Hydrological Summary

for the United Kingdom

November 2019

General

November was another cool and wet autumnal month, with multiple frontal systems bringing persistent and heavy rain to England & Wales. With the exception of north-western Britain (and notably western Scotland), rainfall was above average and exceptionally so across central England. November brings to an end a wet autumn; it was the fifth wettest in the long England and Wales Precipitation series (from 1766). The unsettled weather led to exceptional flow responses in central England, with a major flood event in parts of Yorkshire at the end of the first week. Elsewhere, flows were above normal, apart from in north-western Britain. Soil Moisture Deficits were near-zero across the UK and correspondingly groundwater recharge occurred at most sites, leading to above normal levels (or higher). The wet weather continued to increase reservoir stocks, notably so in some impoundments in southern England, and at the national scale stocks were above average. As a result of the wet summer and autumn the water resources outlook is healthy at the national scale, although in the eastern Chalk groundwater levels remain below normal entering the winter – rainfall over the coming months will determine the longer-term outlook in this area. However, the saturated soils and seasonal outlook for continued wet weather implies that there is a continued risk of flooding over the coming months in many parts of the UK.

Rainfall

The uncharacteristic southerly track of the jet stream continued through November, driving frontal systems across much of the UK with only a brief respite in the third week. On the 2nd, heavy rain in Wales (44mm at Aberdaron) closed several roads and strong winds along the south coast of England suspended cross-channel ferry services. Most notably, on the 7th, a low pressure system stalled over north Wales and central England bringing persistent rain. The 24-hour rainfall totals in Sheffield (82mm) and Doncaster (78mm) were more than 120% of the November average in these locations, and have provisional return periods of more than 40 years. A major incident was declared, road and rail networks were closed by surface water flooding and landslides and thousands of households were evacuated. For November as a whole, rainfall was more than 150% of average across the Midlands and north-eastern Britain with large parts of Yorkshire and Lincolnshire registering more than twice the average. In contrast, most of north-western Britain recorded less than 70% of average rainfall with less than 30% across much of western Scotland. A similar spatial pattern can be seen for the autumn (September-November), with a large part of central and eastern England receiving more than 150% of average – it was the third wettest autumn for the Yorkshire region (in a series from 1910). For the summer and autumn (June-November) it was the wettest for the Severn-Trent region (in a series from 1910).

River flows

The high flows seen across most catchments in England and Wales during October were sustained into November as a result of the continued unsettled weather. On the 7th/8th, more than 150 Flood Alerts and Warnings were issued across central England and Yorkshire, including six Severe Flood Warnings on the Don indicating the risk of danger to life. New daily and peak flow records were established on the Don and Derbyshire Derwent (in records of more than 50 years), exceeding the flows recorded during the of summer 2007 floods. Further exceptional flows were recorded mid-month in the West Midlands – new November daily and peak flow records were established on the Teme (in a series from 1971). Across both events, around 1,000 properties were flooded, whilst over 20,000 properties were protected by defences. Elsewhere, flows generally receded throughout the month in north-western Britain and new daily flow minima were established for 19 consecutive days on the Ewe. November mean flows were generally above normal or higher across England and Wales and were exceptionally high in most catchments in a band from the Severn estuary to the Humber, exceeding four times the average on the Don, Lud, Witham and Warwickshire Avon. New November mean flow records were established in these catchments as well as the Tweed and Kenwyn, all in records exceeding 50 years. In contrast, flows in the groundwater-fed catchments in south east England (except the Coln) and responsive catchments in north west Britain were in the normal range or below. November mean flows were less than a quarter of average and the lowest on record on the Carron and Ewe in records from 1979 and 1970 respectively. For the autumn (September-November), flows were above normal or higher across most of England and Wales and new maximum mean flow records were established in seven catchments. As a result, autumn outflows from England and Wales were the second highest on record (behind 2000) in a series from 1961.

Groundwater

Groundwater levels rose at the majority of Chalk index sites, becoming exceptionally high in Yorkshire, Lincolnshire and parts of the South Downs – a new November level record was established at Aylesby. Groundwater flooding occurred in the Barrow Upon Humber area in late November (leading to sewer surcharging and standing water) and groundwater flood alerts and warnings were also in force for the south west Chalk. In the Chilterns and East Anglia, where levels are slower to respond to rainfall, levels remained below normal and continued to decline at Therfield Rectory and Dial Farm. Despite falling overall at Pant y Lladron, levels remained above normal in the Carboniferous Limestone and continued to rise at Alstonfield where the level remained exceptionally high. In the Jurassic and Magnesian limestones, levels also remained exceptionally high, with a new record level established at New Red Lion (for a second consecutive month) following substantial recharge in response to the high rainfall. In the Permo-Triassic sandstone, levels generally remained stable (although recharge occurred at Weir Farm, Nuttalls Farm and Bussels No.7a) and ranged from normal to notably high. Levels rose gradually at Lime Kiln Way in the Upper Greensand and remained in the normal range. Recharge occurred in the Fell Sandstone at Royalty Observatory, and levels became above normal.

UK Centre for Ecology & Hydrology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

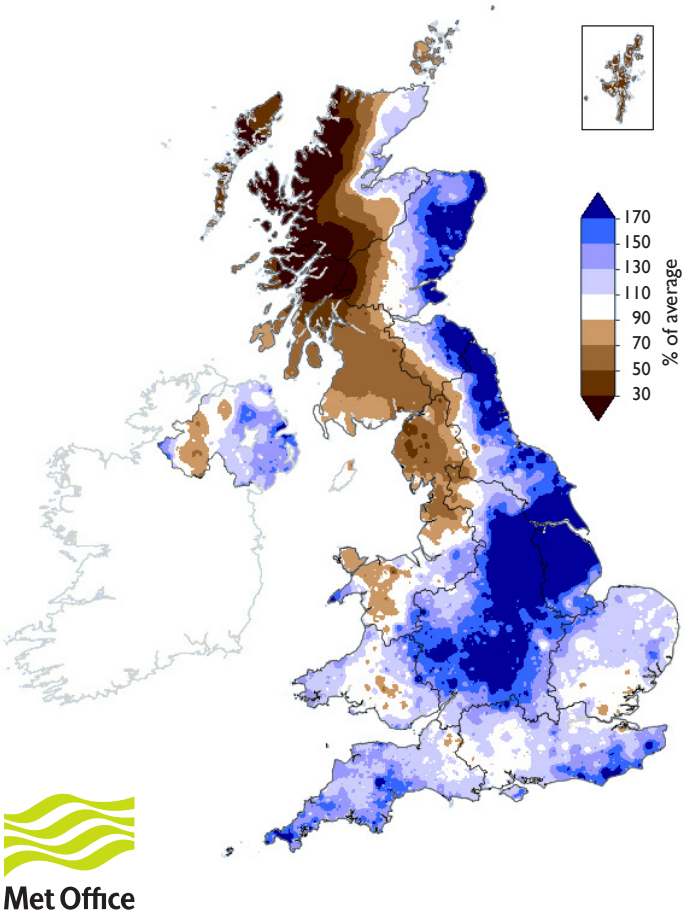
Region	Rainfall	Nov 2019	Sep19 – Nov19	RP	Jun19 – Nov19	RP	Mar19 – Nov19	RP	Dec18 – Nov19	RP
United Kingdom	mm	**118**	379		716		965		1221	
	%	**100**	113	5-10	126	20-30	121	40-60	108	5-10
England	mm	**116**	348		608		779		965	
	%	**134**	142	15-25	139	30-50	127	25-40	114	5-10
Scotland	mm	**104**	389		846		1192		1533	
	%	**65**	84	2-5	113	5-10	113	10-20	101	2-5
Wales	mm	**172**	557		910		1250		1633	
	%	**109**	128	8-12	128	10-15	126	25-40	115	8-12
Northern Ireland	mm	**129**	341		698		993		1230	
	%	**115**	105	2-5	121	8-12	121	30-50	108	5-10
England & Wales	mm	**124**	377		649		843		1057	
	%	**128**	139	15-25	137	25-40	126	25-40	115	5-10
North West	mm	**101**	423		856		1156		1445	
	%	**80**	116	2-5	135	10-20	132	40-60	118	10-20
Northumbria	mm	**131**	341		680		899		1028	
	%	**146**	138	10-20	150	60-90	141	>100	118	10-15
Severn-Trent	mm	**128**	354		648		819		985	
	%	**173**	162	50-80	159	>100	141	>100	126	25-40
Yorkshire	mm	**132**	401		664		851		1018	
	%	**159**	172	50-80	153	50-80	139	80-120	121	10-15
Anglian	mm	**83**	250		448		556		676	
	%	**139**	142	10-20	131	10-20	116	5-10	108	2-5
Thames	mm	**97**	277		466		586		741	
	%	**130**	131	5-10	126	5-10	111	2-5	104	2-5
Southern	mm	**118**	321		503		624		825	
	%	**129**	128	5-10	124	5-10	109	2-5	103	2-5
Wessex	mm	**111**	367		570		735		964	
	%	**115**	138	8-12	129	5-10	117	5-10	109	2-5
South West	mm	**195**	545		813		1044		1377	
	%	**141**	148	20-35	136	15-25	123	15-25	112	5-10
Welsh	mm	**168**	540		885		1210		1576	
	%	**111**	129	8-12	129	10-20	126	25-40	115	8-12
Highland	mm	**83**	388		885		1285		1728	
	%	**43**	71	5-10	103	2-5	105	2-5	96	2-5
North East	mm	**155**	342		665		958		1139	
	%	**141**	108	2-5	123	8-12	128	50-80	112	5-10
Tay	mm	**131**	366		769		1092		1331	
	%	**93**	90	2-5	116	5-10	117	10-15	99	2-5
Forth	mm	**109**	351		747		1033		1222	
	%	**92**	99	2-5	123	10-15	122	20-35	101	2-5
Tweed	mm	**124**	343		716		994		1150	
	%	**120**	116	2-5	136	15-25	135	40-60	112	5-10
Solway	mm	**114**	463		943		1313		1670	
	%	**73**	103	2-5	125	10-20	125	30-50	112	10-20
Clyde	mm	**88**	454		1034		1402		1807	
	%	**46**	82	2-5	114	5-10	111	8-12	99	2-5

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

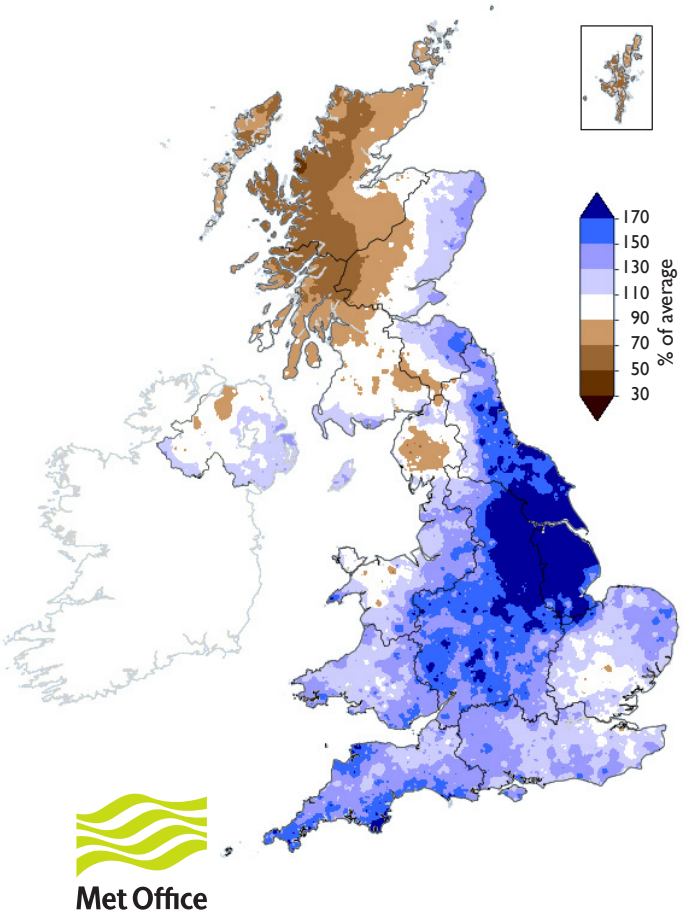
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1910; they also assume a stable climate. The quoted RPs relate to the specific timespans only; for the same timespans, but beginning in any month the RPs would be substantially shorter. The timespans featured do not purport to represent the critical periods for any particular water resource management zone. For hydrological or water resources assessments of drought severity, river flows and/or groundwater levels normally provide a better guide than return periods based on regional rainfall totals. Note that precipitation totals in winter months may be underestimated due to snowfall undercatch. All monthly rainfall totals since January 2018 are provisional.

Rainfall . . . Rainfall . . .

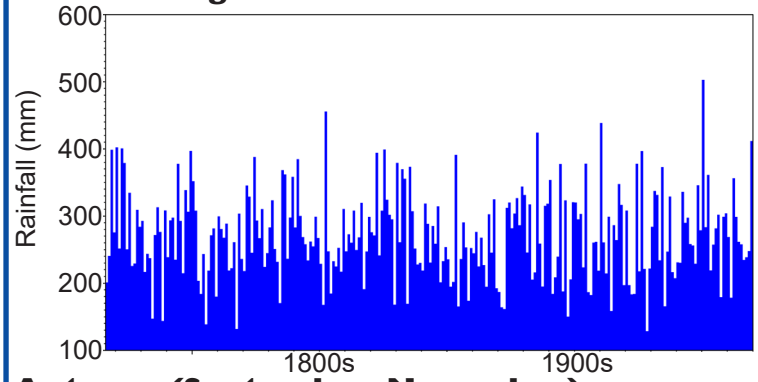
November 2019 rainfall as % of 1981-2010 average



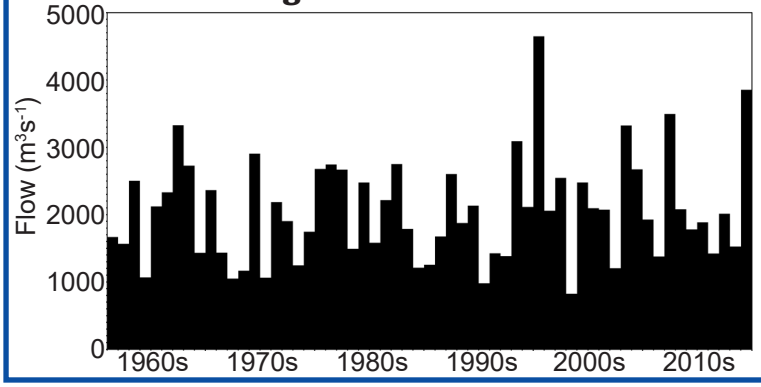
September 2019 - November 2019 rainfall as % of 1981-2010 average



Autumn (September-November) rainfall for CRU England & Wales



Autumn (September-November) average outflows for England & Wales



Hydrological Outlook UK

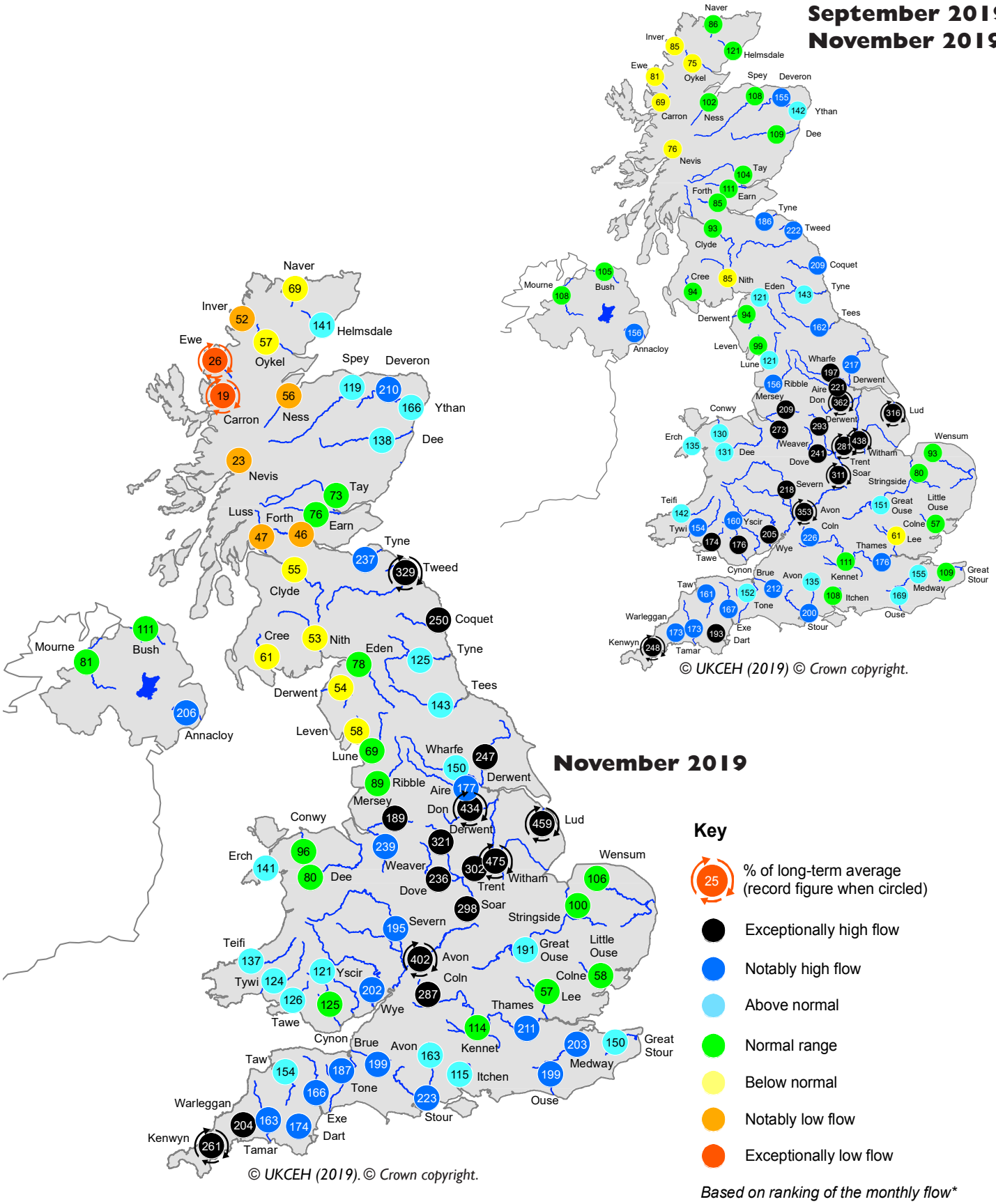
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from December 2019**
Issued: **10.12.2019**
using data to the end of November 2019

The outlook for December is for river flows and groundwater levels to be normal to above normal across the majority of the UK. River flows and groundwater levels may continue to be notably high in parts of the East Midlands. River flows in the Chalk fed catchments of East Anglia and the Chilterns, as well as the groundwater levels of this region, are likely to be normal to below normal over December-January-February as a whole.

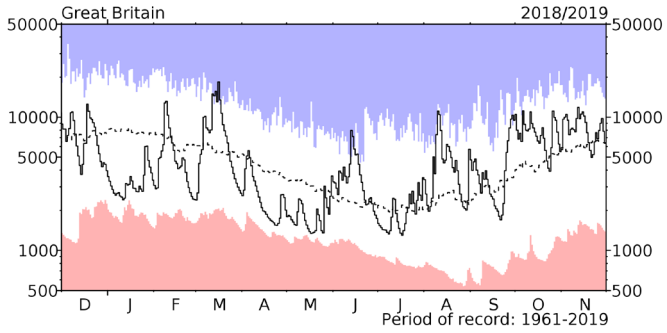
River flow . . . River flow . . .

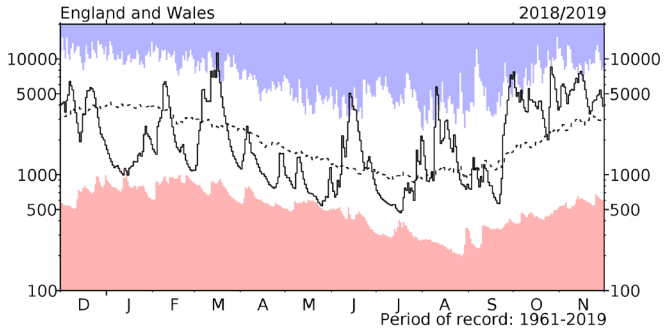


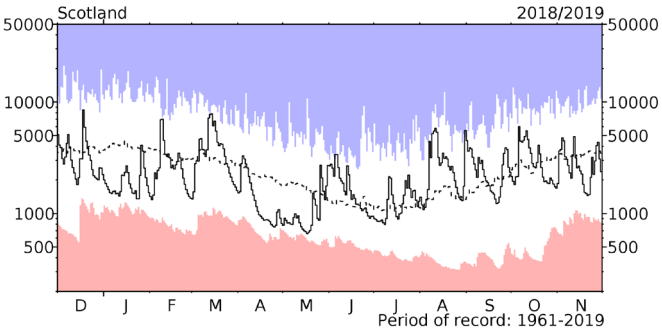
River flows

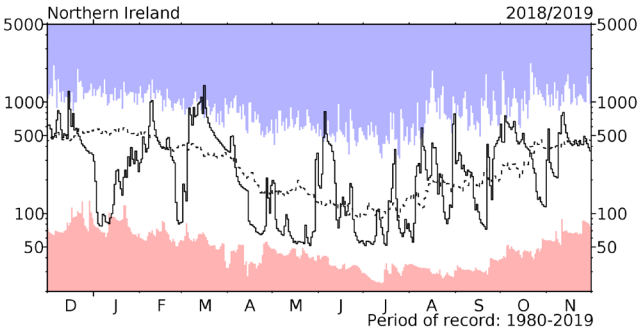
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

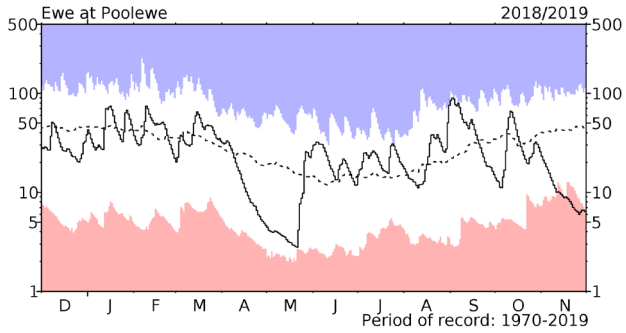
River flow . . . River flow . . .

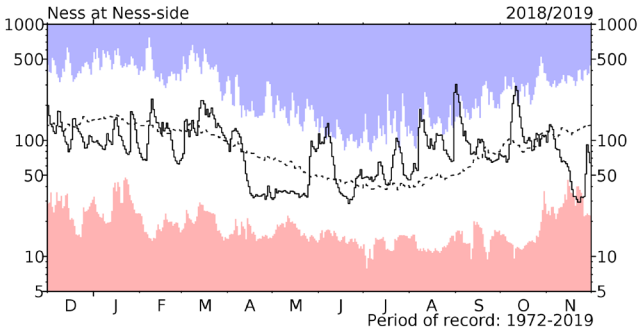


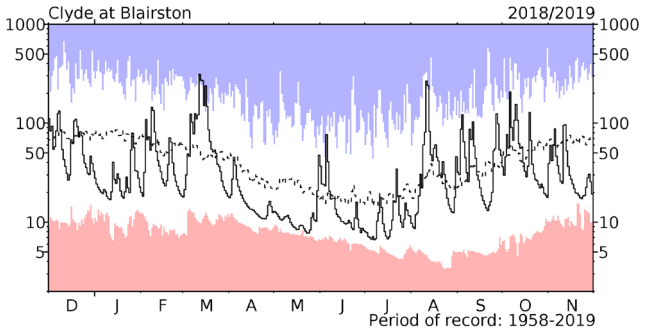


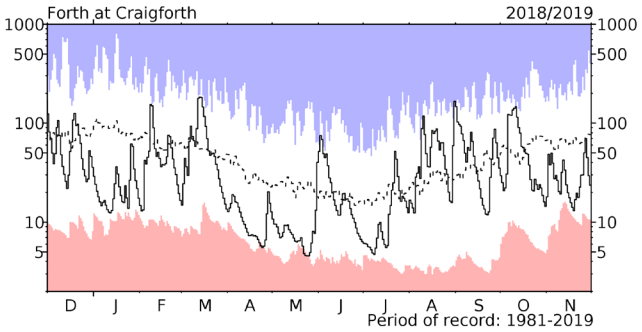


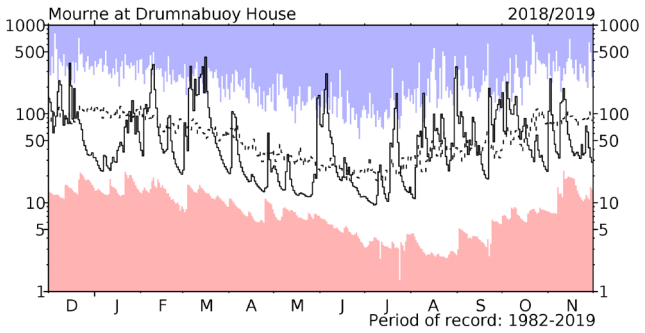


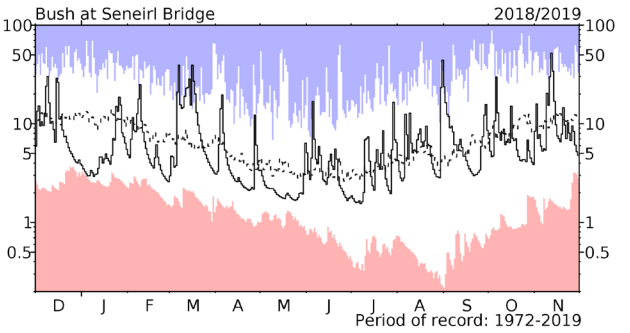








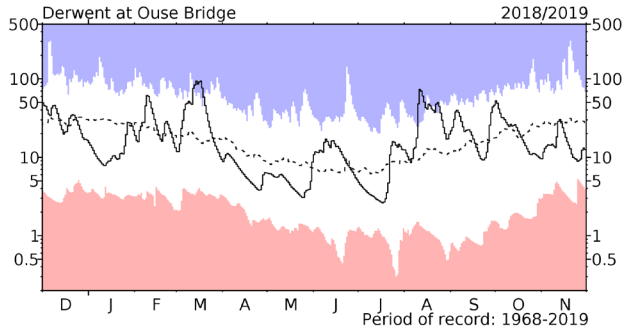


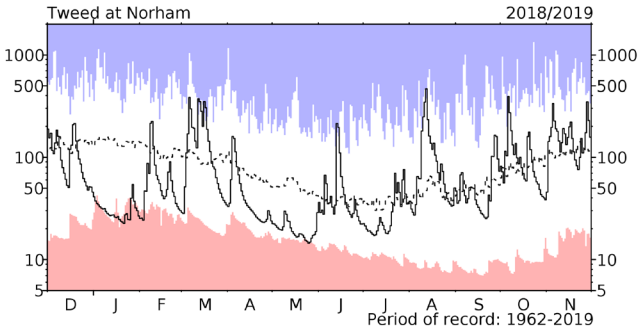


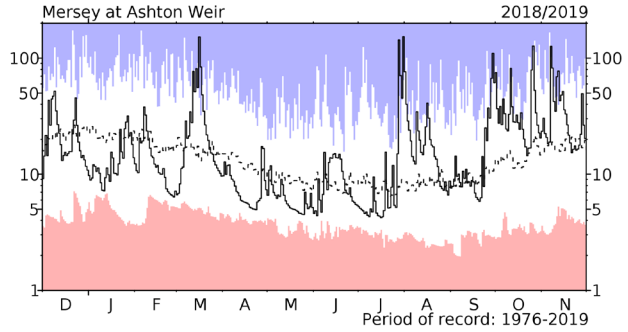
River flow hydrographs

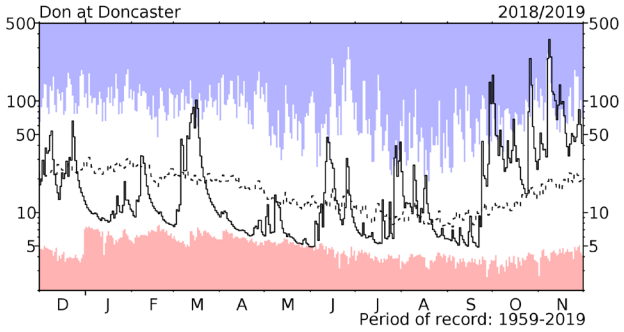
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to December 2018 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

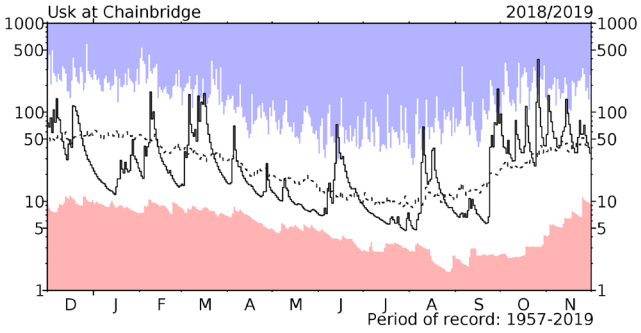
River flow . . . River flow . . .

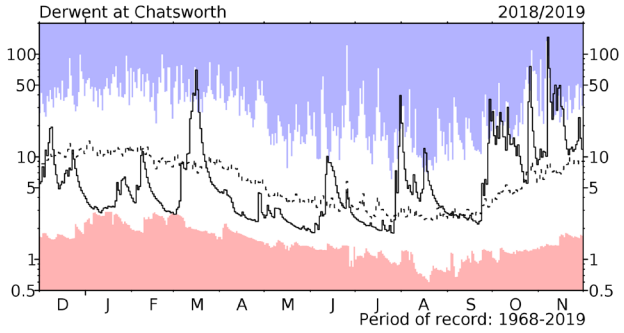


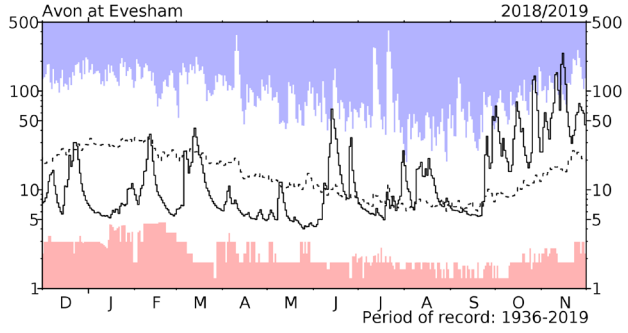


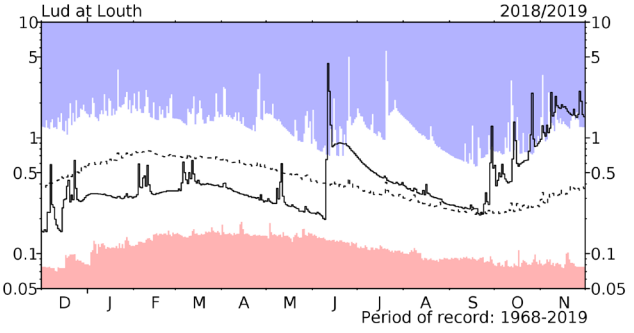


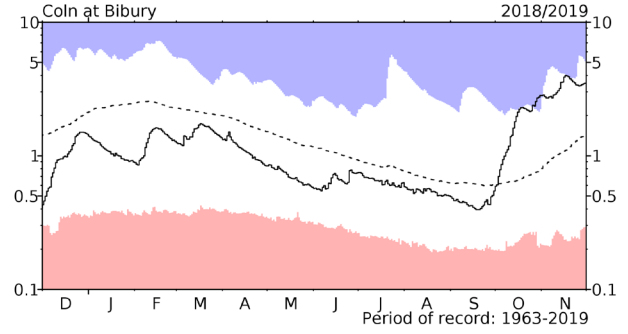


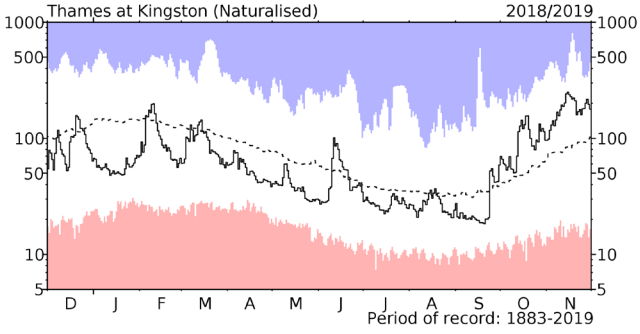


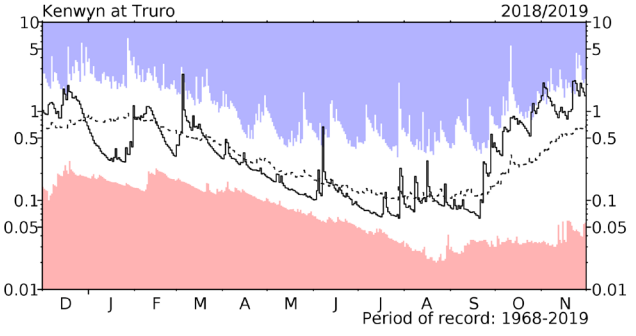


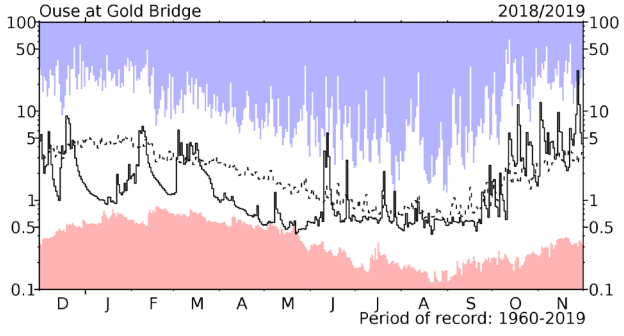




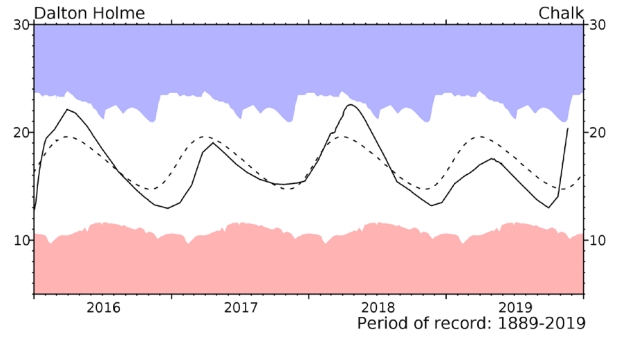


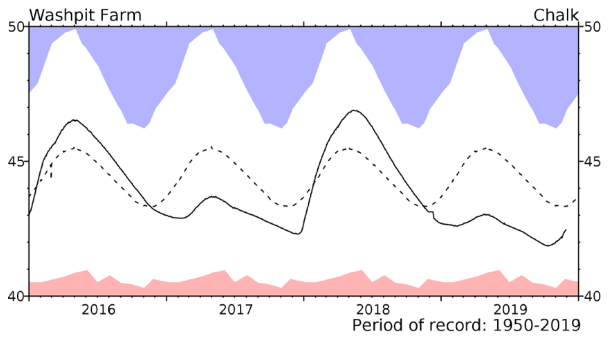


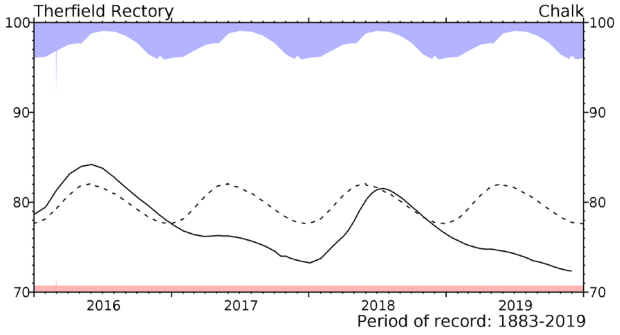


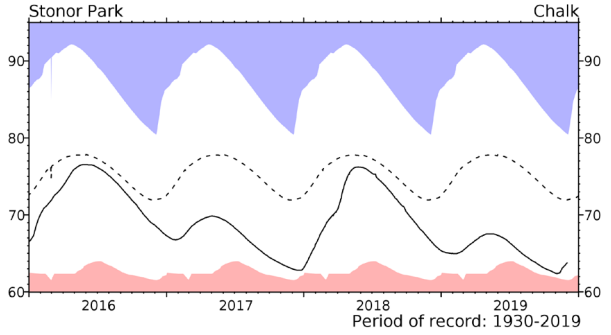


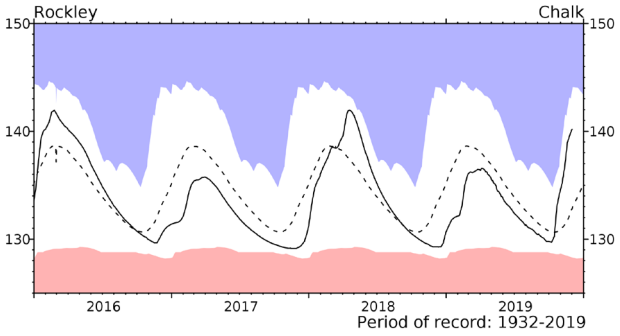
Groundwater…Groundwater

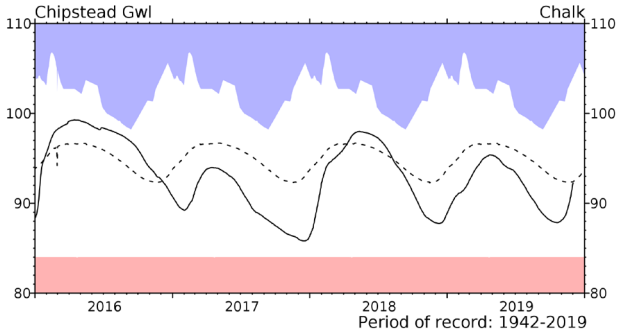


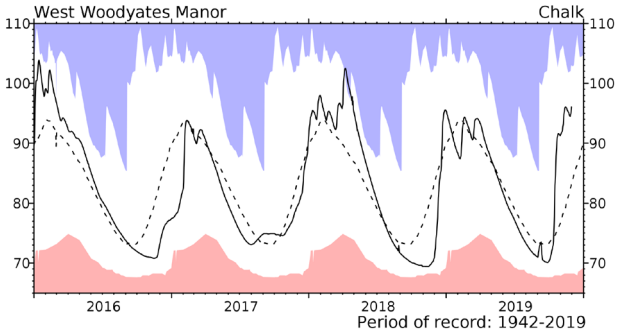


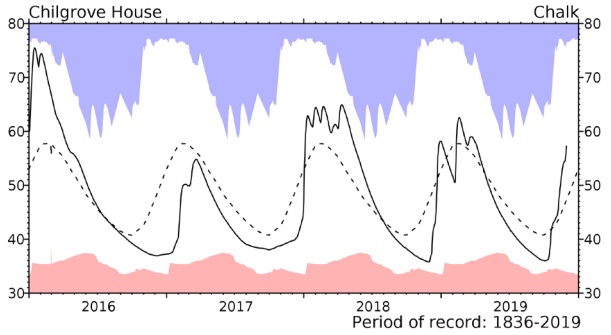


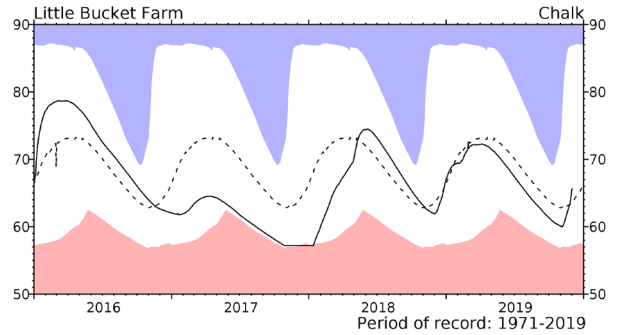


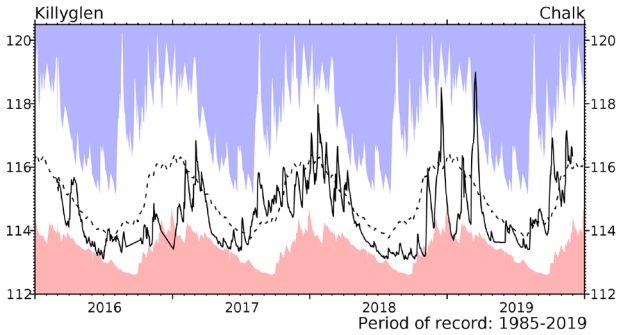






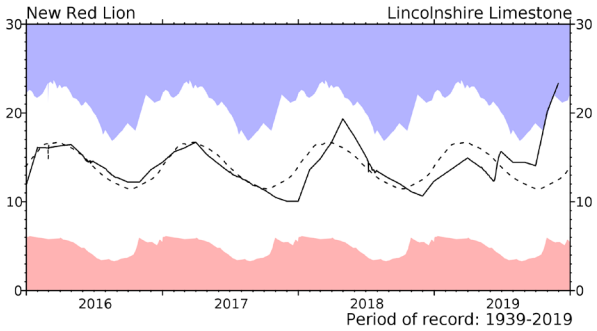


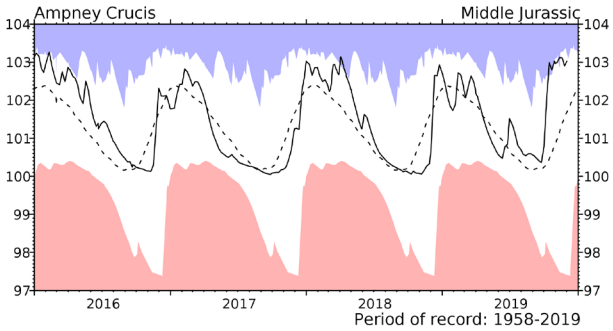


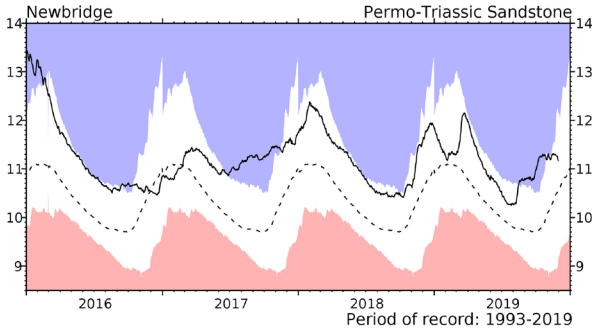


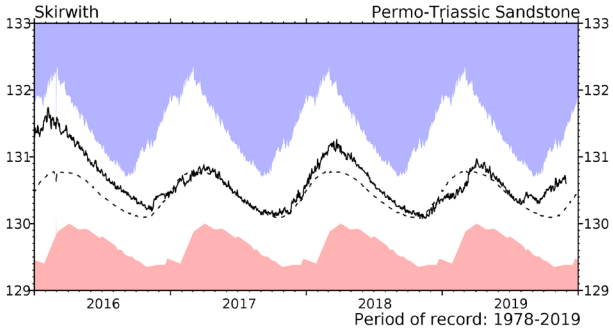
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

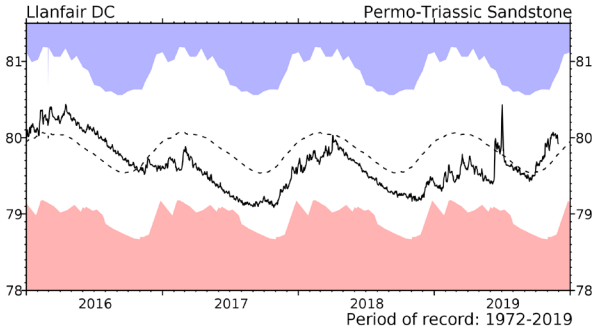
Groundwater ... Groundwater

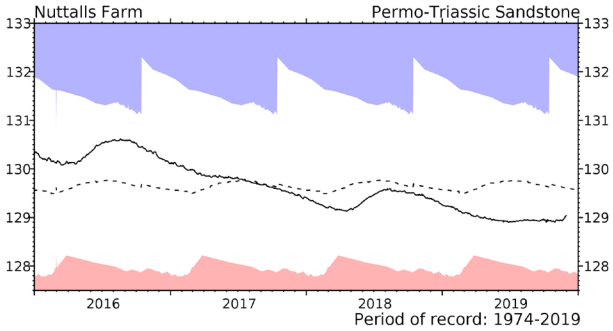


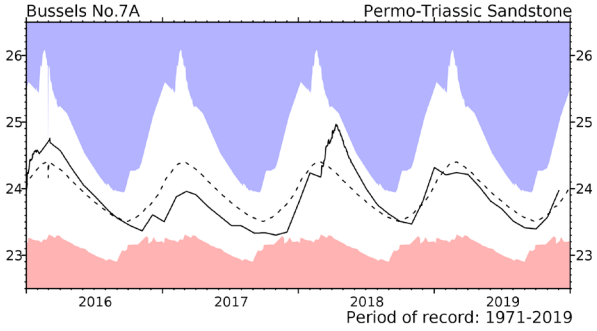


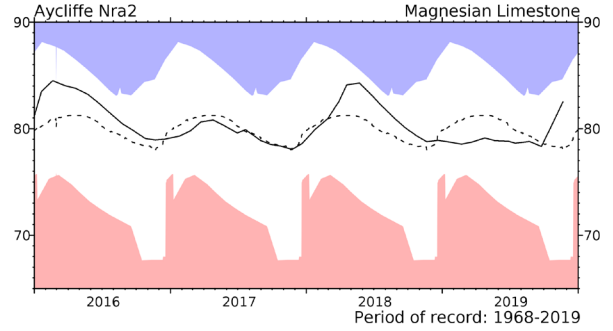


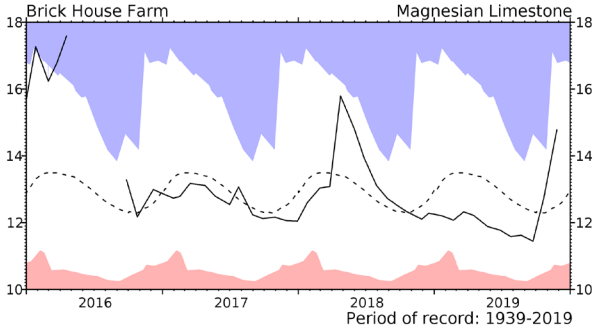


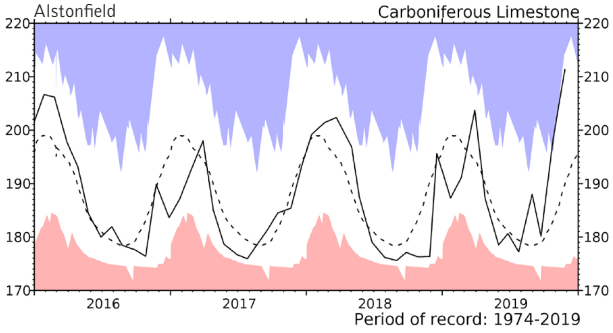


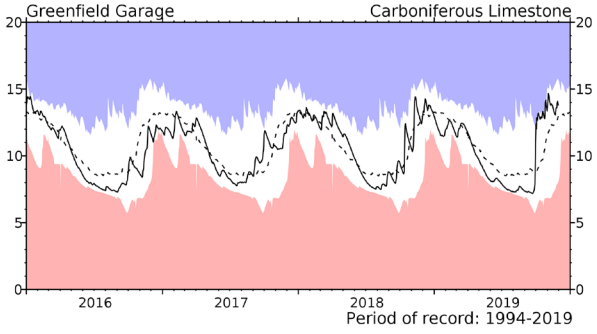


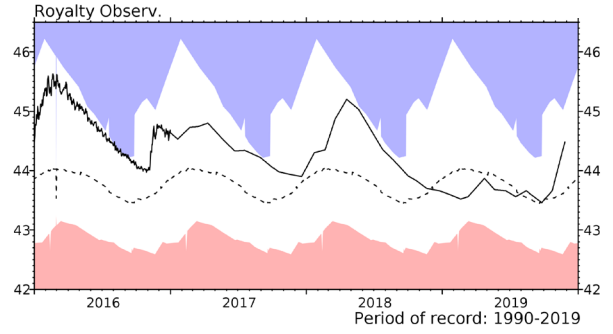


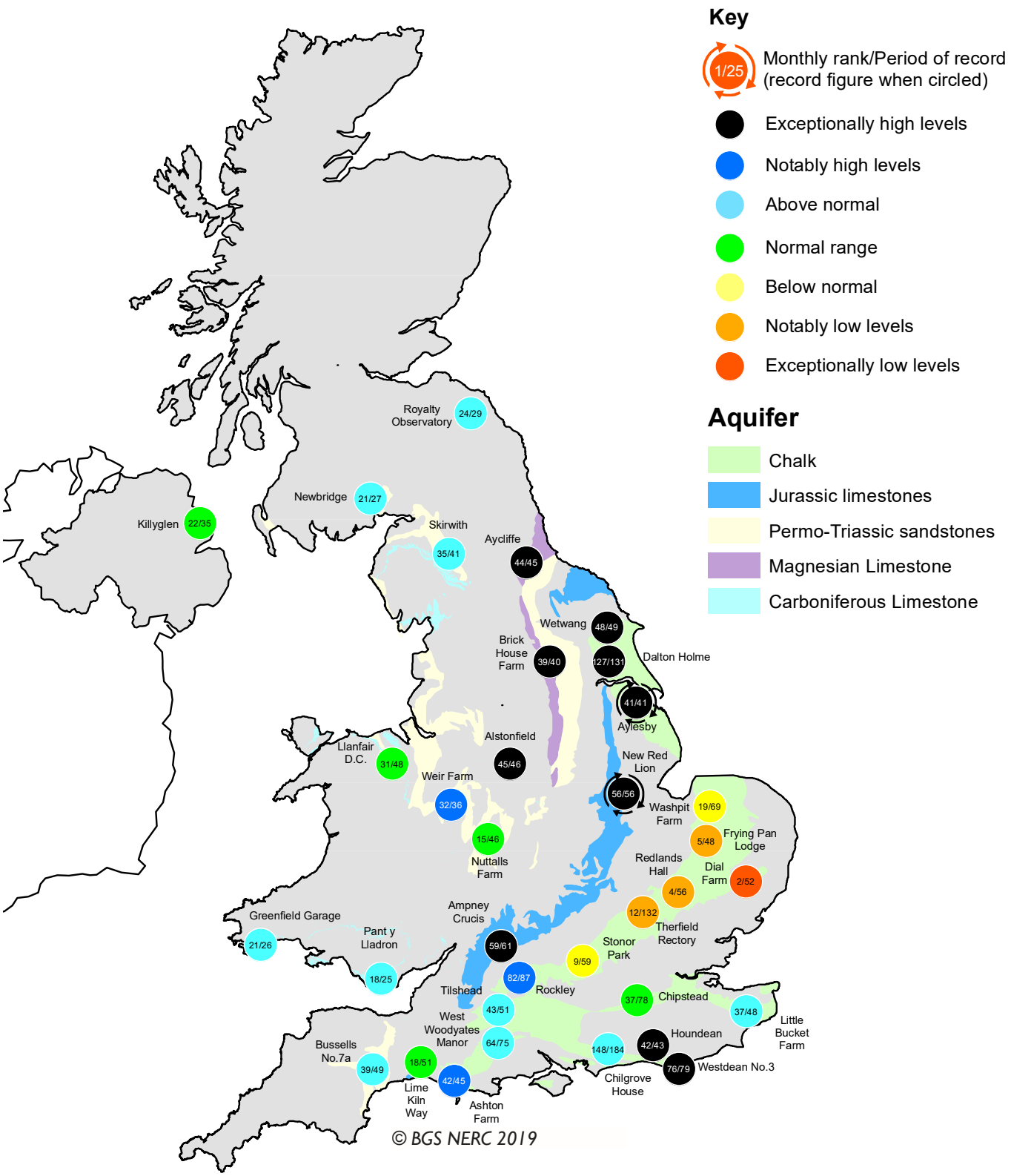










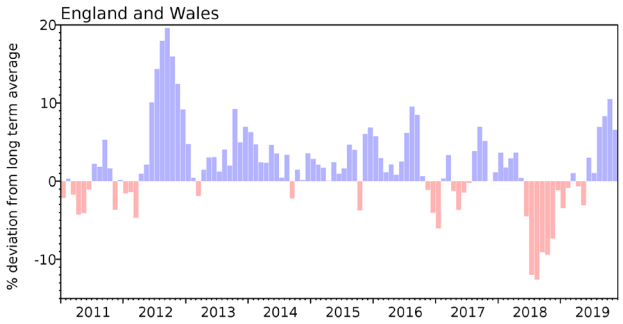


Groundwater levels - November 2019

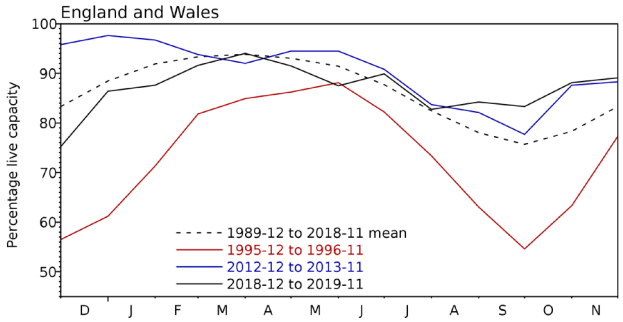
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Sep	2019 Oct	2019 Nov	Nov Anom.	Min Nov	Year* of min	2018 Nov	Diff 19-18
North West	N Command Zone	•	124929	80	78	74	-4	44	1993	84	-10
	Vyrnwy		55146	100	100	96	13	33	1995	81	14
Northumbrian	Teesdale	•	87936	98	96	100	17	39	1995	86	13
	Kielder		(199175)	85	82	81	-5	55	2007	82	-1
Severn-Trent	Clywedog		49936	100	88	86	4	43	1995	87	-1
	Derwent Valley	•	46692	95	100	100	22	9	1995	40	60
Yorkshire	Washburn	•	23373	95	99	92	16	16	1995	60	32
	Bradford Supply	•	40942	91	100	100	18	20	1995	54	46
Anglian	Grafham		(55490)	76	84	88	6	47	1997	60	28
	Rutland		(116580)	93	96	96	17	57	1995	77	19
Thames	London	•	202828	65	89	92	10	52	1990	61	31
	Farmoor	•	13822	98	97	95	7	52	1990	94	1
Southern	Bewl		31000	65	77	85	22	33	2017	72	13
	Ardingly		4685	54	67	100	27	14	2011	42	59
Wessex	Clatworthy		5364	59	85	100	22	16	2003	52	48
	Bristol	•	(38666)	71	88	99	31	27	1990	61	38
South West	Colliford		28540	51	59	68	-6	42	1995	62	6
	Roadford		34500	48	58	66	-9	19	1995	54	12
	Wimbleball		21320	71	88	100	28	34	1995	50	50
	Stithians		4967	70	99	100	34	29	2001	55	45
Welsh	Celyn & Brenig	•	131155	89	84	84	-4	50	1995	78	6
	Brianne		62140	100	100	99	3	72	1995	100	-1
	Big Five	•	69762	85	87	86	3	49	1990	84	2
	Elan Valley	•	99106	91	97	99	5	47	1995	94	5
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	87	88	90	4	45	2003	92	-2
	East Lothian	•	9317	100	100	100	11	38	2003	76	24
Scotland(W)	Loch Katrine	•	110326	95	95	95	4	65	2007	99	-4
	Daer		22494	97	100	97	0	73	2003	99	-2
	Loch Thom		10798	100	96	89	-6	72	2003	99	-10
Northern Ireland	Total+	•	56800	92	96	99	13	59	2003	86	13
	Silent Valley	•	20634	90	97	99	17	43	2001	85	14

( ) figures in parentheses relate to gross storage

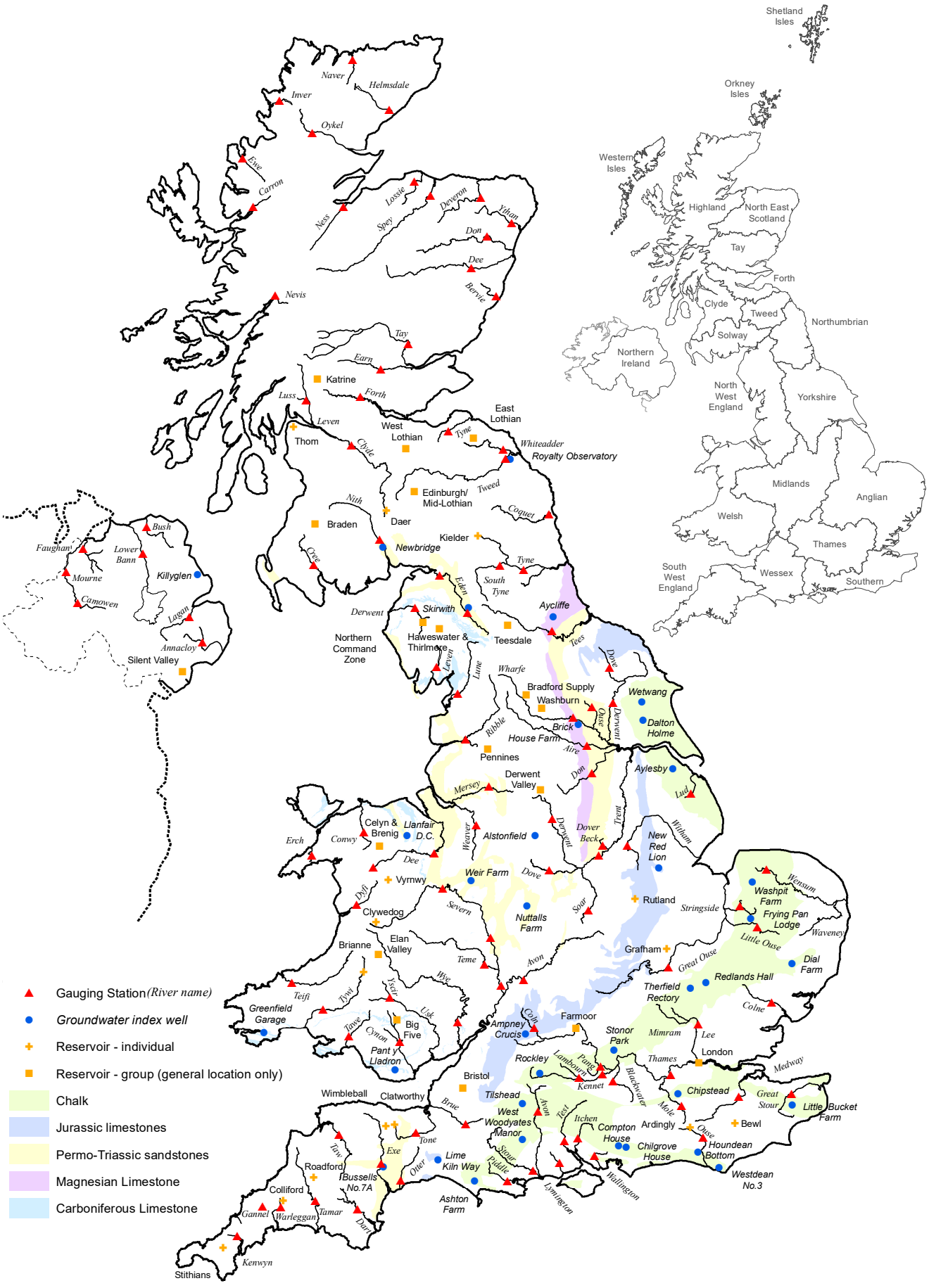
• denotes reservoir groups

*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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