Hydrological Summary

for the United Kingdom

General

July bore all of the hallmarks of a typical British summer: sunny and occasionally very hot weather accompanied by disruptive thunderstorm activity. Most memorably, a short exceptionally hot spell in late July, driven by a strong plume of continental air, culminated on the 25th in a new record UK temperature (for any month) of 38.7°C at Cambridge Botanic Gardens. However, this was bookended by intense thunderstorms and heavy rainfall which triggered disruptive surface water and fluvial flooding, and had severe impacts in northern Britain. July rainfall totals were notably above average for the UK, particularly across most of northern and central Britain, but were generally below average further south and west. Soil moisture deficits (SMDs) were near-zero across north-west Britain but drier than average in south-east England. River flows were above average in north-west Scotland, the Midlands and catchments draining the southern Pennines. In contrast, river flows in southern England and south Wales were generally below normal. Groundwater levels receded as normal for the month, and levels in the Chalk of eastern England remained notably to exceptionally low. Reservoir stocks for England & Wales were near-average for the time of year (only Roadford and Colliford were substantially below average), and for Scotland and particularly Northern Ireland were above average. Excessive summer rainfall and generally healthy reservoir stocks have alleviated water resource pressure in 2019. However, as expected, near-average summer rainfall across the Chalk aquifer of south-east England has not remedied the current notably and exceptionally low groundwater levels. As such, the water resources situation for 2020 in these areas will be influenced by the onset and magnitude of recharge over the winter half-year 2019/2020.

July 2019

Rainfall

The first half of July was dominated by anticyclonic conditions with plenty of dry summer weather; rainfall was generally restricted to brief interludes (e.g. 80mm at Fettercairn, Kincardineshire on the 10th), albeit triggering surface water flooding and impacting power and transport networks on 11th/12th (e.g. in Manchester). From mid-month, more unsettled weather followed under a south-westerly airflow, bringing further disruption to power and transport infrastructure from convective activity: on the 19th, in Aberdeen, Cheshire and south Wales; on the 24th/25th, affecting up to 20,000 properties in northern Britain; and on the 28th (e.g. 91mm at Rochdale in 24 hours to 9pm on the 28th), causing surface water flooding of properties and transport networks in Scotland and north-west England. Most significantly of all, on the 30th, persistent convective activity across the Peak District and Yorkshire Dales resulted in remarkable rainfall totals: 95mm at Old Spital Farm (58mm in 45 minutes) and 102mm at Arkle Town (82mm in 90 minutes). This caused severe disruption through surface water flooding of local road networks and landslides across railway lines in the Yorkshire Dales. Substantially above average July rainfall totals were recorded in northern England, the Midlands and much of Scotland, most notably in an area stretching through the southern Pennines, Cheshire (which recorded more than twice the July average) and the Midlands. Conversely, rainfall was generally below average in Wales (61% of average) and southern England, and notably low in south-west Wales and parts of Wessex and Norfolk. Rainfall accumulations for the summer so far (June-July) were above average for the vast majority of the country, 137% of average for the UK. Large swathes of Cheshire, Lincolnshire and the Midlands received more than 170% of average (already more than their entire summer average rainfall), in addition to parts of Northumberland and Kent. Only parts of south Wales and south-west England registered below average rainfall.

River flows

River flows generally began July near or below average and were initially in recession through the first fortnight. One exception to this was on the 11th, when the Naver exceeded its previous July peak flow record by around 10% (in a series from 1977). In East Anglia, the Waveney established new daily flow minima for five days mid-month, and the continued lack of rainfall in southern Britain led to some sustained low flows throughout July. From mid-month, there were swift increases in flows across northern Britain. On the 22nd, the Carron recorded its highest July daily mean flow in a series from 1979, more than 150% of the previous maximum. River flooding on the 28th in localised parts of northern England was reported. The Mersey recorded its two highest July daily mean flows on record (in a series from 1976) on the 28th and 31st. Rivers across the southern Pennines also responded markedly to exceptional rainfall on the 30th, destroying an iconic bridge near Grinton (North Yorkshire). July mean flows were generally above normal in northern Scotland, Yorkshire and the East Midlands, and were particularly notable in parts of north-west England (more than twice the average on the Mersey). Further south, July mean flows were below normal, notably so in parts of East Anglia, Dorset and south Wales. Flows on the Brue, Taw and Tawe were around a third of average, and the Tywi registered less than a quarter of average. Average river flows for the summer so far (June-July) have been above average across Wales, northern and eastern Scotland, and central and north-east England, with exceptionally high flows on the Wharfe, Lud and Weaver. The latter recorded three times its average flow and registered as the second highest June-July mean flow (behind 2007) in a series from 1938.

Groundwater

SMDs were drier than average across most of the Chalk aquifer of south-east England. Levels fell at all of the Chalk boreholes (apart from Aylesby where a rise was recorded). Levels were generally below normal or notably low, especially so in eastern England where Dial Farm remained exceptionally low. July levels at Frying Pan Lodge, Dial Farm and Washpit Farm were their lowest since 1997. Nevertheless, Killyglen and two Chalk boreholes in south-east England ended July in the normal range. Levels at both of the Jurassic limestone boreholes in central England fell but remained above average. Levels in the Magnesian limestones fell and remained below average. In the Carboniferous Limestone levels fell, to notably low in south Wales but remained in the normal range at Alstonfield. In the Permo-Triassic sandstones, levels generally fell and remained in the normal range or below (except at Newbridge), reflecting the variations in both July rainfall and SMDs. Levels fell at Lime Kiln Way (Upper Greensand) and were below normal. Levels at Royalty Observatory in the Fell Sandstone receded but remained in the normal range.

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.

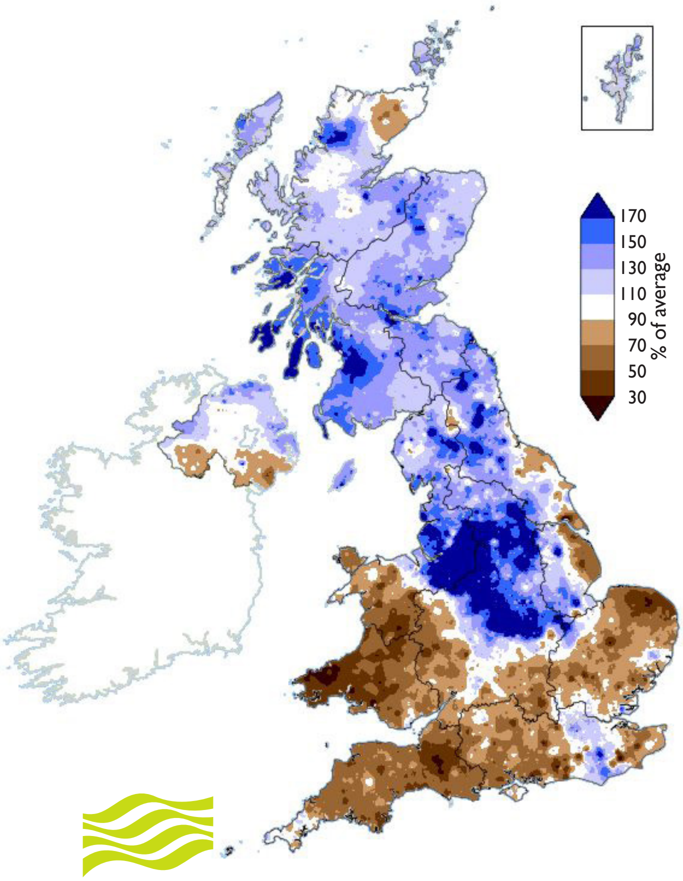
Region	Rainfall	Jul 2019	Jun 19 – Jul 19	RP	Feb 19 – Jul 19	RP	Nov 19 – Jul 19	RP	Aug 18 – Jul 19	RP
United Kingdom	mm	**89**	200		522		828		1122	
	%	**118**	137	8-12	112	5-10	101	2-5	99	2-5
England	mm	**68**	178		397		624		819	
	%	**111**	145	8-12	110	2-5	101	2-5	97	2-5
Scotland	mm	**133**	235		688		1083		1528	
	%	**141**	133	8-12	113	10-15	98	2-5	101	2-5
Wales	mm	**55**	214		647		1107		1489	
	%	**61**	123	2-5	115	5-10	107	2-5	105	2-5
Northern Ireland	mm	**87**	199		571		878		1107	
	%	**106**	126	5-10	118	10-15	106	2-5	97	2-5
England & Wales	mm	**66**	183		431		690		912	
	%	**101**	141	5-10	111	2-5	102	2-5	99	2-5
North West	mm	**137**	259		639		954		1303	
	%	**158**	156	10-20	129	25-40	108	2-5	106	2-5
Northumbria	mm	**94**	207		471		643		877	
	%	**140**	156	10-20	124	10-15	101	2-5	101	2-5
Severn-Trent	mm	**76**	214		424		611		788	
	%	**127**	174	20-30	122	5-10	107	2-5	101	2-5
Yorkshire	mm	**86**	189		416		622		804	
	%	**141**	147	8-12	113	2-5	101	2-5	96	2-5
Anglian	mm	**47**	152		289		427		571	
	%	**90**	142	8-12	102	2-5	95	2-5	92	2-5
Thames	mm	**43**	138		303		495		650	
	%	**84**	135	2-5	98	2-5	95	2-5	91	2-5
Southern	mm	**43**	135		316		583		752	
	%	**86**	136	2-5	99	2-5	101	2-5	94	2-5
Wessex	mm	**36**	130		354		647		821	
	%	**63**	114	2-5	97	2-5	100	2-5	93	2-5
South West	mm	**51**	158		463		915		1169	
	%	**65**	106	2-5	93	2-5	100	2-5	95	2-5
Welsh	mm	**55**	211		626		1066		1433	
	%	**63**	126	2-5	115	5-10	107	2-5	105	2-5
Highland	mm	**132**	244		778		1218		1809	
	%	**131**	127	5-10	109	5-10	92	2-5	100	2-5
North East	mm	**102**	190		529		791		1045	
	%	**140**	133	2-5	123	10-15	108	2-5	103	2-5
Tay	mm	**115**	210		616		971		1309	
	%	**139**	132	5-10	114	5-10	99	2-5	98	2-5
Forth	mm	**118**	214		567		842		1121	
	%	**145**	135	8-12	114	8-12	96	2-5	93	2-5
Tweed	mm	**109**	207		542		761		1040	
	%	**141**	140	8-12	125	10-20	102	2-5	101	2-5
Solway	mm	**140**	231		723		1187		1592	
	%	**143**	126	5-10	122	25-40	111	8-12	107	5-10
Clyde	mm	**182**	296		793		1287		1803	
	%	**158**	140	15-25	111	5-10	98	2-5	99	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 2018 are provisional.

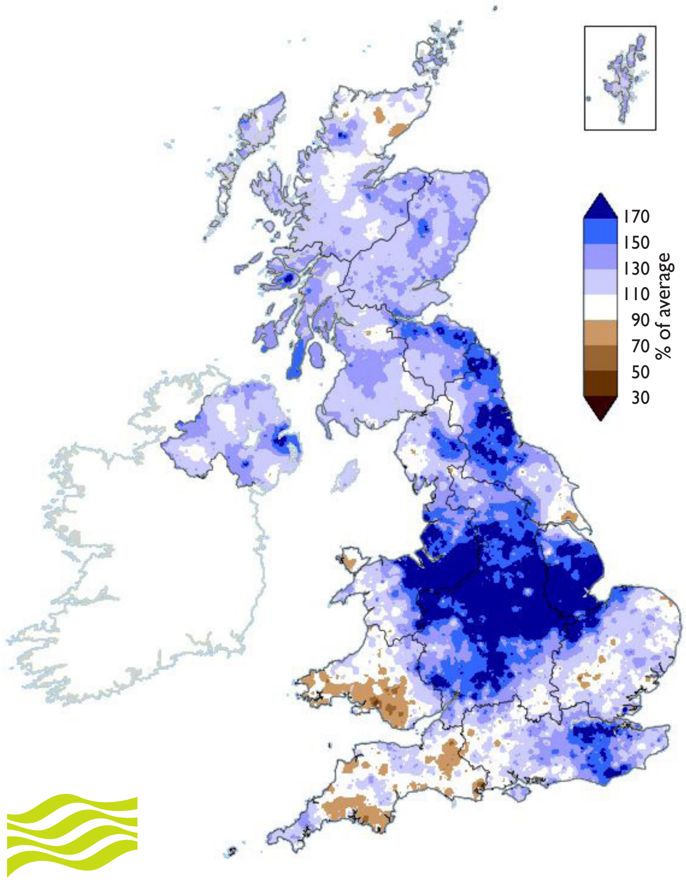
Rainfall . . . Rainfall . . .

July 2019 rainfall as % of 1981-2010 average



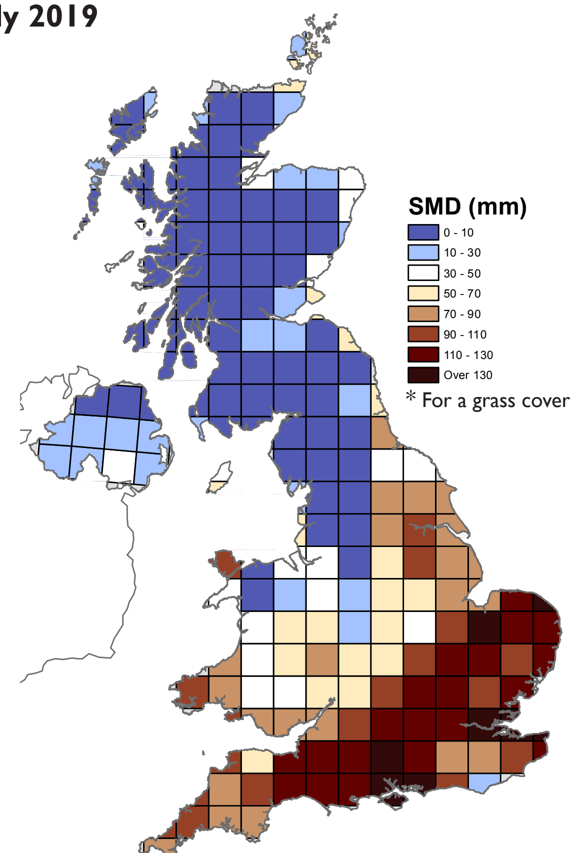
Met Office

June 2019 - July 2019 rainfall as % of 1981-2010 average



Met Office

MORECS Soil Moisture Deficits* July 2019



Hydrological Outlook UK

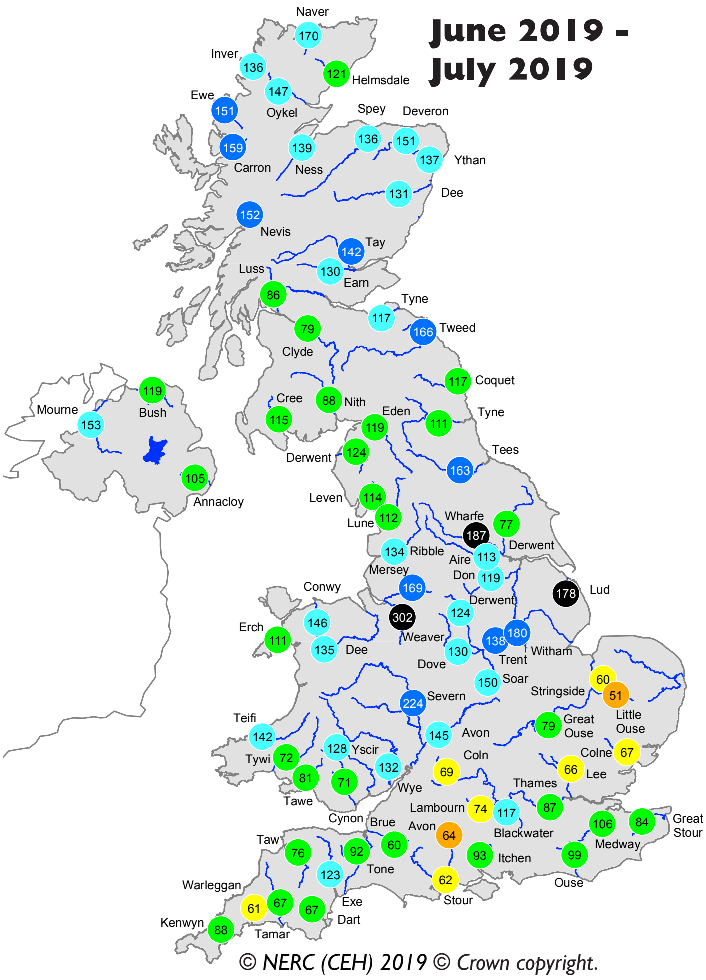
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

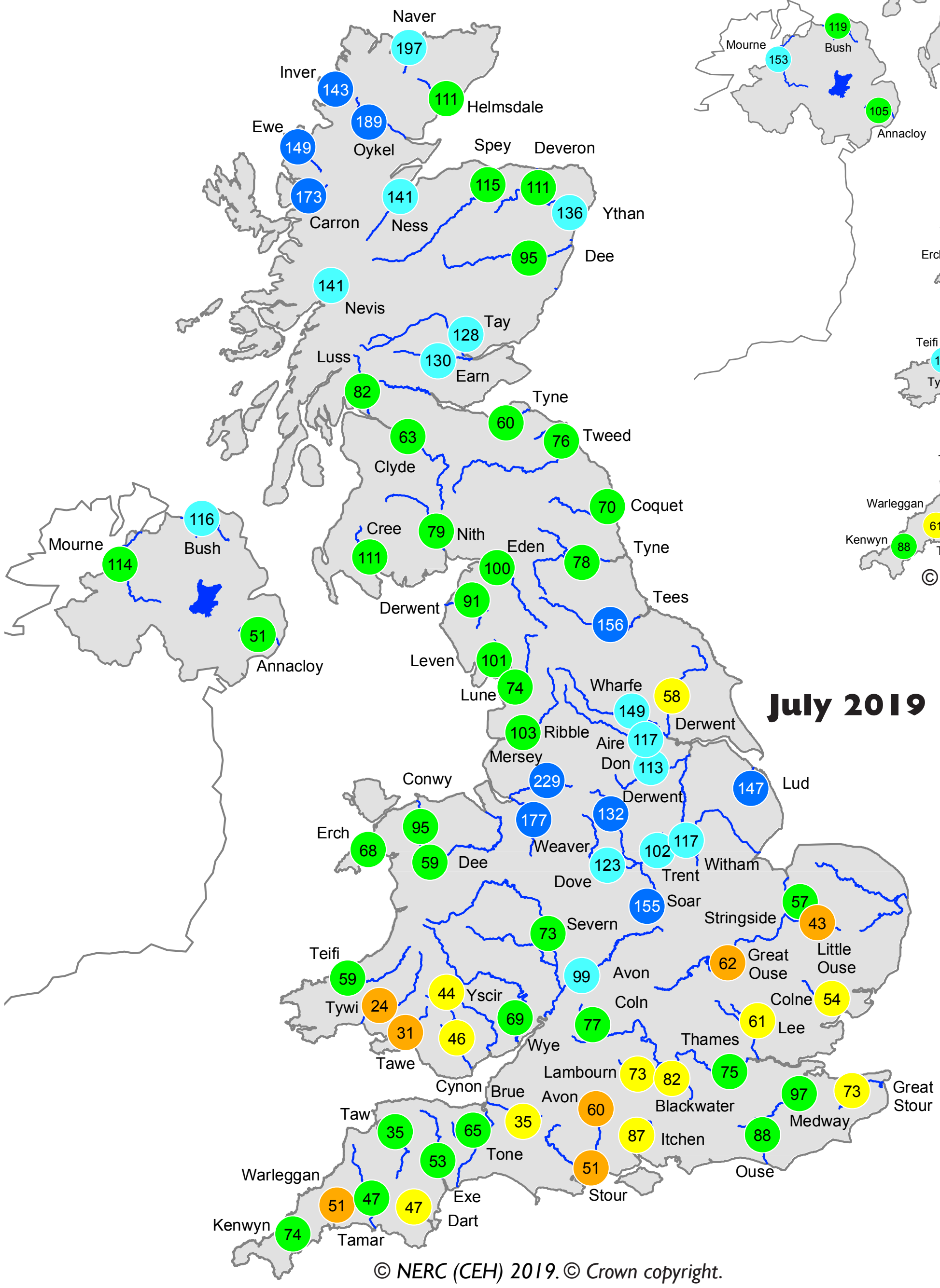
The complete version of the Hydrological Outlook UK can be found at: www.hydoutuk.net/latest-outlook/

Period: **from August 2019**
Issued: **08.08.2019**
using data to the end of July 2019

The outlook is for a continuation of below normal river flows across southern England and East Anglia throughout August. Over the next three months, flows in this area are likely to be normal to below normal. Conversely, in central England, flows in the majority of catchments are likely to be above normal for August, and normal to above normal over the three month period August-October. Elsewhere across the northern and western parts of the UK, flows are expected to be within the normal range. Groundwater levels across the southern and eastern Chalk aquifer are likely to be below normal for August. Elsewhere, groundwater levels are most likely to be within the normal range for August.

River flow . . . River flow . . .





Key

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

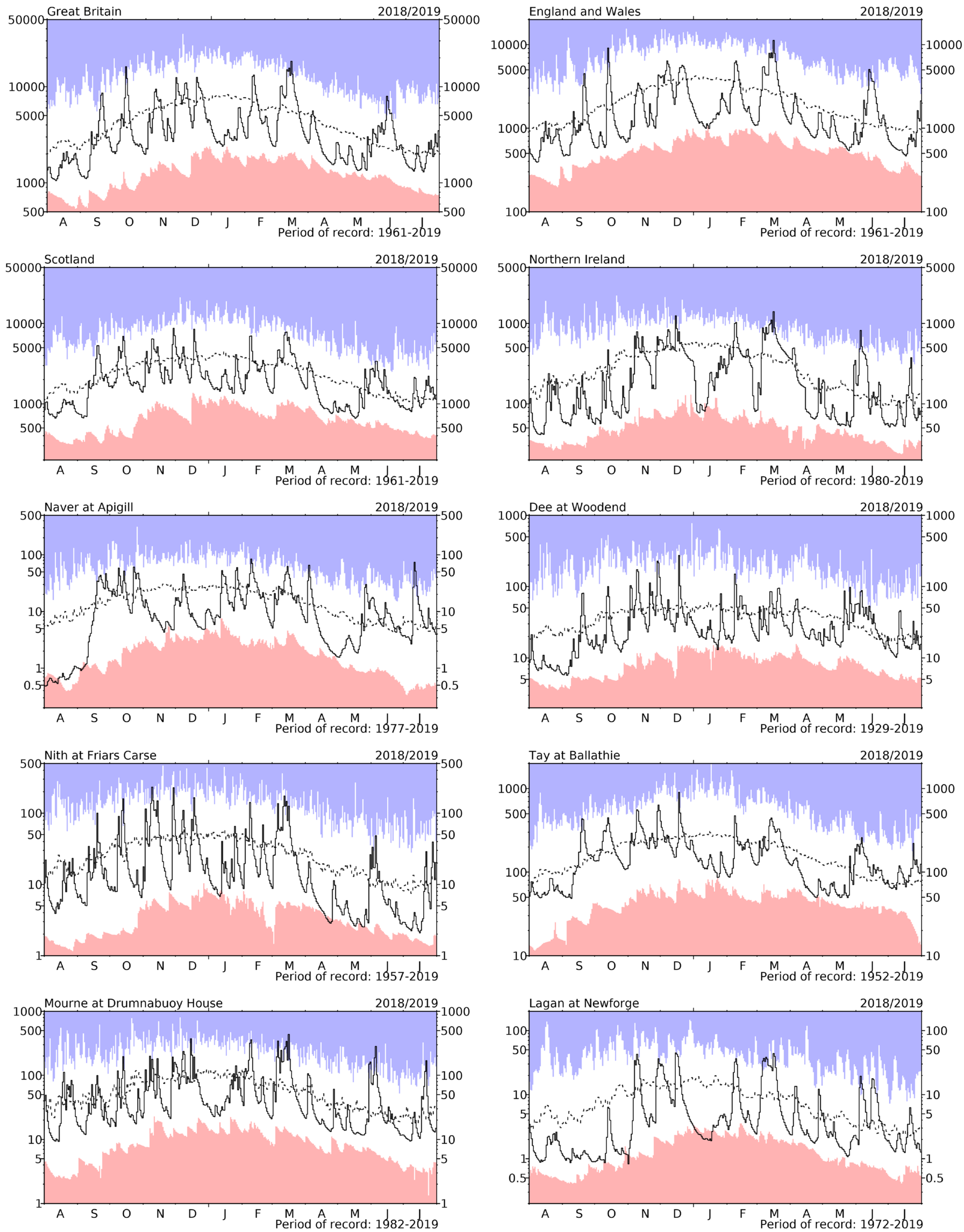
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

*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.

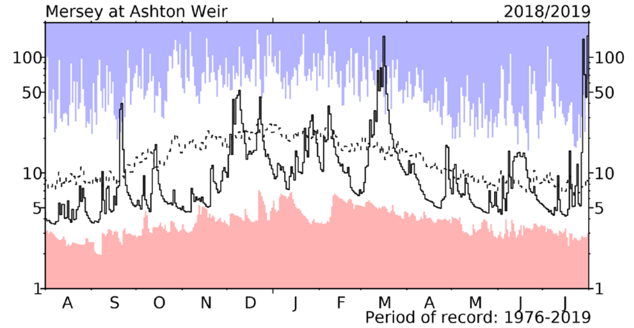
River flow . . . River flow . . .

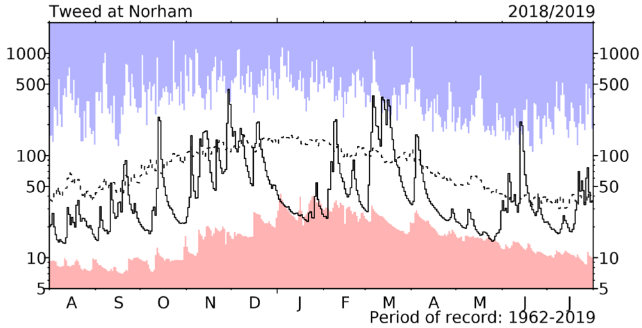


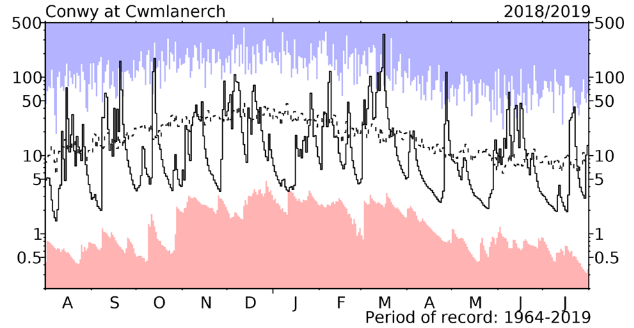
River flow hydrographs

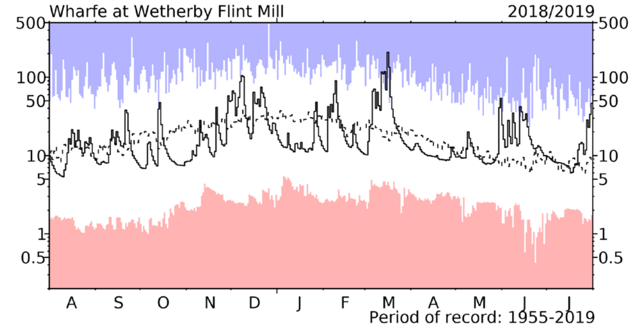
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to August 2018 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

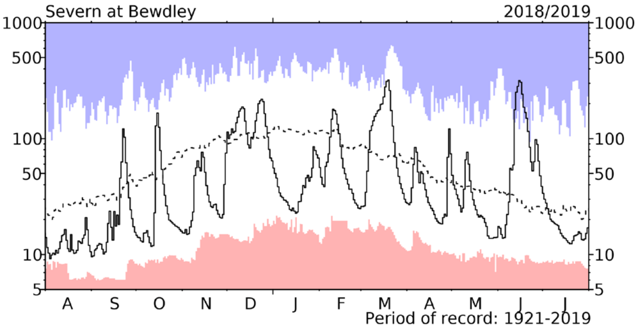
River flow . . . River flow . . .

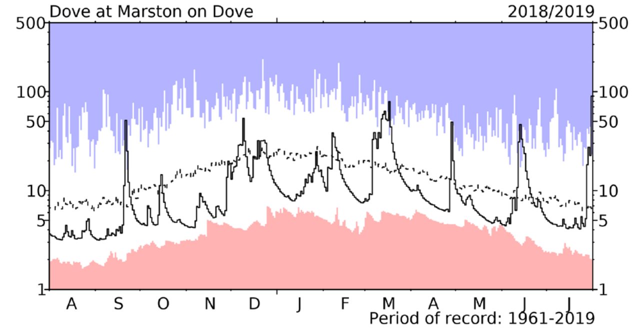


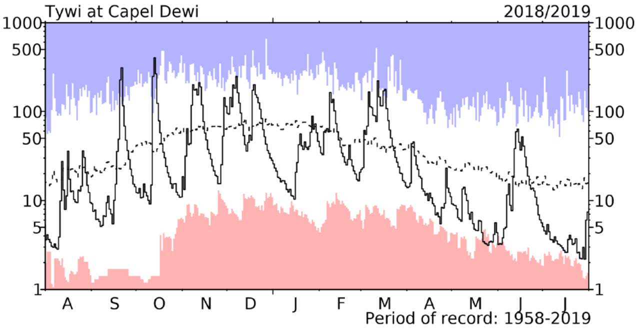


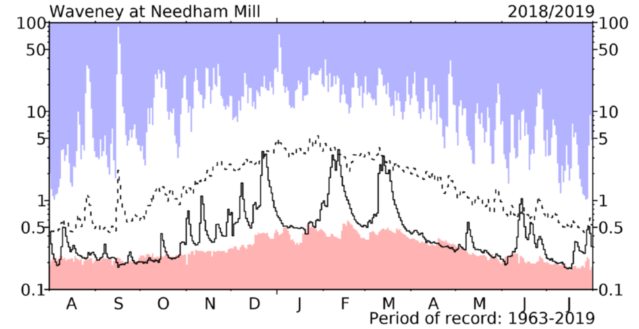


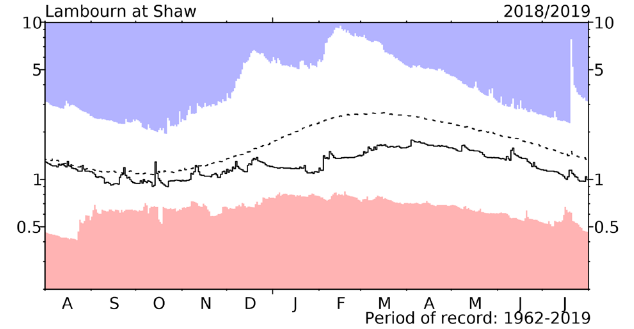


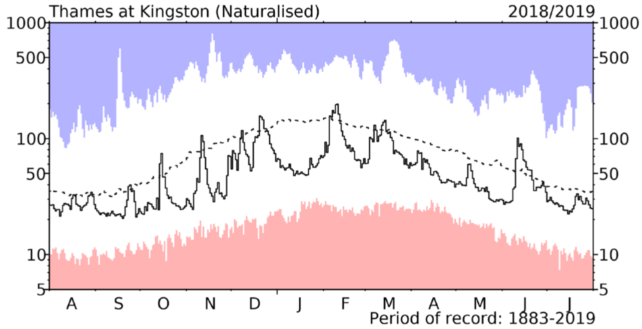


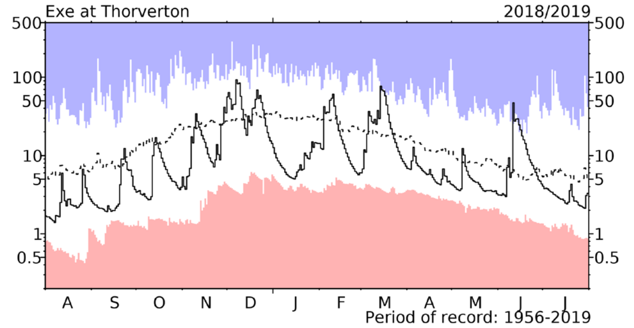


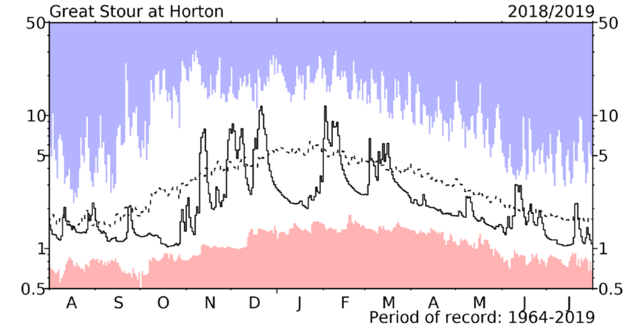




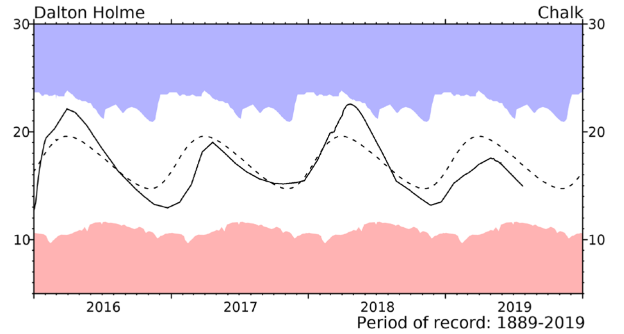


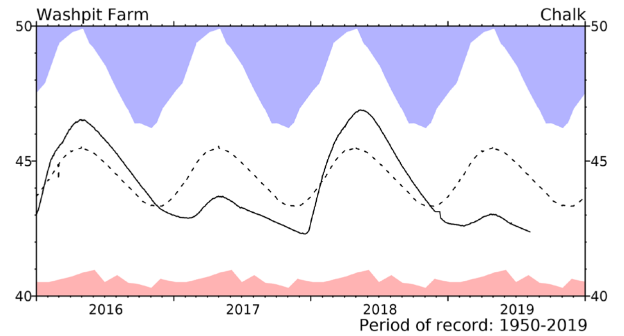


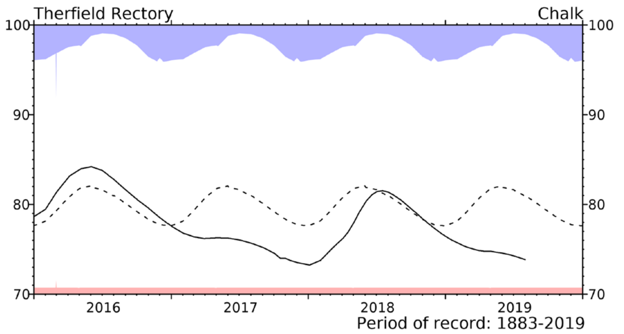


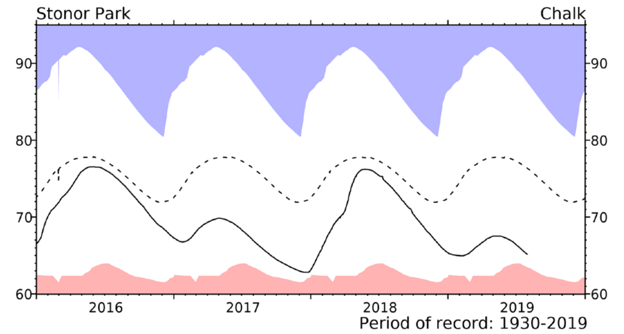


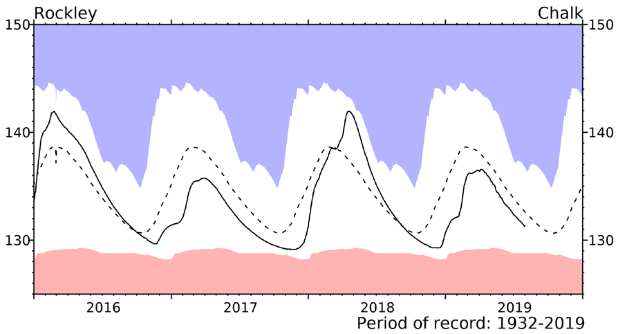
Groundwater . . . Groundwater

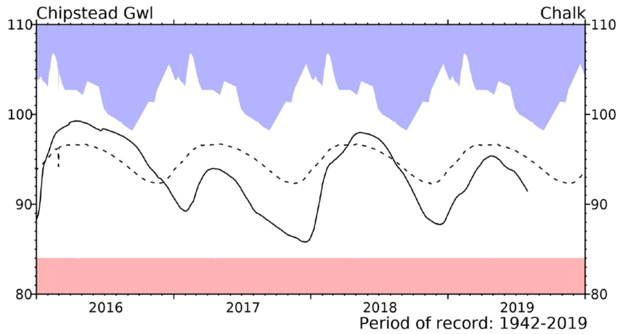


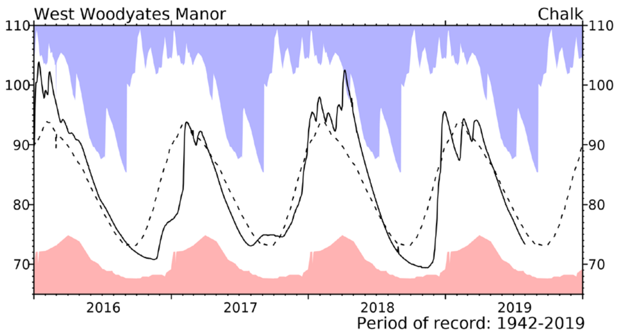


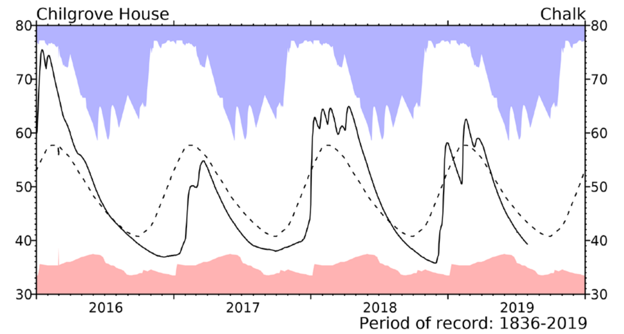


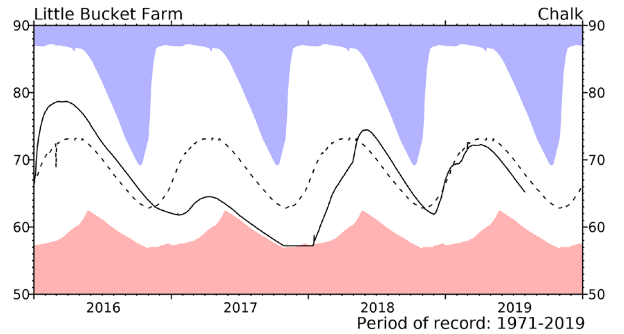


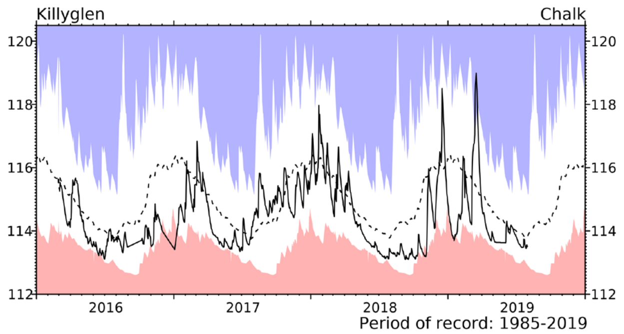




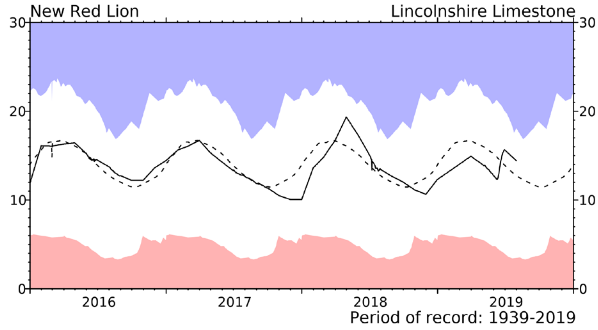


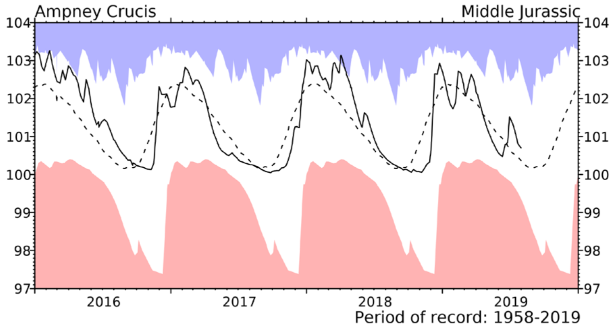


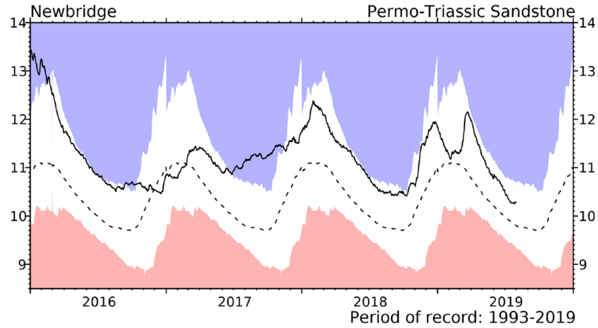


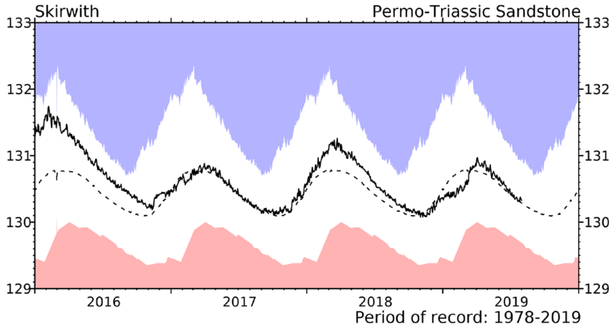


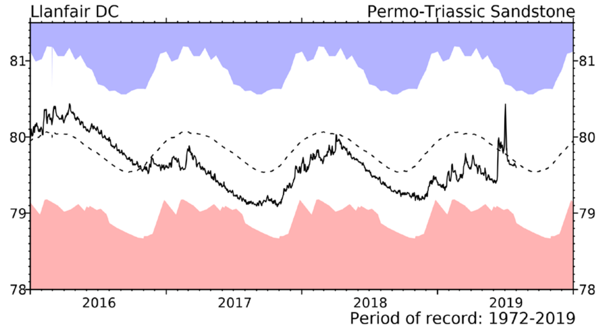
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

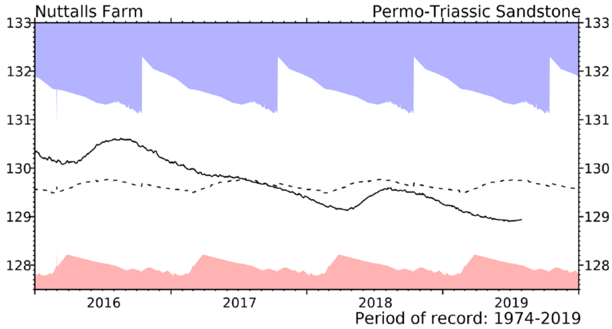

New Red Lion
Lincolnshire Limestone
2016
2017
2018
2019
Period of record: 1939-2019

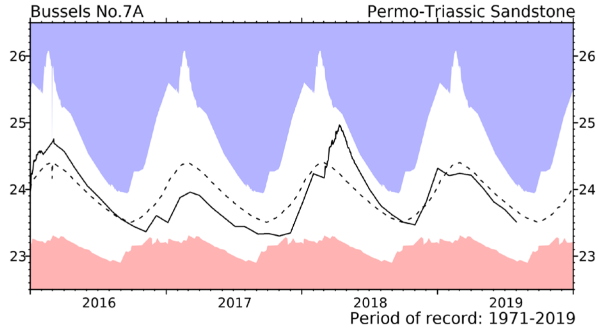

Ampney Crucis
Middle Jurassic
2016
2017
2018
2019
Period of record: 1958-2019

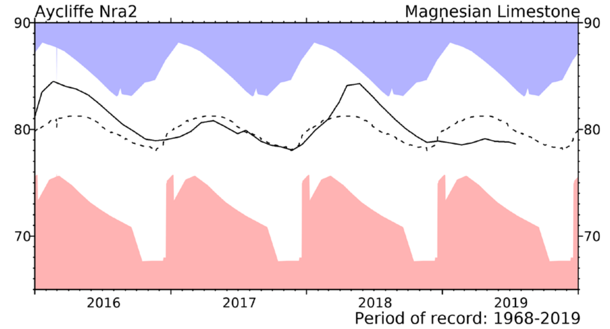

Newbridge
Permo-Triassic Sandstone
2016
2017
2018
2019
Period of record: 1993-2019

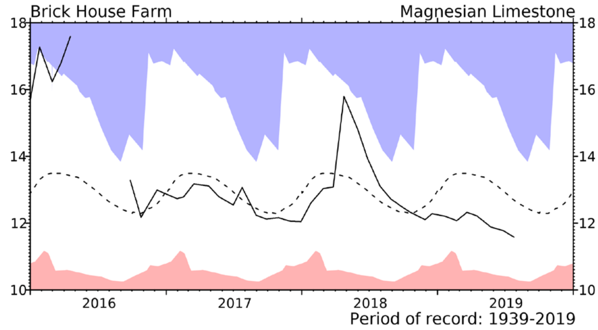

Skirwith
Permo-Triassic Sandstone
2016
2017
2018
2019
Period of record: 1978-2019

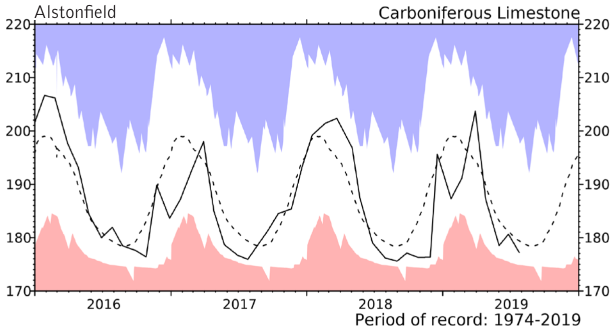

Llanfair DC
Permo-Triassic Sandstone
2016
2017
2018
2019
Period of record: 1972-2019

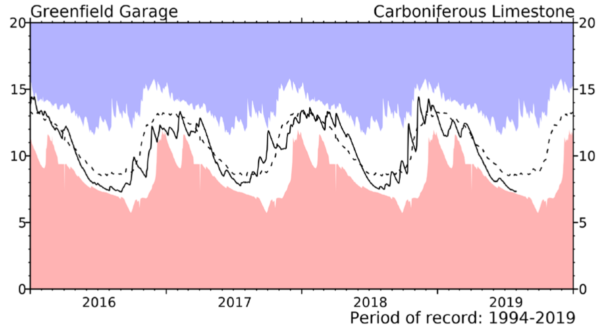

Nuttalls Farm
Permo-Triassic Sandstone
2016
2017
2018
2019
Period of record: 1974-2019

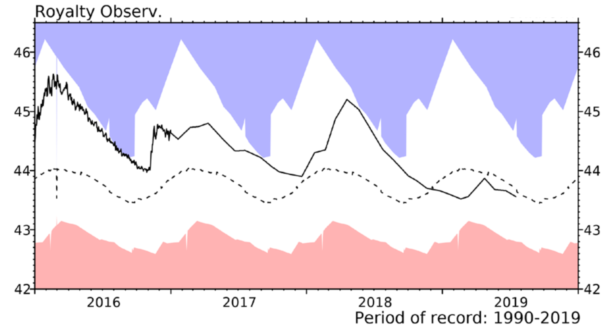

Bussels No.7A
Permo-Triassic Sandstone
2016
2017
2018
2019
Period of record: 1971-2019


Aycliffe Nra2
Magnesian Limestone
2016
2017
2018
2019
Period of record: 1968-2019

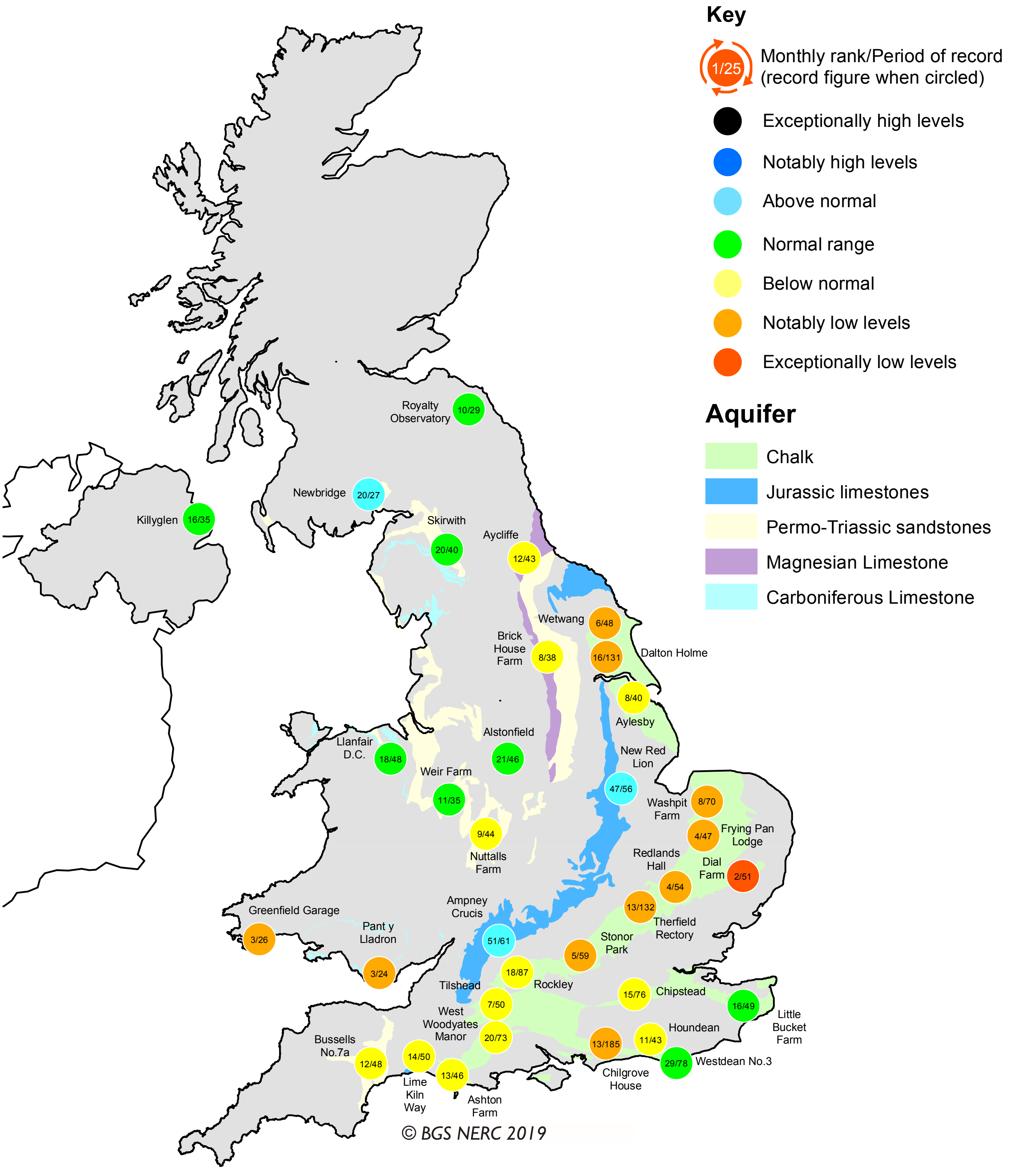

Brick House Farm
Magnesian Limestone
2016
2017
2018
2019
Period of record: 1939-2019


Alstonfield
Carboniferous Limestone
2016
2017
2018
2019
Period of record: 1974-2019


Greenfield Garage
Carboniferous Limestone
2016
2017
2018
2019
Period of record: 1994-2019


Royalty Observ.
2016
2017
2018
2019
Period of record: 1990-2019

Groundwater...Groundwater

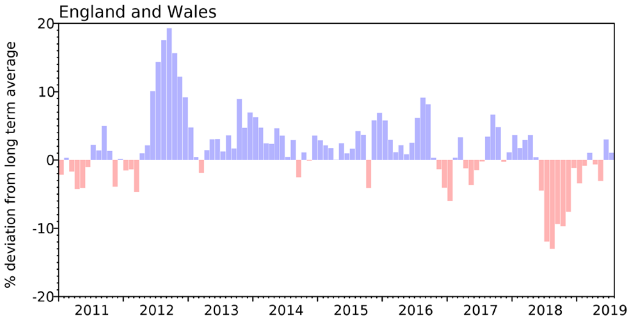


Groundwater levels - July 2019

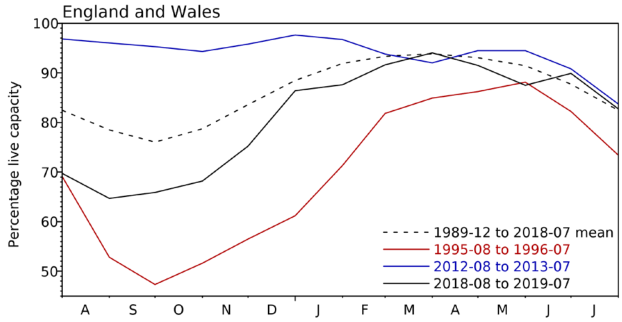
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

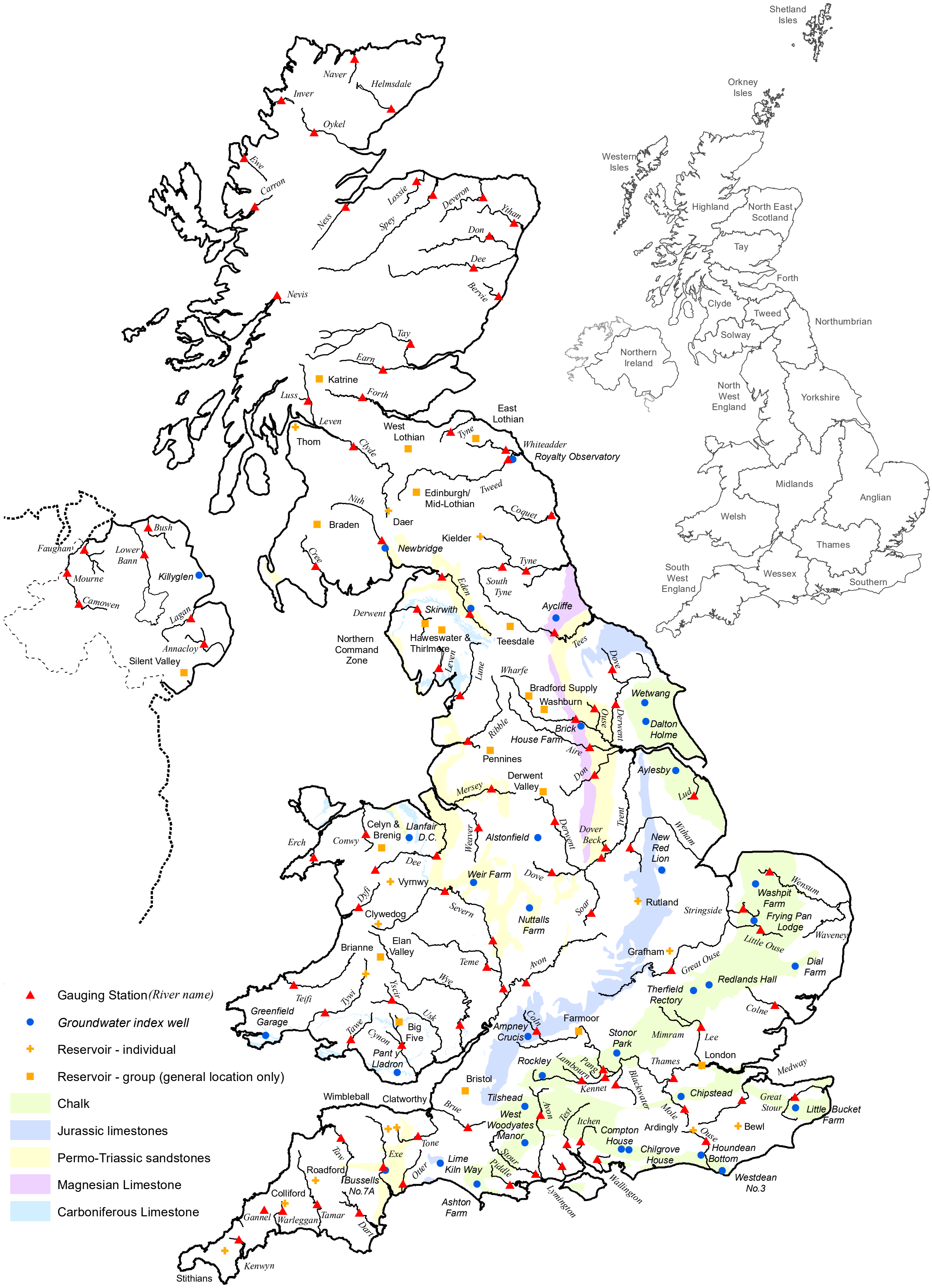
Area	Reservoir		Capacity (Ml)	2019 May	2019 Jun	2019 Jul	Jul Anom.	Min Jul	Year* of min	2018 Jul	Diff 19-18
North West	N Command Zone	•	124929	67	69	61	-2	23	1984	41	20
	Vyrnwy		55146	97	100	91	15	45	1984	69	22
Northumbrian	Teesdale	•	87936	85	84	80	6	45	1989	61	20
	Kielder		(199175)	91	90	90	0	66	1989	77	13
Severn-Trent	Clywedog		49936	100	99	96	11	50	1976	72	24
	Derwent Valley	•	46692	77	81	66	-7	43	1996	52	14
Yorkshire	Washburn	•	23373	84	95	81	8	50	1995	57	24
	Bradford Supply	•	40942	73	88	70	-1	38	1995	52	19
Anglian	Grafham		(55490)	90	93	86	-4	66	1997	83	2
	Rutland		(116580)	94	96	95	9	74	1995	89	6
Thames	London	•	202828	88	95	84	-3	73	1990	80	4
	Farmoor	•	13822	98	98	99	2	84	1990	98	0
Southern	Bewl		31000	92	89	82	6	45	1990	84	-2
	Ardingly		4685	95	94	79	-6	65	2005	80	-1
Wessex	Clatworthy		5364	89	100	85	12	43	1992	59	26
	Bristol	•	(38666)	90	86	78	3	53	1990	71	7
South West	Colliford		28540	83	75	65	-13	47	1997	75	-10
	Roadford		34500	73	70	59	-18	46	1996	70	-11
	Wimbleball		21320	94	95	85	8	53	1992	73	13
	Stithians		4967	93	89	77	7	39	1990	67	11
Welsh	Celyn & Brenig	•	131155	93	94	91	2	65	1989	71	20
	Brianne		62140	90	98	89	-1	67	1995	71	18
	Big Five	•	69762	85	87	75	-2	41	1989	58	17
	Elan Valley	•	99106	93	97	85	3	53	1976	62	23
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	88	85	81	-2	51	1998	81	0
	East Lothian	•	9317	100	100	100	10	72	1992	83	17
Scotland(W)	Loch Katrine	•	110326	88	91	87	12	53	2000	62	24
	Daer		22494	85	83	81	0	56	2013	64	17
	Loch Thom		10798	88	97	98	14	59	2000	83	15
Northern Ireland	Total+	•	56800	93	93	87	9	54	1995	68	19
	Silent Valley	•	20634	96	96	87	13	42	2000	64	23

( ) 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.

The Hydrological Summary is supported by the Natural Environment Research Council award number NE/R016429/1 as part of the UK-SCAPE programme delivering National Capability.

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 Department for Infrastructure - Rivers 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.

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