Hydrological Summary

for the United Kingdom

October 2019

General

October was a cool and very wet month for most, with a succession of frontal systems delivering persistent heavy rainfall across England and Wales. Although October rainfall for the UK was only marginally above average, there were substantial regional variations; the majority of England and Wales was characterised by notably wet weather, exceptionally so in parts of eastern England. This concluded an exceptionally wet summer and autumn so far (June-October) in northern, central and eastern England; for the Severn-Trent region, it was the wettest June-October on record (in a series from 1910). River flows were substantially above average across most of England and Wales, with exceptionally high flows recorded throughout central areas and in parts of the north-east (many of which were also new October monthly mean flow maxima). Late October soil moisture deficits (SMDs) were near-zero across the UK (away from East Anglia). Correspondingly, groundwater levels in the majority of boreholes increased during October and were above normal or higher, with the exception of the Chalk of eastern England. The wet weather enabled reservoir replenishment (particularly those in the English Lowlands) and overall stocks for England & Wales were comfortably above average, and after five months of wet weather water resources are very healthy. Whilst there were some notably low groundwater levels in the Chalk of the Chilterns and East Anglia, the groundwater recharge season has started earlier than normal. Further wet weather and extreme rainfall totals in early November have caused significant flooding in parts of northern and central England, and the seasonal outlook for continued wet weather (particularly in the north and west) implies a high risk of further flooding this winter.

Rainfall

Adopting an anomalously southern track, the jet stream propelled a series of cyclonic systems across the UK throughout much of October, with the associated wet weather across England and Wales only briefly relenting towards month-end. On the 1st, surface water flooding from intense rainfall (41mm in Carlisle) closed roads and railway lines in parts of northern and central England. On the 6th, heavy rainfall in East Anglia (47mm at Tiberham Airfield, Norfolk) caused flash flooding of properties. The most disruptive wet weather occurred across the 25th-26th, with 48-hour rainfall totals of 80-120mm in the Severn catchment (and 101mm on the 25th at Libanus, Powys). Extensive surface water flooding in mid-Wales and the Midlands closed road and rail networks, necessitated evacuations of homes and inundated agricultural land. For October overall, rainfall totals were more than 130% of average in a band from the south-west to the north-east of England. Parts of Yorkshire, Lincolnshire, Norfolk and the East Midlands registered in excess of 170% of average. It was the wettest October for Yorkshire since 2000, and the fourth wettest in a series from 1910. In contrast, most of Scotland and Northern Ireland received less than 90% of average rainfall. Since the start of summer (June-October), almost all of the UK received above average rainfall. A swathe of northern, central and eastern England registered 150% of average, with localised parts of the East Midlands receiving more than 170% of average. For England & Wales, in the last 50 years only the exceptional 2012 was wetter over the June-October timeframe.

River flows

Successive frontal rainfall maintained high flows throughout October in catchments across England and Wales, some of which were high at the start of October, the result of heavy late September rainfall. High flows were particularly numerous and notable in Wales and northern and central England; new October daily flow maxima were established on the Yorkshire Don, Trent, Witham, Weaver, Teme and Usk. On the 27th, high flows culminated in more than 300 Flood Warnings and Flood lerts across Wales and northern, central and south-west England. In some southern catchments (e.g. the Coln, Dorset Stour and Brue), the persistent rainfall continued to drive dramatic increases from the low flow conditions recorded in early September. In contrast, river flows in Scotland and Northern Ireland were generally in recession through October. October mean flows were generally above normal or higher across England and Wales and within the normal range in Scotland and Northern Ireland. Outflows from England & Wales were the second highest for October in a series from 1961. River flows were exceptionally high in a band from south Wales through the Midlands into Yorkshire, with many at least 300% of average (and exceeding five times the average on the Witham). Many new maximum October mean flows were established, exceeding previous maxima by at least 25% in records for the Severn and Trent (in series from 1921 and 1958, respectively). Over the June-October period, mean flows were above normal or higher (except for south-east England, where flows were generally below average). Flows were notably high throughout Wales and northern and central England, exceptionally so in the Midlands and some catchments draining the southern Pennines (many of which recorded around twice their average flow). New maximum June-October mean flows were established on the Mersey, Trent and Weaver, the latter approaching three times the average.

Groundwater

Groundwater levels in the Chalk fell in the North Downs, Chilterns and most of East Anglia (coinciding with areas still with SMDs), although they started to rise by the end of October at Chipstead. Levels at Dial Farm remained exceptionally low and became such at Stonor Park. Elsewhere, recharge commenced; levels were in the normal range or above in Yorkshire, above normal throughout Wessex and the South Downs, and exceptionally high at Wetwang, Ashton Farm and Westdean No.3. Levels in the Jurassic limestones rose and were exceptionally high, registering a new October record at New Red Lion. In the Magnesian Limestone, levels also rose and were normal or above normal. In the Permo-Triassic sandstones, levels rose and generally ended October above normal to notably high, but remained in the normal range at Bussells No.7a. However, at Nuttalls Farm levels fell and remained below normal. Levels continued to recede in the Upper Greensand at Lime Kiln Way, but were within the normal range. In the Carboniferous Limestone, levels rose and were above normal, notably high at Pant y Lladron and registering a new October record at Alstonfield. Levels in the Fell Sandstone rose 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.

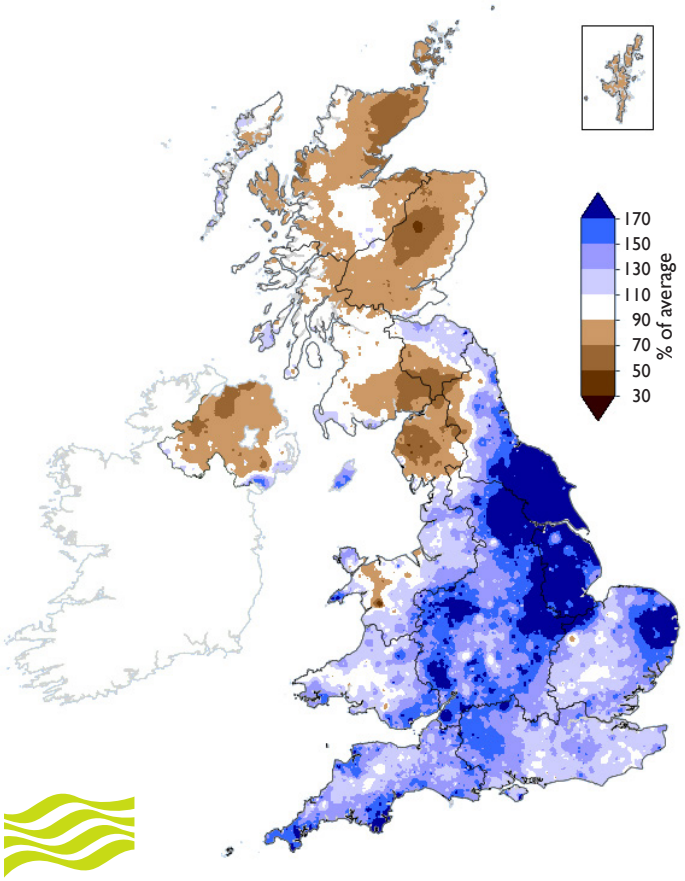
Region	Rainfall	Oct 2019	Sep19 – Oct19	RP	Jun19 – Oct19	RP	Feb19 – Oct19	RP	Nov18 – Oct19	RP
United Kingdom	mm	**139**	261		598		920		1226	
	%	**112**	120	5-10	133	30-50	120	30-50	109	5-10
England	mm	**125**	232		492		711		938	
	%	**138**	146	10-20	141	25-40	121	10-20	111	5-10
Scotland	mm	**153**	285		742		1195		1590	
	%	**90**	95	2-5	126	15-25	117	20-30	105	5-10
Wales	mm	**199**	384		737		1170		1630	
	%	**120**	138	8-12	133	10-20	124	15-25	115	8-12
Northern Ireland	mm	**100**	212		569		940		1248	
	%	**84**	100	2-5	122	5-10	119	20-30	110	8-12
England & Wales	mm	**135**	253		525		774		1033	
	%	**134**	144	10-20	139	20-35	122	10-20	112	5-10
North West	mm	**137**	323		755		1135		1450	
	%	**100**	134	5-10	149	20-35	136	50-80	119	10-20
Northumbria	mm	**99**	209		549		812		984	
	%	**116**	133	5-10	150	40-60	133	50-80	113	5-10
Severn-Trent	mm	**121**	227		520		730		916	
	%	**150**	156	20-30	156	>100	131	40-60	117	8-12
Yorkshire	mm	**145**	268		532		759		964	
	%	**178**	180	30-50	152	40-60	129	20-35	115	5-10
Anglian	mm	**97**	167		364		502		640	
	%	**154**	143	10-15	130	8-12	109	2-5	102	2-5
Thames	mm	**106**	181		370		535		726	
	%	**136**	132	5-10	125	5-10	106	2-5	102	2-5
Southern	mm	**122**	203		385		566		833	
	%	**125**	127	5-10	122	2-5	106	2-5	105	2-5
Wessex	mm	**144**	256		459		683		977	
	%	**144**	152	10-20	133	8-12	115	2-5	111	2-5
South West	mm	**196**	350		618		924		1375	
	%	**141**	153	15-25	134	10-20	114	5-10	112	5-10
Welsh	mm	**194**	372		717		1132		1572	
	%	**122**	139	8-12	134	10-20	124	15-25	115	8-12
Highland	mm	**175**	305		803		1337		1778	
	%	**88**	86	2-5	120	5-10	112	8-12	98	2-5
North East	mm	**97**	187		510		849		1110	
	%	**82**	90	2-5	119	5-10	119	10-15	109	2-5
Tay	mm	**127**	235		638		1044		1398	
	%	**84**	89	2-5	123	5-10	115	8-12	104	2-5
Forth	mm	**128**	243		638		991		1265	
	%	**96**	102	2-5	130	10-20	120	15-25	105	5-10
Tweed	mm	**101**	219		592		927		1146	
	%	**91**	113	2-5	140	15-25	130	30-50	112	5-10
Solway	mm	**151**	349		828		1321		1784	
	%	**88**	119	5-10	139	25-40	131	80-120	120	40-60
Clyde	mm	**199**	367		946		1444		1938	
	%	**97**	101	2-5	132	20-30	118	15-25	107	5-10

% = 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.

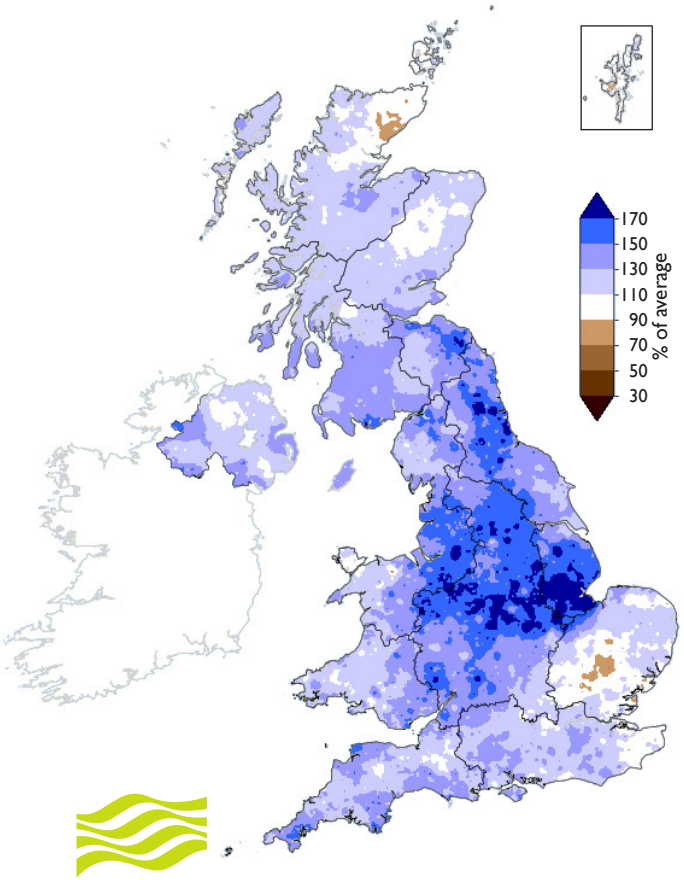
Rainfall . . . Rainfall . . .

October 2019 rainfall as % of 1981-2010 average



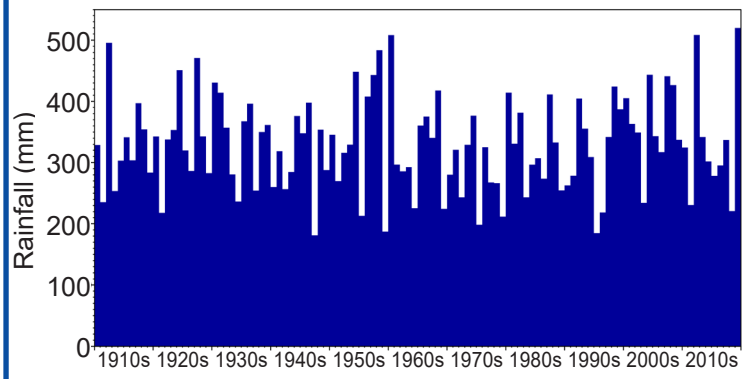
Met Office

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

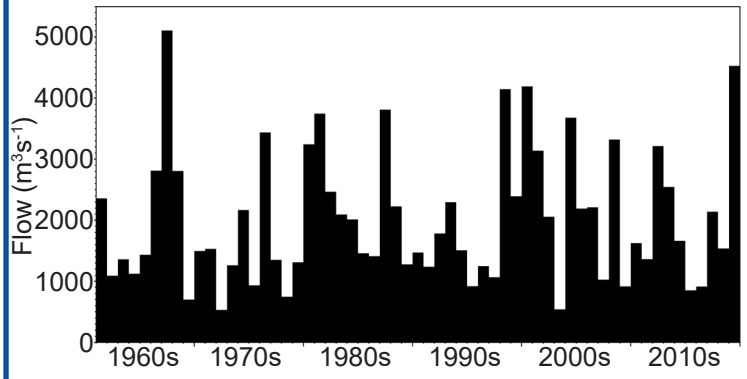


Met Office

June - October rainfall for Severn-Trent



October mean outflows for England & Wales



Hydrological Outlook UK

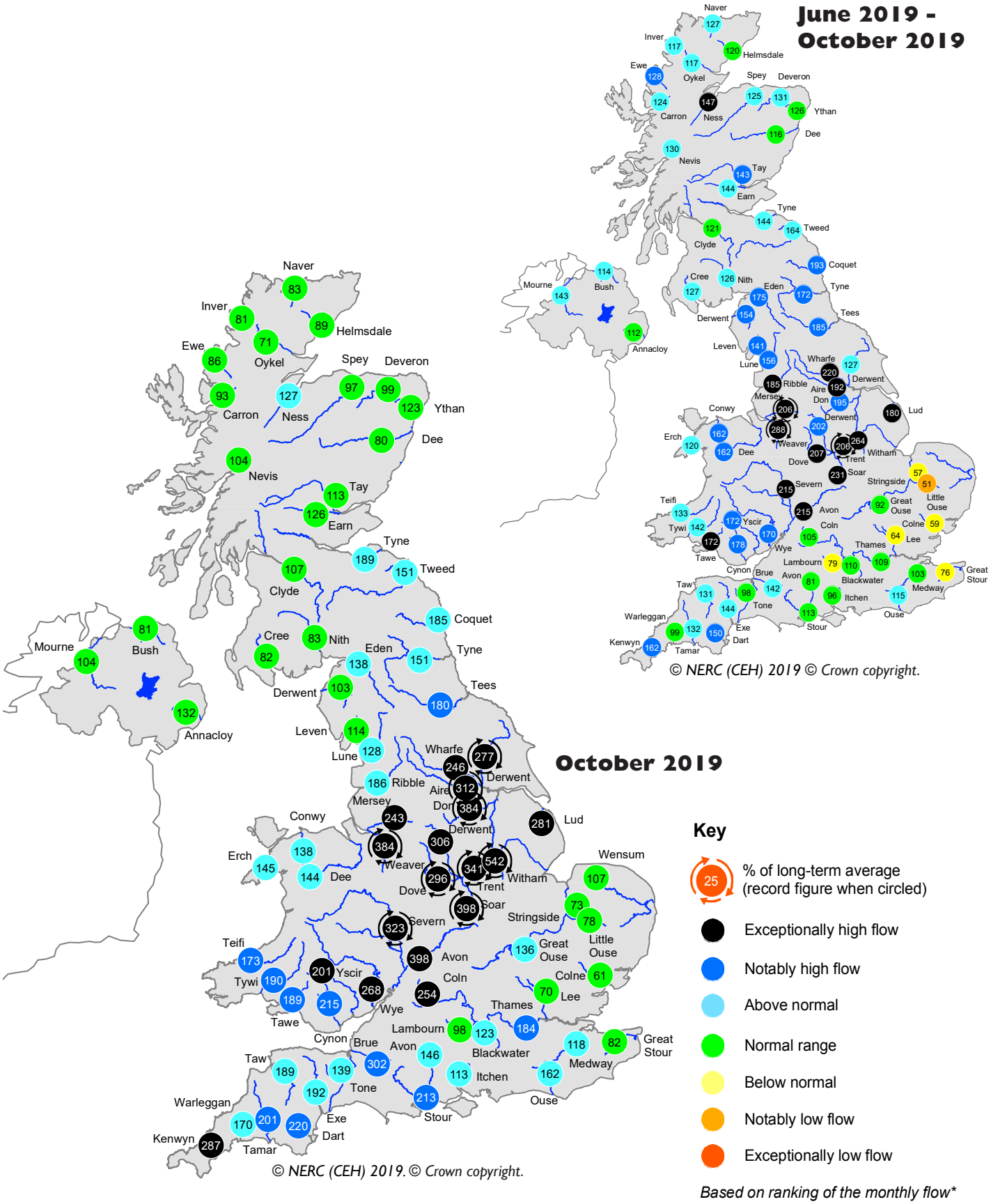
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from November 2019**
Issued: **11.11.2019**
using data to the end of October 2019

For river flows, the outlooks for November and over the next three months are for normal to above normal flows across the majority of the UK, with above normal flows most likely in central and parts of north-east England. In November, groundwater levels are likely to be below normal across the Chalk aquifer of the Chilterns and East Anglia. Elsewhere, and over the next three months, the outlook for groundwater levels is less clear owing to the impact of recent wet weather on the onset of recharge.

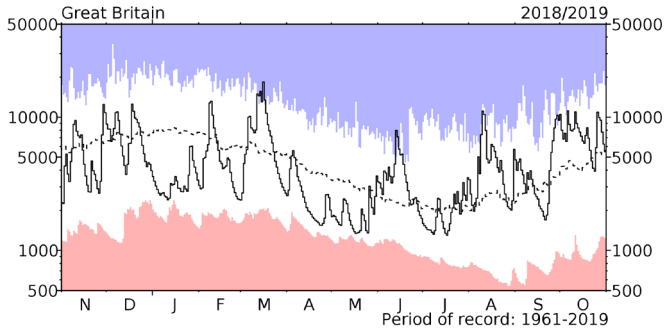
River flow . . . River flow . . .

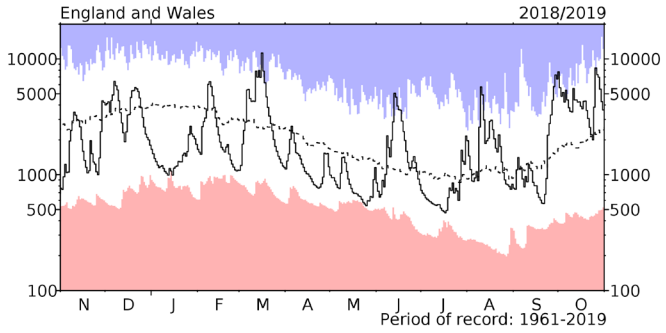


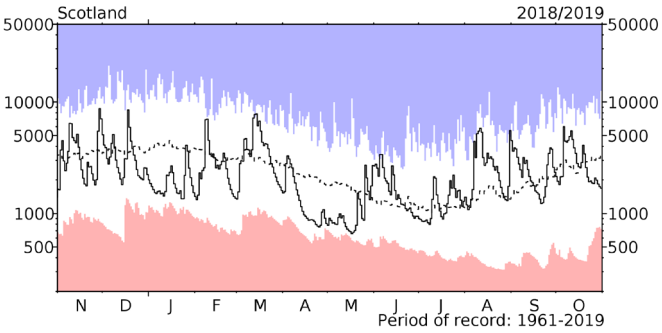
River flows

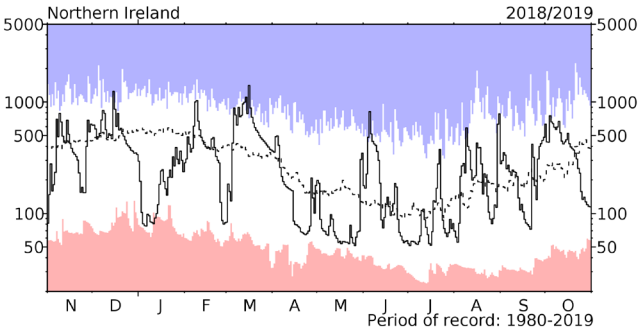
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

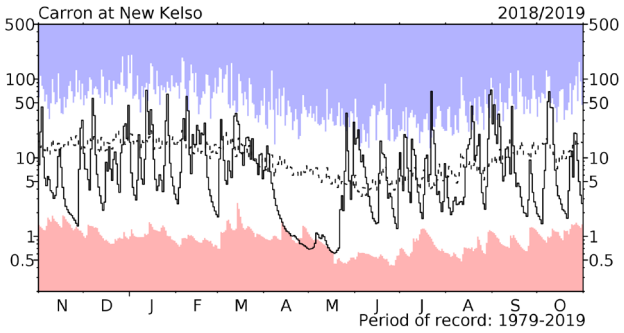
River flow . . . River flow . . .

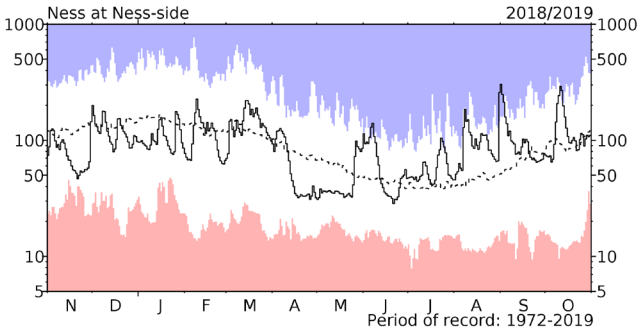


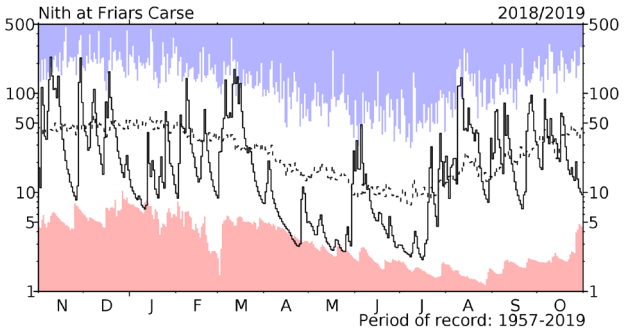


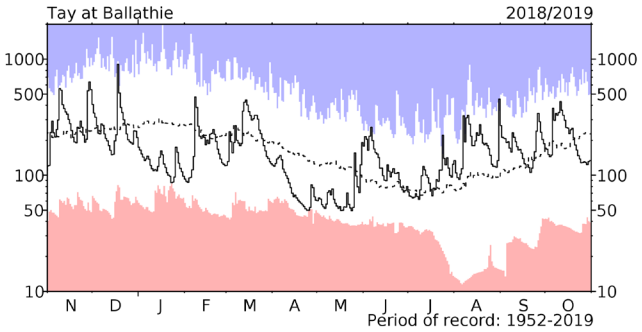


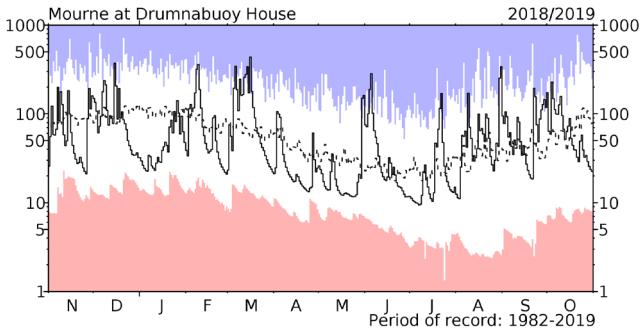


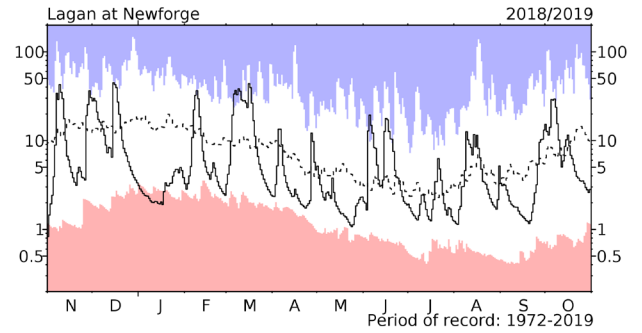








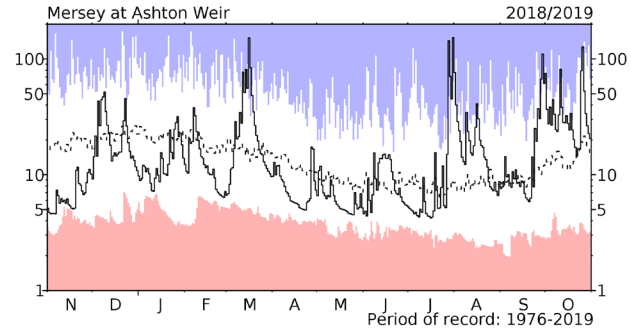


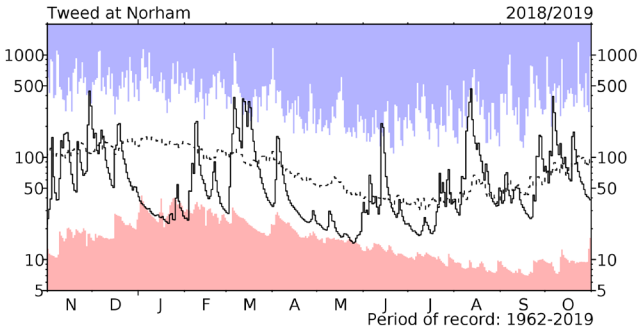


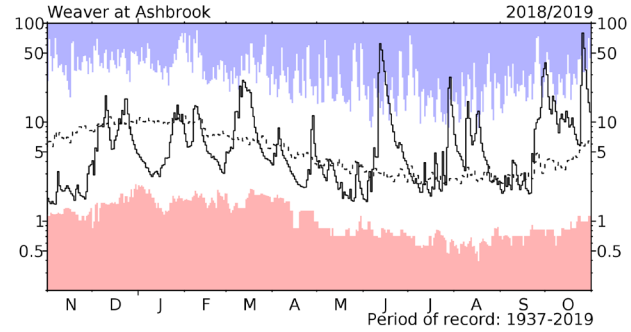
River flow hydrographs

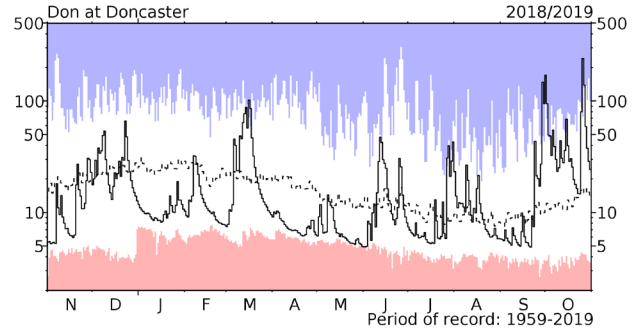
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to November 2018 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

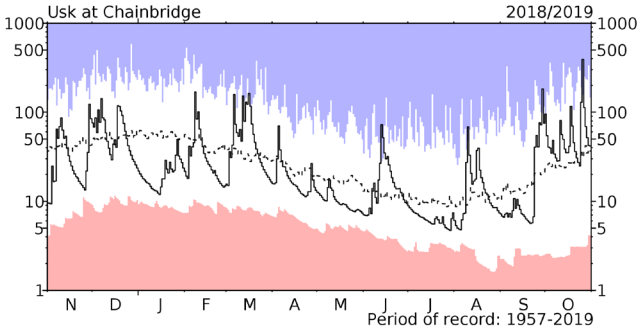
River flow . . . River flow . . .

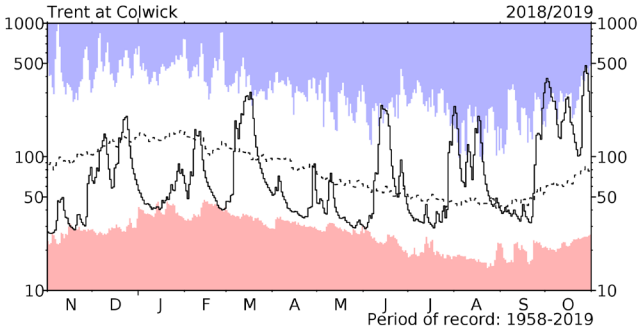


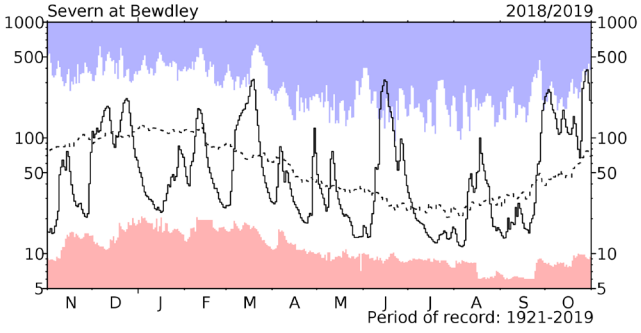


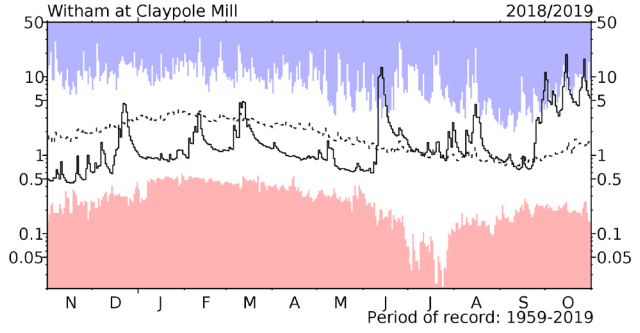


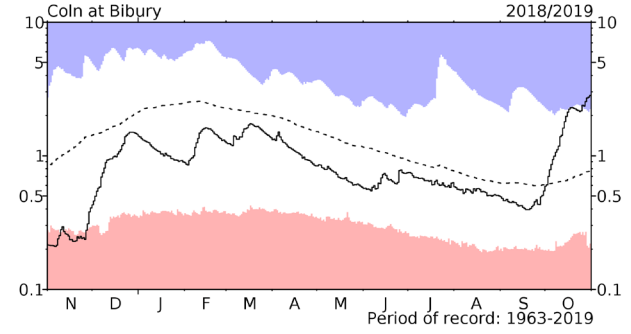


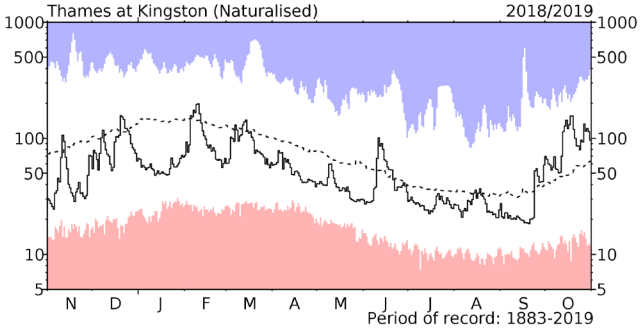


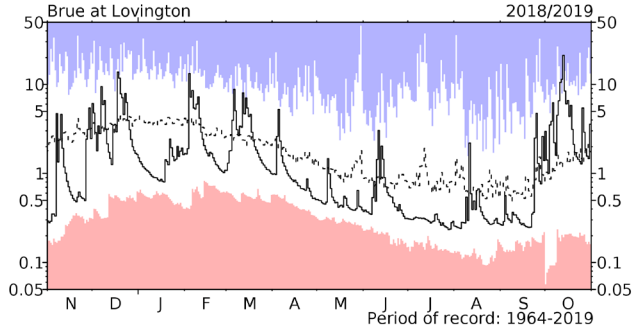


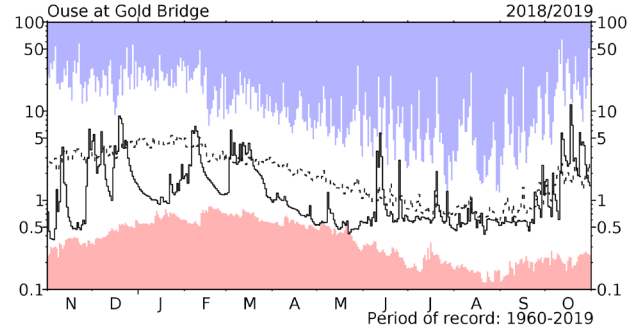




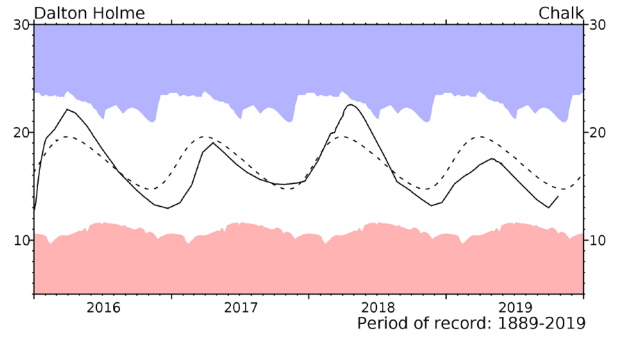


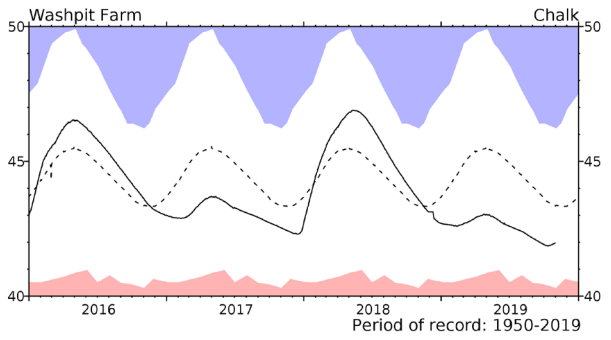


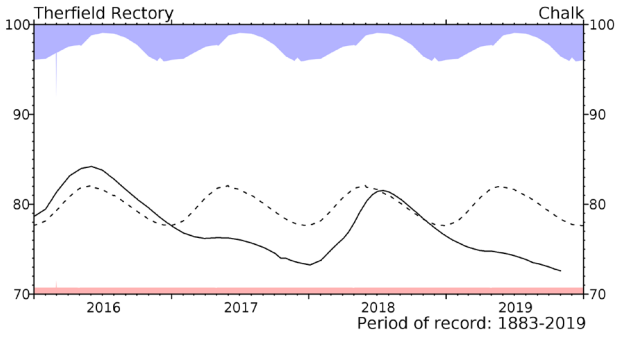


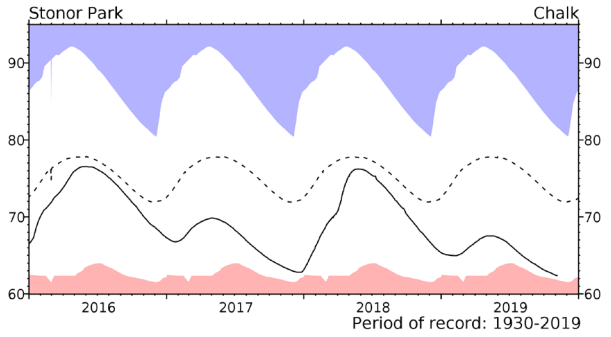


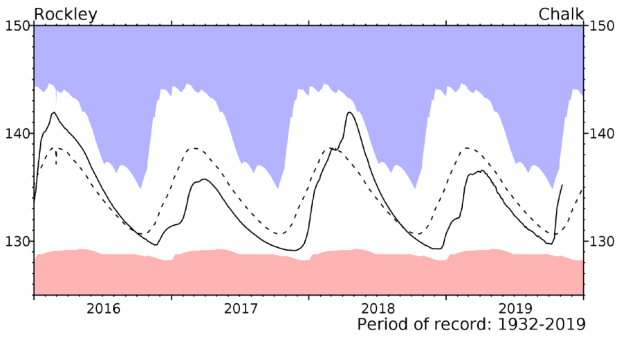
Groundwater…Groundwater

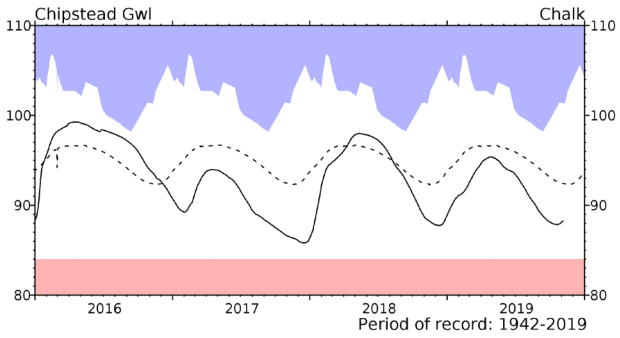


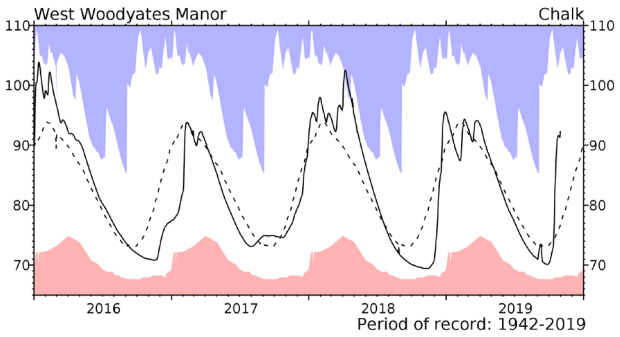


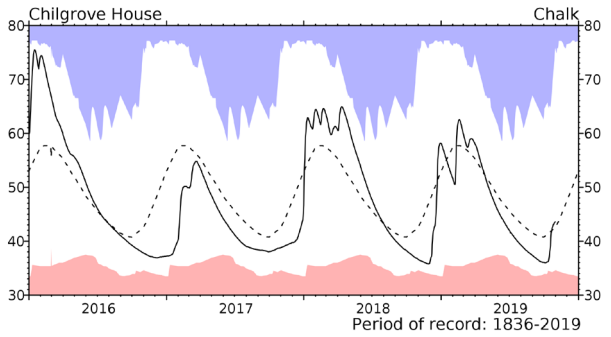


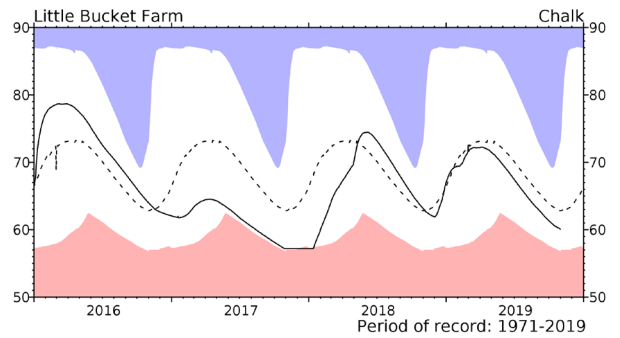


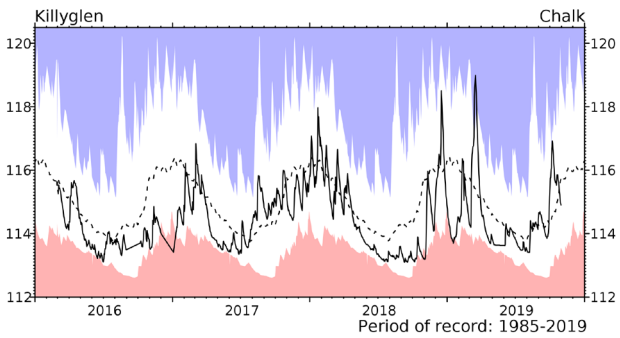






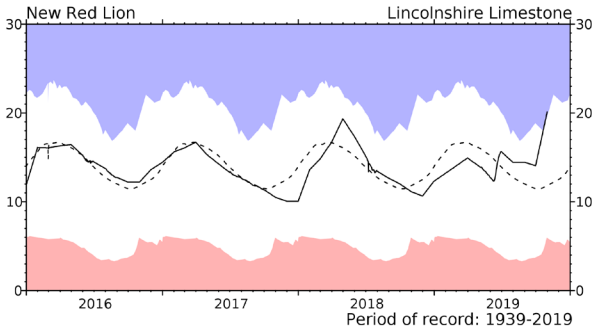




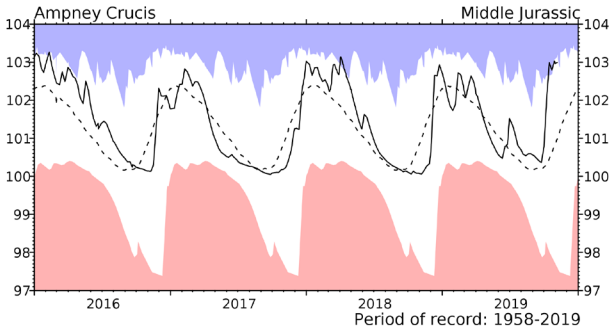


Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

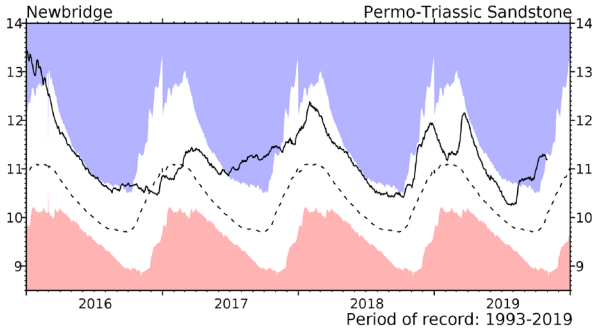
Groundwater … Groundwater



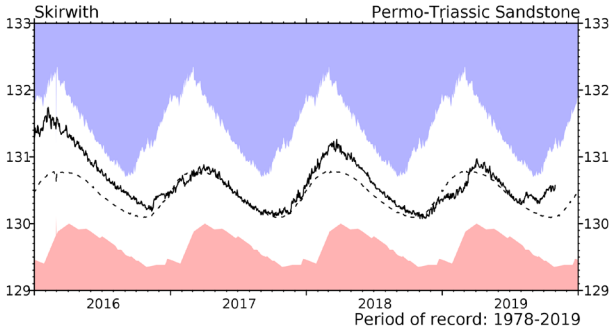
Period of record: 1939-2019



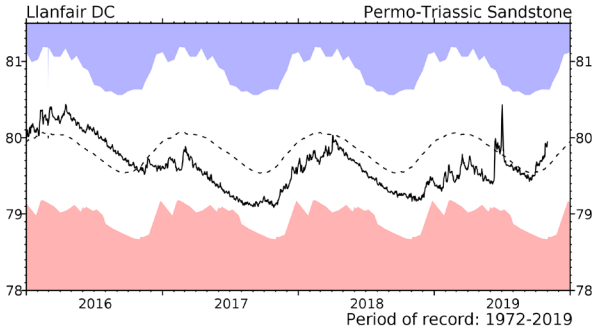
Period of record: 1958-2019



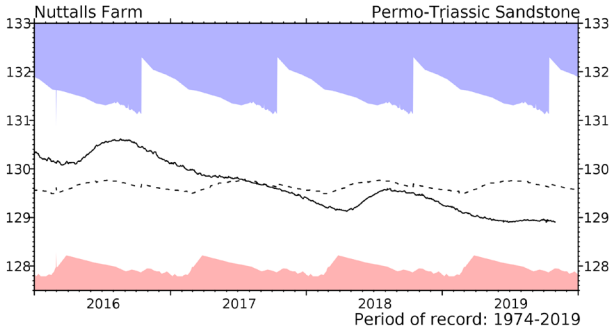
Period of record: 1993-2019



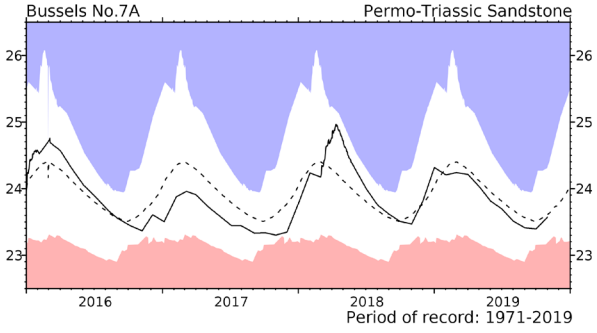
Period of record: 1978-2019



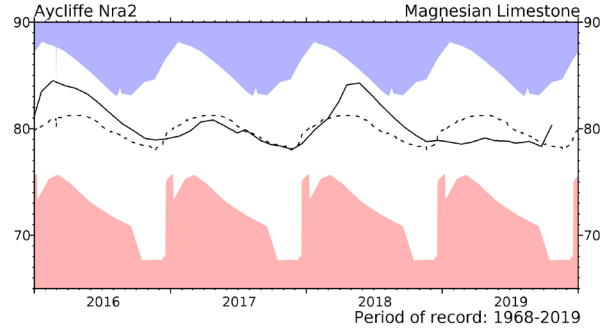
Period of record: 1972-2019



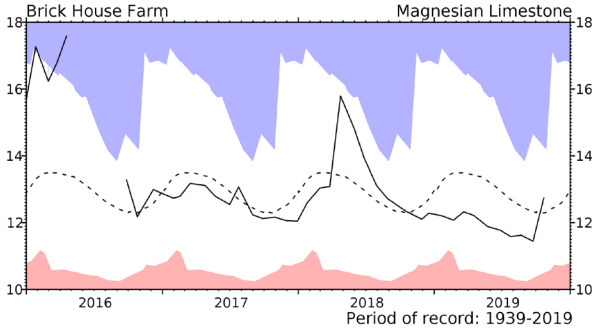
Period of record: 1974-2019



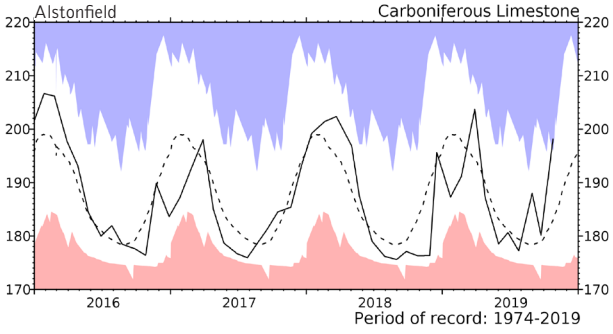
Period of record: 1971-2019



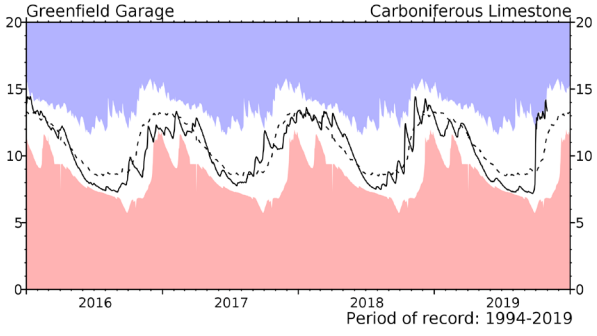
Period of record: 1968-2019



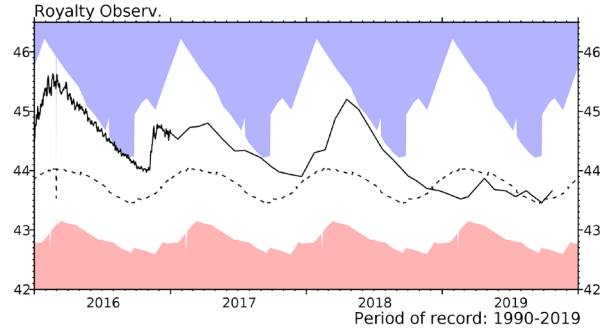
Period of record: 1939-2019



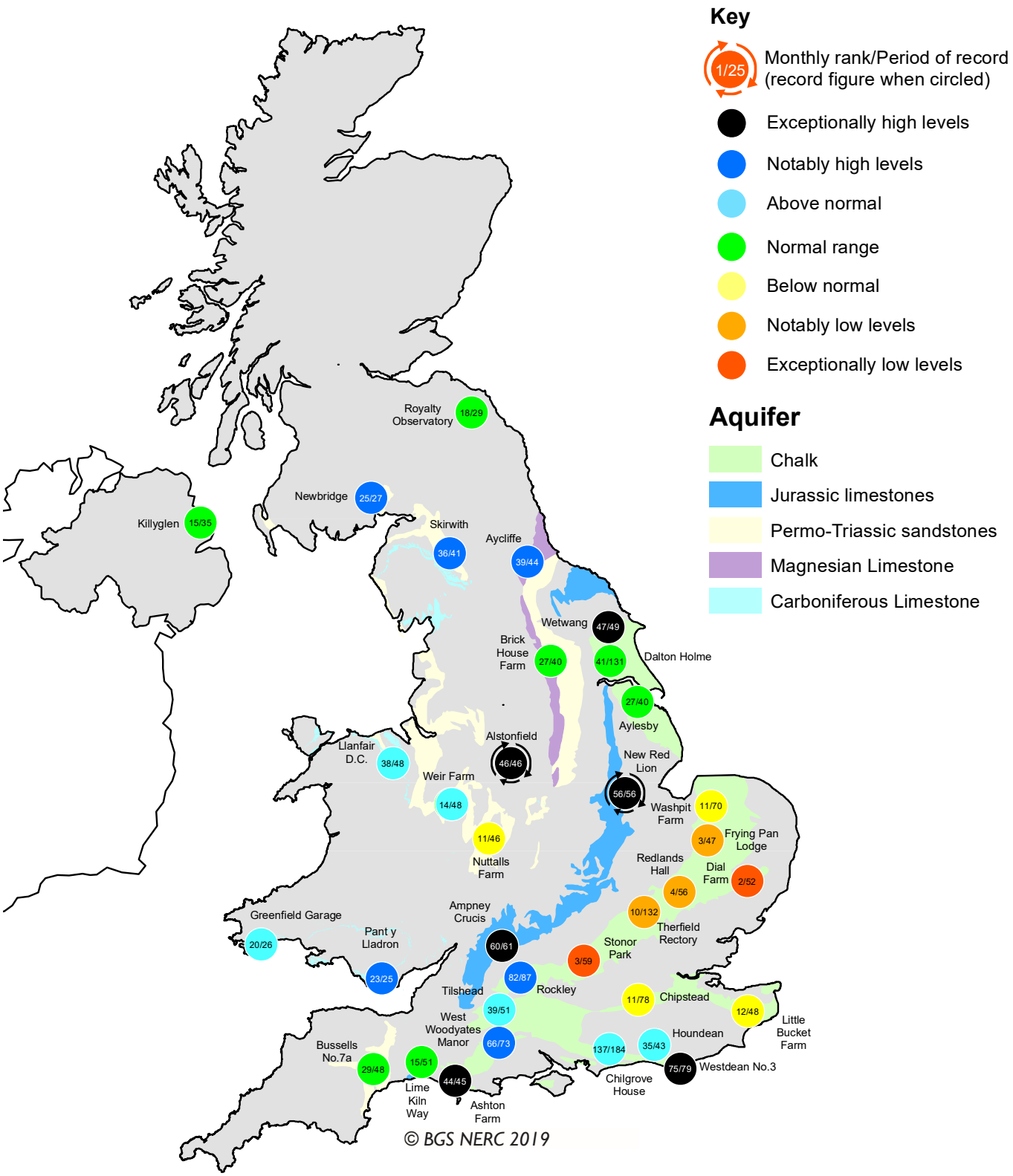
Period of record: 1974-2019



Period of record: 1994-2019



Period of record: 1990-2019

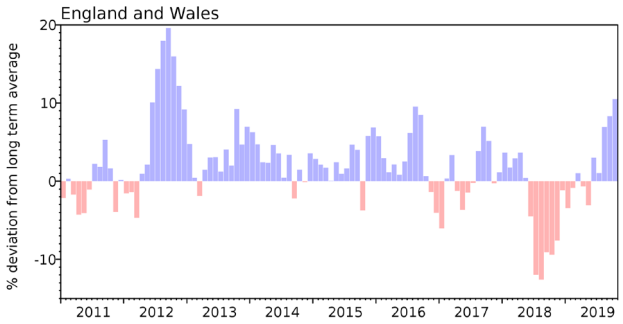


Groundwater levels - October 2019

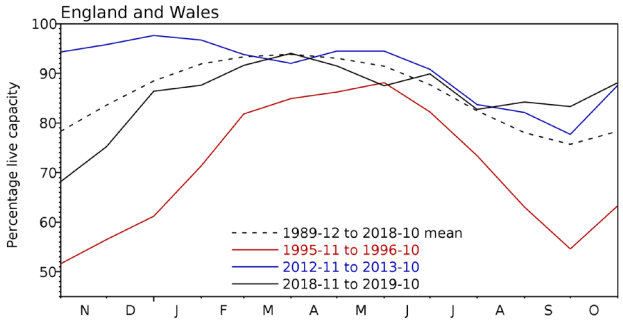
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Aug	2019 Sep	2019 Oct	Oct Anom.	Min Oct	Year* of min	2018 Oct	Diff 19-18
North West	N Command Zone	•	124929	80	80	78	10	33	2003	67	11
	Vyrnwy		55146	98	100	100	24	25	1995	74	27
Northumbrian	Teesdale	•	87936	91	98	96	20	33	1995	74	23
	Kielder		(199175)	90	85	82	-4	63	1989	80	2
Severn-Trent	Clywedog		49936	95	100	88	11	38	1995	79	9
	Derwent Valley	•	46692	86	95	100	31	15	1995	37	63
Yorkshire	Washburn	•	23373	89	95	99	30	15	1995	44	55
	Bradford Supply	•	40942	83	91	100	28	16	1995	46	54
Anglian	Grafham		(55490)	81	76	84	1	44	1997	70	14
	Rutland		(116580)	95	93	96	17	59	1995	79	17
Thames	London	•	202828	76	65	89	12	46	1996	57	32
	Farmoor	•	13822	96	98	97	8	43	2003	88	9
Southern	Bewl		31000	72	65	77	17	33	1990	64	13
	Ardingly		4685	63	54	67	1	15	2003	40	27
Wessex	Clatworthy		5364	70	59	85	24	14	2003	33	52
	Bristol	•	(38666)	75	71	88	26	24	1990	53	35
South West	Colliford		28540	55	51	59	-11	38	2006	54	6
	Roadford		34500	50	48	58	-13	18	1995	46	12
	Wimbleball		21320	78	71	88	23	26	1995	40	49
	Stithians		4967	72	70	99	42	18	1990	35	64
Welsh	Celyn & Brenig	•	131155	89	89	84	0	48	1989	71	14
	Brianne		62140	97	100	100	7	57	1995	100	0
	Big Five	•	69762	82	85	87	11	38	2003	73	14
	Elan Valley	•	99106	83	91	97	13	37	1995	73	24
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	84	87	88	7	48	2003	81	7
	East Lothian	•	9317	100	100	100	16	38	2003	67	33
Scotland(W)	Loch Katrine	•	110326	91	95	95	8	40	2003	89	6
	Daer		22494	99	97	100	10	42	2003	86	14
	Loch Thom		10798	100	100	96	6	66	2007	100	-4
Northern Ireland	Total+	•	56800	92	92	96	15	39	1995	66	30
	Silent Valley	•	20634	94	90	97	21	34	1995	58	39

( ) figures in parentheses relate to gross storage

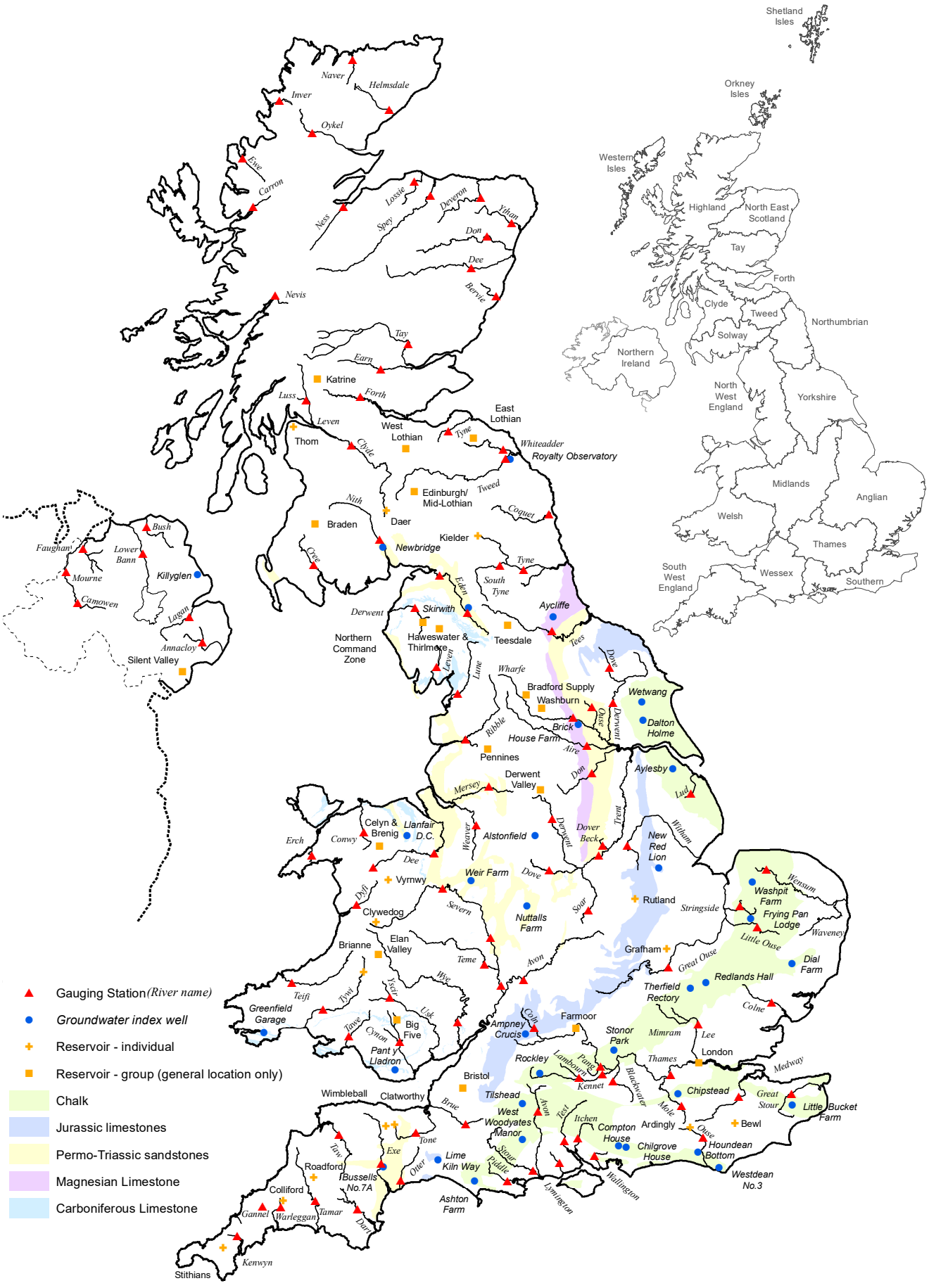
• denotes reservoir groups

*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.

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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