Hydrological Summary

for the United Kingdom

November 2021

General

For the most part, November was a settled but wintery month with little appreciable rainfall. Storm 'Arwen' was most notable for significant wind damage after a rare, red weather warning was issued on the 26th/27th. Three people lost their lives, thousands of trees were felled and hundreds of thousands of homes were without power for several days (in some cases, for over two weeks) across northern England. Rainfall for the UK was less than two-thirds of average, with exceptionally dry conditions in southern England. Correspondingly, river flows and soil moisture were in the normal range to notably low. Groundwater levels fell in most boreholes in England; despite this, levels were predominantly in the normal range to above normal. Month-end reservoir stocks varied across the UK although in general, fell relative to average and approached 20% below average at Silent Valley, Bradford Supply and Derwent Valley. Despite the dry November, the water resources situation is healthy entering the winter (overall stocks for England & Wales were near-average), and current outlooks suggest normal to above normal flows in northern areas, with elevated flood risk in the short term following a wetter start to December.

Rainfall

Wet weather at the end of October continued in the first week of November, particularly in northern parts, e.g. 47mm at Stonyhurst (Lancashire) on the 1st, 60mm at Seathwaite (Cumbria) on the 7th. Thereafter, high pressure prevailed and brought more settled conditions with little appreciable rainfall at the national scale, although several frontal incursions brought rainfall to northern Scotland (e.g. 58mm Resallach on the 18th and 67mm Achfary on the 19th, both Highlands). The settled conditions remained until the last week with 31mm at Pen-y-Coed (Powys) on the 25th, and storm 'Arwen' on the 26th/27th brought snow, predominantly across the Southern Uplands and the Pennines (e.g. 18cm recorded in Middleton, Derbyshire), on the 27th. The UK as a whole received 63% of average November rainfall – the driest since 1993, in a series from 1910. Less than a half the average rainfall was registered across much of England and Wales, with large parts receiving less than a third. It was the third driest November on record for England and the driest since 1956 in Wales. At the regional scale, it was the driest November on record for Wessex (19% of average), and the second driest for Thames and Southern regions with 21% and 15% of average, respectively (all in series from 1910). Only in the far north of Scotland, Western Isles, Orkney, Shetland and around Berwick-upon-Tweed was rainfall above average, with over 170% in some parts. The autumn was more mixed, with much of England and Wales receiving less than 90% of average, but with localised areas of above average rainfall. Over the longer-term (Mar-Nov) below average rainfall was received, with only the North East region in Scotland receiving average rainfall for this period.

River flows

High flows persisted into the first few days of November, with new daily flow maxima established in catchments across the north and west of the UK, including the fifth highest November peak flow on the Ribble on the 1st (in a series from 1964). Thereafter, recessions commenced from well above-average and became established to month-end across England, Wales and Northern Ireland, with flows in many rivers well below average. Muted responses occurred in Northern Ireland, northern England and East Anglia mid-month, but did not disrupt the overall recession. Rainfall associated with storm 'Arwen' brought high flows to catchments away from southern England and Wales. Despite increases at month-end, outflows from England & Wales ended the month just below average. Monthly mean flows were generally in the normal range, although for the most part were below average, with many less than half the average (e.g. on the Annacloy, Waveney, Colne, Great Ouse, Medway and Brue). Notably low flows were recorded in south Wales, with the Yscir and Cynon less than half the average – the third and fifth lowest on record (in series from 1973 and 1957, respectively). A pattern similar to November was established over the autumn (Sep-Nov) and, for the most part, extends back to the spring. Over the last nine months (Mar-Nov) below normal to exceptionally low flows were recorded in Northern Ireland, with a minimum set for this period on the Annacloy at half the average flow. Whilst above normal flows were recorded in several catchments extending from Norfolk to Devon, with notably high flows in some areas (almost 125% of average on the Itchen). Elsewhere, flows were in the normal range, but were generally below average.

Soil moisture and Groundwater

Soils generally dried throughout November, but there were some sharp increases at month-end in response to rainfall in the last week. For the most part, soil moisture was in the normal range to notably dry, with exceptionally low soil moisture recorded at Hollin Hill and notably wet soils at Glensaugh. Any remaining soil moisture deficits were eliminated in Scotland, whilst a deficit remained in the east of England. Groundwater levels fell at over half of Chalk sites, in the Chilterns and more easterly locations. Despite this recharge hiatus, levels at most sites became, or remained, in the normal range, with a few above normal. In the Jurassic Limestones levels rose and remained in the normal range. Groundwater levels fell in the Magnesian Limestone, and moved towards normal, now being above normal at Aycliffe and notably high at Brick House Farm. Levels in the Carboniferous Limestone of south Wales fell steeply following a peak related to end of October rainfall and were below normal. At Pant y Lladron the levels changed from notably high in October to below normal for November. At Alstonfield the level rose and remained in the normal range. Levels fell in the Permo-Triassic sandstones, and generally remained in the normal range or moved towards normal. At Lime Kiln Way in the Upper Greensand, levels fell but remained exceptionally high; levels rose slightly in the Fell Sandstones and were in the normal range.

Note that due to continuing issues with data access, no data are available for Scotland.

National Hydrological Monitoring Programme | UK Centre for Ecology & Hydrology | BGS British Geological Survey

Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

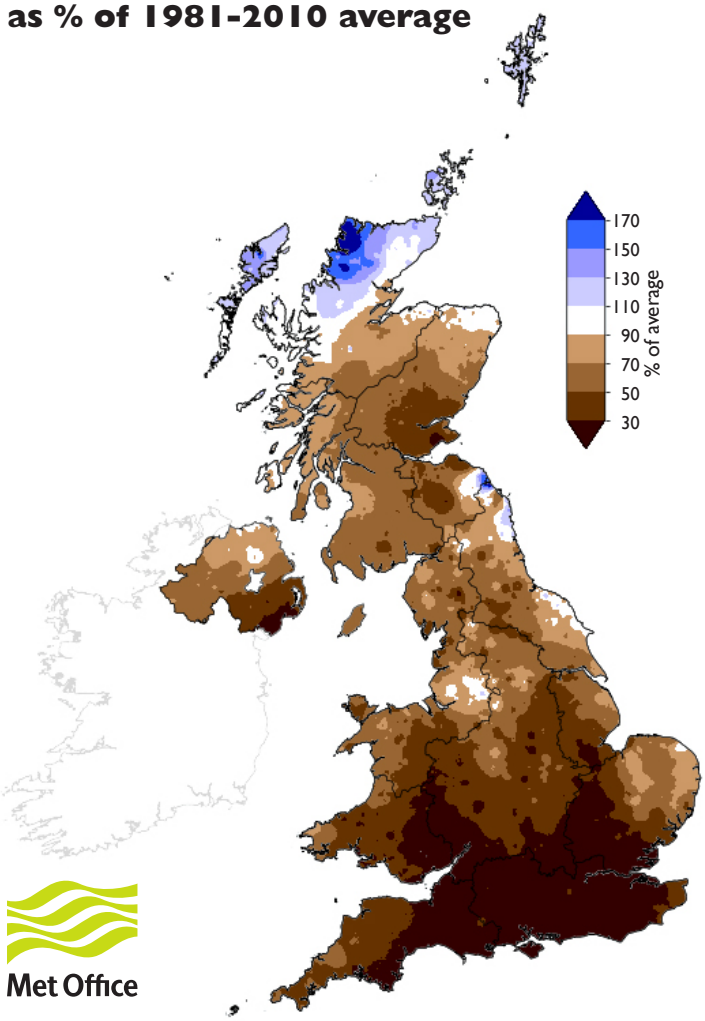
Region	Rainfall	Nov 2021	Sep21 – Nov21	RP	Jun21 – Nov21	RP	Mar21 – Nov21	RP	Dec20 – Nov21	RP
United Kingdom	mm	**75**	316		498		721		1122	
	%	**63**	94	2-5	87	2-5	90	2-5	100	2-5
England	mm	**39**	220		395		567		895	
	%	**45**	90	2-5	91	2-5	92	2-5	106	2-5
Scotland	mm	**137**	462		650		936		1408	
	%	**86**	100	2-5	87	2-5	89	2-5	93	2-5
Wales	mm	**69**	393		582		906		1525	
	%	**44**	90	2-5	82	5-10	91	2-5	107	2-5
Northern Ireland	mm	**69**	281		470		685		1041	
	%	**62**	87	2-5	81	5-10	83	5-10	92	2-5
England & Wales	mm	**43**	244		421		614		981	
	%	**45**	90	2-5	89	2-5	92	2-5	106	2-5
North West	mm	**86**	392		594		869		1333	
	%	**68**	107	2-5	94	2-5	99	2-5	109	2-5
Northumbria	mm	**68**	233		386		554		936	
	%	**76**	95	2-5	85	2-5	87	2-5	107	2-5
Severn-Trent	mm	**31**	189		337		508		814	
	%	**42**	86	2-5	83	2-5	88	2-5	104	2-5
Yorkshire	mm	**54**	208		379		570		921	
	%	**65**	90	2-5	88	2-5	93	2-5	110	2-5
Anglian	mm	**28**	141		280		401		641	
	%	**48**	80	2-5	82	2-5	84	2-5	103	2-5
Thames	mm	**16**	179		367		510		753	
	%	**21**	85	2-5	99	2-5	97	2-5	105	2-5
Southern	mm	**14**	195		426		553		844	
	%	**15**	78	2-5	105	2-5	97	2-5	106	2-5
Wessex	mm	**18**	223		408		585		888	
	%	**19**	84	2-5	92	2-5	93	2-5	101	2-5
South West	mm	**53**	341		571		811		1334	
	%	**38**	93	2-5	95	2-5	96	2-5	109	2-5
Welsh	mm	**65**	381		567		879		1477	
	%	**43**	91	2-5	82	5-10	91	2-5	108	2-5
Highland	mm	**209**	557		754		1107		1592	
	%	**108**	102	2-5	87	2-5	91	2-5	88	2-5
North East	mm	**87**	313		510		748		1105	
	%	**79**	99	2-5	95	2-5	100	2-5	109	2-5
Tay	mm	**80**	346		565		854		1318	
	%	**57**	85	2-5	85	2-5	91	2-5	98	2-5
Forth	mm	**64**	341		528		748		1172	
	%	**54**	96	2-5	87	2-5	88	2-5	97	2-5
Tweed	mm	**66**	320		477		686		1121	
	%	**64**	108	2-5	90	2-5	93	2-5	109	5-10
Solway	mm	**94**	490		656		922		1449	
	%	**59**	109	2-5	87	2-5	88	2-5	97	2-5
Clyde	mm	**136**	525		719		994		1569	
	%	**72**	95	2-5	79	5-10	79	5-10	86	2-5

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

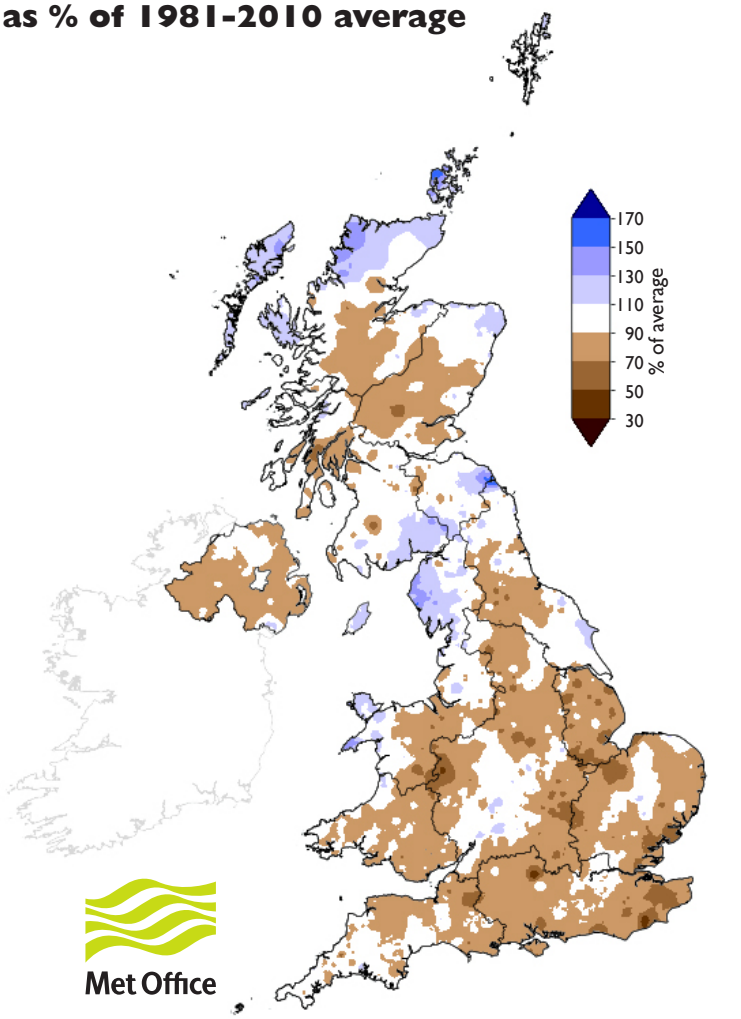
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic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

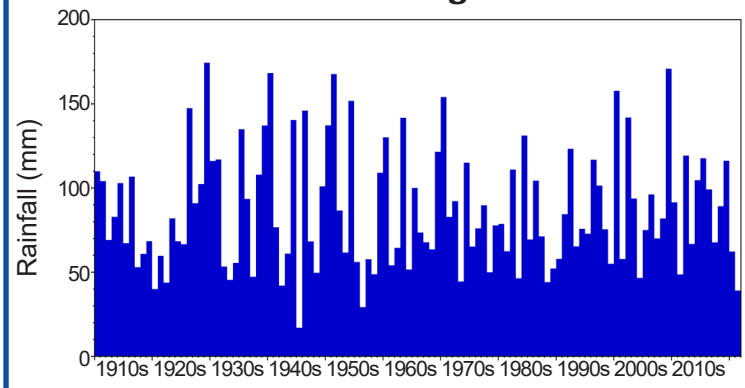
November 2021 rainfall as % of 1981-2010 average



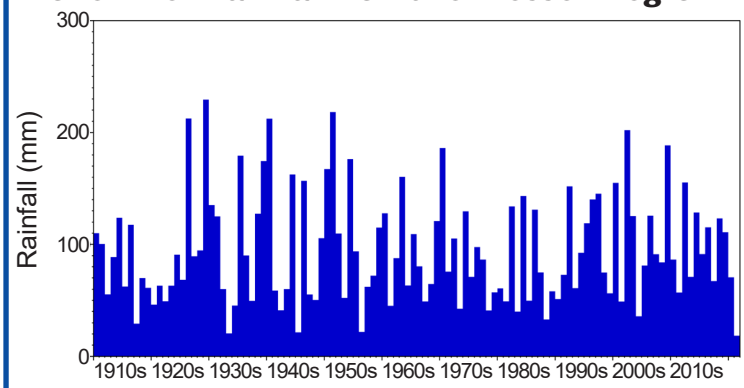
September 2021 - November 2021 rainfall as % of 1981-2010 average



November rainfall for England



November rainfall for the Wessex region



Hydrological Outlook UK

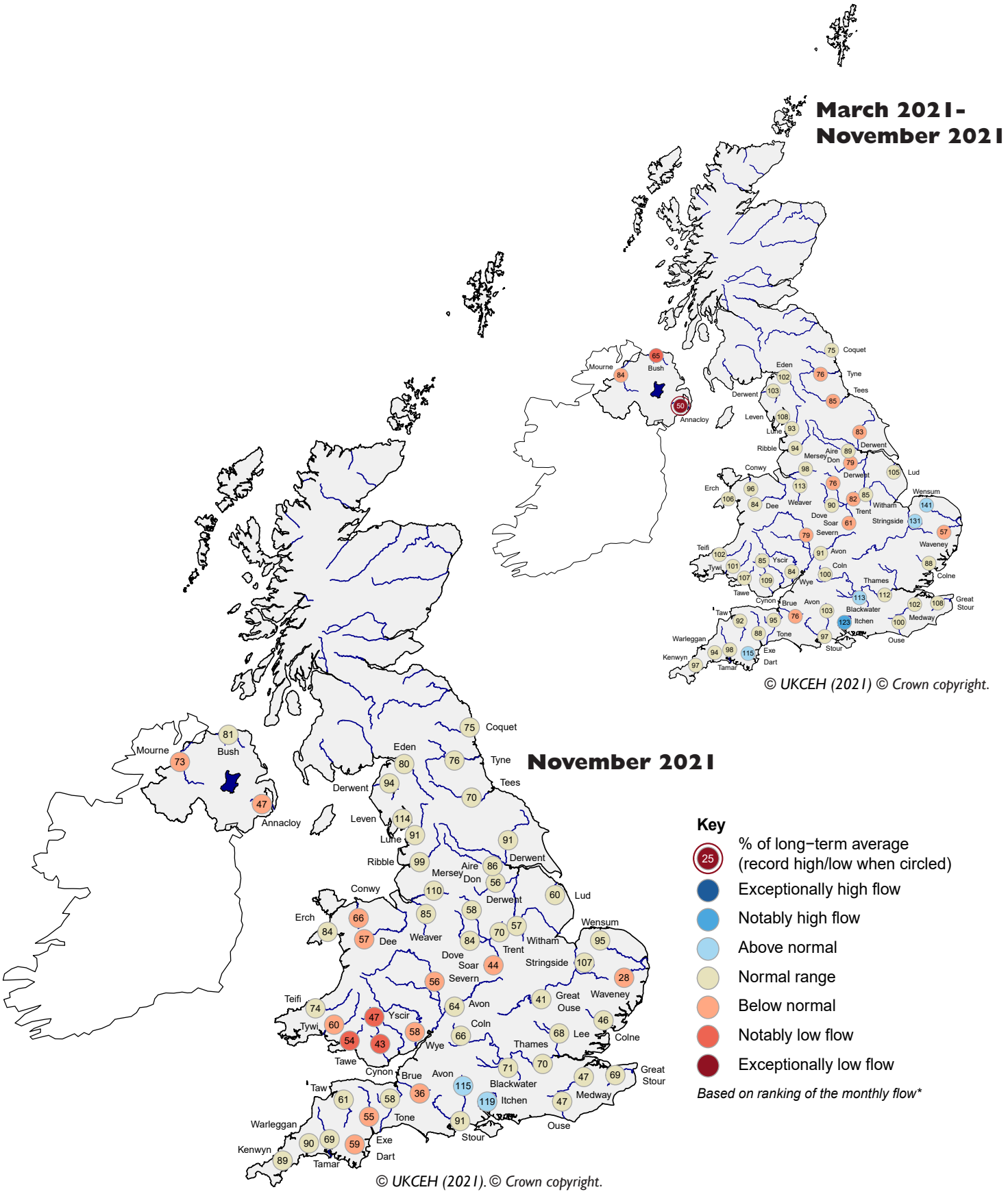
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from December 2021**
Issued: **09.12.2021**
using data to the end of November2021

River flows in December are likely to be normal to above normal in northern Britain, and normal to below normal in the south. Groundwater levels are likely to be normal to above normal across the country. Over the three month period to February 2022, river flows expected to be normal to above normal in the north and normal in the south. Groundwater levels are most likely to be in the normal range over this period.

River flow . . . River flow . . .

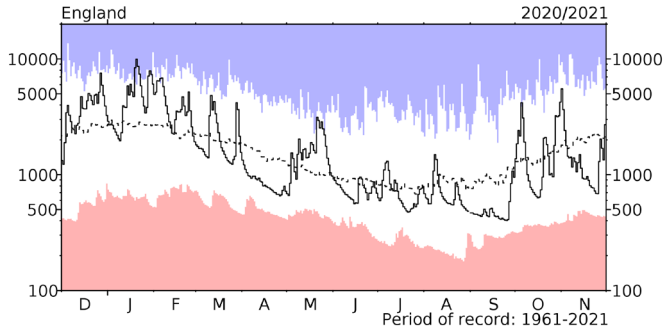


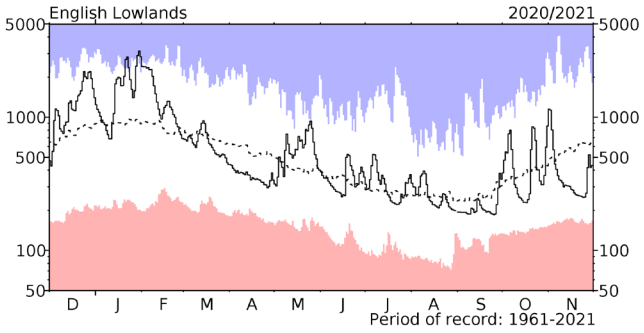
River flows

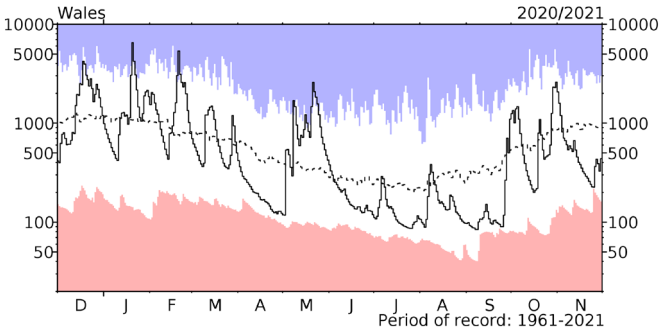
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

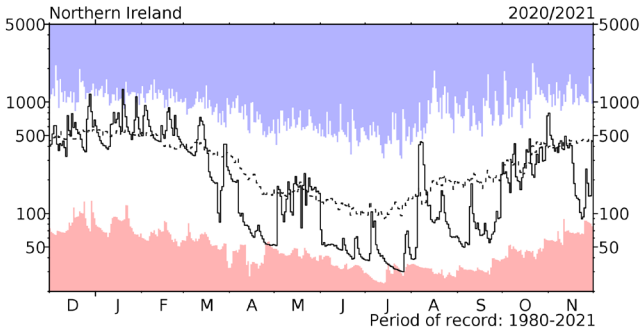
Note that due to continuing issues with data access, no data are available for Scotland.

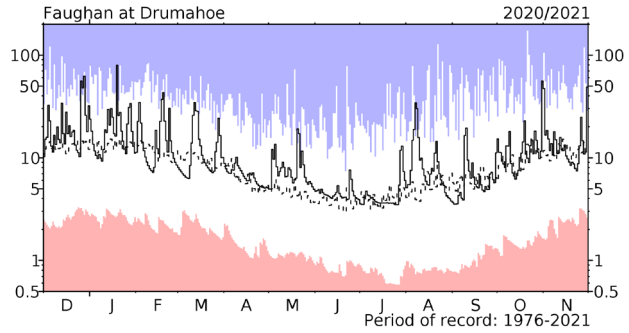
River flow . . . River flow . . .

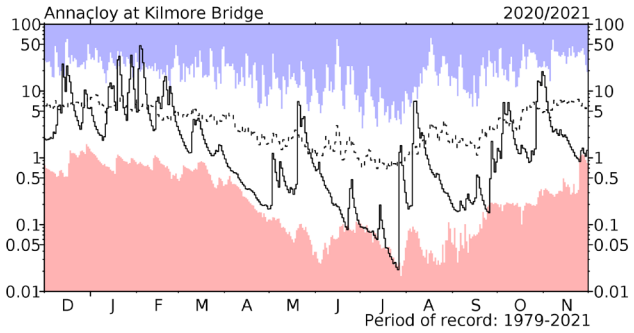


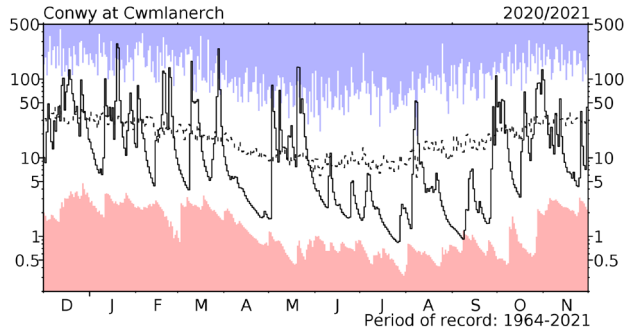


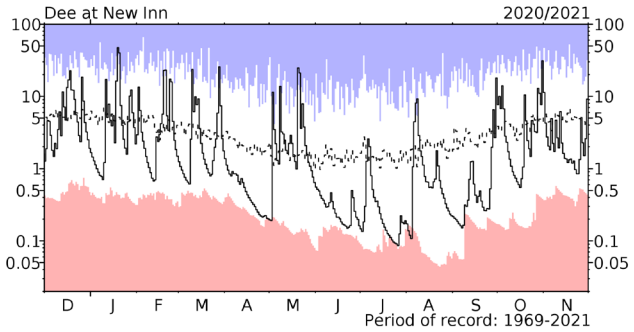


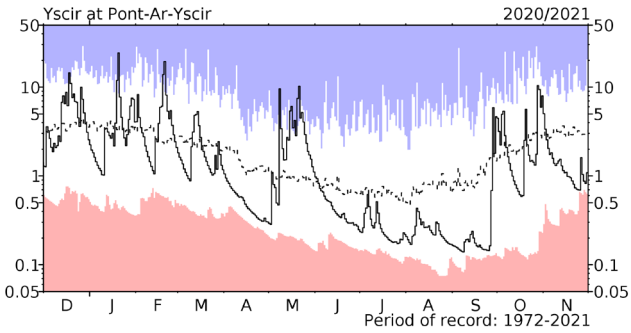


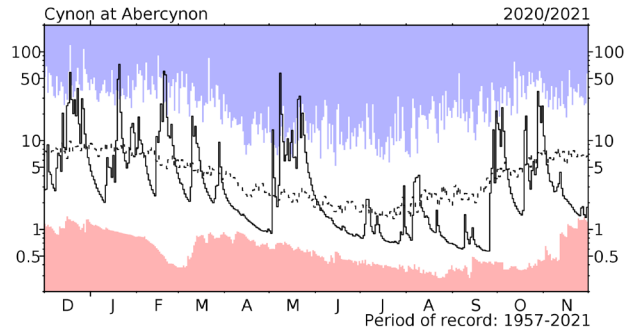








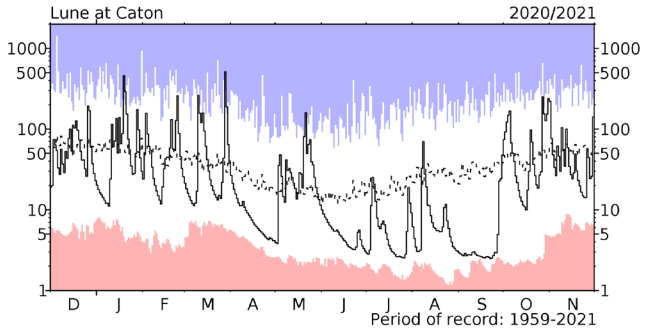


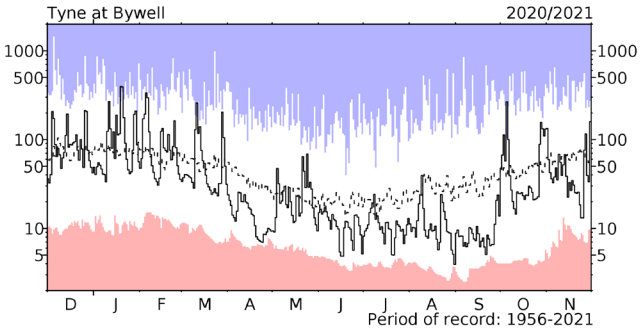


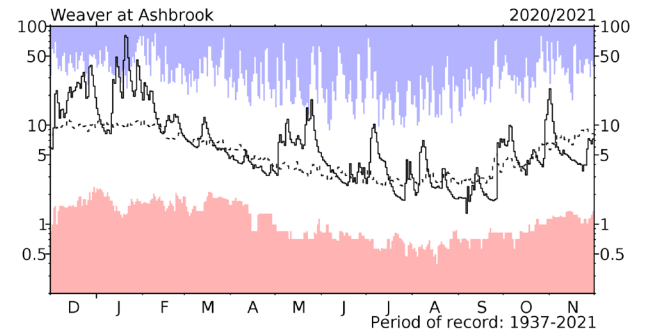
River flow hydrographs

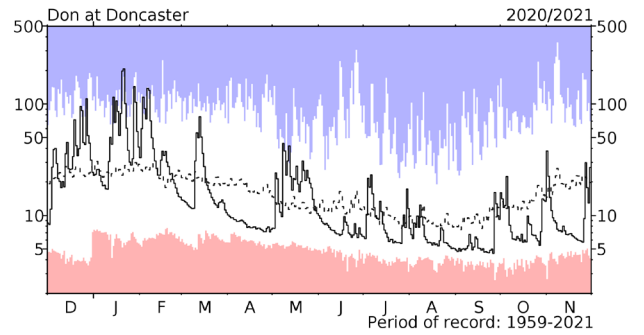
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to December 2020 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

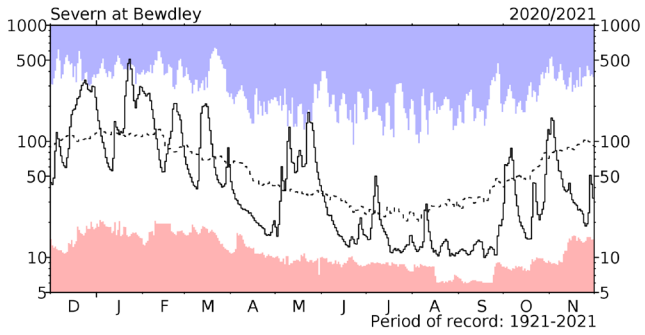
River flow . . . River flow . . .

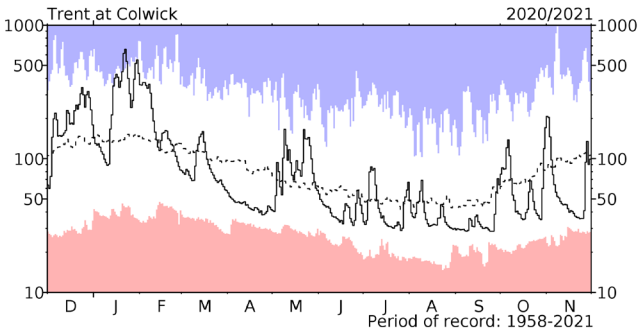


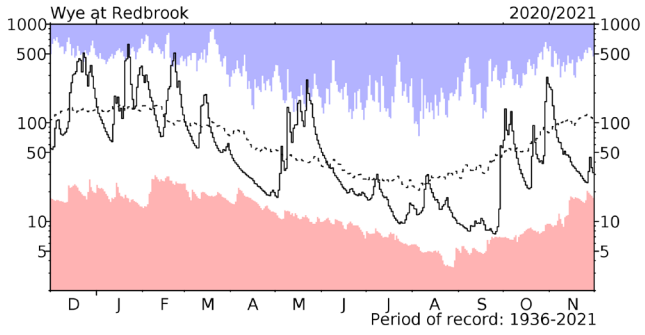


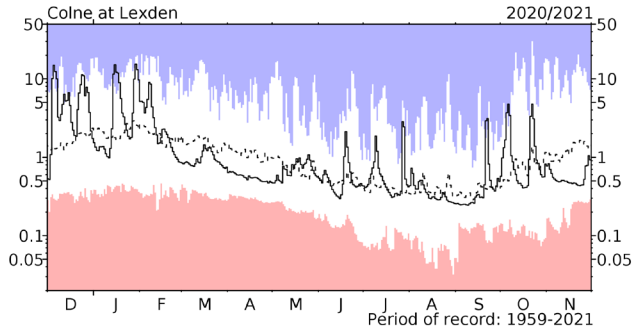


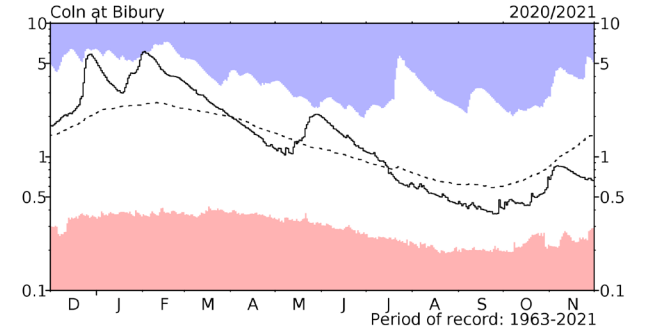


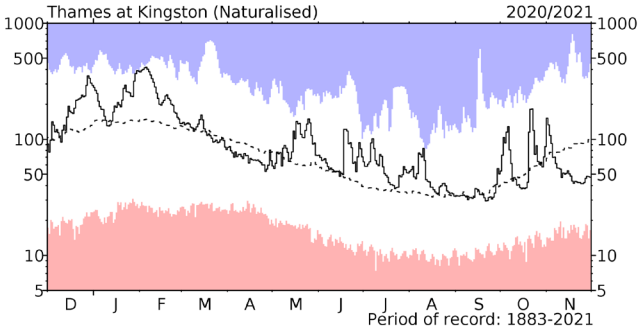


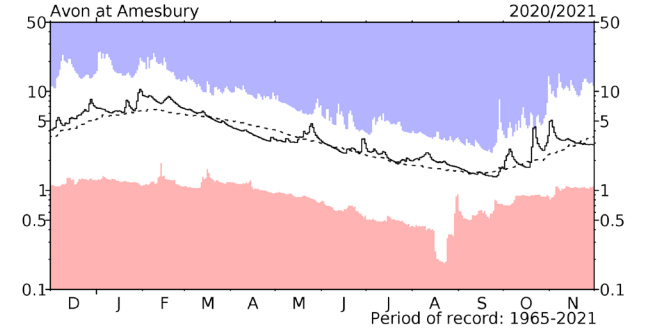


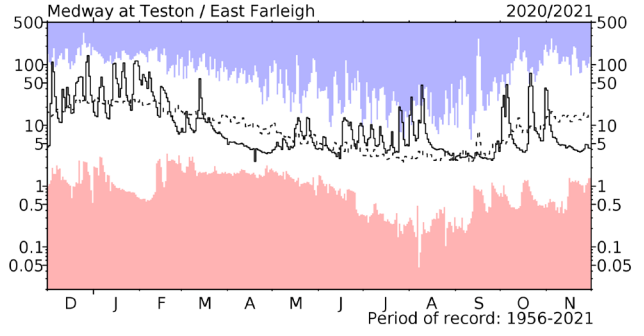




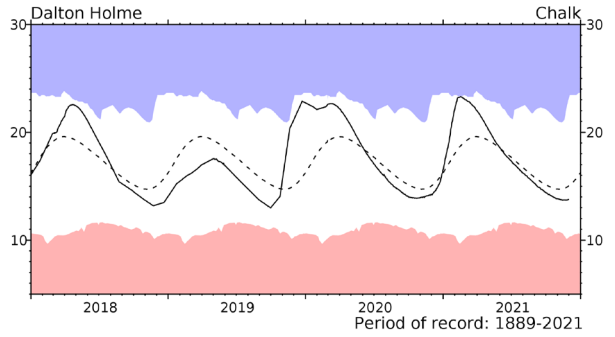


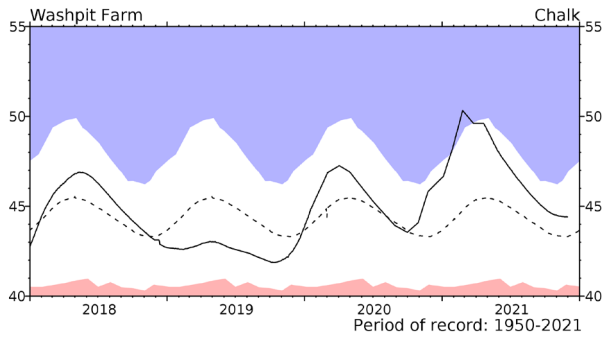


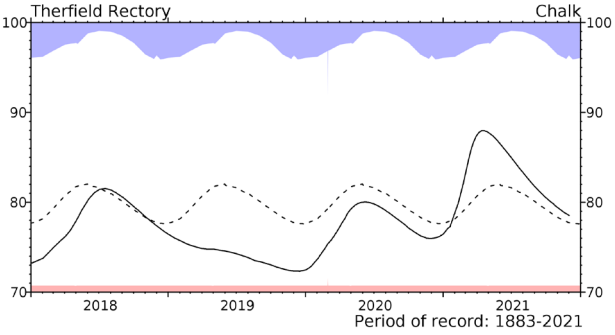


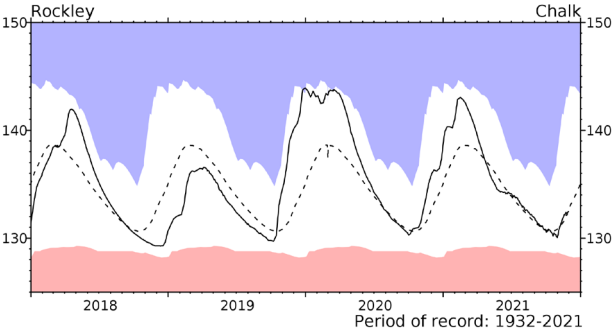


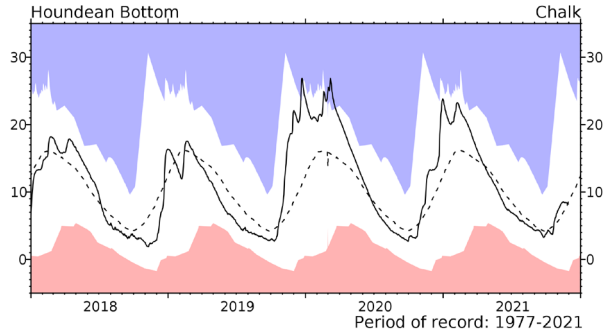
Groundwater…Groundwater

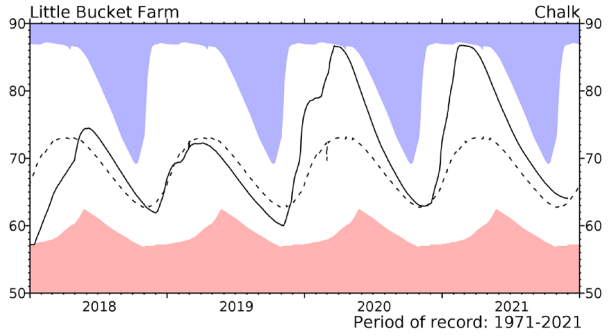


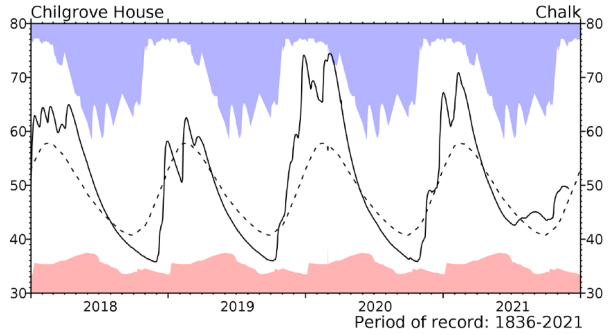


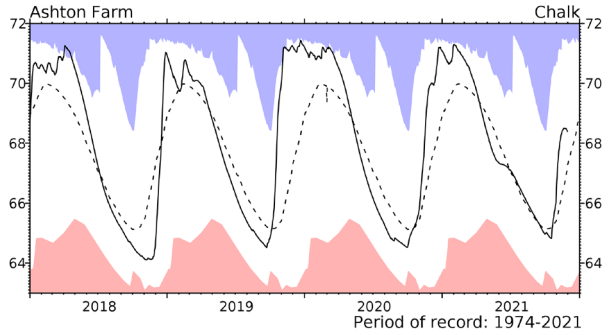


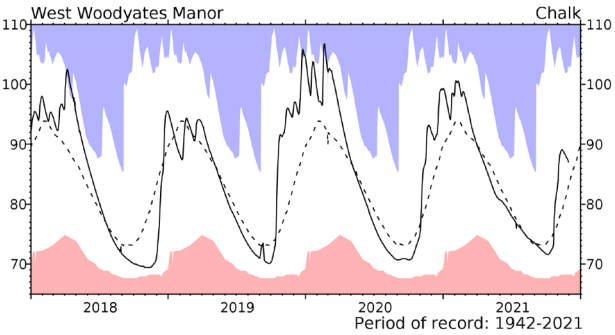


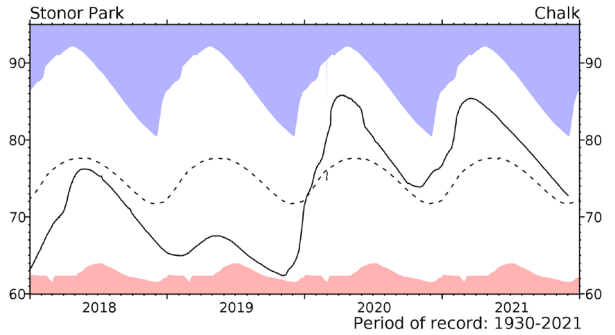






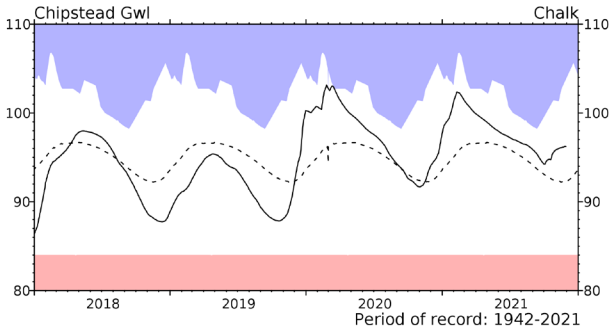


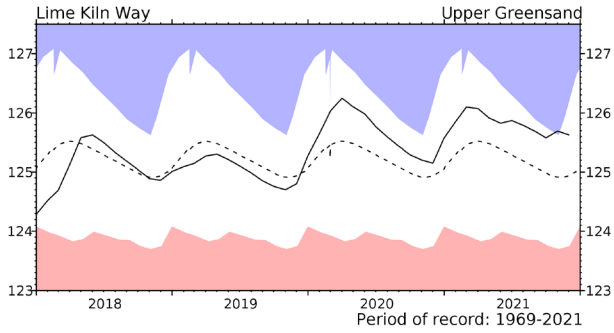


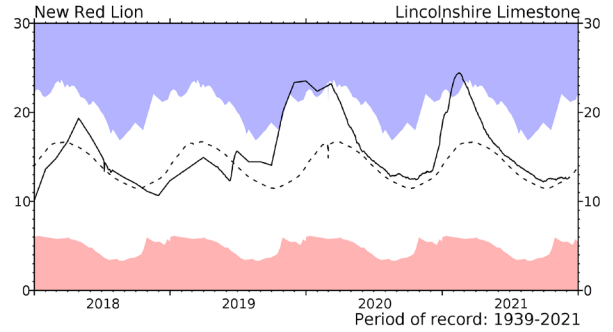


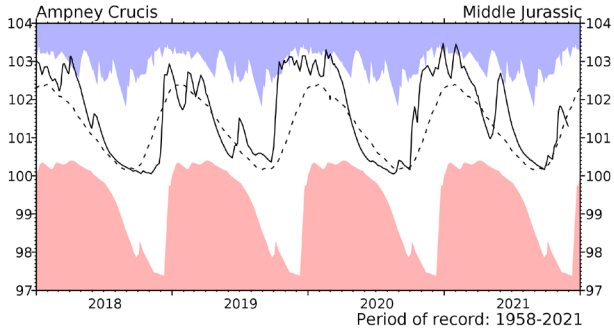
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is 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 calculated with data from the start of the record to the end of 2017. 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.

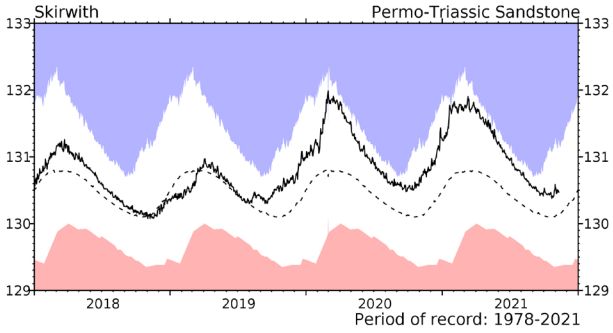
Groundwater…Groundwater

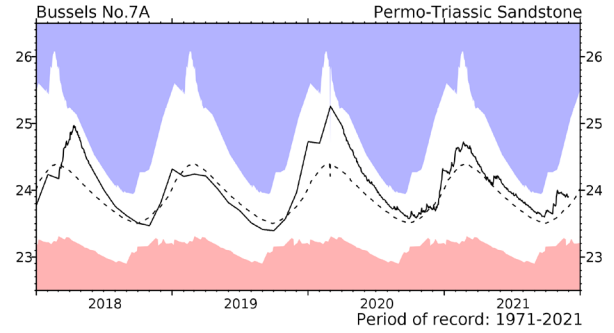


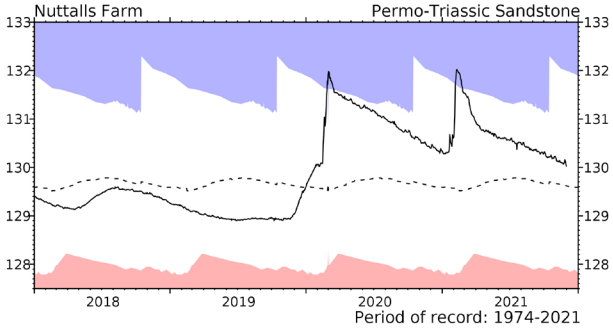


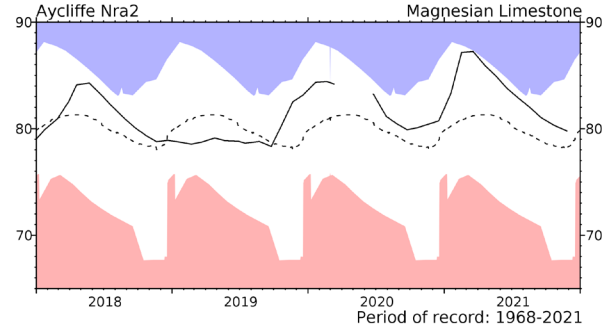


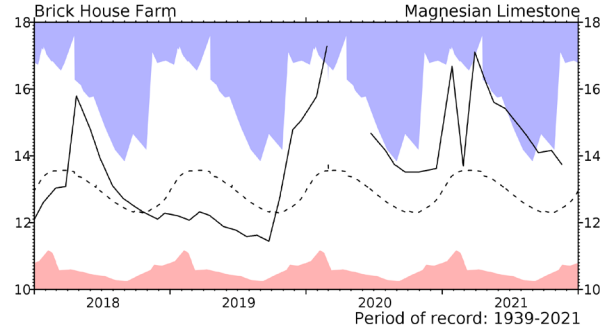


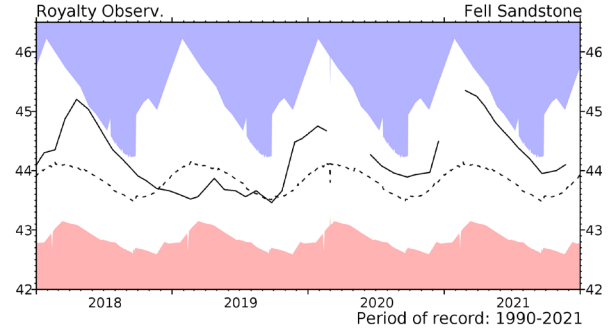


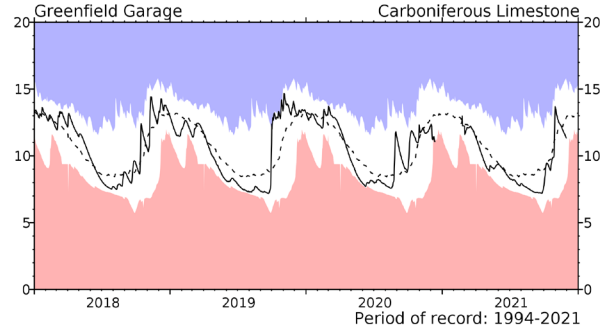


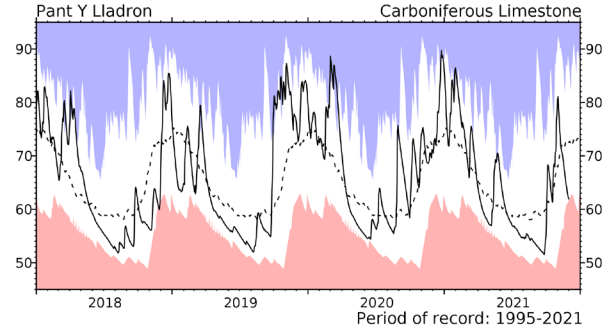












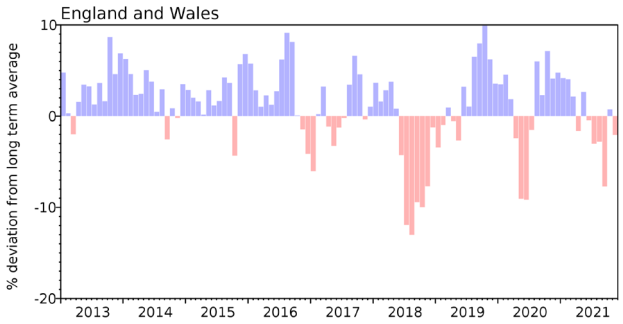
Groundwater levels - November 2021

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.

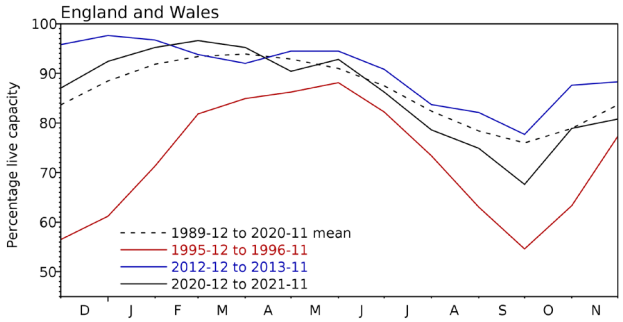
Note that due to continuing issues with data access, no data are available for Scotland.

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)	2021 Sep	2021 Oct	2021 Nov	Nov Anom.	Min Nov	Year* of min	2020 Nov	Diff 21-20
North West	N Command Zone	•	124929	30	72	76	-3	44	1993	99	-23
	Vyrnwy		55146	62	91	82	-2	33	1995	97	-15
Northumbrian	Teesdale	•	87936	41	69	75	-8	39	1995	80	-5
	Kielder		(199175)	76	81	85	-1	55	2007	89	-4
Severn-Trent	Clywedog		49936	73	88	88	6	43	1995	84	4
	Derwent Valley	•	46692	47	51	63	-16	9	1995	91	-28
Yorkshire	Washburn	•	23373	66	73	76	-1	16	1995	96	-20
	Bradford Supply	•	40942	51	66	68	-16	20	1995	98	-31
Anglian	Grafham		(55490)	92	94	94	11	47	1997	89	5
	Rutland		(116580)	86	80	76	-4	57	1995	87	-11
Thames	London	•	202828	81	82	82	0	52	1990	79	3
	Farmoor	•	13822	84	90	93	4	52	1990	90	2
Southern	Bewl		31000	74	74	72	8	33	2017	63	9
	Ardingly		4685	73	96	100	27	14	2011	46	54
Wessex	Clatworthy		5662	60	78	85	6	16	2003	100	-15
	Bristol	•	(38666)	58	67	72	3	27	1990	83	-11
South West	Colliford		28540	59	64	65	-8	42	1995	66	-1
	Roadford		34500	79	87	89	15	19	1995	73	16
	Wimbleball		21320	69	74	76	2	34	1995	76	-1
	Stithians		4967	52	56	62	-5	29	2001	73	-10
Welsh	Celyn & Brenig	•	131155	71	80	85	-3	50	1995	97	-12
	Brianne		62140	80	100	97	1	72	1995	100	-3
	Big Five	•	69762	61	78	80	-3	49	1990	76	4
	Elan Valley	•	99106	66	80	81	-13	47	1995	86	-5
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	64	85	88	2	45	2003	95	-7
	East Lothian	•	9317	91	100	100	10	38	2003	100	0
Scotland(W)	Loch Katrine	•	110326	41	71	92	0	65	2007	96	-4
	Daer		22494	37	100	100	3	73	2003	100	0
	Loch Thom		10721	40	75	83	-11	72	2003	83	0
Northern Ireland	Total+	•	56800	63	75	74	-12	59	2003	98	-24
	Silent Valley	•	20634	51	68	65	-18	43	2001	98	-33

( ) figures in parentheses relate to gross storage

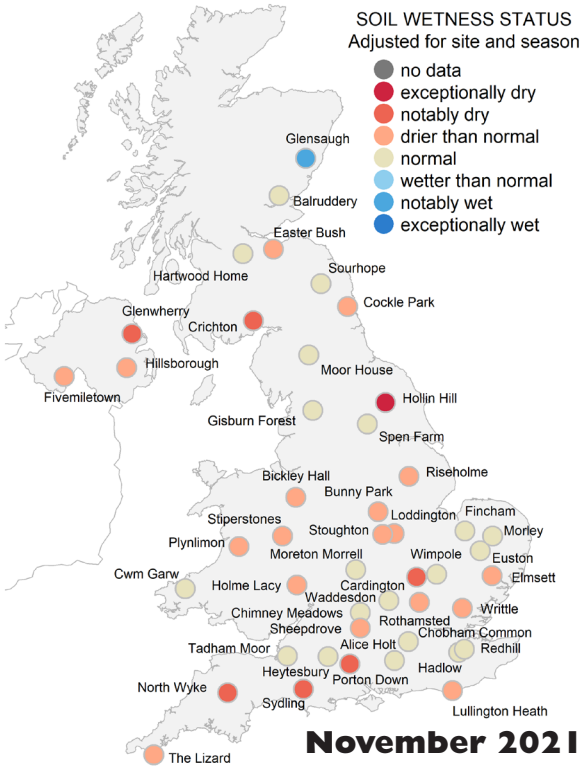
• denotes reservoir groups

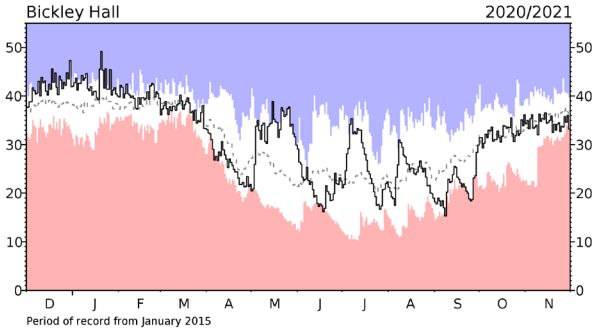
*last occurrence

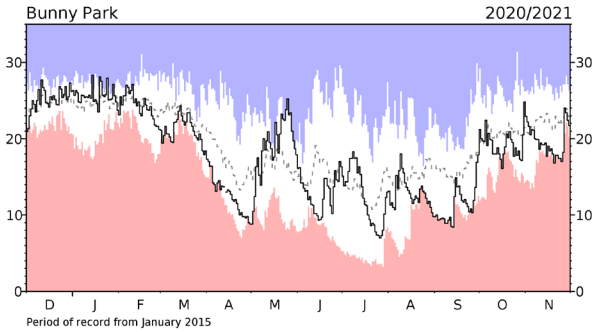
+ excludes Lough Neagh

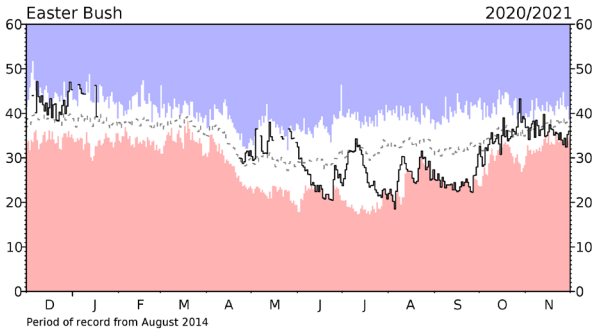
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed 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.

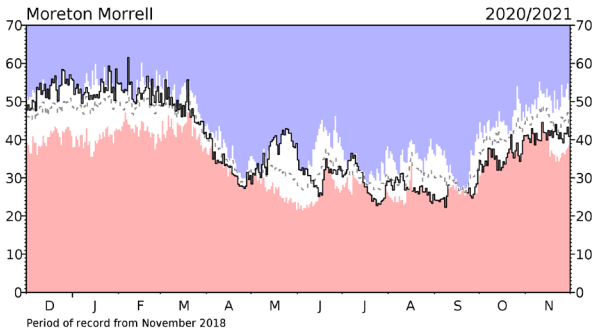
Soil Moisture . . . Soil Moisture

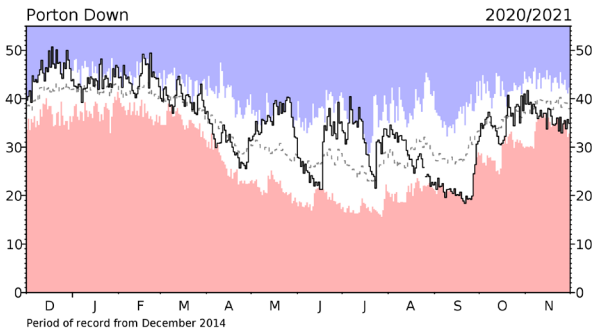












At the end of November, soil moisture was in the normal range or drier than normal.

November is a month during which soil moisture is expected to increase (as rainfall will usually exceed evaporation), yet at some sites the low rainfall led to a reduction in soil moisture (e.g. Easter Bush, Holme Lacy, Porton Down and Lullington Heath). At other sites, rainfall and evaporation were roughly equal and soil moisture remained fairly constant through the month (e.g. Crichton, Bickley Hall, Morton Morell and Hadlow).

Heavy rainfall associated with storm 'Arwen' caused rapid increases in soil moisture month-end where otherwise soil moisture had been falling (e.g. Bunny Park) or was relatively constant (e.g. Cockle Park).

At the end of November soil moisture was close to field capacity at most sites; since this is a time when soils are often above field capacity, many sites were drier than normal for the time of year.

Soil moisture data

These data are from UKCEH's COSMOS-UK network. The time series graphs show volumetric water content as a percentage in black together with the maximum and minimum daily values for the period-of-record of the sites. The dashed line represents the period-of-record mean VWC. For more information visit cosmos.ceh.ac.uk.

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 https://doi.org/10.1002/joc.1161

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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