Hydrological Summary

for the United Kingdom

August 2019

General

August was generally an unsettled month, with a characteristic mix of warm sunny weather and thundery showers. In northern and western areas rainfall was persistent and it was an exceptionally wet month, while in the southeast it was dry, especially later in the month. Overall it was nearly 1°C warmer than average and there were some hot spells, especially in the south-east later in the month. The downpours led to notable river flow responses in northern Britain, bringing widespread flood alerts and transport disruption, but few reported major impacts – with the exception of the incident at Toddbrook reservoir in the first few days, a response to the exceptional late July rainfall. August brings to a close a summer of marked contrasts between northern Britain, which saw exceptionally high flows and localised flooding incidents, and the English lowlands, where flows continued to recede towards late summer minima in some catchments. Groundwater levels were below normal across much of the Chalk and notably or exceptionally low in some boreholes. Overall, reservoir stocks at the national scale were above-average for the end of August, with only a few impoundments (Ardingly, Colliford and Roadford) having stocks appreciably below average. The current water resources situation is healthy at the national scale, but with notably low groundwater levels and river flows in the English Lowlands entering autumn (and a continuation of the late August dryness into early September) the 2019/2020 recharge season will be starting from a below-average baseline, with potential implications for the longer-term water resources outlook.

Rainfall

Following the wet end to July, the first few days of August were generally quiet in meteorological terms. A very unsettled spell prevailed through mid-month, as several deep depressions brought persistent and often heavy rainfalls to northern Britain, notably from the 8th-11th and 14th-16th. While daily rainfall totals were rarely exceptional (71.4mm was received at Spadeadam, Cumbria on the 10th), the heavy rainfall and associated surface water flooding and landslides, alongside unseasonally high winds, caused widespread transport disruption. From the 21st, a more settled anticyclonic spell developed before cooler and wetter conditions returned in the final days; however, many parts of the English lowlands received little appreciable rainfall in the latter half of the month. The UK as a whole received 157% of the average rainfall for August, but Scotland received twice its typical August rainfall – the wettest August on record (in a record from 1910). The Northumbria and North West England regions also received >170% of average, and above average rainfall was also received across western England and large areas of central England. In contrast, southern and eastern England was drier than average, with less than 50% received across large areas of East Anglia. The summer as whole (June-August) was exceptionally wet across northern Britain and some parts of central England. It was the wettest summer on record for Scotland, and also the wettest summer half year (March-August).

River flows

While the first few days of August saw generally quiescent weather, in hydrological terms the month started dramatically, with many responsive rivers in high spate following the exceptionally wet end to July, particularly in parts of the Pennines – on the 1st, the Dove registered its highest August peak flow on record (in a record from 1962). The exceptional flow volumes caused damage to the Toddbrook reservoir in the Peak District, leading to an evacuation of over 1500 residents from Whaley Bridge and surrounding areas on the 1st. A major emergency response ensued to reduce levels and repair damage over the following week before residents could return. Further high flow responses around mid-month led to widespread flood alerts in northern Britain, e.g. around the 9th-10th in Scotland and the 14th-16th in Cumbria and the Pennines. The Cumbrian Derwent registered a new August peak flow maximum on the 11th, and the Ness on the 31st (in records from 1969 and 1972 respectively). Correspondingly, mean flows for August were notably high across much of northern Britain, and exceptionally high in some catchments (the Ness, Eden, Tyne and Coquet all saw new August mean flow records, with four times the typical August average in the latter). Across the English lowlands, generally flows receded through August and the monthly mean flows were notably low in some catchments. River flow accumulations for the summer show a similar contrast. Summer mean flows were among the highest on record in some northern catchments (e.g. the Weaver and Coquet registered their second highest summer flows, after 2007 and 2012 respectively, in records from and 1938 and 1964). Correspondingly, summer outflows for Great Britain were the fourth highest on record. In contrast, for a number of lowland catchments (e.g. Hampshire Avon, Colne) summer flows were among the lowest on record, after notable drought years (1976, 1997, 2010-2011), while the Little Ouse saw its second lowest summer flow (after 1976) in a record from 1968.

Groundwater

While soil moisture deficits (SMDs) decreased in northern Britain in response to the August rainfall, they continued to increase across the south and east and were significantly above average for late August across the Chalk outcrop. Correspondingly, groundwater levels at most Chalk sites continued to decline during August and were mostly below normal or notably low, similar to the situation in July. The level became exceptionally low at Chilgrove House (South Downs), which saw its sixth lowest August value in a record from 1835, and remained so at Dial Farm (the second lowest August level since 1968) for the third consecutive month. In the Jurassic limestone levels remained above normal, while the Magnesian Limestones were normal or below normal for August. The situation improved in the Carboniferous Limestone of South Wales: levels rose and changed from notably low to below normal and normal. The Carboniferous Limestone site at Alstonfield recorded a large rise in water level and became notably high. Levels at Lime Kiln Way in the Upper Greensand continued to recede and remained below normal. In the Permo-Triassic Sandstone, following above average rainfall, Newbridge became exceptionally high for the time of year and other sites were mainly in the normal or above normal range, the exceptions being Nuttalls Farm and Bussells No. 7a which remained below normal. The Fell Sandstone site at Royalty Observatory remained in the normal range, with little response to the high rainfall in the area over August.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

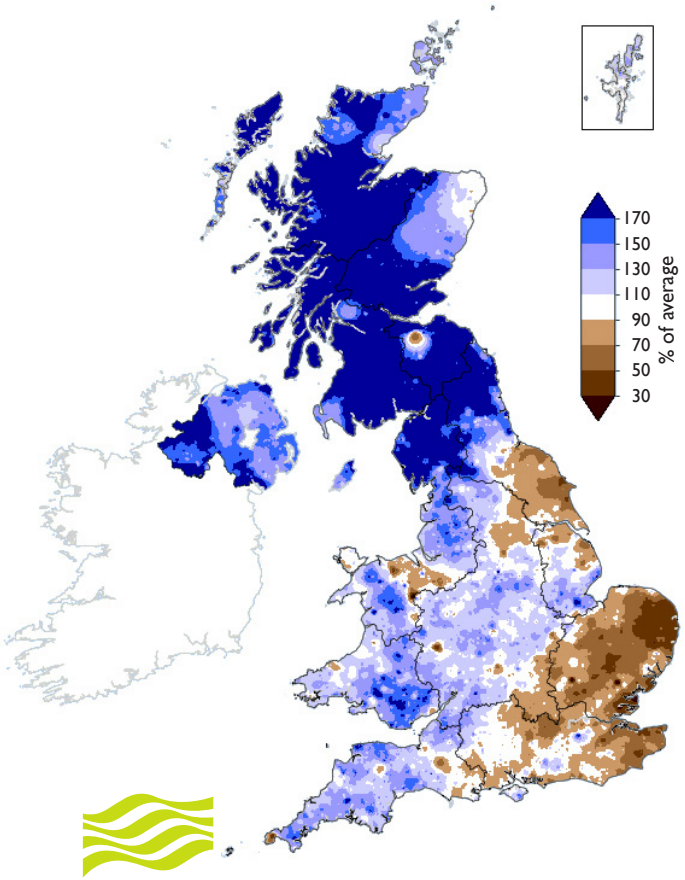
Region	Rainfall	Aug 2019	Jul19 – Aug19	RP	Jun19 – Aug19	RP	Mar19 – Aug19	RP	Sep18 – Aug19	RP
United Kingdom	mm	**137**	225		337		586		1173	
	%	**157**	139	5-10	144	15-25	126	50-80	104	2-5
England	mm	**82**	150		260		430		834	
	%	**120**	116	2-5	136	5-10	117	5-10	99	2-5
Scotland	mm	**222**	355		457		803		1642	
	%	**199**	172	>100	158	>100	136	>>100	108	10-20
Wales	mm	**139**	194		353		693		1526	
	%	**135**	100	2-5	128	2-5	124	8-12	107	2-5
Northern Ireland	mm	**158**	245		357		653		1163	
	%	**162**	137	5-10	140	10-15	131	50-80	102	2-5
England & Wales	mm	**90**	156		272		467		930	
	%	**123**	113	2-5	135	5-10	118	5-10	101	2-5
North West	mm	**173**	311		433		733		1378	
	%	**172**	166	10-20	162	20-30	144	>100	112	8-12
Northumbria	mm	**132**	227		340		558		928	
	%	**177**	159	8-12	163	15-25	143	50-80	107	2-5
Severn-Trent	mm	**79**	155		294		464		811	
	%	**122**	124	2-5	156	15-25	129	10-20	104	2-5
Yorkshire	mm	**74**	160		263		451		833	
	%	**104**	121	2-5	131	5-10	119	5-10	99	2-5
Anglian	mm	**46**	93		198		306		558	
	%	**80**	85	2-5	121	2-5	101	2-5	89	2-5
Thames	mm	**51**	94		189		309		644	
	%	**90**	87	2-5	119	2-5	97	2-5	90	2-5
Southern	mm	**47**	90		183		304		722	
	%	**84**	85	2-5	117	2-5	95	2-5	91	2-5
Wessex	mm	**73**	109		203		368		827	
	%	**114**	90	2-5	114	2-5	101	2-5	94	2-5
South West	mm	**110**	162		268		499		1192	
	%	**134**	100	2-5	116	2-5	104	2-5	97	2-5
Welsh	mm	**134**	189		345		670		1468	
	%	**133**	100	2-5	128	2-5	124	8-12	107	2-5
Highland	mm	**254**	386		498		897		1950	
	%	**206**	172	80-120	158	>100	133	>100	108	8-12
North East	mm	**133**	234		323		617		1124	
	%	**167**	154	5-10	145	5-10	143	70-100	111	5-10
Tay	mm	**192**	308		403		726		1421	
	%	**200**	172	10-20	158	15-25	138	40-60	106	5-10
Forth	mm	**181**	298		395		682		1220	
	%	**193**	171	15-25	157	20-30	138	70-100	101	2-5
Tweed	mm	**166**	276		374		651		1109	
	%	**199**	172	10-20	161	15-25	148	60-90	108	5-10
Solway	mm	**249**	389		480		850		1701	
	%	**210**	180	30-50	159	20-35	142	>100	114	30-50
Clyde	mm	**284**	466		580		948		1937	
	%	**201**	182	>100	164	>100	134	>100	106	8-12

% = 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.

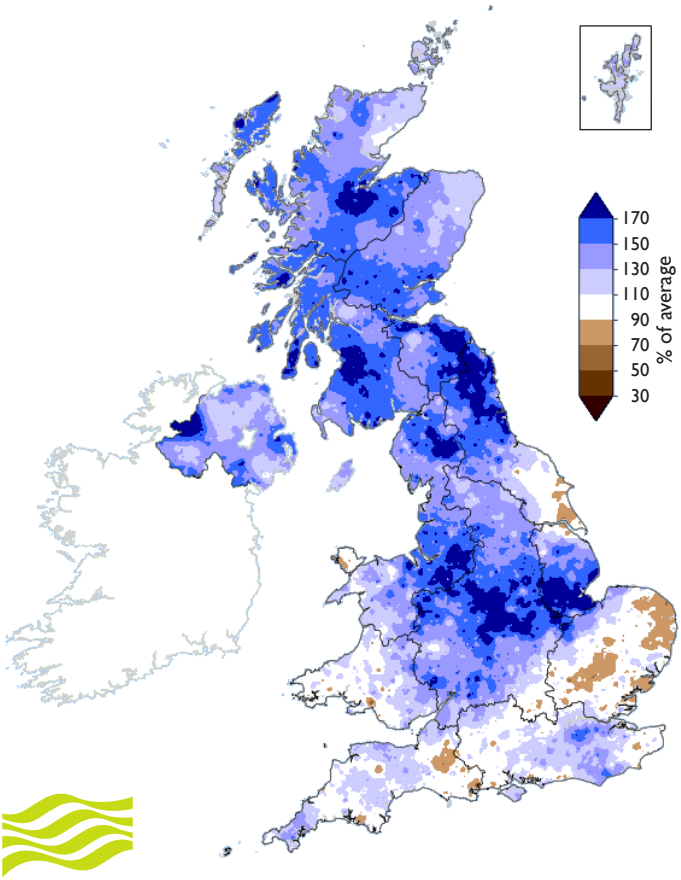
Rainfall . . . Rainfall . . .

August 2019 rainfall
as % of 1981-2010 average



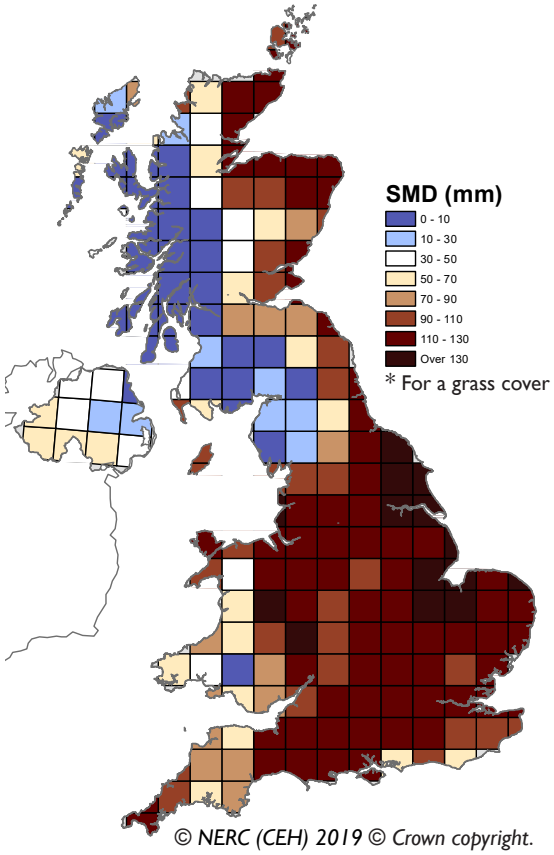
Met Office

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



Met Office

MORECS Soil Moisture Deficits*
August 2019



Hydrological Outlook UK

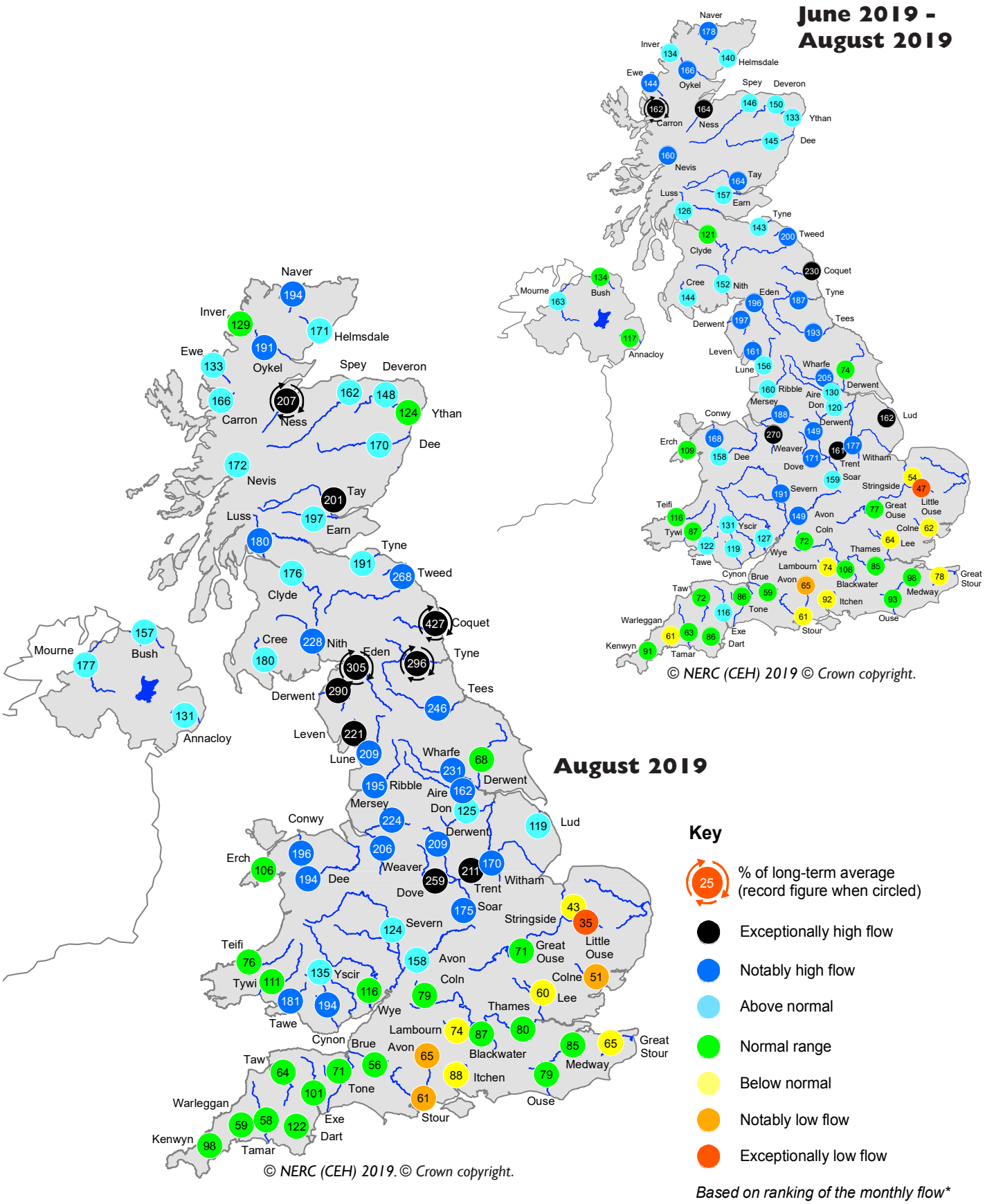
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from September 2019**
Issued: **09.09.2019**
using data to the end of August 2019

The outlook for September is for normal to above normal river flows in the north of the UK, flows within the normal range in central regions, and below normal flows in the south-east. Groundwater levels are likely to be below normal in September in the southern and eastern Chalk, and generally within the normal range elsewhere. The three-month outlook is for river flows in the south-east to be normal to below normal, and in the normal range elsewhere. Groundwater levels across the UK are likely to be in the normal range for the September-November period.

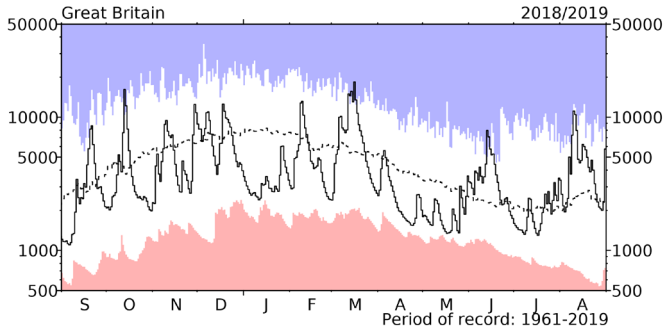
River flow . . . River flow . . .

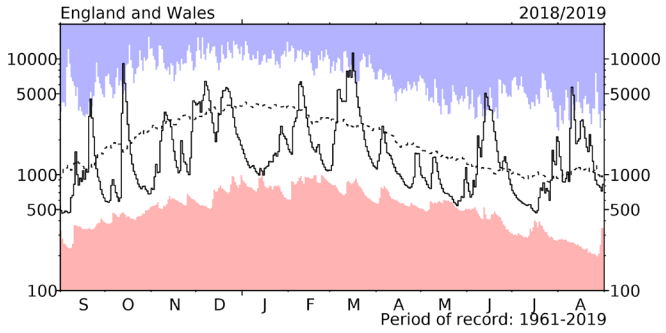


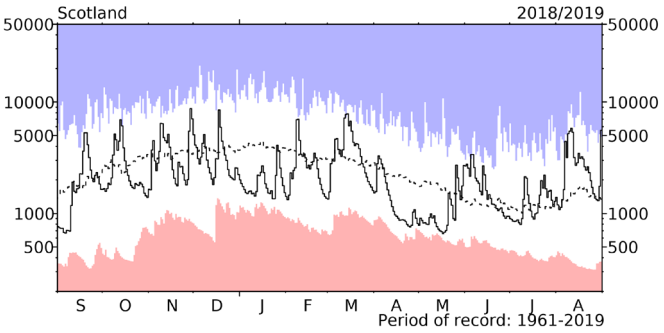
River flows

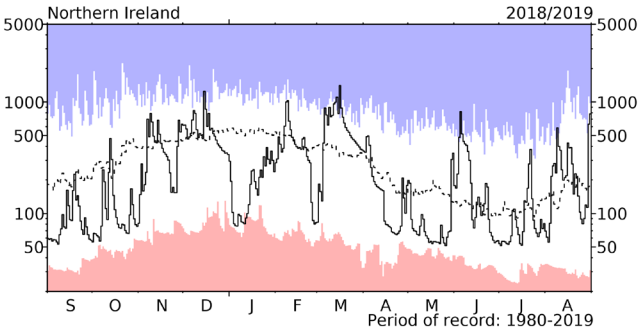
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

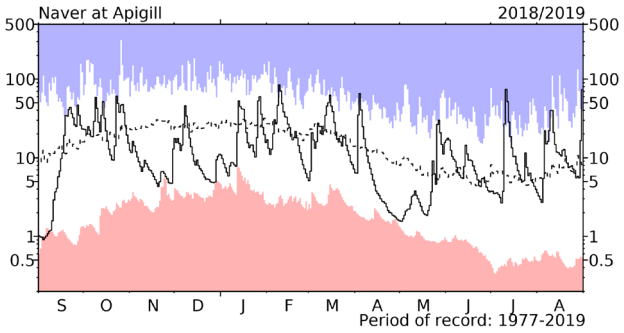
River flow . . . River flow . . .

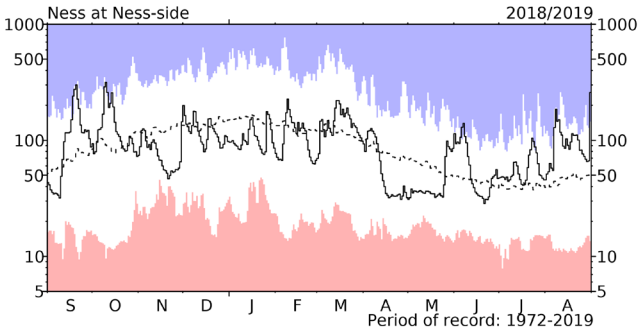


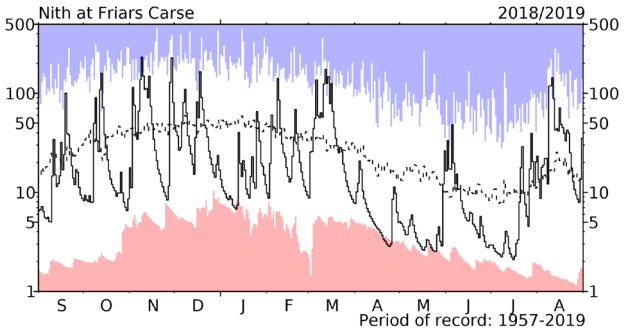


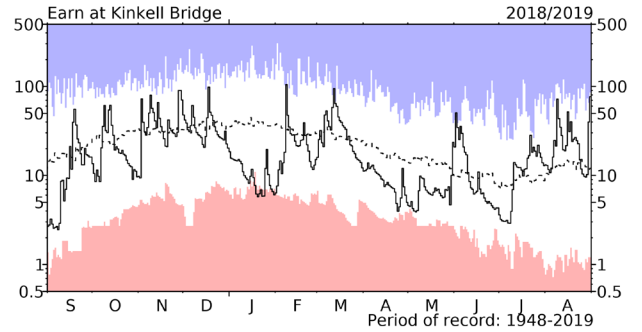


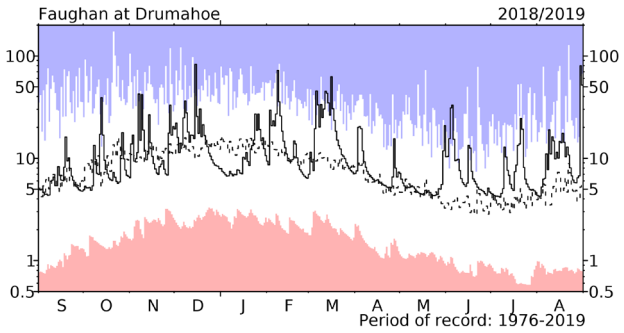


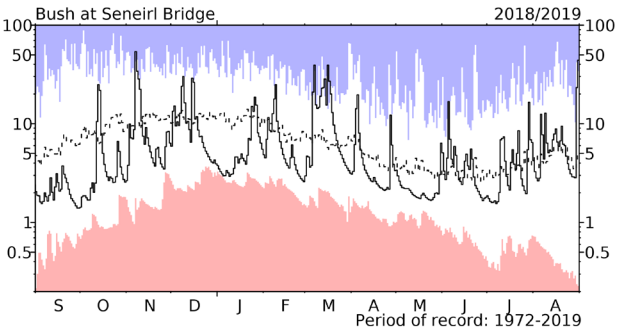








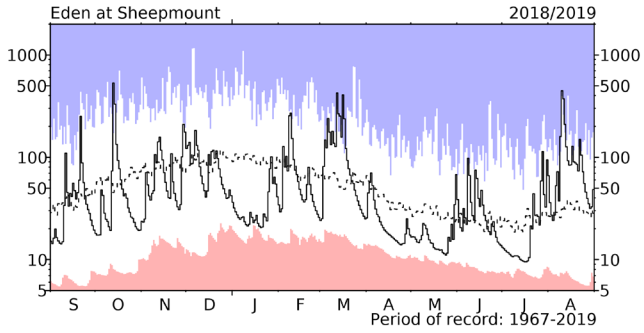


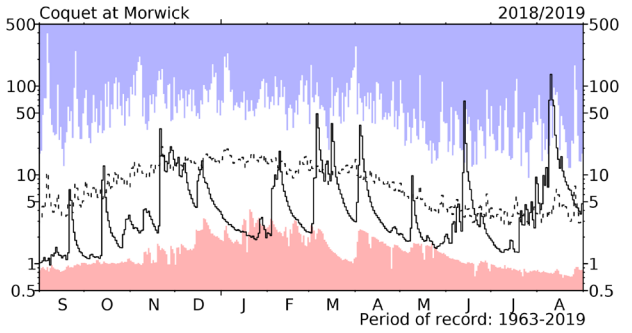


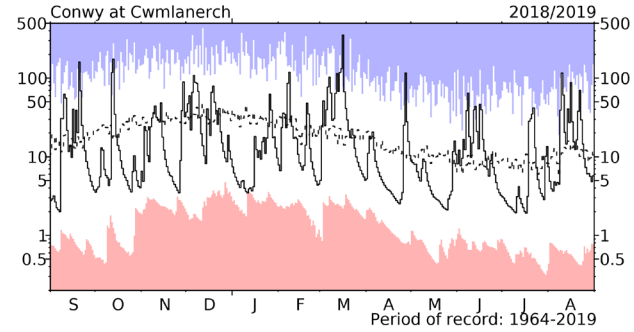
River flow hydrographs

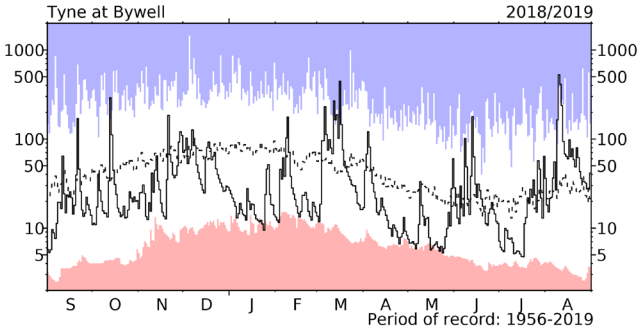
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to September 2018 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

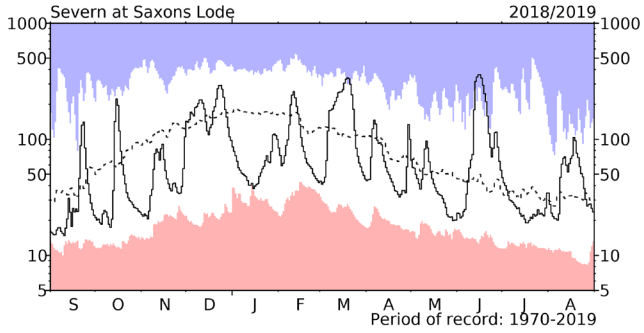
River flow . . . River flow . . .

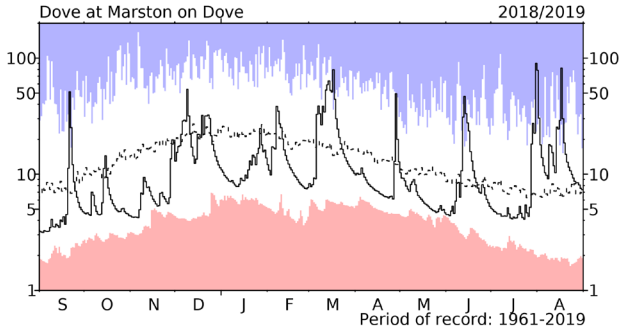


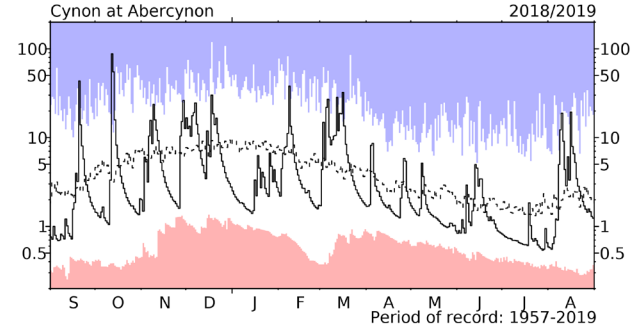


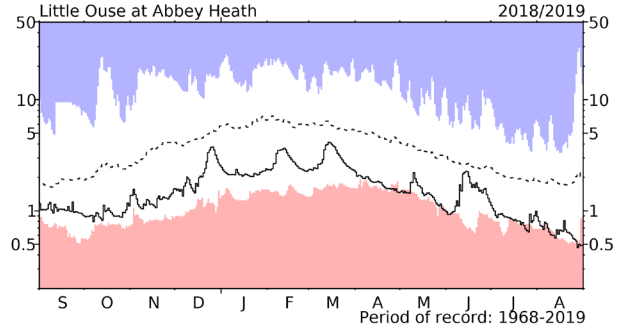


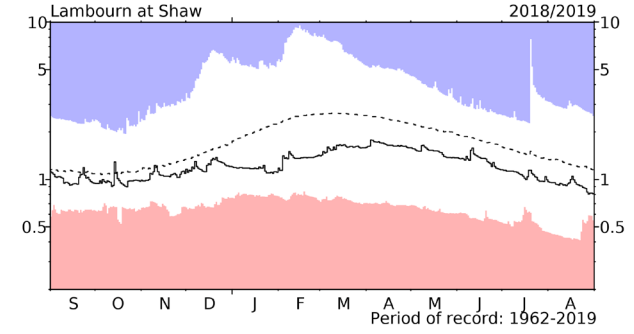


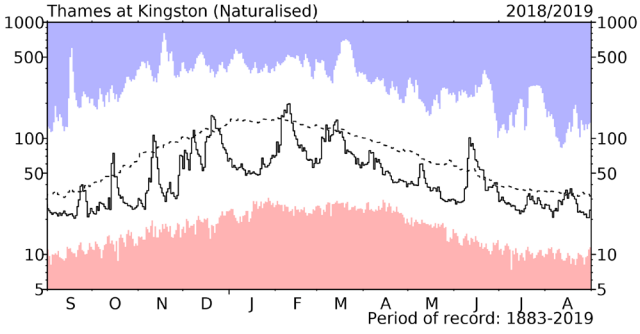


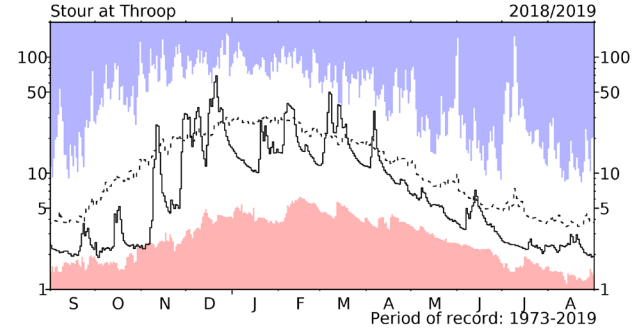


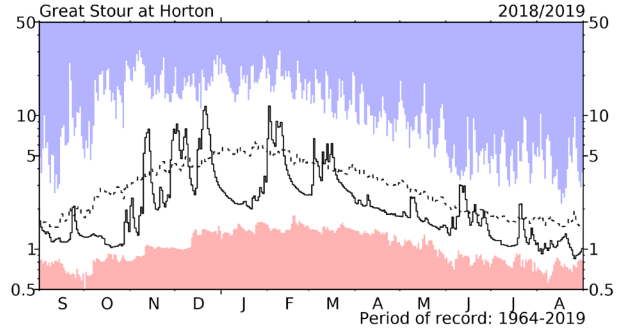




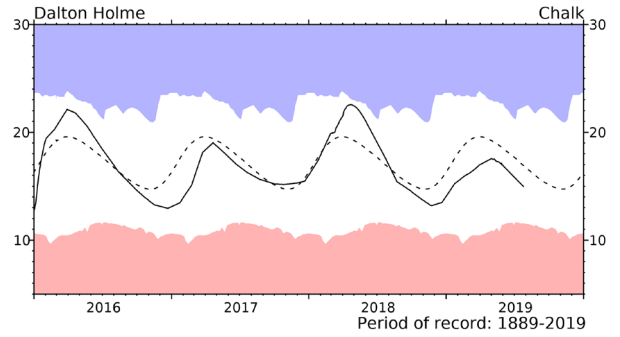


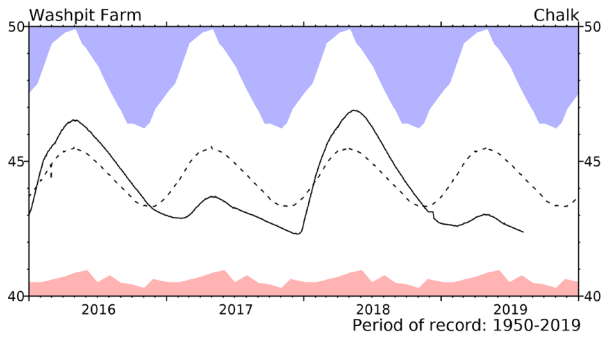


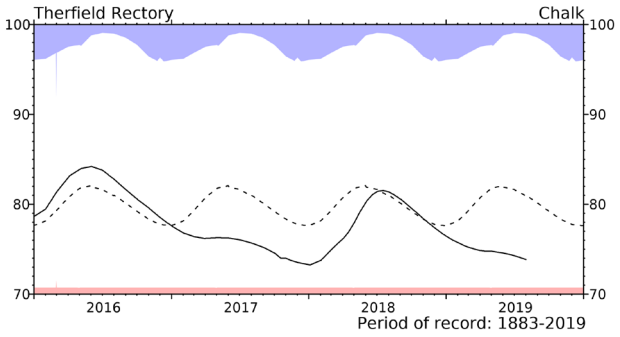


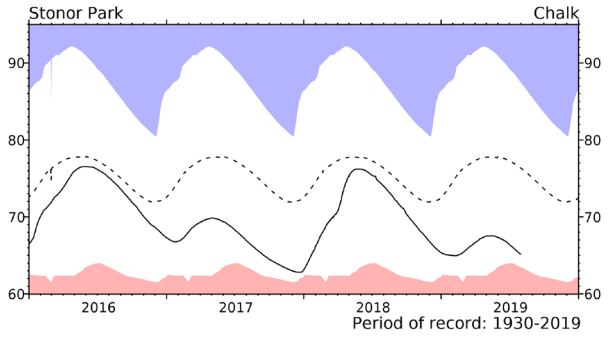


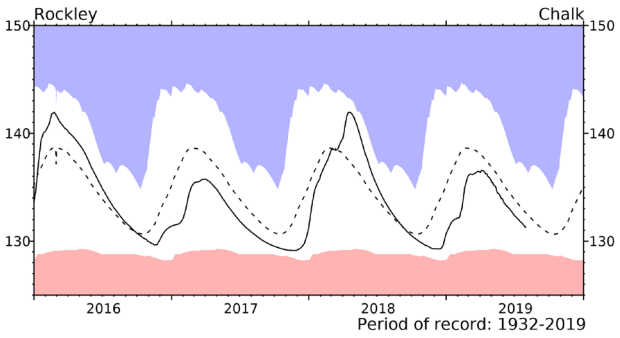
Groundwater…Groundwater

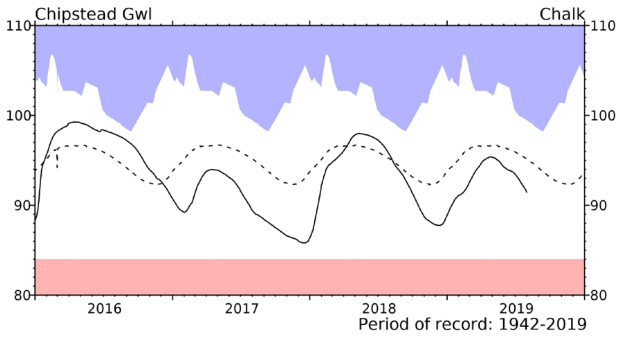


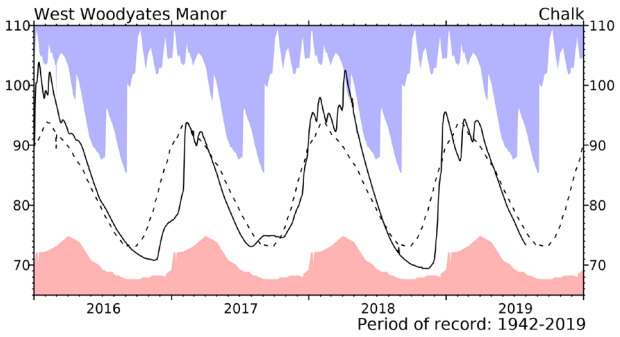


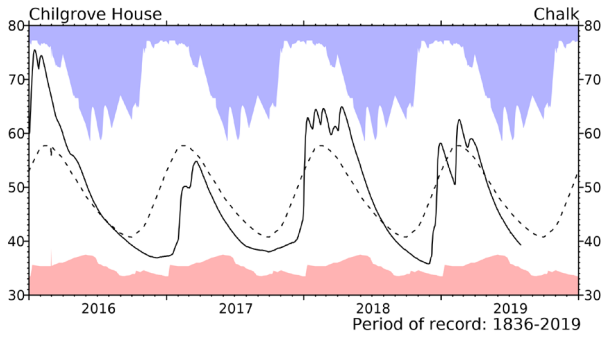


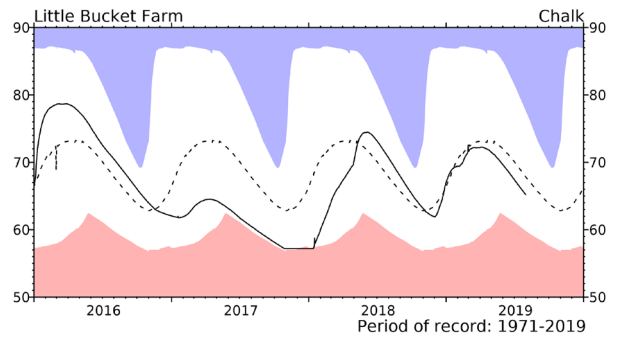


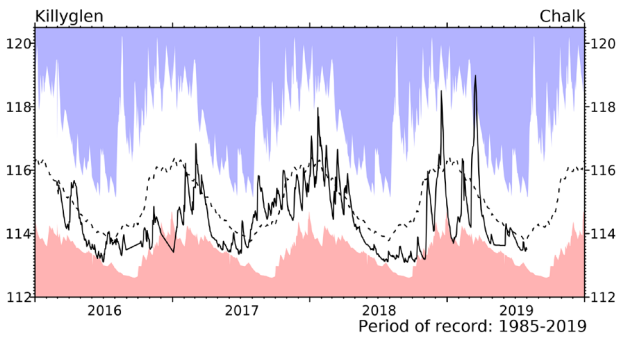






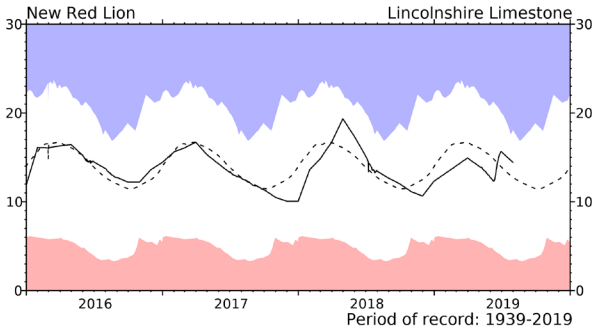


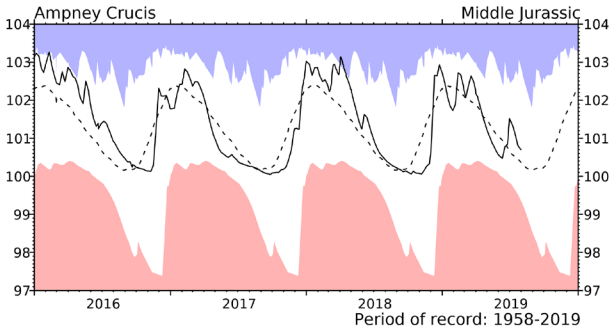


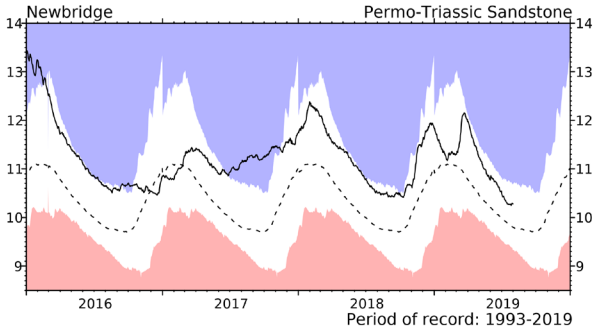


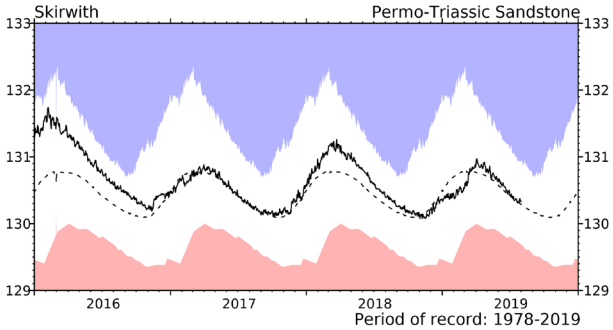
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

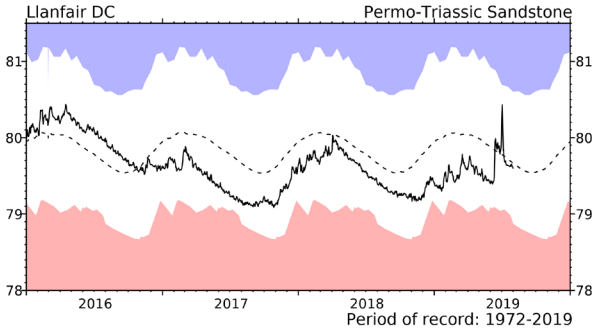
Groundwater … Groundwater

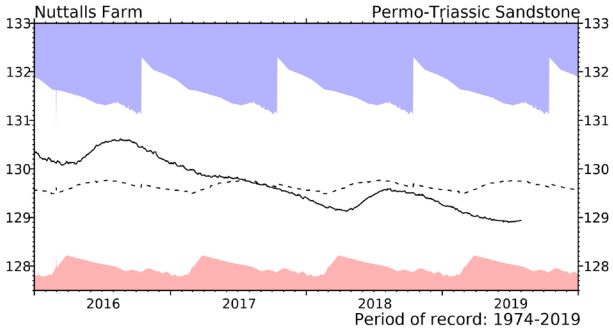


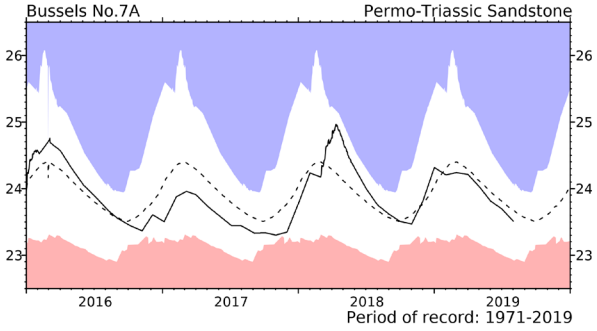


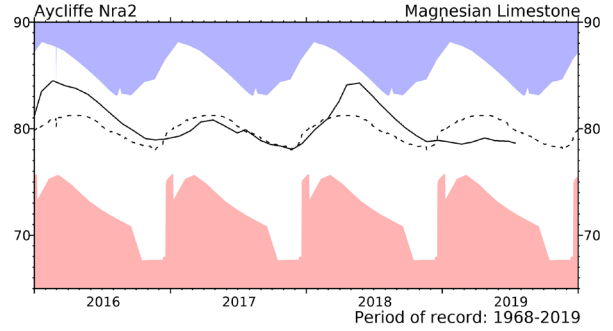


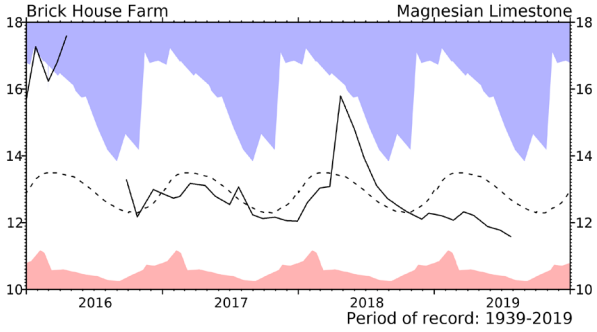


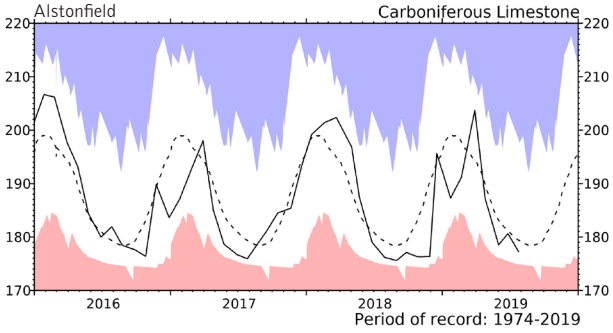


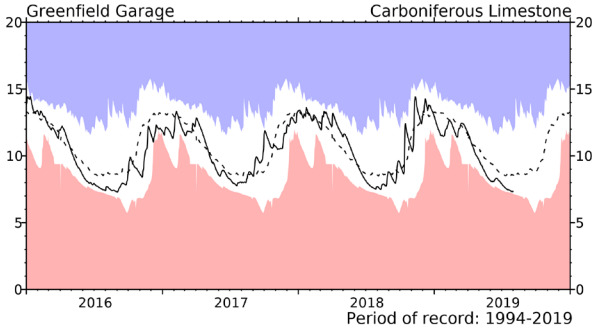


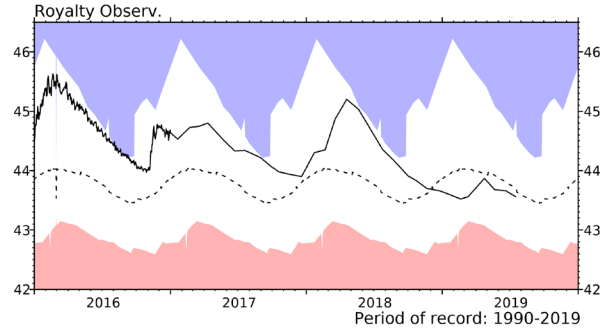


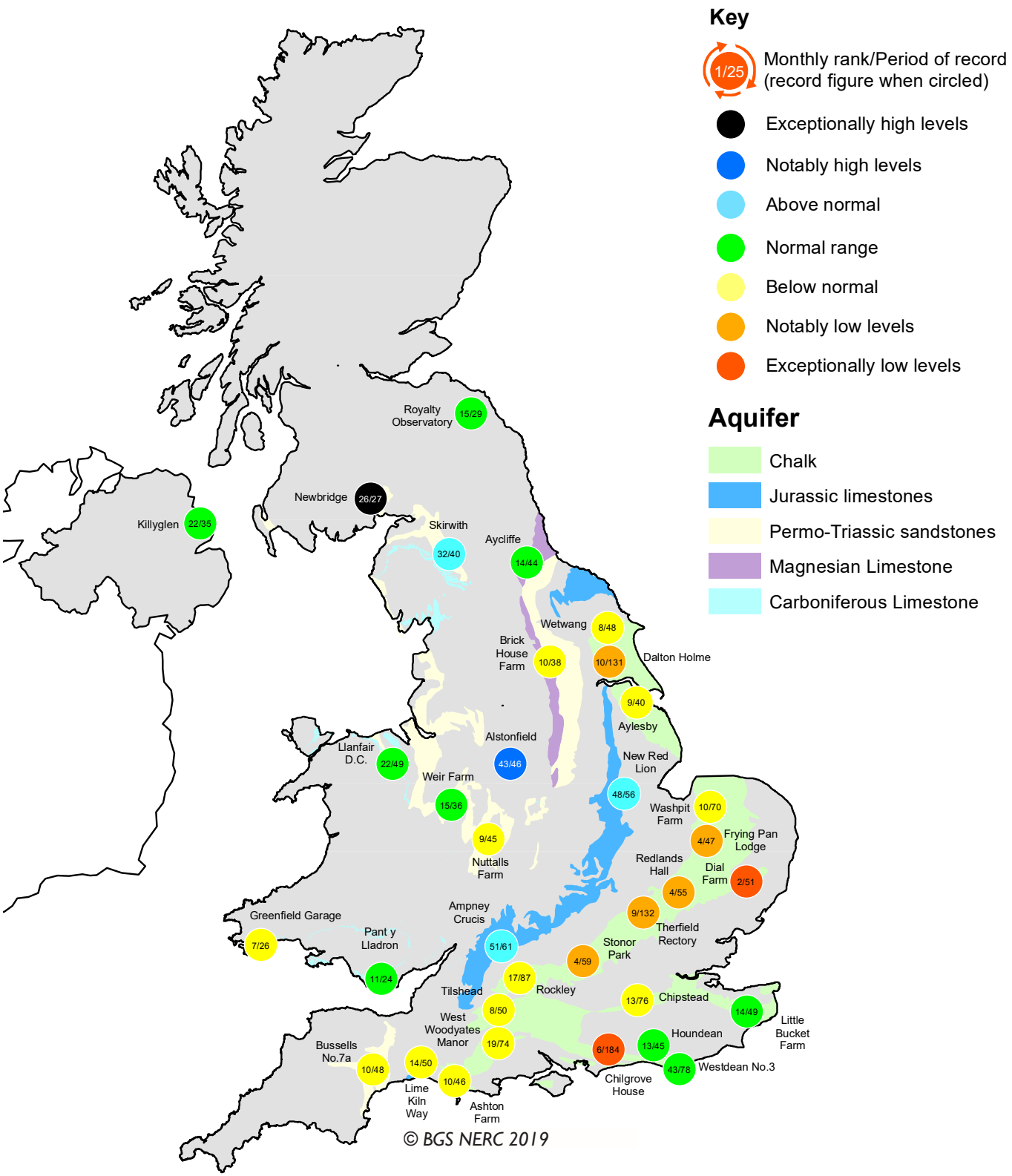










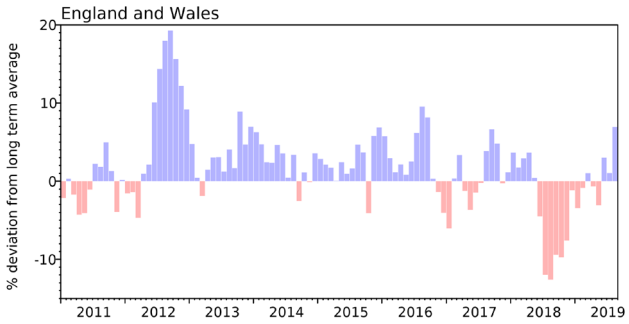


Groundwater levels - August 2019

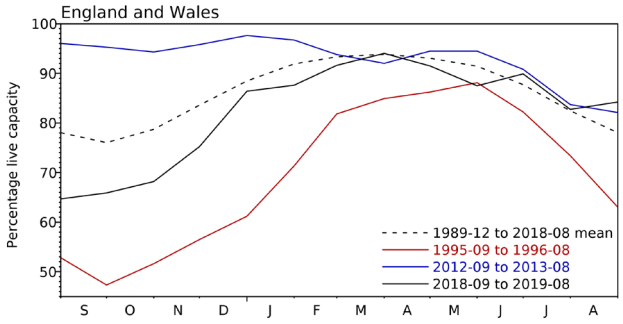
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Jun	2019 Jul	2019 Aug	Aug Anom.	Min Aug	Year* of min	2018 Aug	Diff 19-18
North West	N Command Zone	•	124929	69	61	80	21	15	1984	45	35
	Vyrnwy		55146	100	91	98	27	36	1995	60	39
Northumbrian	Teesdale	•	87936	84	80	91	19	38	1995	62	29
	Kielder		(199175)	90	90	90	2	66	1989	78	12
Severn-Trent	Clywedog		49936	99	96	95	18	27	1976	63	32
	Derwent Valley	•	46692	81	66	86	20	34	1995	40	46
Yorkshire	Washburn	•	23373	95	81	89	19	34	1995	48	40
	Bradford Supply	•	40942	88	70	83	16	21	1995	47	37
Anglian	Grafham		(55490)	93	86	81	-6	59	1997	79	1
	Rutland		(116580)	96	95	95	12	66	1995	85	10
Thames	London	•	202828	95	84	76	-6	62	1995	72	3
	Farmoor	•	13822	98	99	96	3	64	1995	95	1
Southern	Bewl		31000	89	82	72	3	38	1990	78	-6
	Ardingly		4685	94	79	63	-11	47	1996	62	1
Wessex	Clatworthy		5364	100	85	70	6	31	1995	48	22
	Bristol	•	(38666)	86	78	75	6	43	1990	66	9
South West	Colliford		28540	75	65	55	-18	43	1997	66	-12
	Roadford		34500	70	59	50	-22	40	1995	59	-9
	Wimbleball		21320	95	85	78	8	40	1995	61	17
	Stithians		4967	89	77	72	9	30	1990	56	16
Welsh	Celyn & Brenig	•	131155	94	91	89	6	49	1989	61	28
	Brianne		62140	98	89	97	9	55	1995	72	25
	Big Five	•	69762	87	75	82	10	29	1995	52	30
	Elan Valley	•	99106	97	85	83	7	37	1976	48	35
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	85	81	84	5	45	1998	78	6
	East Lothian	•	9317	100	100	100	14	63	1989	77	23
Scotland(W)	Loch Katrine	•	110326	91	87	91	18	50	2000	59	32
	Daer		22494	83	81	99	21	41	1995	64	35
	Loch Thom		10798	97	98	100	16	58	1997	93	7
Northern Ireland	Total+	•	56800	93	87	92	16	40	1995	70	22
	Silent Valley	•	20634	96	87	94	21	33	2000	66	28

( ) figures in parentheses relate to gross storage

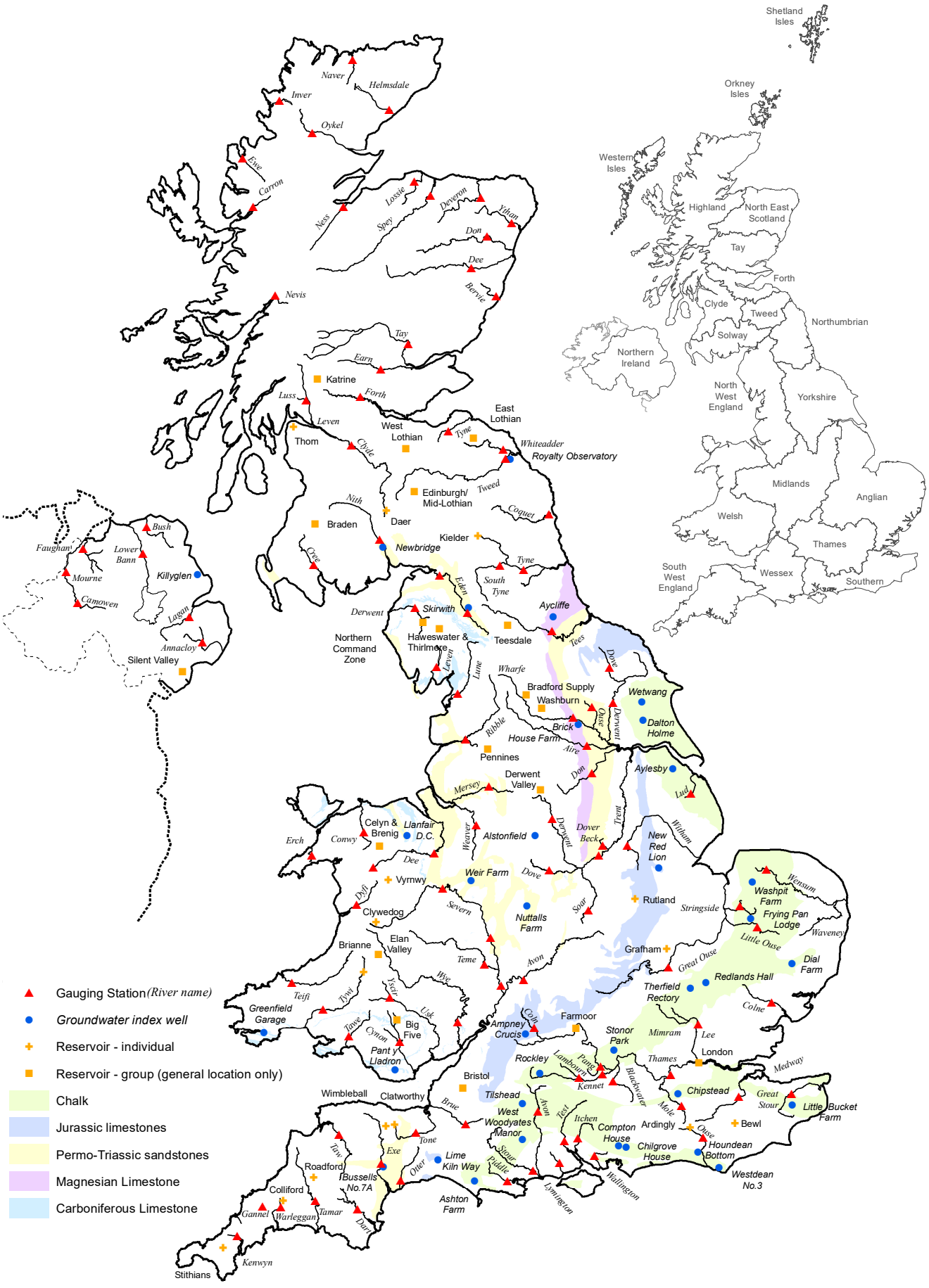
• denotes reservoir groups

*last occurrence

+ excludes Lough Neagh

Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes. Monthly figures may be artificially low due to routine maintenance or turbidity effects in feeder rivers.

Location map…Location map



NHMP

The National Hydrological Monitoring Programme (NHMP) was started in 1988 and is undertaken jointly by the Centre for Ecology & Hydrology (CEH) and the British Geological Survey (BGS). The NHMP aims to provide an authoritative voice on hydrological conditions throughout the UK, to place them in a historical context and, over time, identify and interpret any emerging hydrological trends. Hydrological analysis and interpretation within the Programme is based on the data holdings of the National River Flow Archive (NRFA; maintained by CEH) and National Groundwater Level Archive (NGLA; maintained by BGS), including rainfall, river flows, borehole levels, and reservoir stocks.

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

Some of the features displayed on the maps contained in this report are based on the following data with permission of the controller of HMSO.

i. Ordnance Survey data. © Crown copyright and/or database right 2005. Licence no. 100017897.
ii. Land and Property Services data. © Crown copyright and database right, S&LA 145.
iii. Met Office rainfall data. © Crown copyright.