Hydrological Summary for the United Kingdom

February 2020

General

February was a truly remarkable month in hydrological terms, with three named storms ('Ciara', 'Dennis' and 'Jorge') and record-breaking river flows bringing widespread, protracted and severe flooding. The greatest rainfall anomalies (more than 350% of long term average) were over upland areas of northern and central England and in Wales, and for the UK as a whole it was the fourth wettest month on record (in a series from 1910). New peak flow, daily mean and monthly mean maxima were established on numerous rivers in England, Wales, Northern Ireland and southern Scotland – the extent, duration and magnitude of high flows across England contributing to the highest recorded monthly mean outflow (of any month, in a series from 1961). Three people died in storm-related incidents, hundreds of thousands of homes lost power and there was widespread travel disruption. Over 3,000 properties were flooded, with northern England, the west Midlands and south Wales the worst affected areas, and on the 16th, there were more live Flood Warnings and Flood Alerts in England than on any other day (in a record from 2006). Reservoirs were near capacity across the UK, and groundwater levels rose in all but two of the index sites, with more than half of the sites ending the month exceptionally high. The risk of surface and groundwater flooding from further rain on fully wetted soils remains, and damaging flows in large catchments continued into March.

Rainfall

After a quiet first week, storm 'Ciara' arrived on the 8th-9th bringing strong winds and heavy rain and causing extensive travel disruption. The highest rainfall totals were in north-west England (where 184mm was recorded in 48 hours at Wet Sleddale Reservoir, Cumbria), Yorkshire and north Wales. On the 15th-16th, storm 'Dennis' brought widespread heavy rain, especially over high ground (148mm at Maerdy, Mid Glamorgan). Subsequent rain and snow, some noteworthy (180mm of rain at Honister Pass, Cumbria on the 19th and 23cm of lying snow in Copley, Durham on the 24th) traversed the UK and culminated in storm 'Jorge' on the 28th-29th with rainfall in south Wales again amongst the highest (120mm at Treherbert, Mid Glamorgan). Monthly rainfall anomalies were exceptionally high across much of the UK, and greatest (locally exceeding four times the long term average) in the Pennines, north-west England and north Wales. With the UK as a whole receiving 240% of the long term average monthly rainfall, it was the wettest February in a series from 1910. Most regions received more than twice their average February rainfall, and North West England, Yorkshire and Severn Trent around three times their respective averages. February rainfall maxima (in series from 1910) were established in Northern Ireland, Wales and in regions across southern Scotland and northern and central England, most dramatically in Yorkshire (129% of the previous maximum in 1966). The three-month winter accumulation for the UK was 144% of average, the fifth wettest in a series from 1910.

River flows

River flows initially receded before successive peaks caused by bands of heavy rain, predominantly those associated with the named storms. On 9th-10th, new daily flow maxima were set on many rivers in southern Scotland and northern England (with peak flows comparable with December 2015 maxima on the Ribble and Irwell on the 9th), and hundreds of properties were flooded in the Calder Valley. From the 15th-17th, flows rose again sharply with widespread new daily maxima, and peak flows exceeded the highest recorded on the Cynon and the Wye (in records from 1961 and 1908 respectively). By the 16th, there was significant property flooding from the Teme, Severn, Wye and Taff, and the daily outflow from England and Wales marginally exceeded the maximum established in October 2000. Flows remained high particularly in northern England and the west of the UK (exceeding daily maxima on the Leven from 20th-26th in a record from 1939), and there was property flooding from the lower Aire and the Severn towards month-end. Mean February river flows were notably or exceptionally high across most of the UK, with normal or below normal flows seen only in parts of north-east Scotland and south-east England. Record monthly mean flows were recorded on numerous rivers for February (including the Ribble, Lune and many others in England, and the Clyde, Conwy, Welsh Dee and Tawe) and for any month on the Mourne and the Aire (exceeding the maxima established in November 2009 and December 2015, respectively). Average flows over October to February (the winter half-year so far) were the highest on record for this period for many rivers in a band from Yorkshire across the Midlands to south Wales, with the Severn at Bewdley recording 112% of the previous maximum (2000-2001) in a series from 1921. Total outflows from England were the highest for February (in a series from 1961, at 106% of that recorded in 2014) and marginally exceeded the maximum for any month (recorded in November 2000). Average outflows for the winter half-year so far from Great Britain equalled those recorded in 2015-2016.

Groundwater

Soil moisture deficits remained near-zero across the UK. Groundwater levels rose in all but one of the Chalk index boreholes, and at month-end they were exceptionally high in eight, mainly in southern England (including a record high for February at Houndean) although most were lower than in early 2014. At the end of February, the Environment Agency had 23 groundwater Flood Warnings in force, as spring and bourne flows resumed, and there was some flooding of roads, fields, basements and cellars, and impact on the sewerage network. In contrast, levels remained normal or below normal in the Chalk of the Chilterns and East Anglia. In the Jurassic limestones levels also rose, remaining exceptionally high at New Red Lion and a new February maximum level was recorded at Ampney Crucis. Levels rose in the Magnesian Limestone at Brick House Farm, again to a record level, and at Aycliffe levels remained notably high. Levels rose in the Carboniferous Limestone, moving from the normal range to exceptionally high at Alstonfield and Pant y Lladron; they were above normal at Greenfield Garage. Groundwater levels in the Permo-Triassic sandstones rose and ended the month exceptionally high at all sites, with record February levels at Weir Farm and Nuttalls Farm. In the Upper Greensand at Lime Kiln Way, levels rose and became notably high, whilst in the Fell Sandstone at Royalty Observatory levels fell and were above normal.

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Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

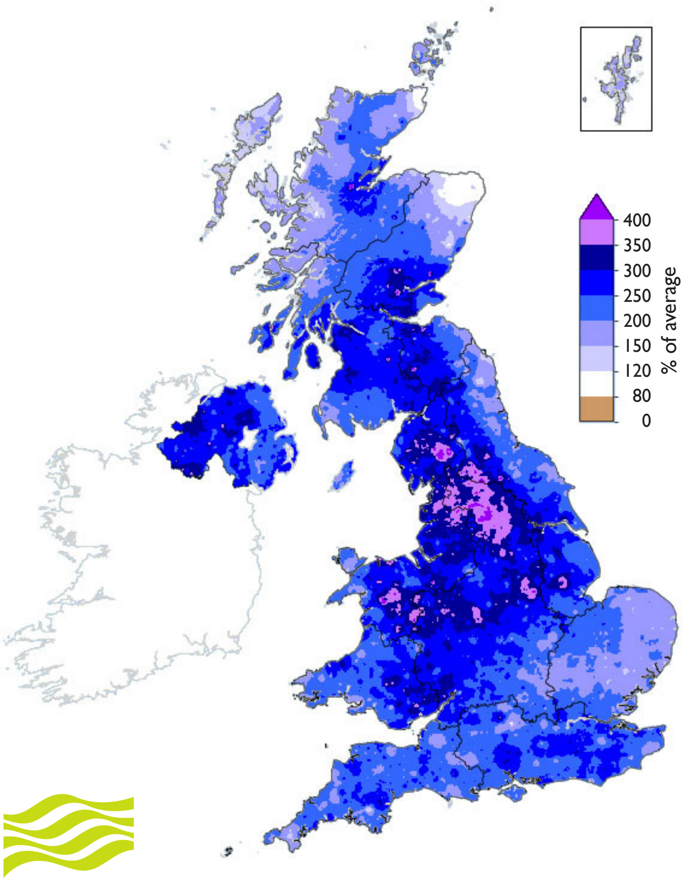
Region	Rainfall	Feb 2020	Dec19 – Feb20		Oct19 – Feb20		Jun19 – Feb20		Mar19 – Feb20	
				RP		*RP*		*RP*		*RP*
United Kingdom	mm	**209**	470		726		1185		1435	
	%	**240**	144	60-90	127	80-120	132	>>100	127	>>100
England	mm	**155**	329		570		937		1108	
	%	**260**	144	15-25	140	40-60	140	>100	131	>100
Scotland	mm	**276**	677		934		1523		1869	
	%	**216**	146	>100	117	20-35	125	>100	123	>100
Wales	mm	**288**	611		982		1521		1861	
	%	**268**	144	15-25	131	25-40	134	>100	131	>100
Northern Ireland	mm	**223**	400		629		1098		1393	
	%	**268**	127	10-15	115	10-15	123	70-100	123	>>100
England & Wales	mm	**173**	368		627		1017		1211	
	%	**262**	144	15-25	138	40-60	139	>100	131	>100
North West	mm	**285**	545		782		1401		1701	
	%	**321**	157	80-120	127	20-35	142	>>100	139	>>100
Northumbria	mm	**155**	271		502		951		1170	
	%	**241**	116	2-5	123	10-15	138	>100	134	>100
Severn-Trent	mm	**155**	299		548		947		1118	
	%	**299**	149	10-20	154	80-120	155	>>100	143	>>100
Yorkshire	mm	**188**	318		595		981		1169	
	%	**308**	139	10-15	151	80-120	148	>100	138	>>100
Anglian	mm	**82**	205		385		653		761	
	%	**208**	140	8-12	143	30-50	134	25-40	121	15-25
Thames	mm	**111**	279		481		745		865	
	%	**229**	149	10-15	141	15-25	133	20-30	120	10-15
Southern	mm	**135**	339		579		842		963	
	%	**240**	150	10-20	140	10-20	132	15-25	120	8-12
Wessex	mm	**147**	369		624		938		1104	
	%	**228**	145	10-20	138	15-25	134	20-35	124	15-25
South West	mm	**228**	533		924		1346		1576	
	%	**228**	140	10-15	140	30-50	137	50-80	128	40-60
Welsh	mm	**272**	584		946		1469		1794	
	%	**266**	145	15-25	132	30-50	134	>100	131	>100
Highland	mm	**313**	837		1094		1722		2121	
	%	**190**	144	40-60	112	8-12	118	20-30	117	25-40
North East	mm	**141**	313		565		977		1271	
	%	**186**	117	2-5	114	5-10	121	10-20	125	50-80
Tay	mm	**275**	614		872		1383		1706	
	%	**248**	150	30-50	125	20-30	129	>100	127	>>100
Forth	mm	**254**	557		794		1304		1591	
	%	**264**	157	>100	131	>100	135	>>100	132	>>100
Tweed	mm	**215**	425		649		1141		1419	
	%	**279**	147	70-100	129	40-60	140	>100	139	>>100
Solway	mm	**294**	652		918		1595		1965	
	%	**260**	149	>100	120	20-30	134	>100	132	>>100
Clyde	mm	**361**	882		1169		1916		2284	
	%	**241**	158	>100	123	30-50	130	>100	126	>100

% = percentage of 1981-2010 average *RP = Return period*

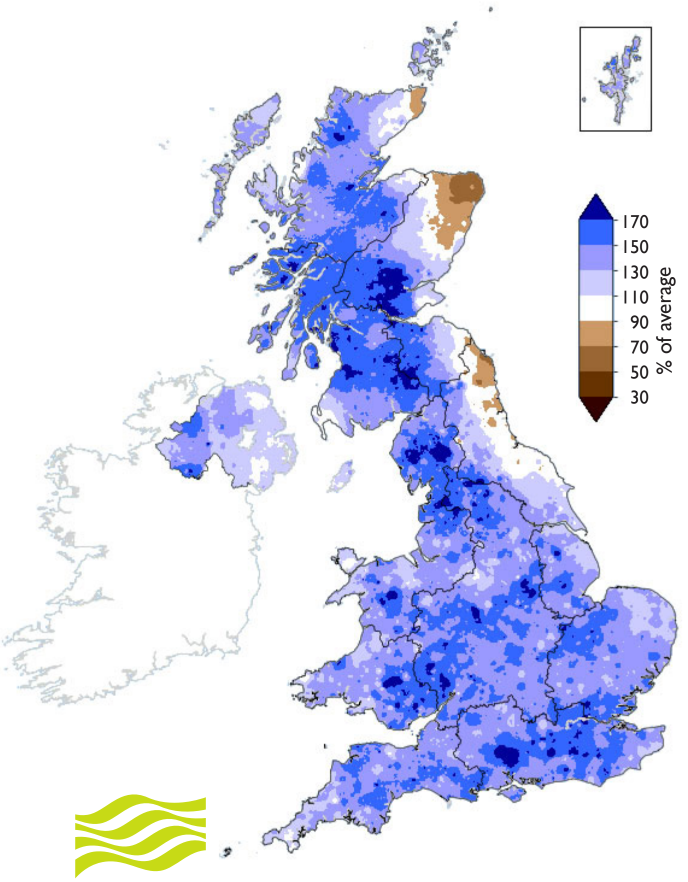
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic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

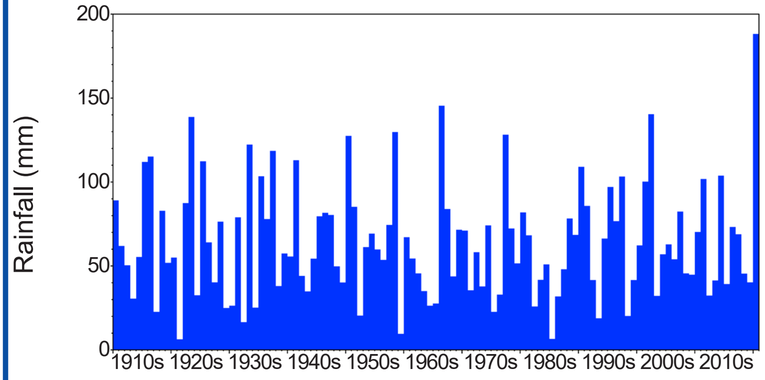
February 2020 rainfall as % of 1981-2010 average



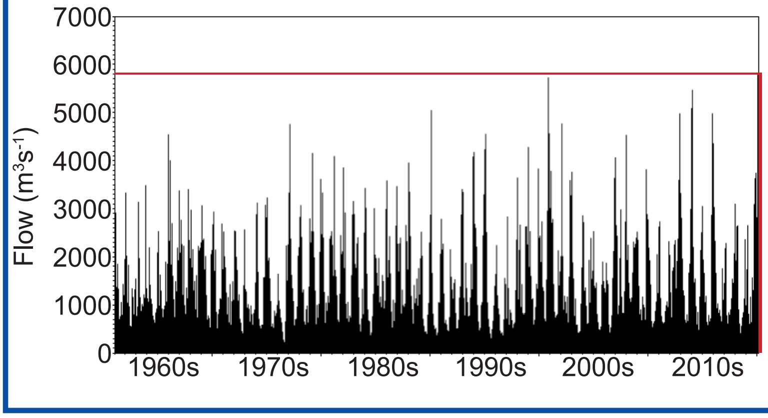
December 2019 - February 2020 rainfall as % of 1981-2010 average



February rainfall totals for Yorkshire



Monthly average outflows for England



Hydrological Outlook UK

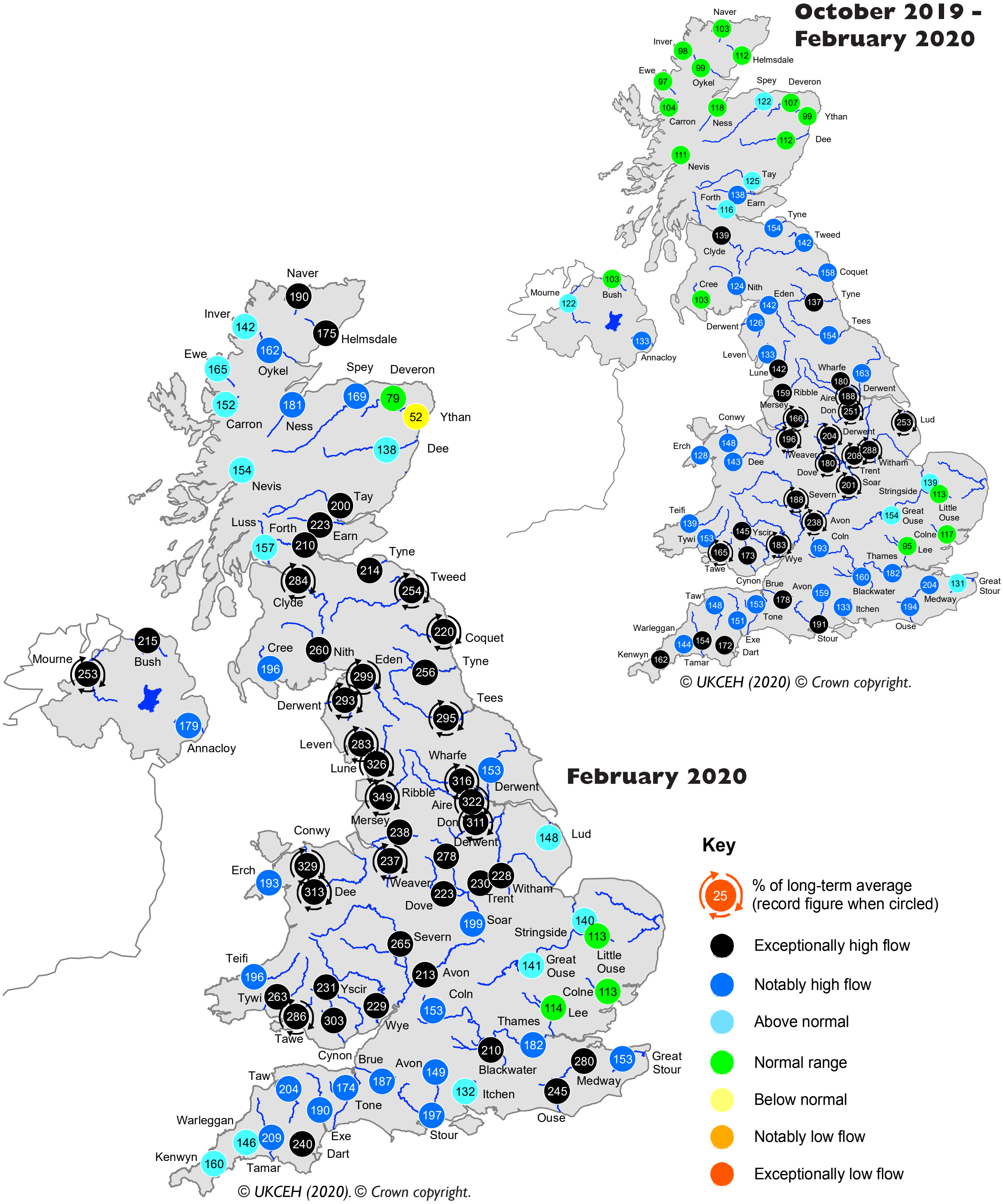
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from March 2020**
Issued: **10.03.2020**
using data to the end of February 2020

Following the exceptional rainfall and associated flooding in February, the outlook for March is for a continuation of above normal (and locally notably high) flows across large parts of southern and central England and Wales. Elsewhere, March flows are likely to be normal to above normal. Groundwater levels are likely to remain above normal across most of the UK, with normal levels most likely in East Anglia and the Chilterns. For the three month outlook, normal to above normal flows are most likely across the UK, with many more rivers entering the normal range. Groundwater levels are also likely to return to normal in many areas, with above normal levels persisting in parts of the southern Chalk and some northern areas..

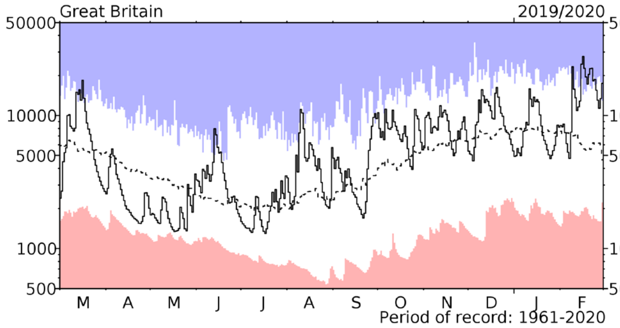
River flow . . . River flow . . .

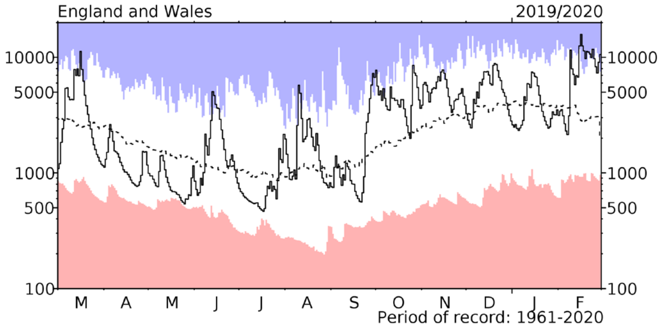


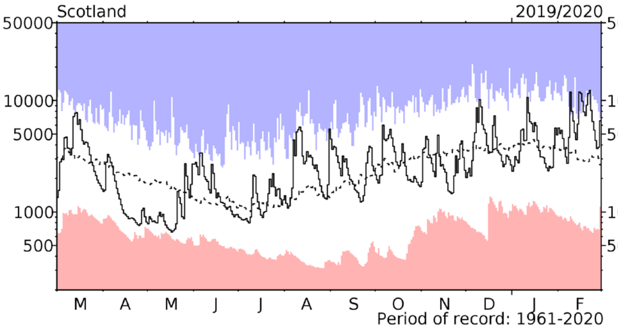
*Based on ranking of the monthly flow**

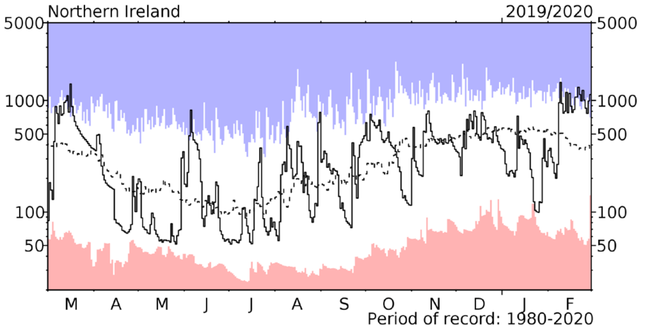
River flows

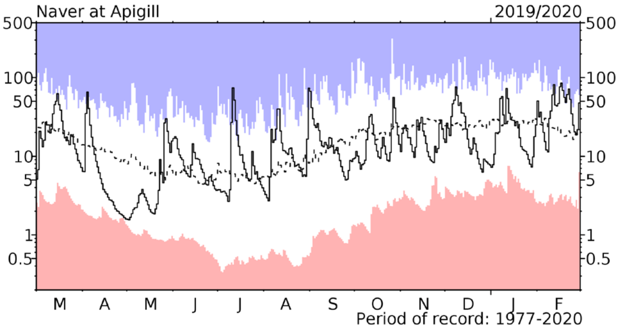
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

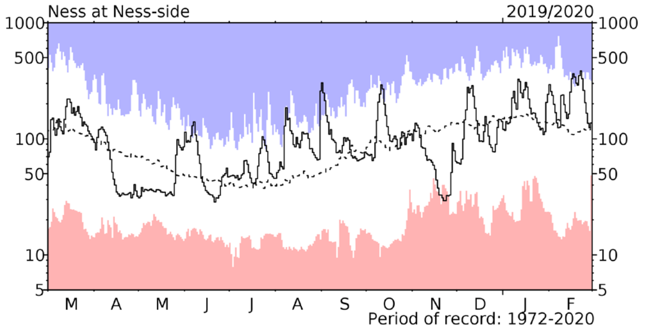


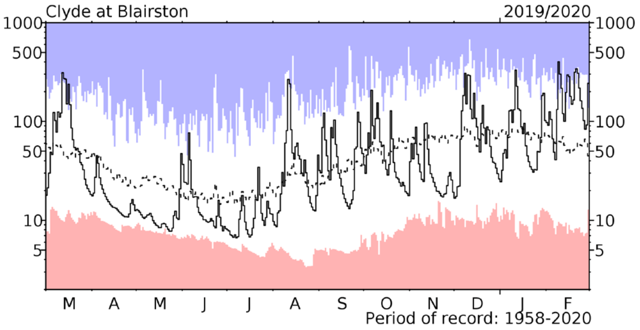


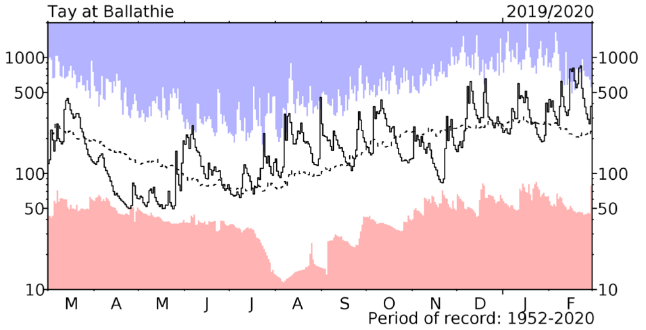


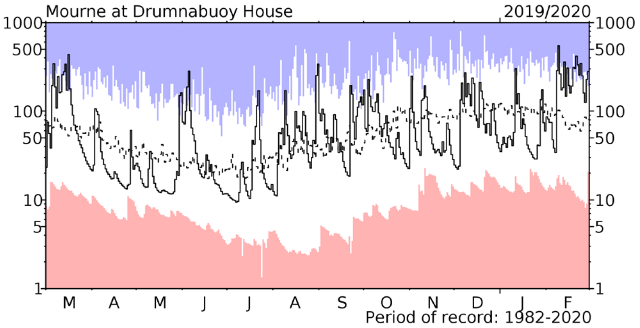


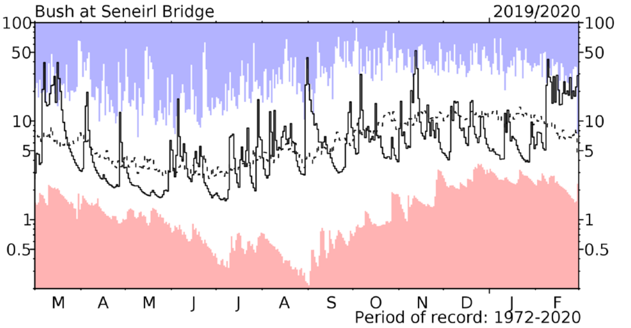








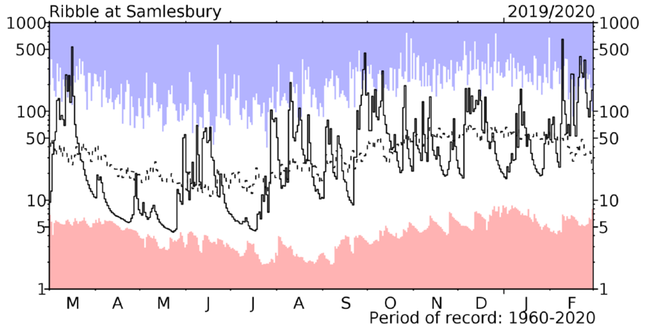




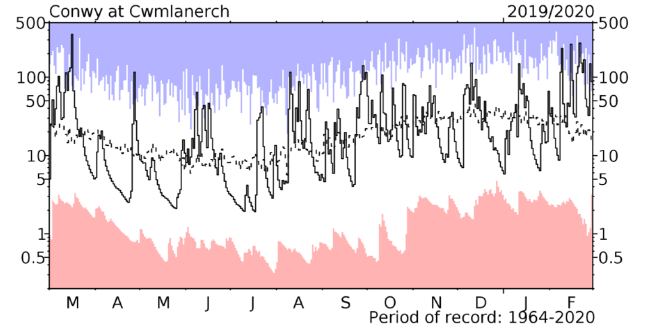
River flow hydrographs

*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to March 2019 (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.

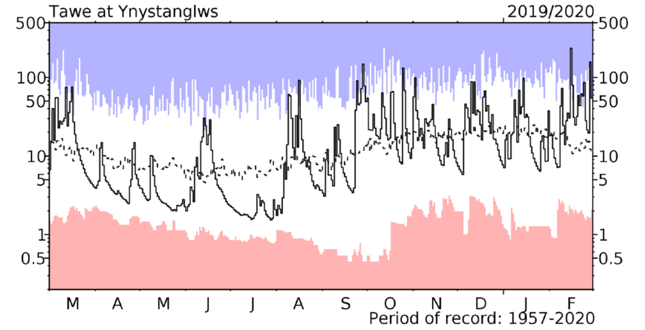
River flow . . . River flow . . .


Ribble at Samlesbury 2019/2020

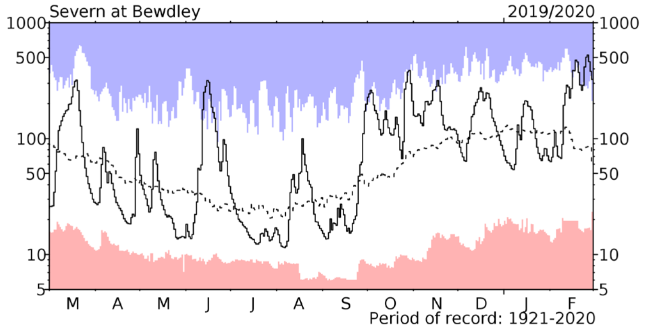
Period of record: 1960-2020


Conwy at Cwmlanerch 2019/2020

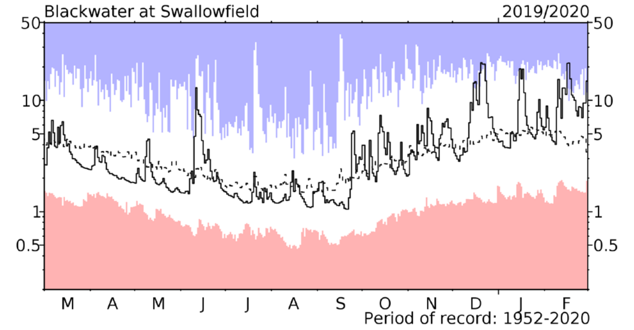
Period of record: 1964-2020


Tawe at Ynystanglws 2019/2020

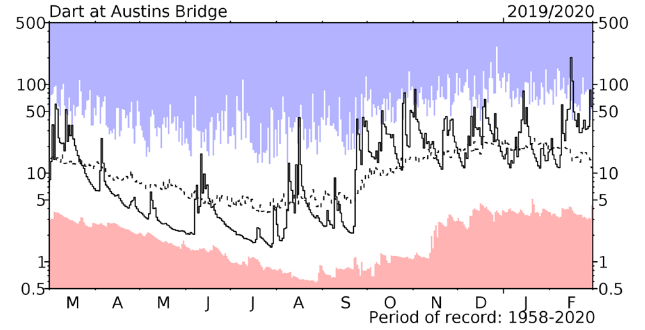
Period of record: 1957-2020


Severn at Bewdley 2019/2020

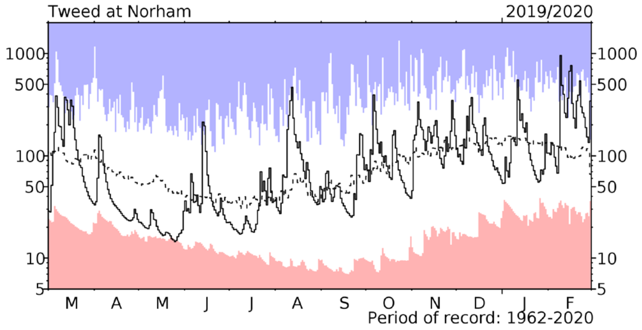
Period of record: 1921-2020


Blackwater at Swallowfield 2019/2020

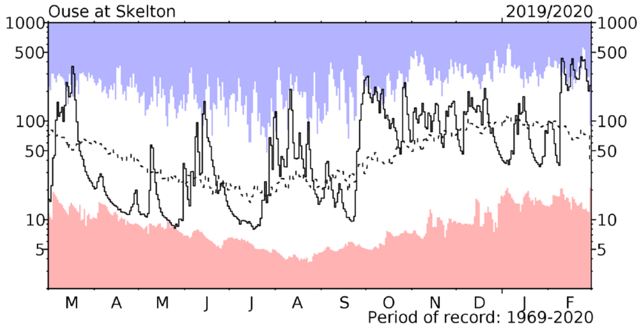
Period of record: 1952-2020


Dart at Austins Bridge 2019/2020

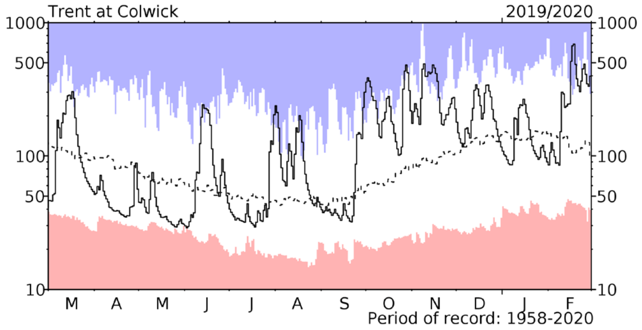
Period of record: 1958-2020


Tweed at Norham 2019/2020

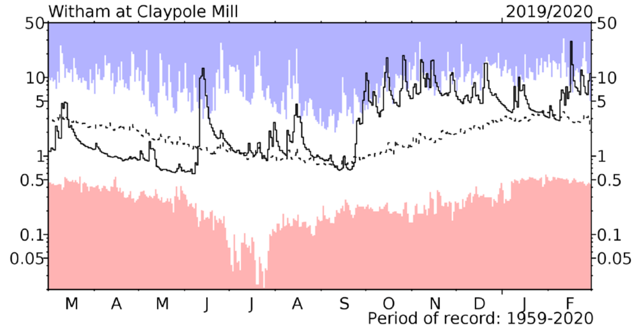
Period of record: 1962-2020


Ouse at Skelton 2019/2020

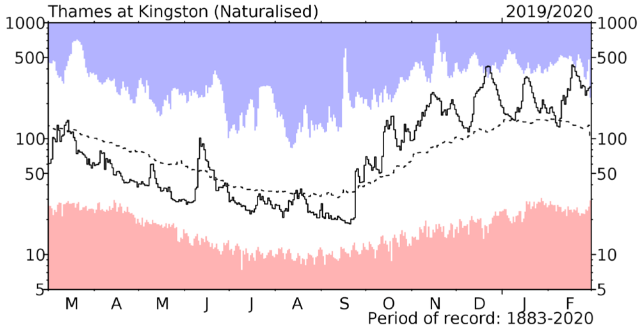
Period of record: 1969-2020


Trent at Colwick 2019/2020

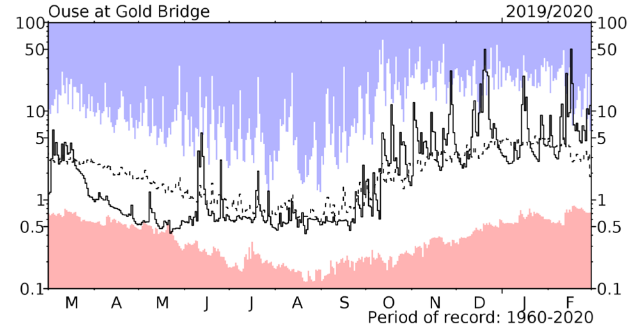
Period of record: 1958-2020


Witham at Claypole Mill 2019/2020

Period of record: 1959-2020

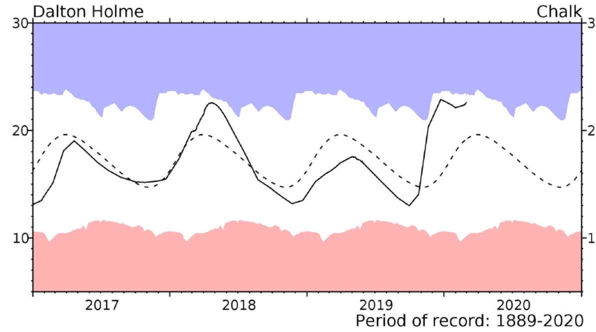

Thames at Kingston (Naturalised) 2019/2020

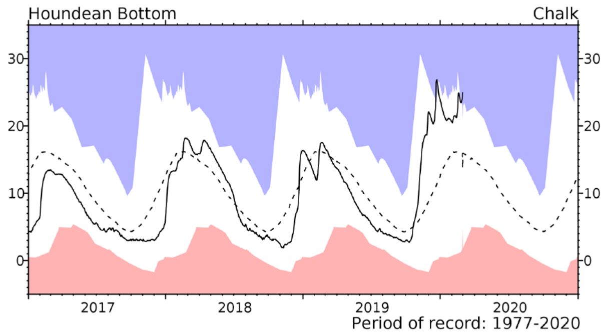
Period of record: 1883-2020

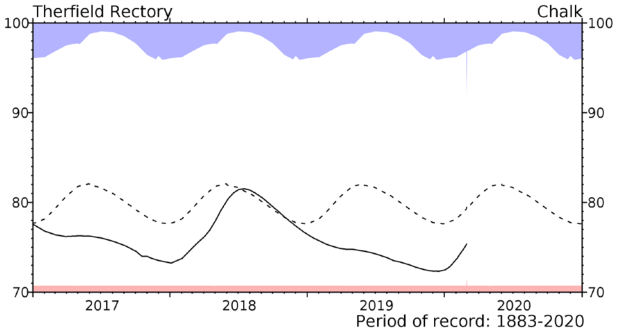

Ouse at Gold Bridge 2019/2020

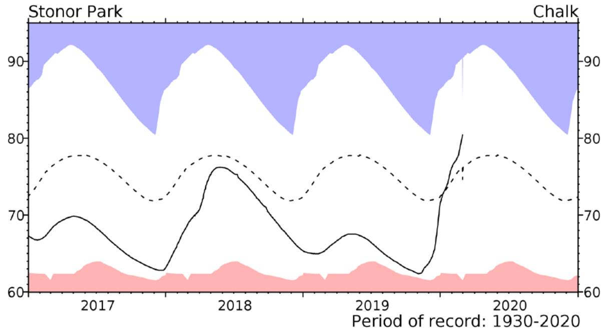
Period of record: 1960-2020

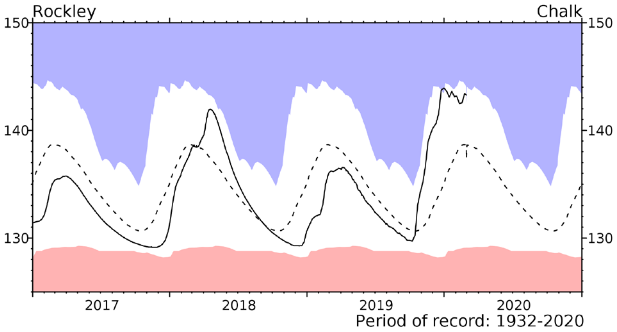
Groundwater . . . Groundwater

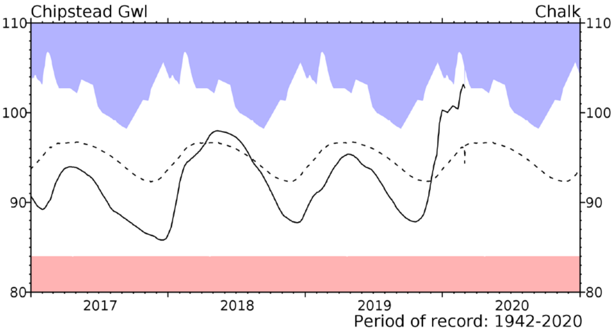


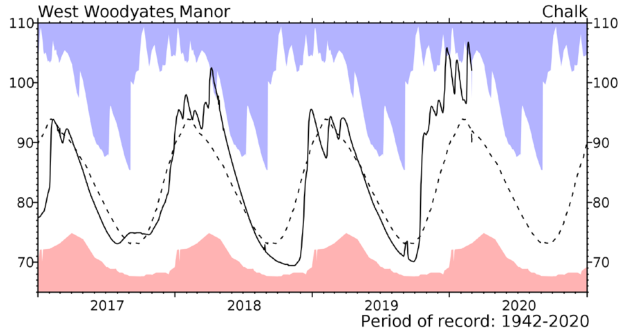


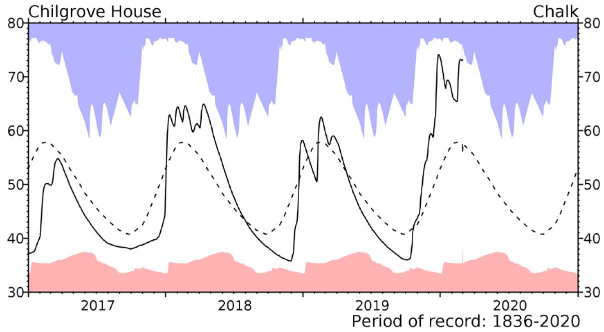


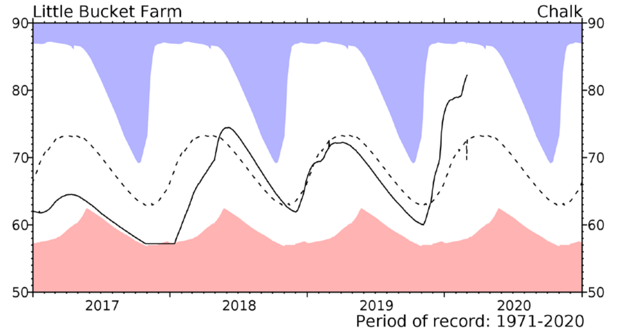


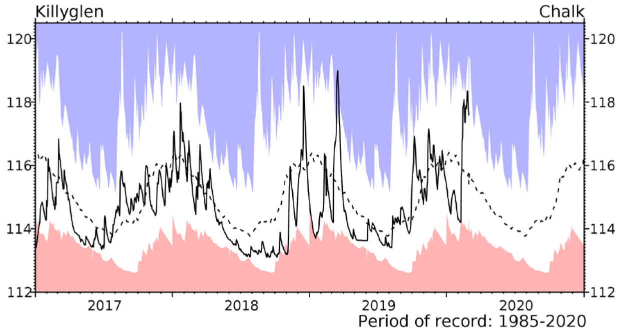






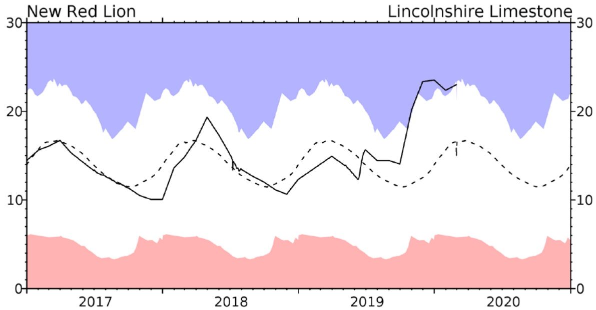




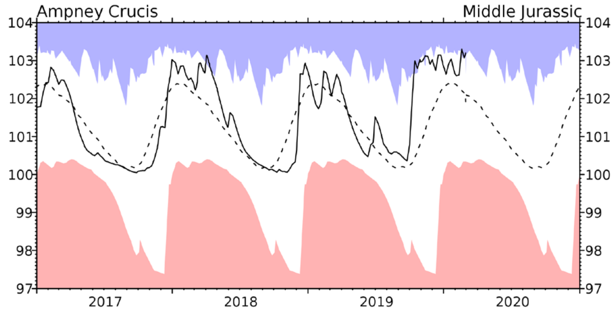


Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

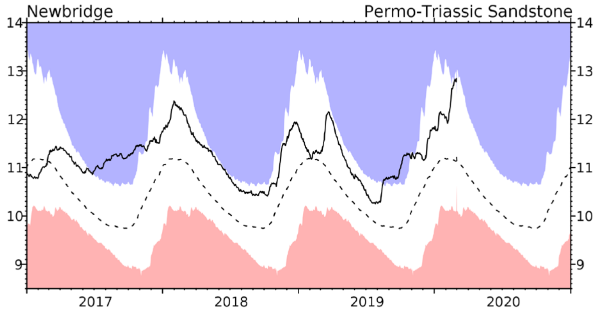
Groundwater... Groundwater



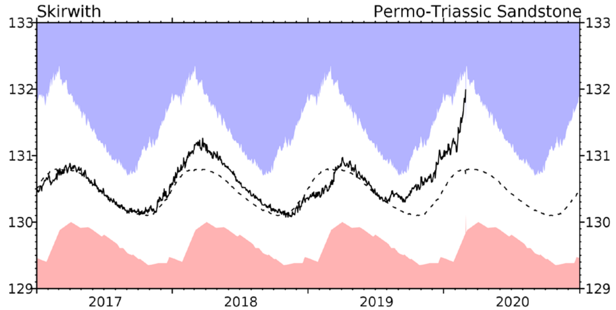
Period of record: 1939-2020



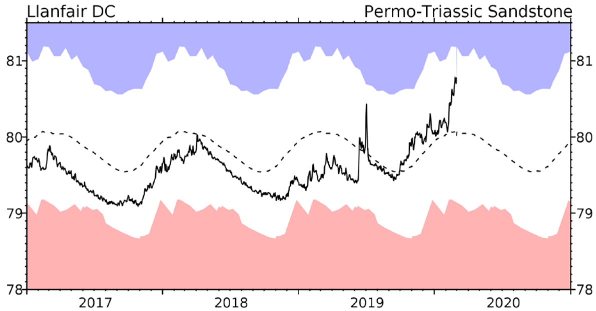
Period of record: 1958-2020



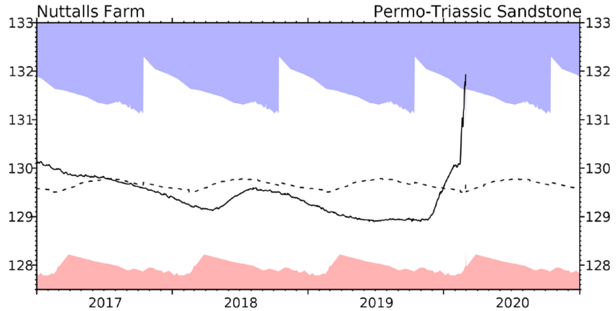
Period of record: 1993-2020



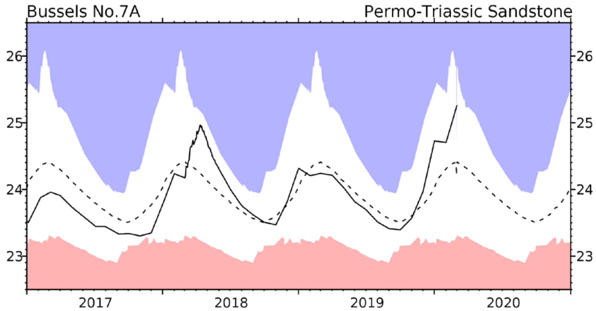
Period of record: 1978-2020



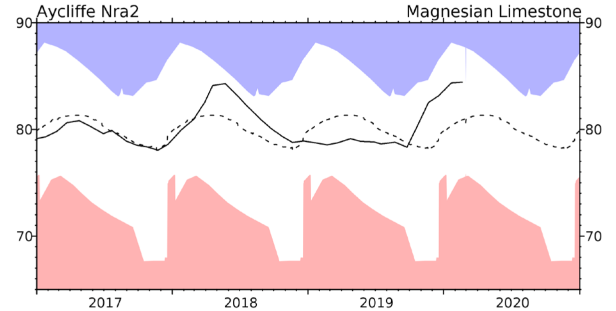
Period of record: 1972-2020



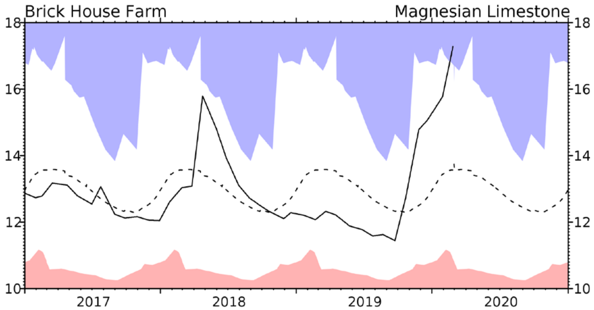
Period of record: 1974-2020



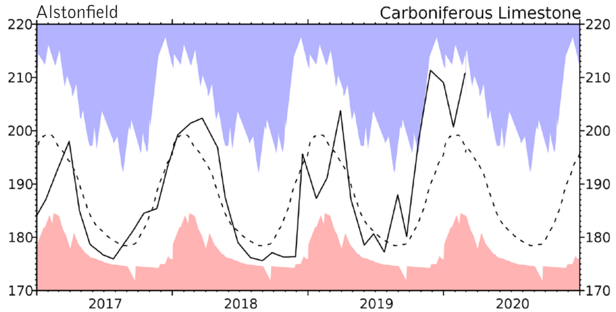
Period of record: 1971-2020



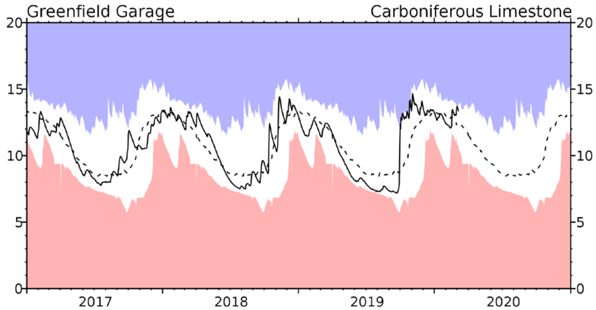
Period of record: 1968-2020



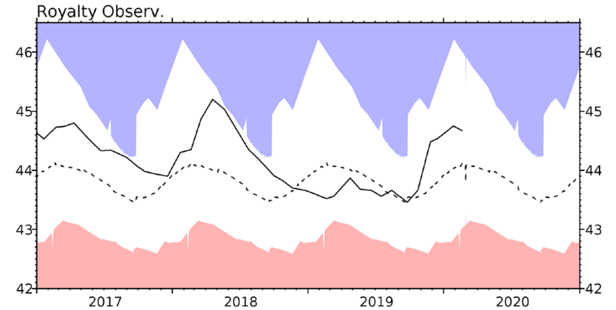
Period of record: 1939-2020



Period of record: 1974-2020

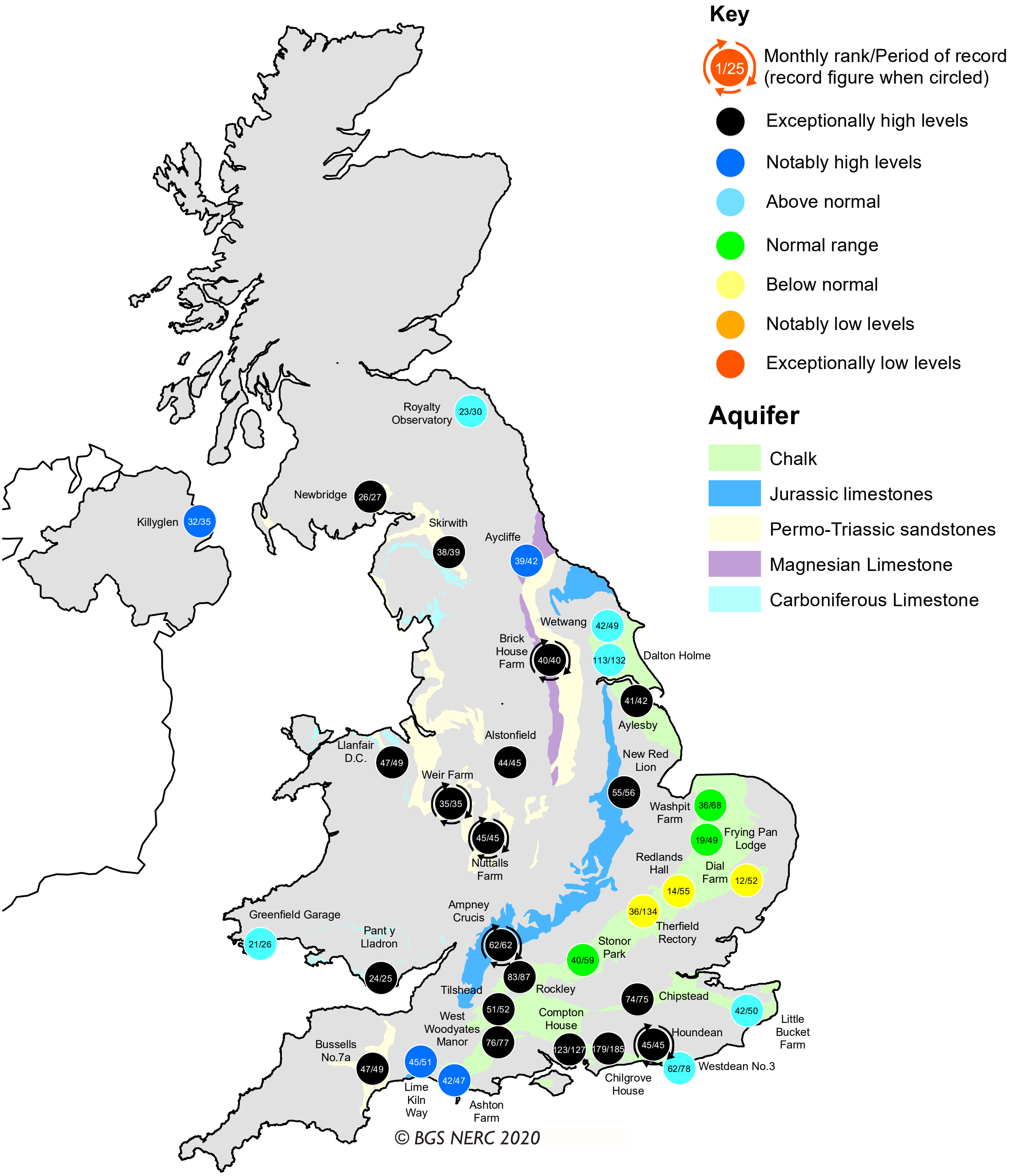


Period of record: 1994-2020



Period of record: 1990-2020

Groundwater…Groundwater



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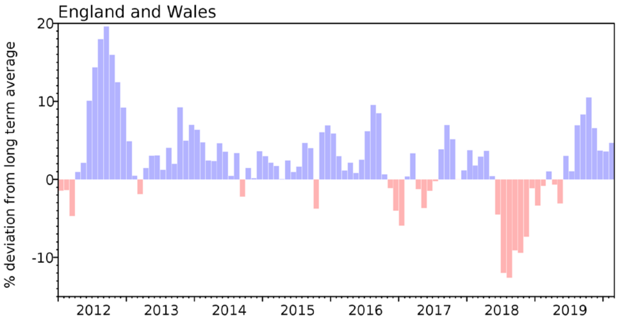
Groundwater levels - February 2020

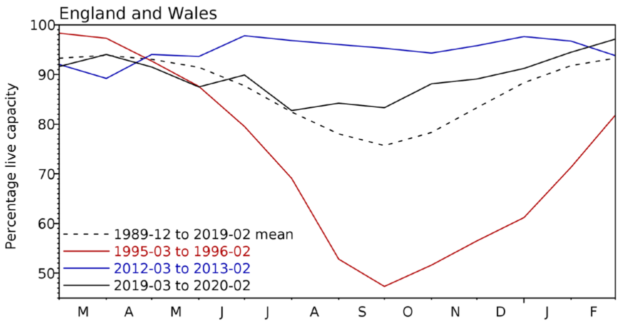
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Dec	2020 Jan	2020 Feb	Feb Anom.	Min Feb	Year* of min	2019 Feb	Diff 20-19
North West	N Command Zone	•	124929	85	98	100	8	78	1996	93	8
	Vyrnwy		55146	95	100	100	5	59	1996	98	2
Northumbrian	Teesdale	•	87936	99	99	99	6	72	1996	98	1
	Kielder		(199175)	84	91	96	4	81	1993	89	7
Severn-Trent	Clywedog		49936	88	93	100	8	77	1996	95	5
	Derwent Valley	•	46692	99	100	100	5	46	1996	83	17
Yorkshire	Washburn	•	23373	91	91	97	4	53	1996	95	3
	Bradford Supply	•	40942	100	100	100	5	53	1996	78	22
Anglian	Grafham		(55490)	88	86	82	-6	72	1997	78	5
	Rutland		(116580)	96	96	97	7	71	2012	90	6
Thames	London	•	202828	91	91	94	2	83	1988	92	2
	Farmoor	•	13822	99	97	97	4	64	1991	93	4
Southern	Bewl		31000	89	93	98	12	40	2012	98	0
	Ardingly		4685	100	100	100	4	46	2012	95	5
Wessex	Clatworthy		5662	100	100	100	2	82	1992	99	1
	Bristol	•	(38666)	99	98	99	6	65	1992	89	10
South West	Colliford		28540	75	81	89	2	57	1997	83	6
	Roadford		34500	75	82	98	14	35	1996	71	27
	Wimbleball		21320	100	100	100	5	72	1996	97	3
	Stithians		4967	100	100	100	6	45	1992	99	1
Welsh	Celyn & Brenig	•	131155	89	93	97	-1	69	1996	94	3
	Brianne		62140	100	99	100	2	92	2004	96	4
	Big Five	•	69762	88	98	98	2	85	1988	97	1
	Elan Valley	•	99106	99	98	100	2	88	1993	98	2
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	94	99	100	5	73	1999	93	7
	East Lothian	•	9317	100	100	100	1	91	1990	98	2
Scotland(W)	Loch Katrine	•	110326	100	100	100	5	76	2010	100	0
	Daer		22494	100	100	100	1	94	2004	100	0
	Loch Thom		10721	91	90	100	2	90	2004	99	1
Northern Ireland	Total^{+}	•	56800	100	96	100	8	81	2004	95	5
	Silent Valley	•	20634	100	94	100	12	57	2002	98	2

( ) figures in parentheses relate to gross storage

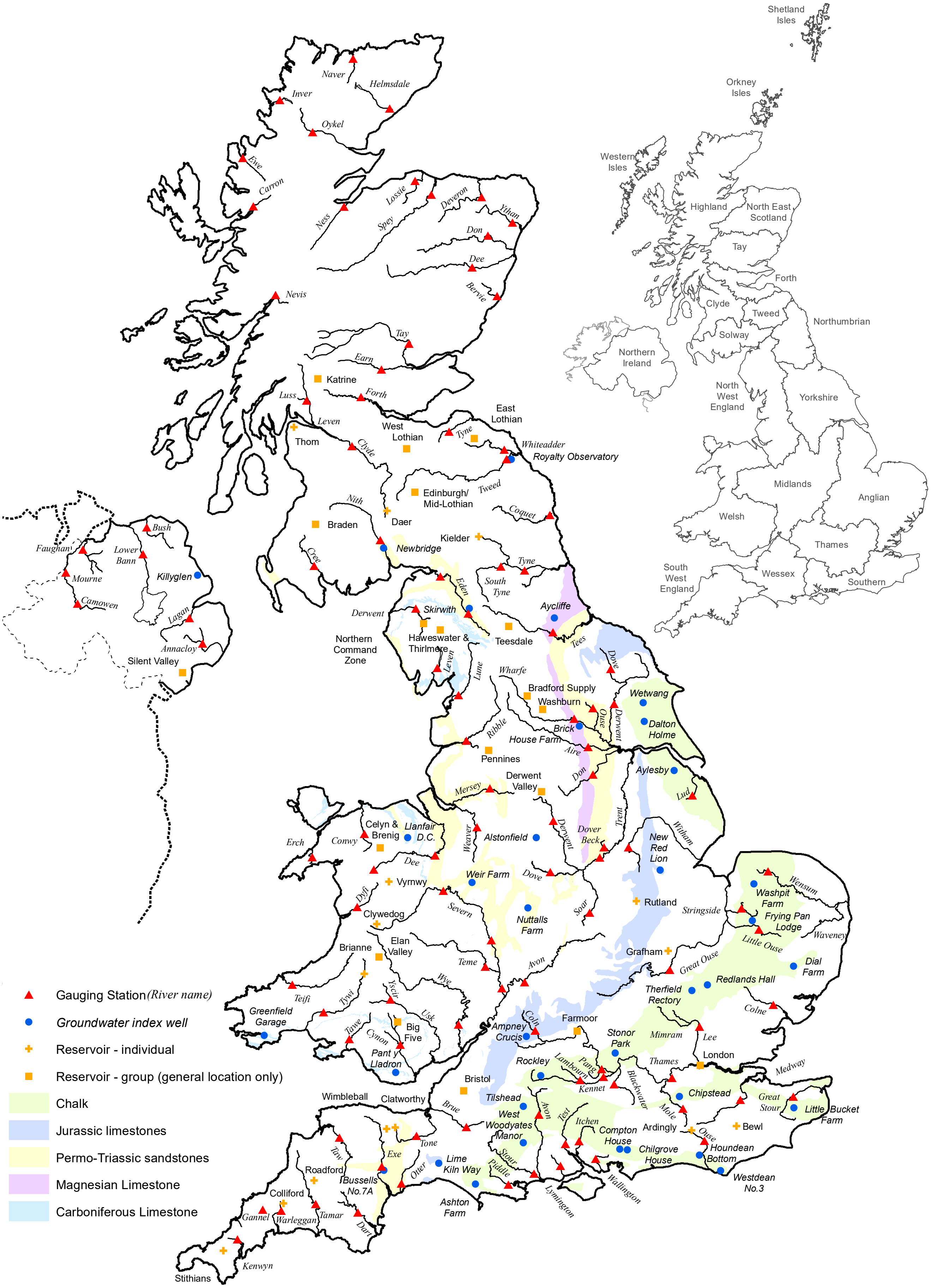
• denotes reservoir groups

*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 UK Centre for Ecology & Hydrology (UKCEH) 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 UKCEH) 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.

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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03/2020

UK-SCAPE
UK Status, Change and Projections of the Environment

UKRI Natural Environment Research Council