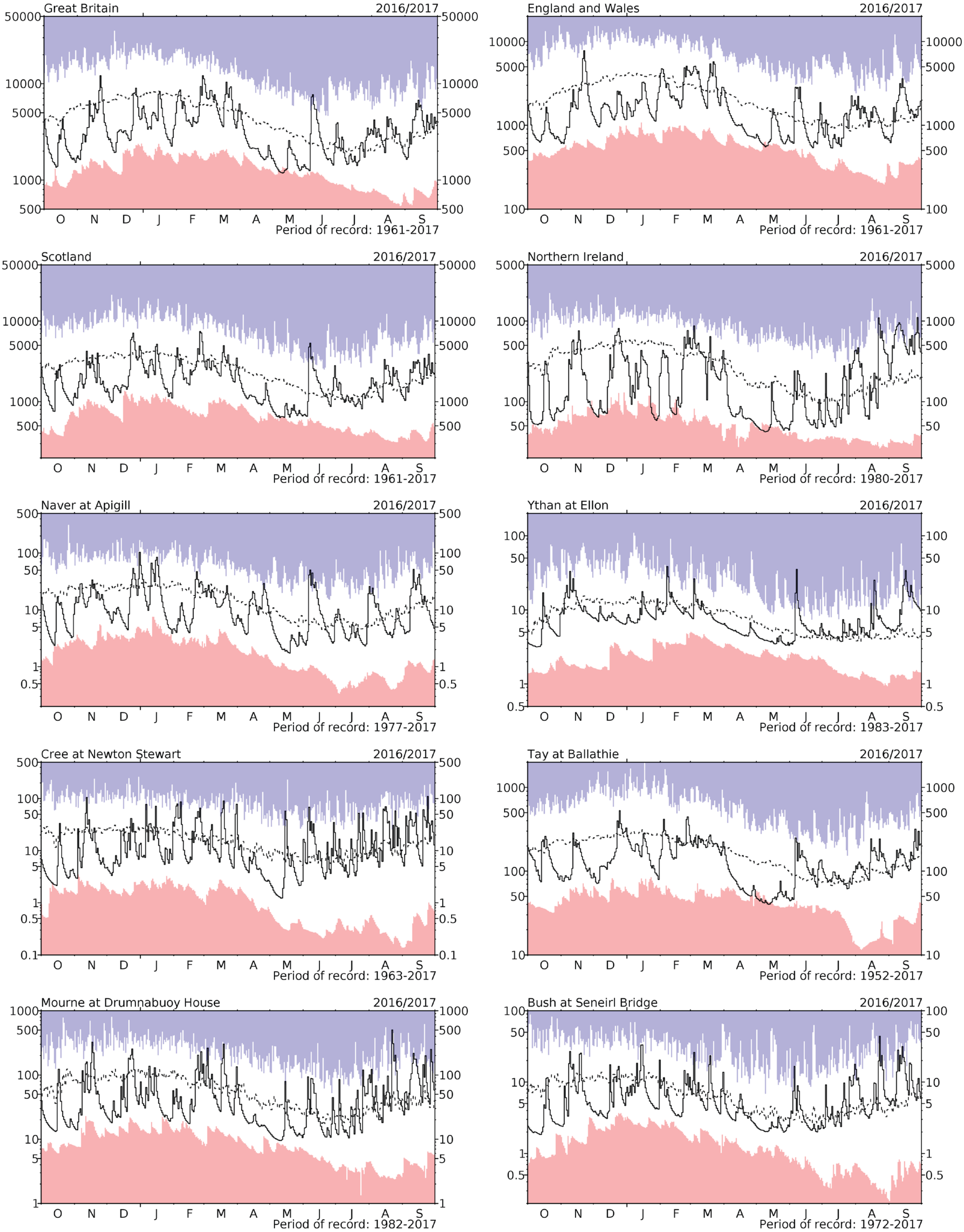
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

*Based on ranking of the monthly flow**

River flows

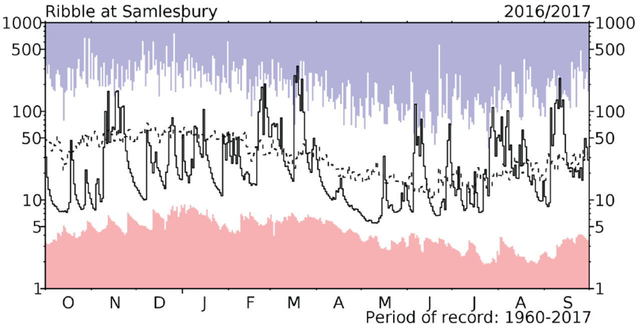
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the averaging period on which these percentages are based is 1981-2010. Percentages may be omitted where flows are under review.

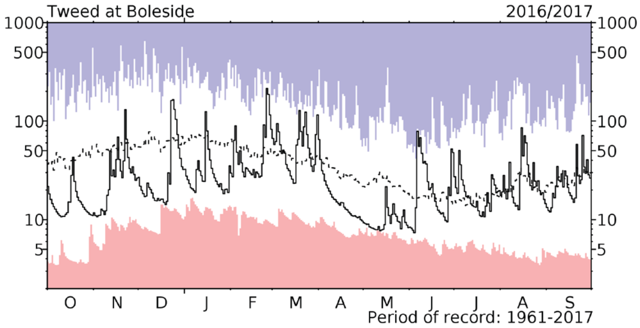
River flow . . . River flow . . .

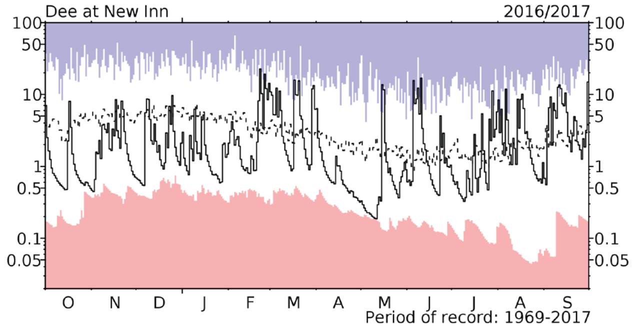


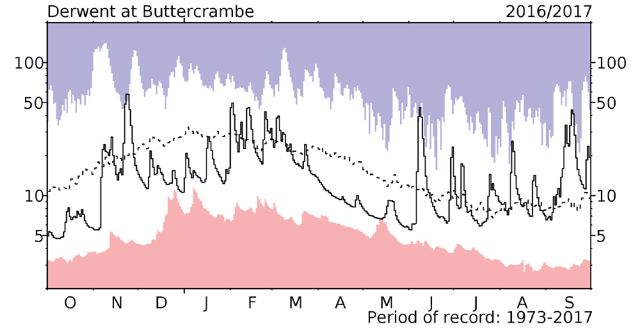
River flow hydrographs

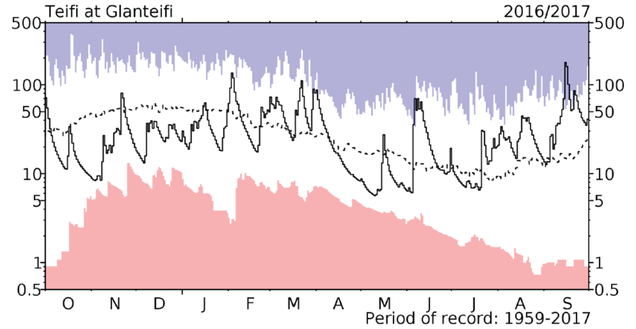
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to October 2016 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

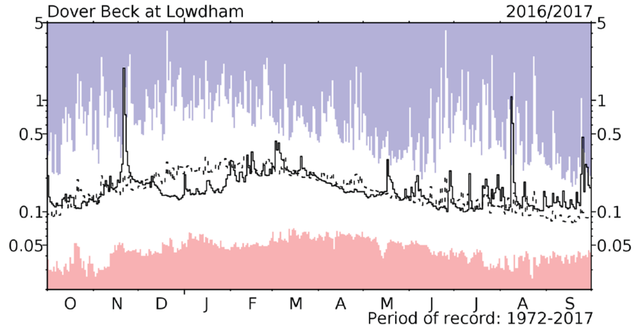

Ribble at Samlesbury
2016/2017
1000
500
100
50
10
5
1
O N D J F M A M J J A S
Period of record: 1960-2017

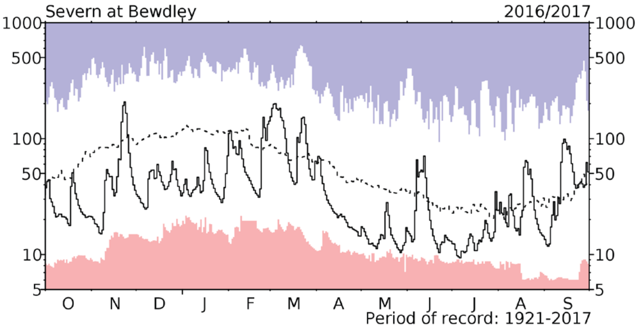

Tweed at Boleside
2016/2017
1000
500
100
50
10
5
O N D J F M A M J J A S
Period of record: 1961-2017

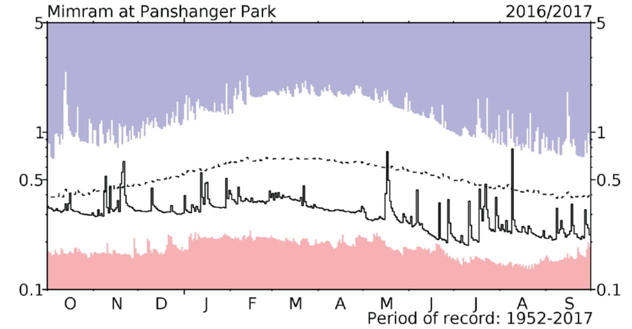

Dee at New Inn
2016/2017
100
50
10
5
1
0.5
0.1
0.05
O N D J F M A M J J A S
Period of record: 1969-2017

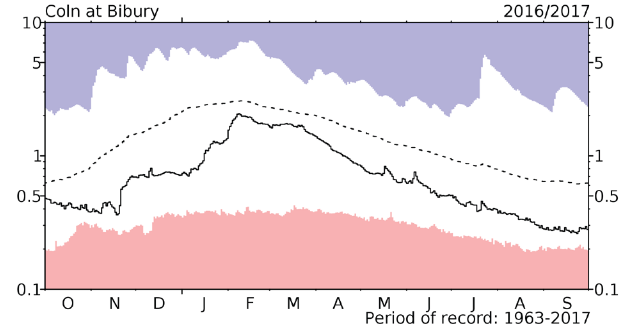

Derwent at Buttercrambe
2016/2017
100
50
10
5
O N D J F M A M J J A S
Period of record: 1973-2017

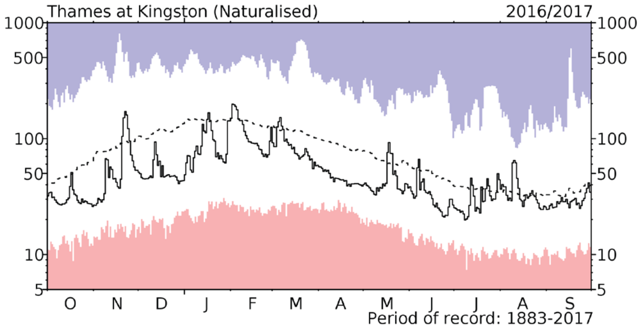

Teifi at Glanteifi
2016/2017
500
100
50
10
5
1
0.5
O N D J F M A M J J A S
Period of record: 1959-2017

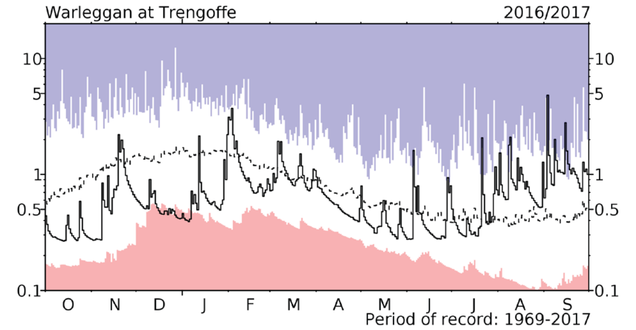

Dover Beck at Lowdham
2016/2017
5
1
0.5
0.1
0.05
O N D J F M A M J J A S
Period of record: 1972-2017

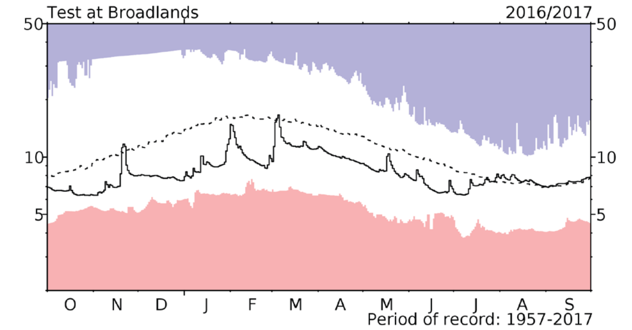

Severn at Bewdley
2016/2017
1000
500
100
50
10
5
O N D J F M A M J J A S
Period of record: 1921-2017


Mimram at Panshanger Park
2016/2017
5
1
0.5
0.1
O N D J F M A M J J A S
Period of record: 1952-2017

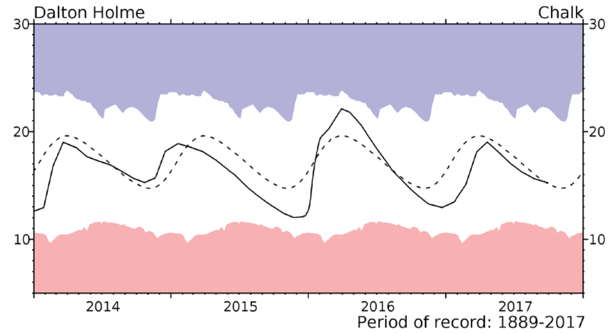

Coln at Bibury
2016/2017
10
5
1
0.5
0.1
O N D J F M A M J J A S
Period of record: 1963-2017

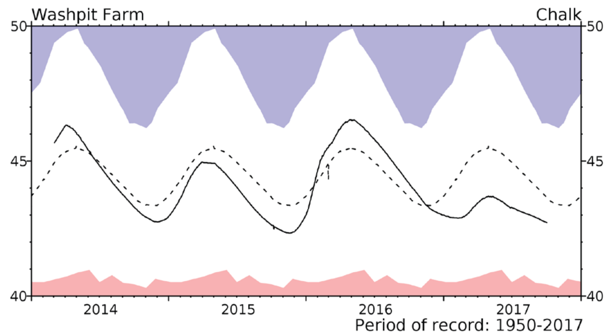

Thames at Kingston (Naturalised)
2016/2017
1000
500
100
50
10
5
O N D J F M A M J J A S
Period of record: 1883-2017

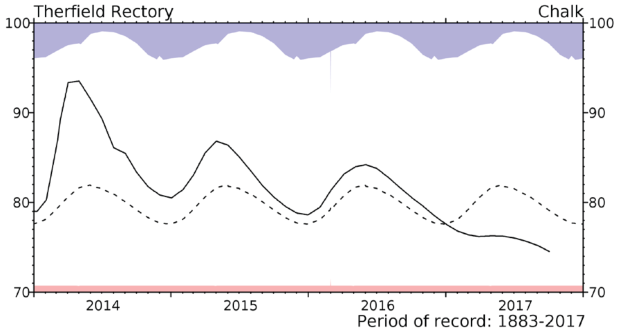

Warleggan at Trengoffe
2016/2017
10
5
1
0.5
0.1
O N D J F M A M J J A S
Period of record: 1969-2017

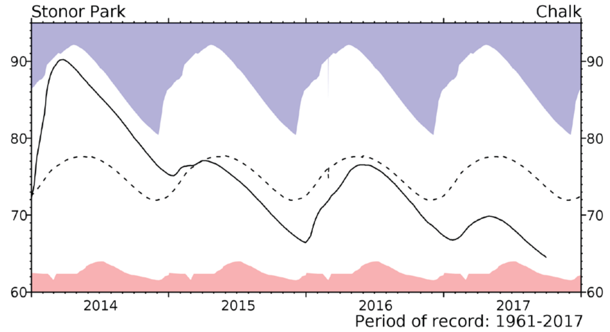

Test at Broadlands
2016/2017
50
10
5
O N D J F M A M J J A S
Period of record: 1957-2017

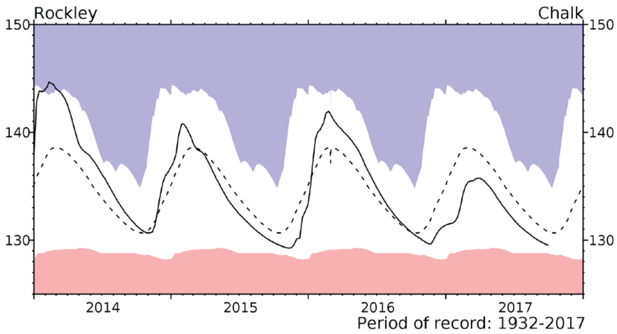
Groundwater . . . Groundwater

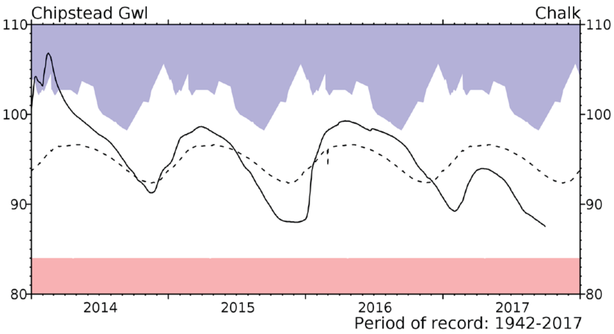


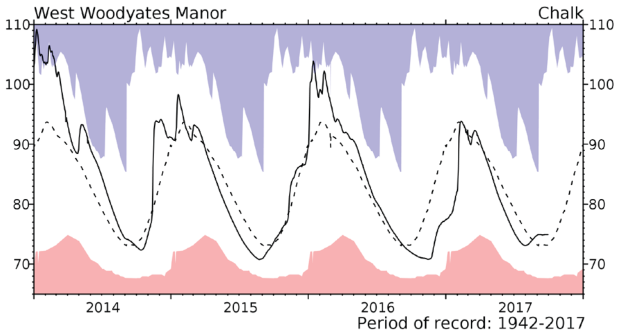


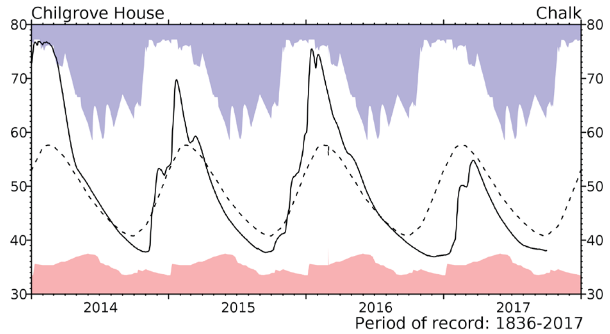


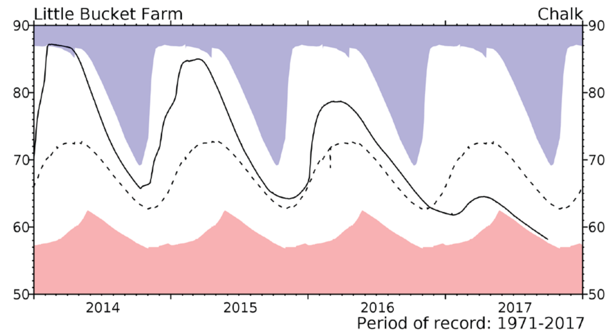


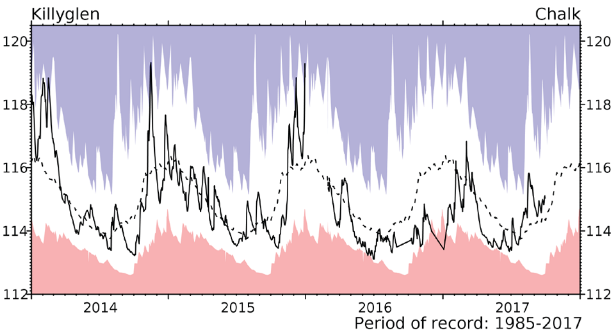




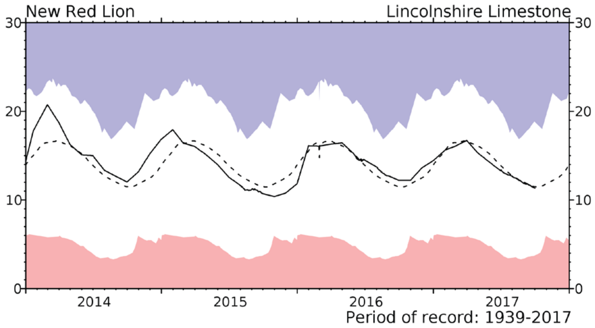


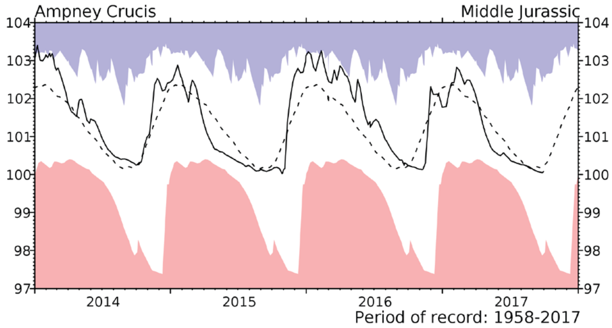


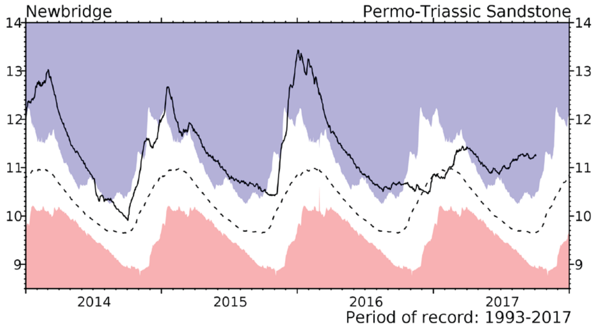


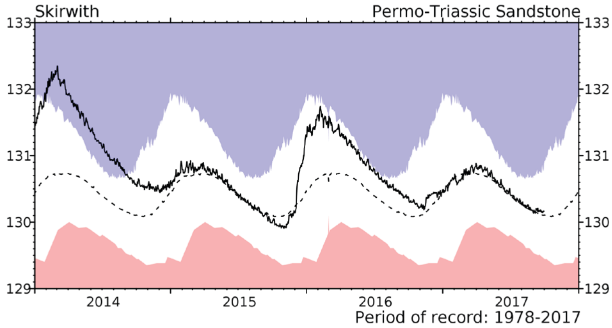


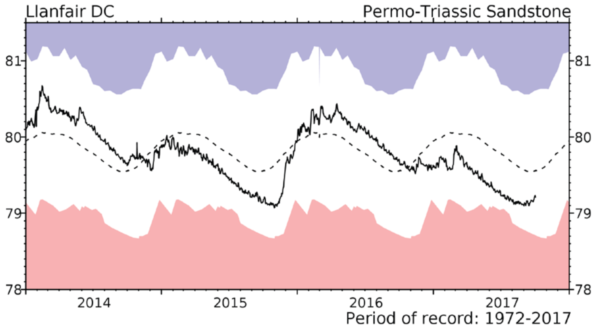
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

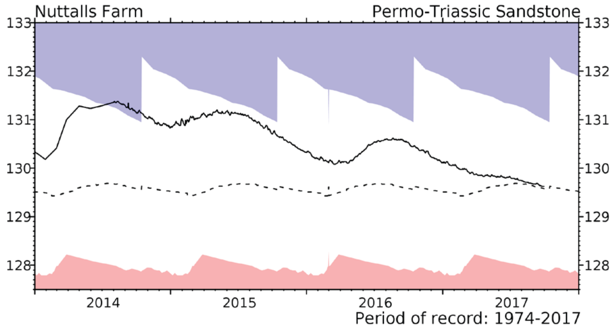

New Red Lion
Lincolnshire Limestone
2014
2015
2016
2017
Period of record: 1939-2017

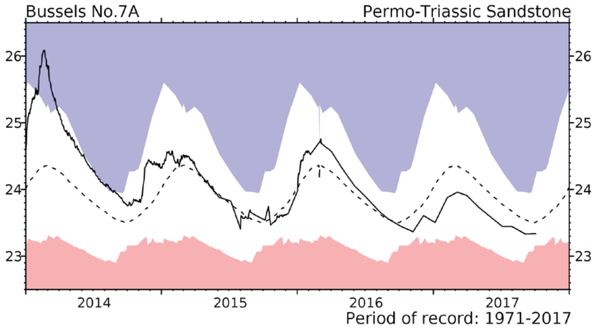

Ampney Crucis
Middle Jurassic
2014
2015
2016
2017
Period of record: 1958-2017

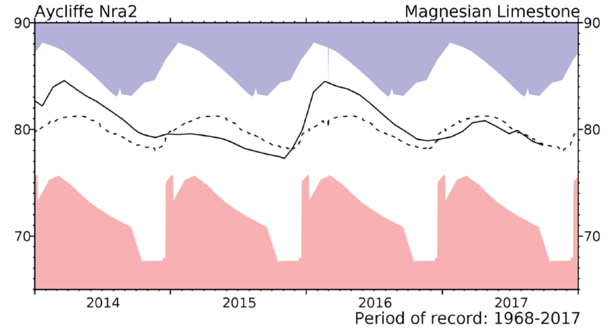

Newbridge
Permo-Triassic Sandstone
2014
2015
2016
2017
Period of record: 1993-2017

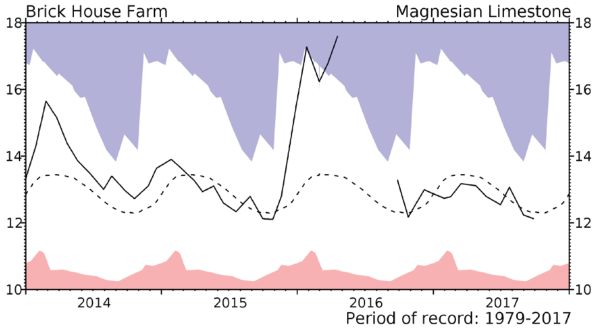

Skirwith
Permo-Triassic Sandstone
2014
2015
2016
2017
Period of record: 1978-2017

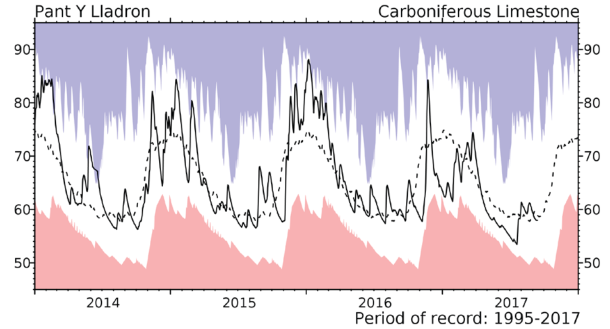

Llanfair DC
Permo-Triassic Sandstone
2014
2015
2016
2017
Period of record: 1972-2017

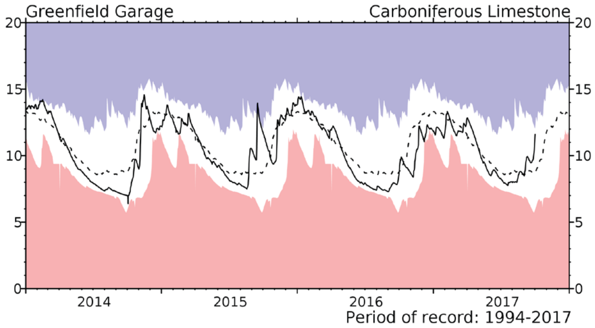

Nuttalls Farm
Permo-Triassic Sandstone
2014
2015
2016
2017
Period of record: 1974-2017

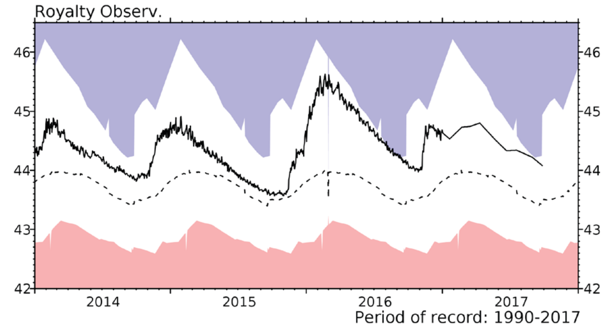

Bussels No.7A
Permo-Triassic Sandstone
2014
2015
2016
2017
Period of record: 1971-2017


Aycliffe Nra2
Magnesian Limestone
2014
2015
2016
2017
Period of record: 1968-2017

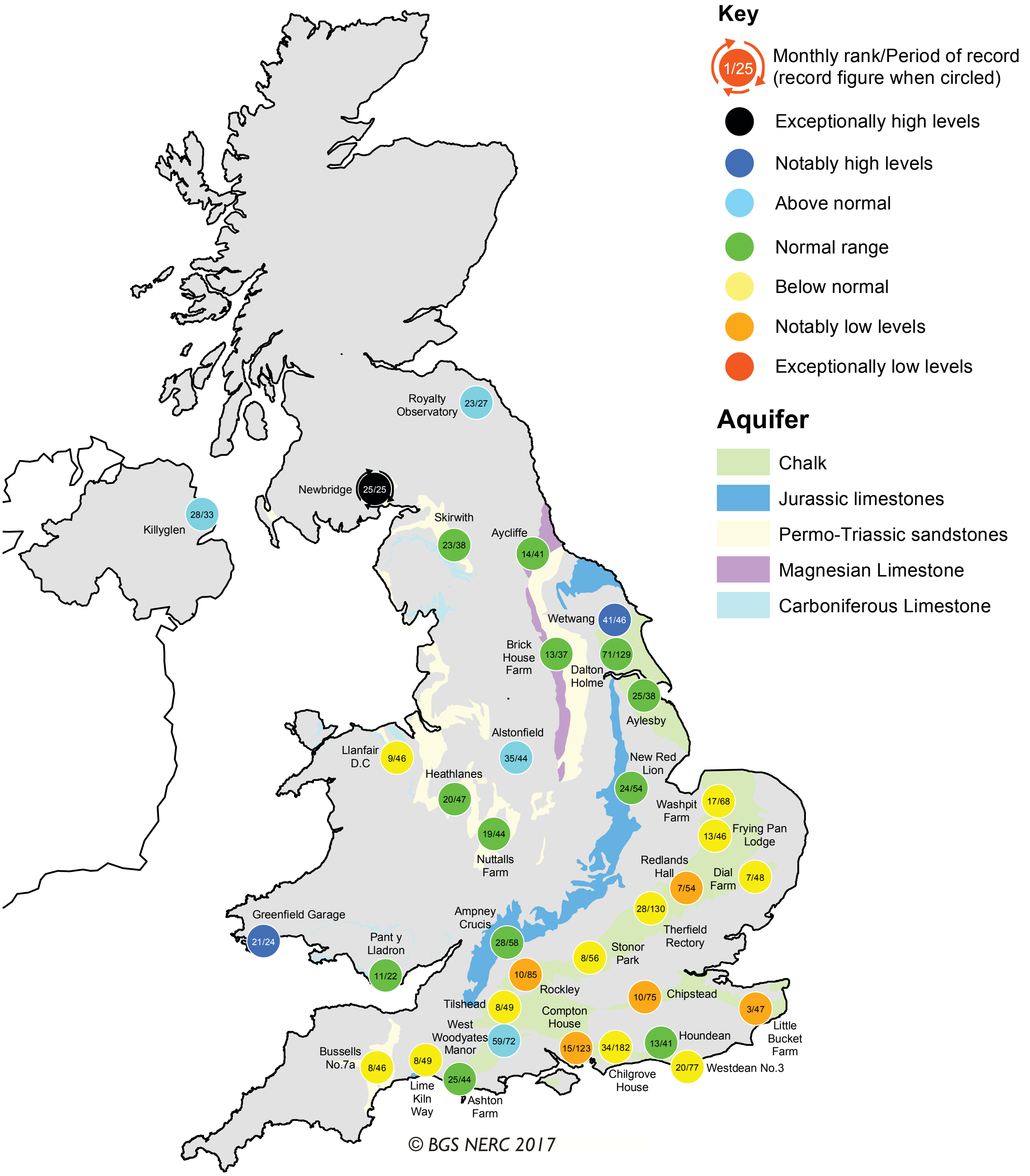

Brick House Farm
Magnesian Limestone
2014
2015
2016
2017
Period of record: 1979-2017


Pant Y Lladron
Carboniferous Limestone
2014
2015
2016
2017
Period of record: 1995-2017


Greenfield Garage
Carboniferous Limestone
2014
2015
2016
2017
Period of record: 1994-2017


Royalty Observ.
2014
2015
2016
2017
Period of record: 1990-2017

Groundwater...Groundwater

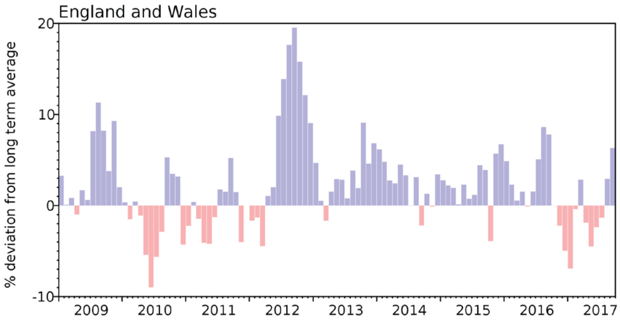


Groundwater levels - September 2017

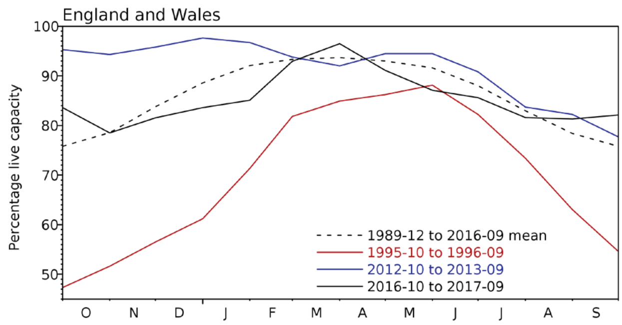
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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

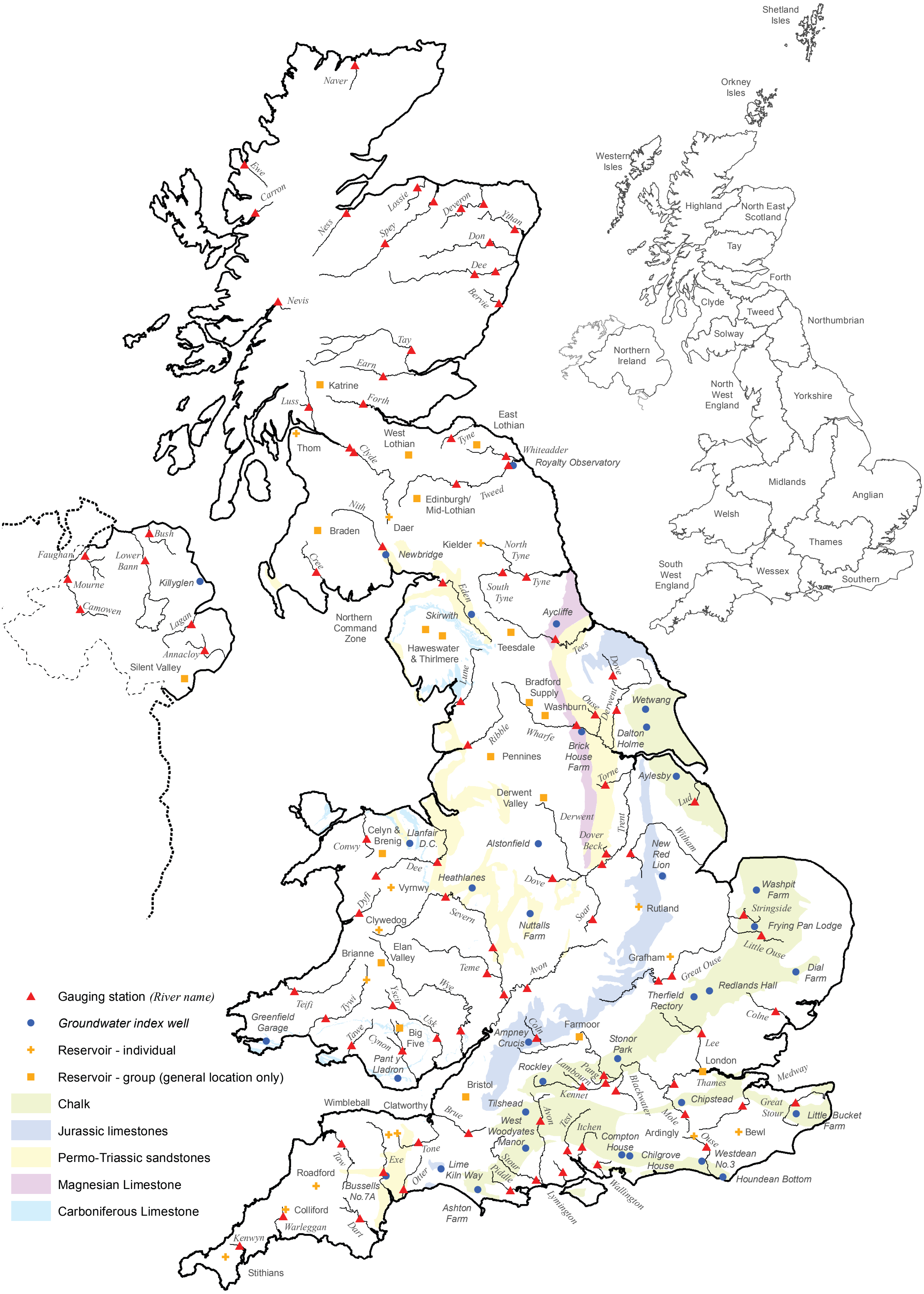
Area	Reservoir		Capacity (Ml)	2017 Jul	2017 Aug	2017 Sep	Sep Anom.	Min Sep	Year* of min	2016 Sep	Diff 17-16
North West	N Command Zone	•	124929	72	72	77	18	13	1995	72	4
	Vyrnwy		55146	93	97	97	27	26	1995	99	-2
Northumbrian	Teesdale	•	87936	81	85	98	28	31	1995	83	15
	Kielder		(199175)	89	87	82	-4	59	1989	92	-10
Severn-Trent	Clywedog		44922	82	93	92	20	24	1989	89	3
	Derwent Valley	•	39525	66	61	68	4	24	1989	82	-14
Yorkshire	Washburn	•	22035	80	77	79	13	24	1995	65	14
	Bradford Supply	•	41407	72	73	80	13	15	1995	70	10
Anglian	Grafham		(55490)	94	96	94	10	46	1997	90	5
	Rutland		(116580)	91	91	90	11	61	1995	89	2
Thames	London	•	202828	82	80	71	-7	53	1997	81	-11
	Farmoor	•	13822	99	91	93	2	54	2003	98	-5
Southern	Bewl		28170	56	50	43	-20	32	1990	69	-25
	Ardingly		4685	84	84	81	15	32	2003	62	19
Wessex	Clatworthy		5364	65	68	69	12	25	2003	40	29
	Bristol	•	(38666)	72	64	61	-2	31	1990	64	-3
South West	Colliford		28540	74	76	81	12	38	2006	69	12
	Roadford		34500	67	68	71	0	26	1995	68	3
	Wimbleball		21320	63	59	76	11	30	1995	50	26
	Stithians		4967	76	73	75	18	22	1990	60	15
Welsh	Celyn & Brenig	•	131155	88	89	93	12	39	1989	95	-2
	Brianne		62140	97	99	100	13	48	1995	100	0
	Big Five	•	69762	81	78	77	7	19	1995	81	-4
	Elan Valley	•	99106	68	68	80	4	33	1976	85	-5
Scotland(E)	Edinburgh/Mid-Lothian	•	96518	82	84	84	6	43	1998	87	-3
	East Lothian	•	9374	100	98	98	16	52	1989	92	6
Scotland(W)	Loch Katrine	•	110326	83	94	95	20	43	1995	95	0
	Daer		22412	78	87	86	8	32	1995	93	-7
	Loch Thom		10798	71	81	89	6	56	1995	100	-11
Northern Ireland	Total+	•	56800	84	88	98	24	29	1995	75	22
	Silent Valley	•	20634	82	87	100	30	27	1995	72	28

( ) 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 1981-2010 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

10/2017

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