Hydrological Summary

for the United Kingdom

September 2021

General

September was warm and somewhat dry, the fourth consecutive month of below average rainfall for the UK as whole. The total rainfall for the UK was 84% of the monthly average, and with an average temperature of 14.7°C, it was the second warmest September for the UK, and for Northern Ireland with 14.2°C, equal warmest with 2006 (both in series from 1910). River flows were average or below average across Northern Ireland, Wales and much of England, although above average in parts of the south-east. Groundwater levels continued to recede everywhere except in the Carboniferous Limestone of south Wales. However, levels remained within the normal range or above, and were exceptionally high in aquifers in the north-east and south-west of England. Reservoir stocks fell, and although close to average for the English Lowlands, were below average elsewhere, most notably in the north-west of the UK. Indeed, stocks for September at Loch Thom were the lowest on record (in a series from 1993) and less than half of those typical of the month, and total stocks for Scotland dropped marginally below the minimum established in 1995. With low September rainfall compounding the effect of the dry summer in the north-west, and little indication of a wet autumn in seasonal outlooks, it is here (in contrast to the south and east where groundwater resources are healthy) that close observation will be required over the coming months.

Rainfall

September saw spells of rain and thundery showers between ridges of high pressure, before a marked change to cooler, more persistently wet weather from the 27th. Settled conditions under high pressure at the start of the month intensified into unseasonable warmth on 7th/8th that was broken by thundery showers (on the 9th and 10th). Patchy rain from westerly fronts continued to affect Scotland and Northern Ireland predominantly, although heavier bursts caused impacts in the south and east on the 14th (with disruption to road and rail transport in London) and in the east on the 19th (causing flooding in Melford and Sudbury, Suffolk). Rain in the final four days of September across much of the UK saw some notable daily totals (77mm at White Barrow, Devon, on the 28th, and 71mm Treherbert, Mid-Glamorgan, on the 30th) and caused travel disruption, including motorway flooding in Scotland and Wales. Whilst September rainfall was widely below average, it was above average for western parts of Northern Ireland, England and Wales, and for inland East Anglia. Northumbria and Southern regions saw the greatest deficits, with around two-thirds of average rainfall. Across the summer half-year (April-September) rainfall was below average for the UK, especially so in Scotland with three-quarters of average, where it was the third driest April-September on record (in a series from 1910). Western regions in Scotland were most severely affected; it was the driest April-September for the Clyde region, and second driest for the Highland region (both in series from 1910).

River flows

River flows started September below average, and remained low throughout the first week. Local responses to thundery showers on the 9th/10th and to moderate frontal systems (e.g. from 12th-14th) interrupted otherwise persistently low flows throughout most of the month. The Erch recorded new daily mean flow minima for six consecutive days from 20th-25th. Recovery began on the 27th, with widespread and marked flow increases in response to the wet weather, and many rivers returned to, or exceeded their average flow. New daily maxima were recorded on the 30th in Wales (the Conwy in a series from 1964, and the Cynon and Tawe, both in series from 1958). September mean flows were less than two-thirds of average for many rivers across Northern Ireland, Wales and northern and central England, with some (the Cumbrian Leven, Lune and Annacloy) less than one fifth of average. The Leven was exceptionally low, and recorded its fourth lowest September flow in a long series from 1939. With notably low flows, the Coquet, Tyne, Aire and Wye each recorded their lowest September monthly mean flow since 2003, and the Cumbrian Derwent since 1996. However, rivers in the south-east recorded above normal flows, some as much as a third above average; the September mean flow on the Itchen was the second highest in its 60 year record (and the highest since 1968). The predominance of low flows meant that September outflows for England & Wales were the ninth lowest in a series from 1961. On average across the summer half-year, river flows were below normal or notably low in Northern Ireland, and across the north of England and Wales, with half the average or less in some catchments.

Groundwater

The late September rainfall increased soil moisture across much of the country, but a marked east-west gradient remained, with the driest soils in the east. Levels in the Chalk receded and were predominantly in the normal range at the end of September, although above normal to notably high at boreholes in the south-east of England. Levels also fell in the Jurassic limestones where they were in the normal range, and in the Magnesian Limestone where they were exceptionally high for the time of year. In the Carboniferous Limestone of south Wales, levels began below normal and receded until the last week of the month when they rose, finishing the month higher than they began and within the normal range. In the Permo-Triassic sandstones, groundwater levels fell whilst remaining in the normal range, above normal or notably high. Levels fell in the Upper Greensand and Fell Sandstone, but remained exceptionally high at Lime Kiln Way and above normal at Royalty Observatory.

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.

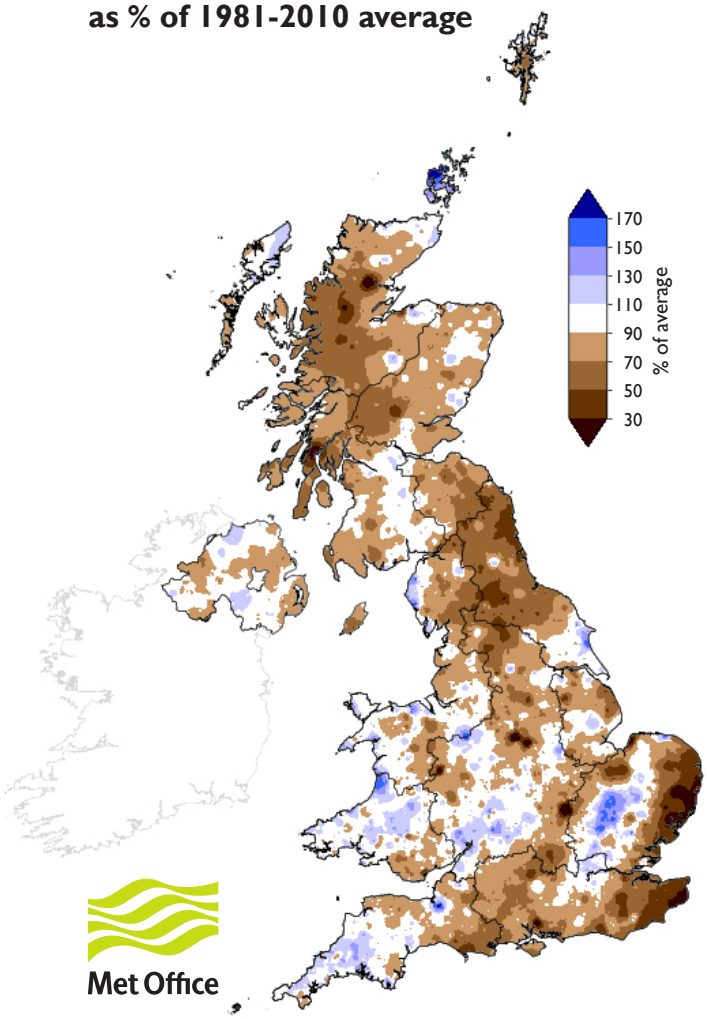
Region	Rainfall	Sep 2021	Aug21 – Sep21	RP	Jun21 – Sep21	RP	Apr21 – Sep21	RP	Oct20 – Sep21	RP
United Kingdom	mm	**79**	144		260		400		1165	
	%	**84**	80	2-5	79	5-10	86	5-10	103	2-5
England	mm	**57**	105		231		354		934	
	%	**82**	77	2-5	89	2-5	94	2-5	111	5-10
Scotland	mm	**105**	188		294		439		1444	
	%	**80**	78	2-5	70	15-25	75	30-50	95	2-5
Wales	mm	**115**	192		304		531		1587	
	%	**103**	89	2-5	78	5-10	95	2-5	112	5-10
Northern Ireland	mm	**85**	192		275		416		1130	
	%	**93**	102	2-5	79	5-10	84	5-10	99	2-5
England & Wales	mm	**65**	117		241		378		1023	
	%	**87**	79	2-5	87	2-5	95	2-5	111	5-10
North West	mm	**88**	169		290		436		1354	
	%	**86**	83	2-5	78	5-10	85	5-10	110	5-10
Northumbria	mm	**43**	98		196		309		927	
	%	**60**	67	5-10	70	10-15	78	5-10	107	2-5
Severn-Trent	mm	**59**	99		207		337		845	
	%	**91**	77	2-5	82	2-5	92	2-5	108	2-5
Yorkshire	mm	**52**	108		222		359		938	
	%	**76**	77	2-5	83	2-5	94	2-5	112	2-5
Anglian	mm	**42**	73		181		269		673	
	%	**78**	65	5-10	83	2-5	86	2-5	107	2-5
Thames	mm	**53**	99		241		352		844	
	%	**91**	86	2-5	111	2-5	108	2-5	118	5-10
Southern	mm	**41**	94		272		362		935	
	%	**65**	79	2-5	124	2-5	111	2-5	117	5-10
Wessex	mm	**56**	105		240		377		954	
	%	**81**	80	2-5	98	2-5	103	2-5	108	2-5
South West	mm	**90**	147		321		509		1367	
	%	**101**	85	2-5	100	2-5	108	2-5	111	5-10
Welsh	mm	**112**	185		298		520		1537	
	%	**103**	89	2-5	79	5-10	96	2-5	112	5-10
Highland	mm	**115**	192		312		466		1593	
	%	**73**	69	5-10	66	20-35	71	40-60	88	2-5
North East	mm	**80**	154		277		445		1150	
	%	**91**	92	2-5	89	2-5	101	2-5	113	5-10
Tay	mm	**85**	178		304		477		1429	
	%	**75**	85	2-5	82	2-5	91	2-5	107	5-10
Forth	mm	**87**	172		274		403		1226	
	%	**83**	86	2-5	77	5-10	81	5-10	102	2-5
Tweed	mm	**65**	140		222		356		1107	
	%	**79**	84	2-5	71	5-10	80	5-10	108	5-10
Solway	mm	**108**	205		274		416		1453	
	%	**89**	85	2-5	65	10-20	70	15-25	98	2-5
Clyde	mm	**126**	225		320		436		1672	
	%	**79**	75	2-5	62	25-40	62	>>100	92	2-5

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

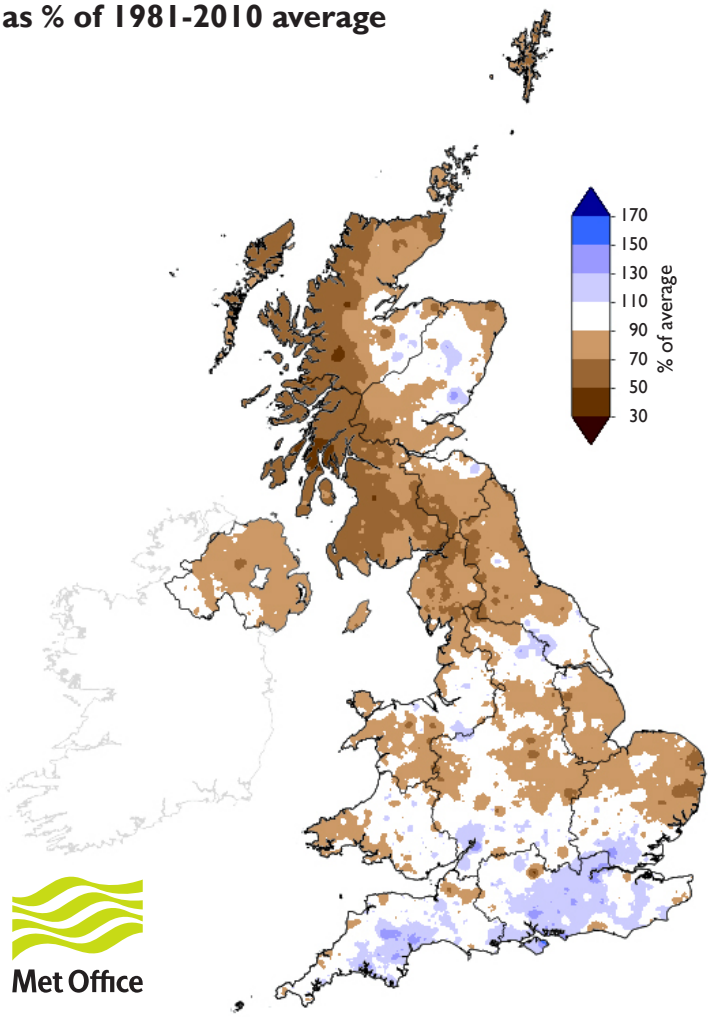
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic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

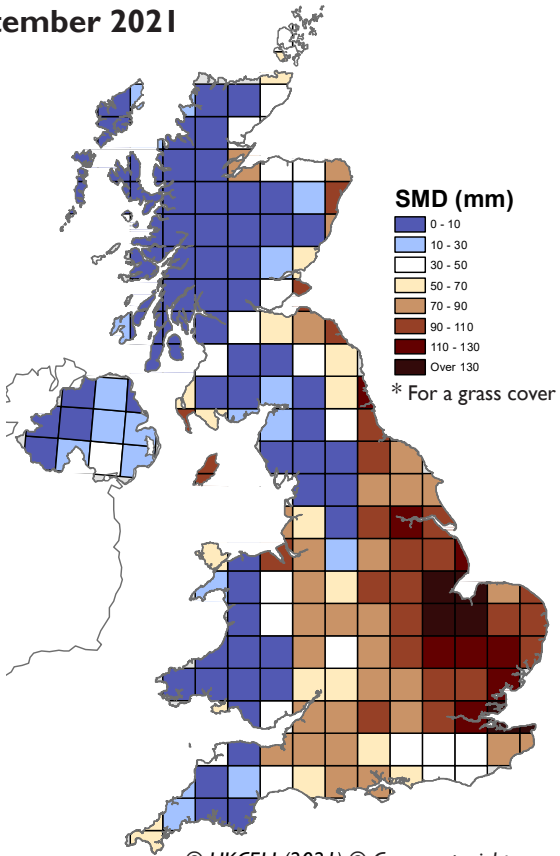
September 2021 rainfall as % of 1981-2010 average



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



MORECS Soil Moisture Deficits* September 2021



Hydrological Outlook UK

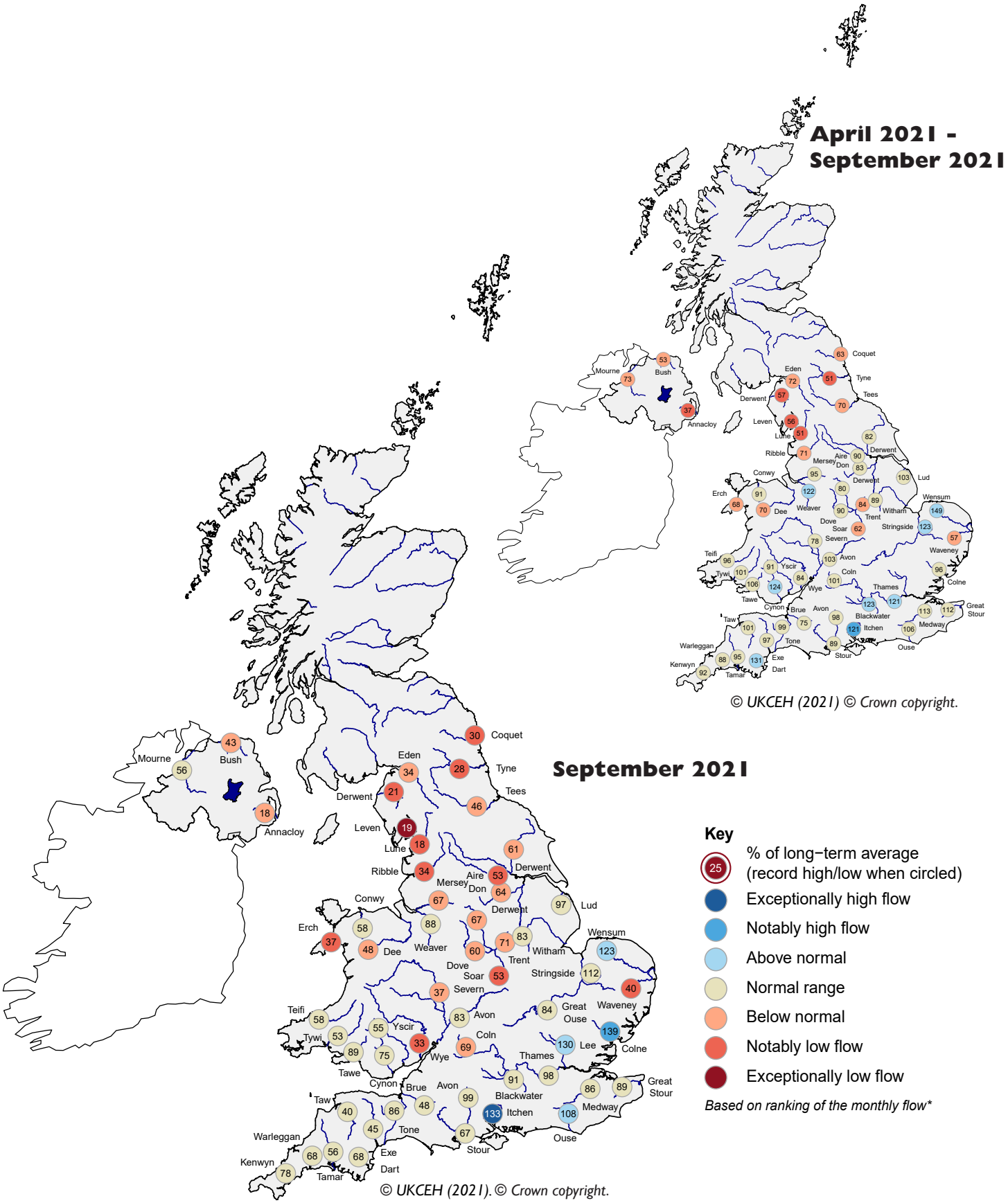
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from October 2021**
Issued: **07.10.2021**
using data to the end of September2021

River flows across the UK are likely to be normal to above normal for October. Groundwater levels are likely to be within the normal range, with localised exceptions for October, and within the normal range for October-November-December.

River flow . . . River flow . . .

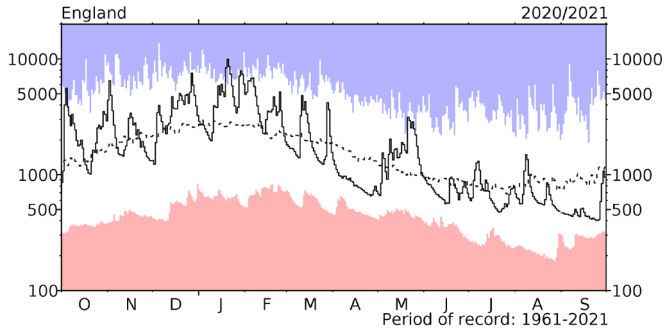


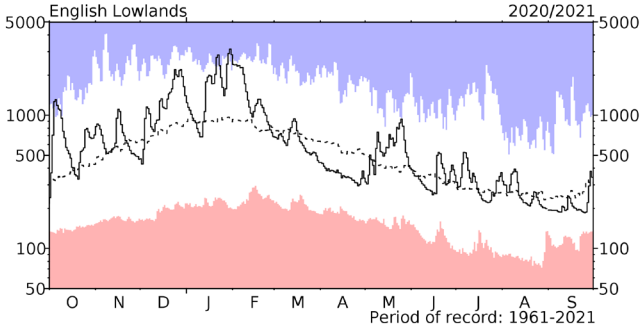
River flows

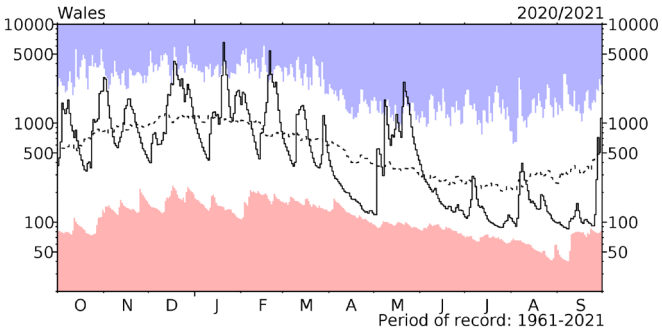
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

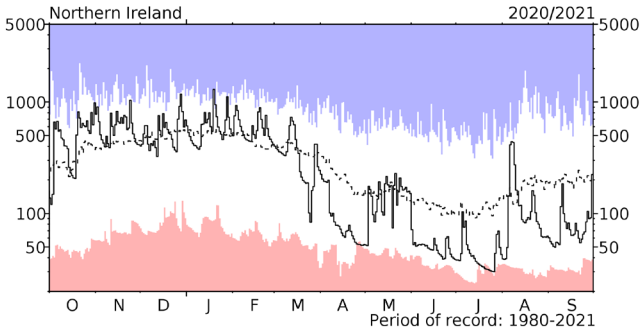
Note that due to continuing issues with data access, no data are available for Scotland.

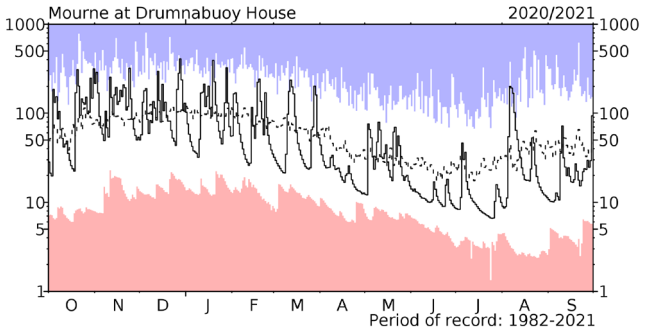
River flow . . . River flow . . .

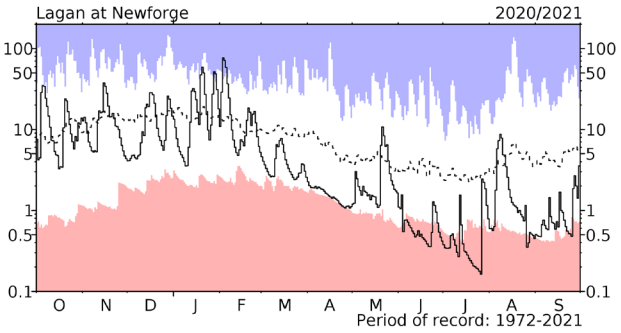


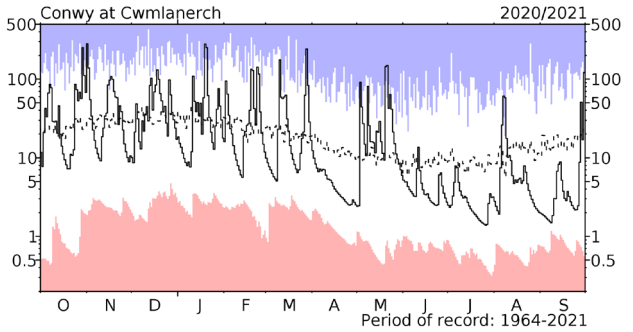


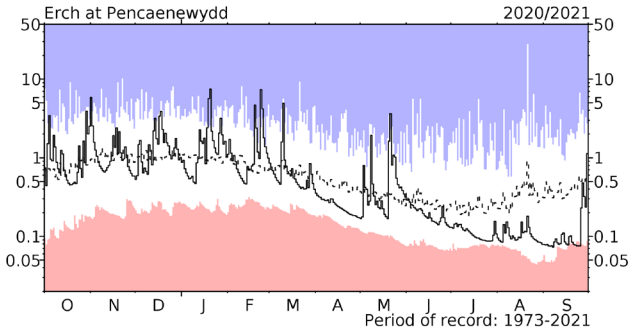


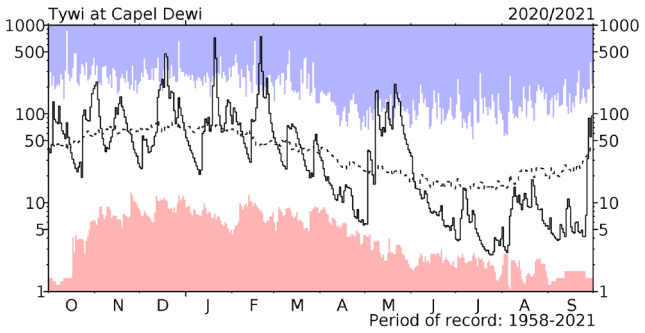


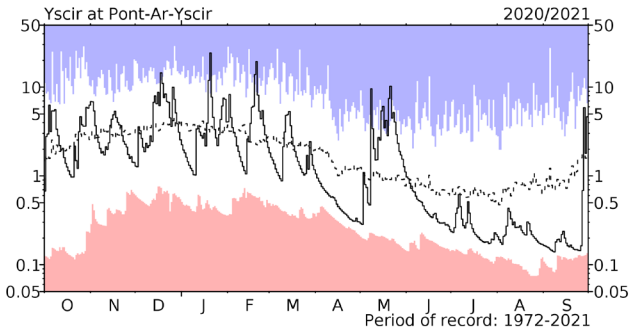








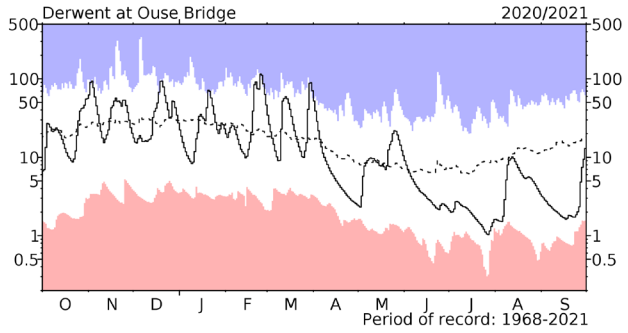


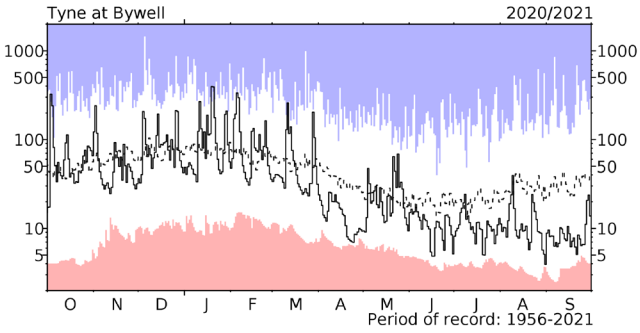


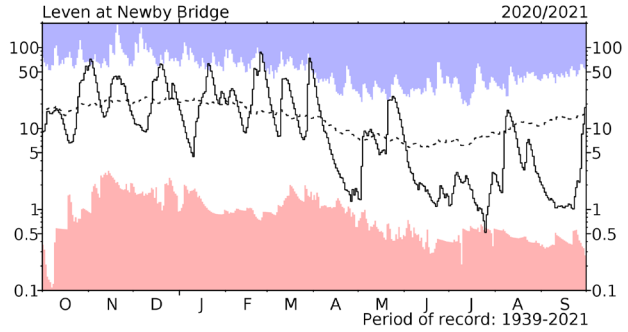
River flow hydrographs

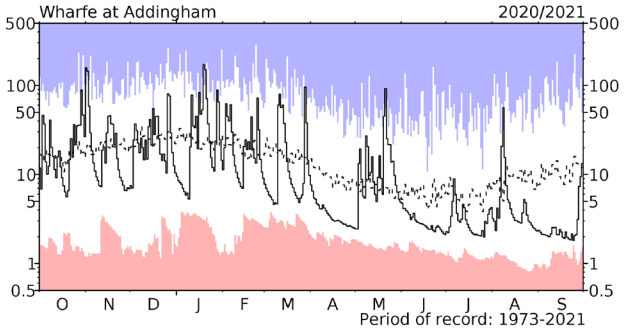
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to October 2020 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

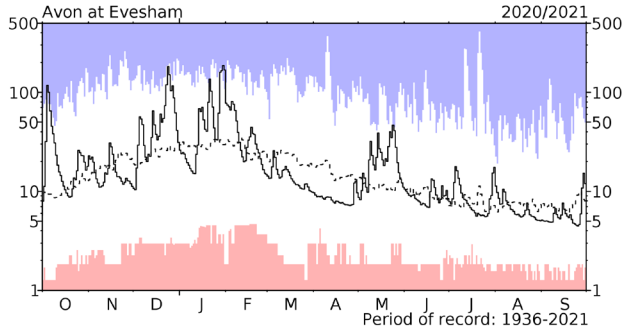
River flow . . . River flow . . .

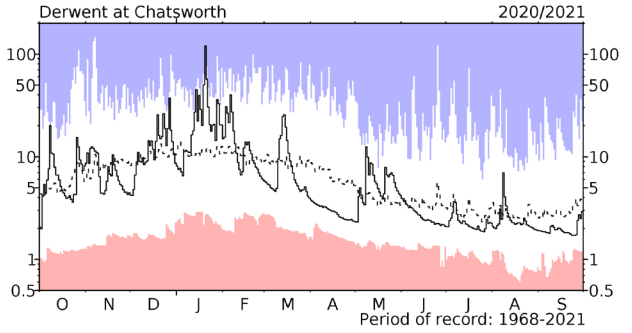


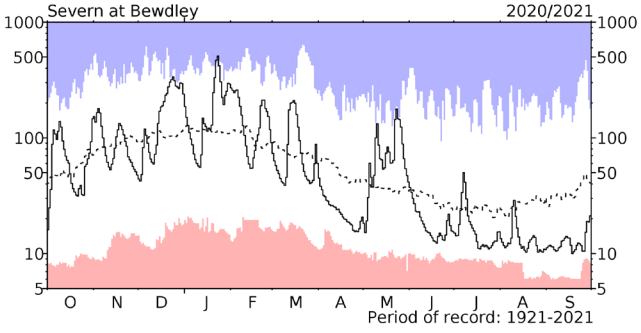


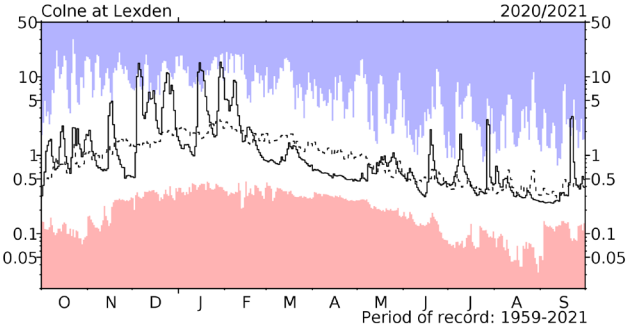


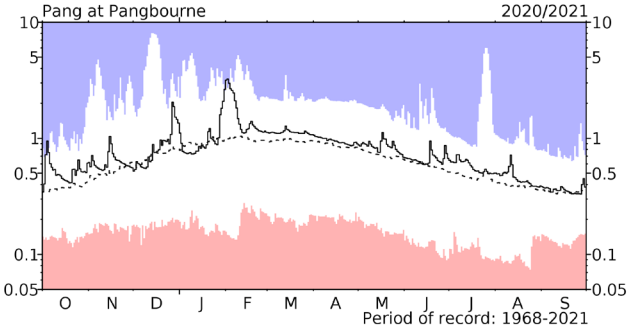


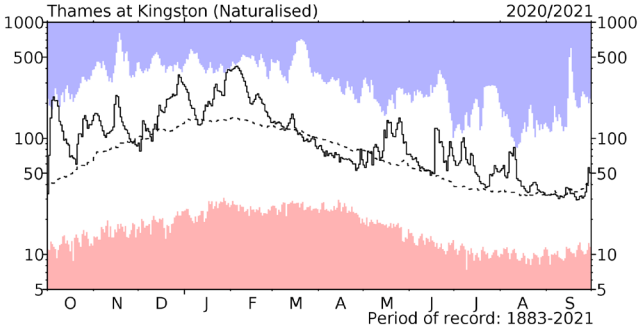


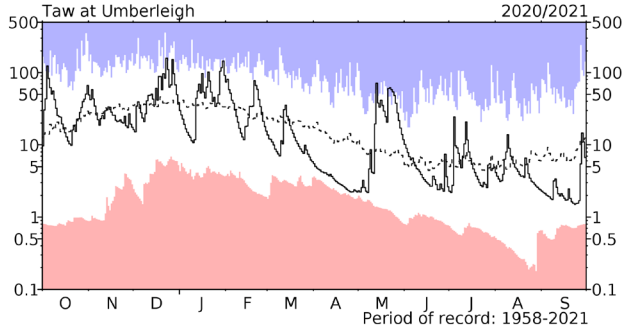


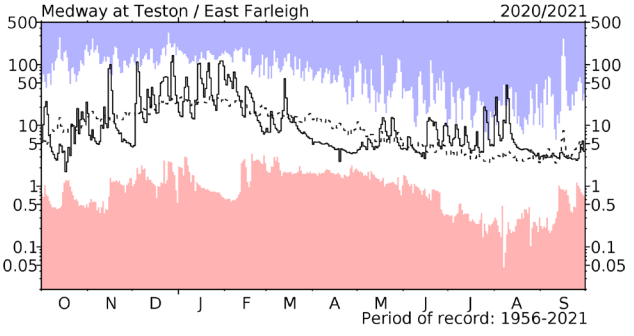




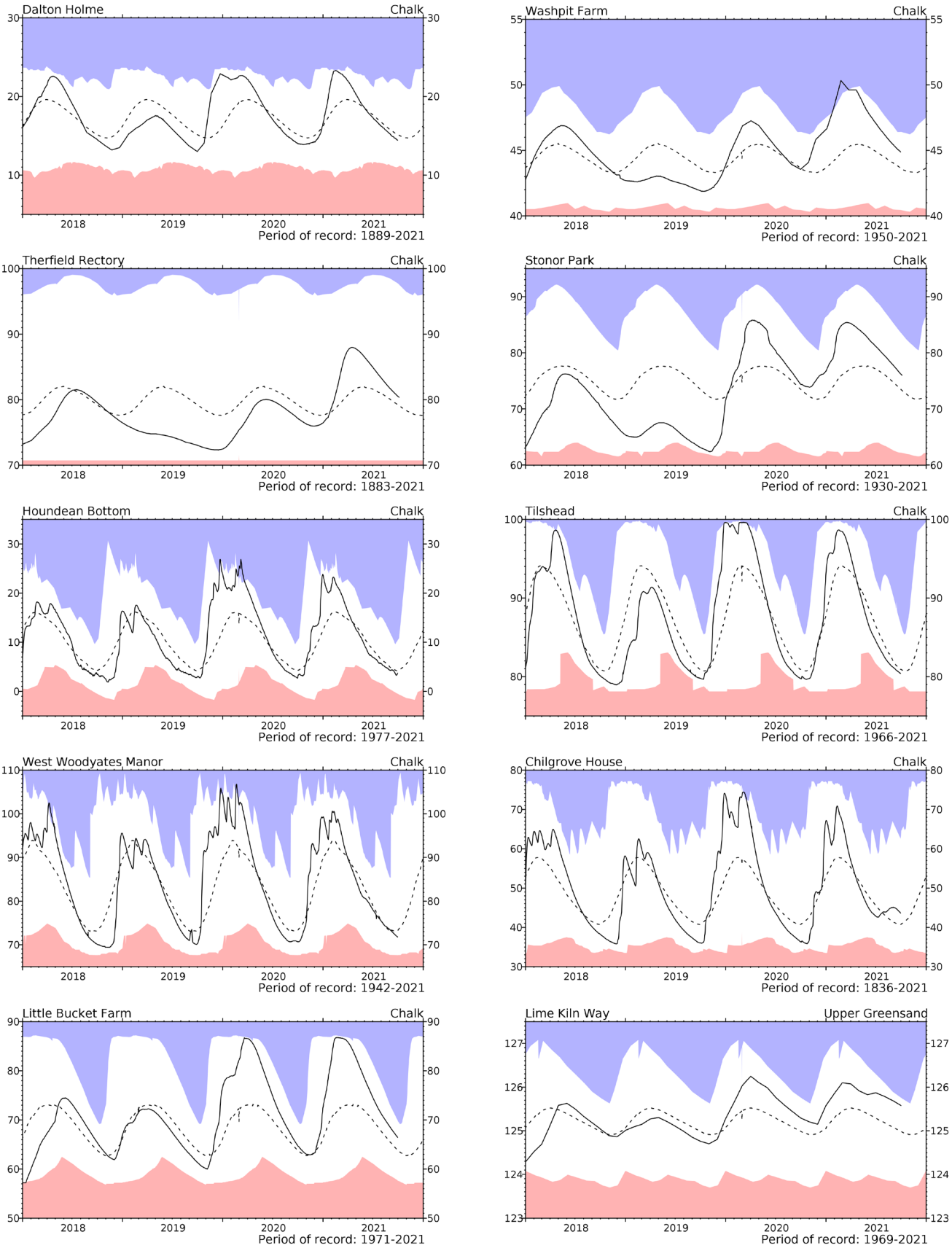






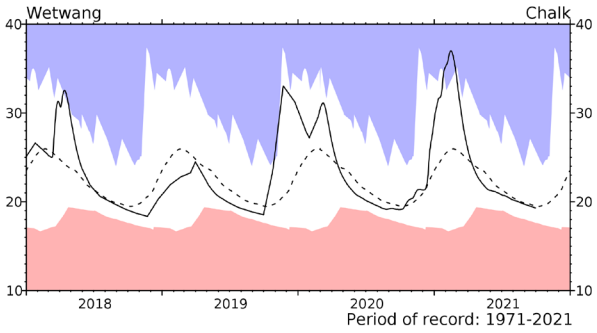


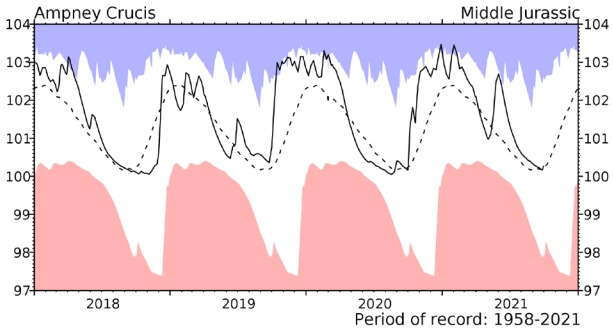
Groundwater…Groundwater

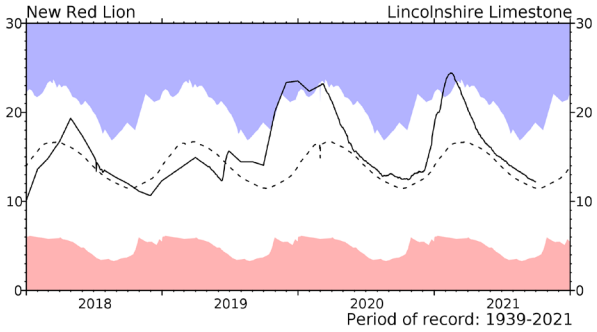


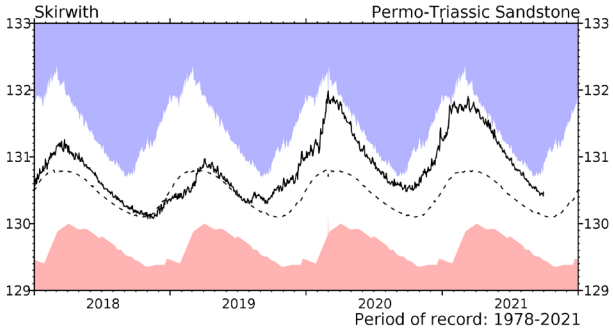
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

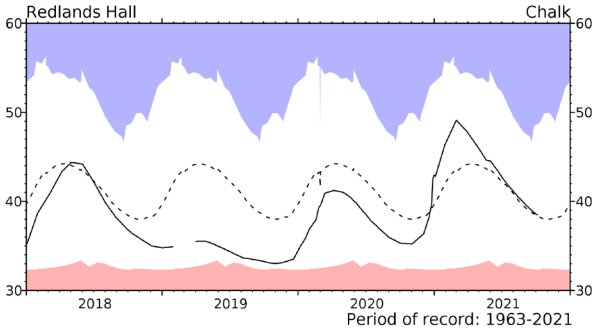
Groundwater…Groundwater

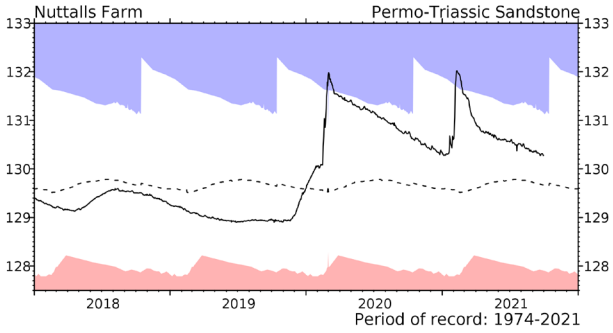


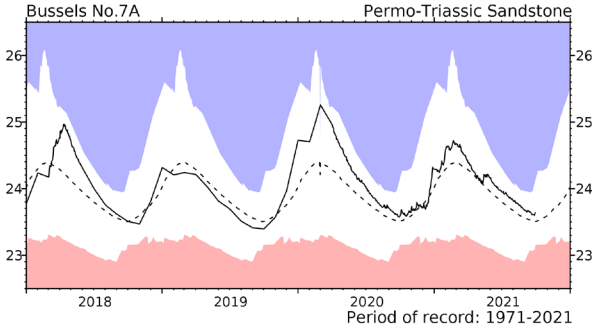


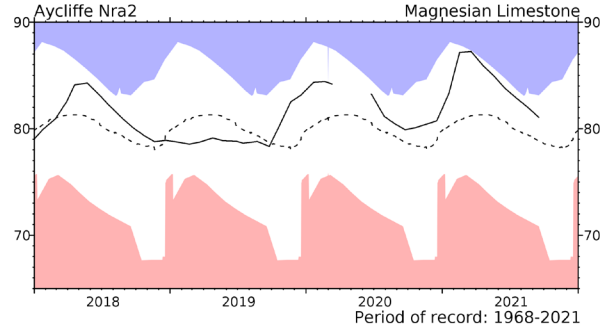


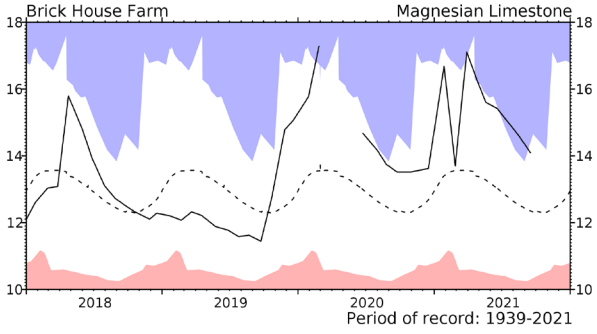


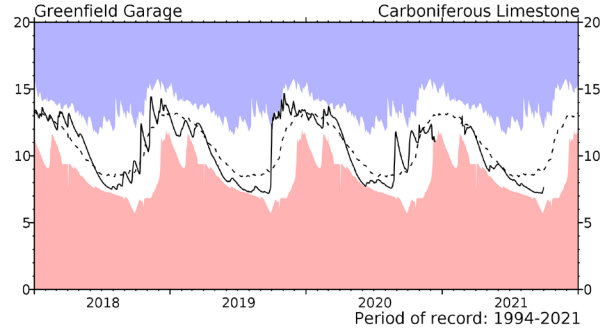


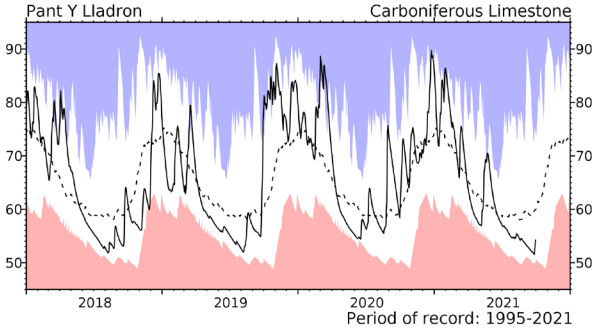


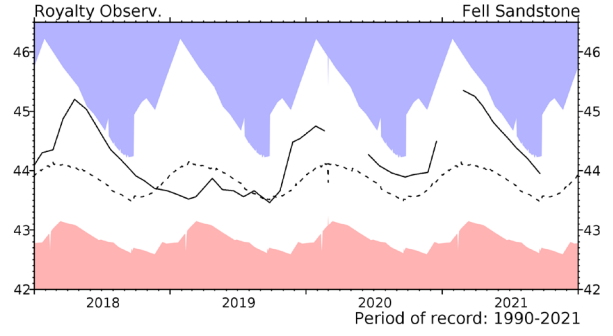












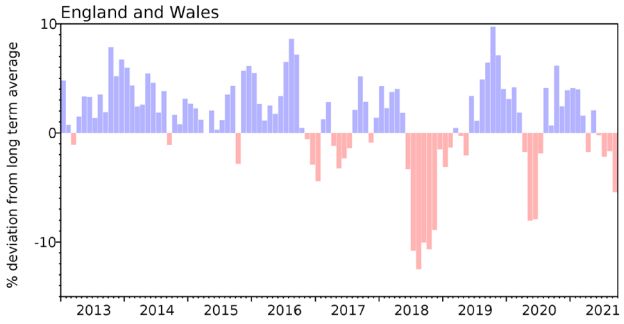
Groundwater levels - September 2021

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.

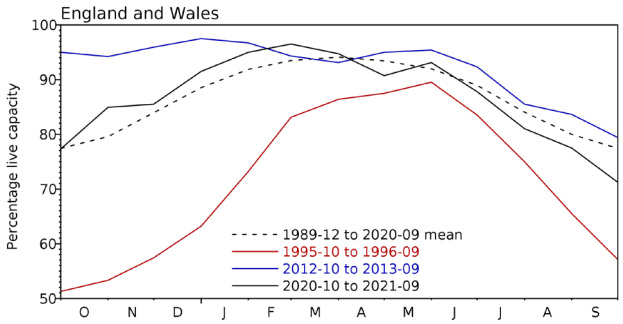
Note that due to continuing issues with data access, no data are available for Scotland.

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



*Note: Due to data access issues, the England and Wales stocks for August and September do not include the Northern Command Zone group or Vyrnwy.

Percentage live capacity of selected reservoirs at end of month

Area	Reservoir		Capacity (Ml)	2021 Jul	2021 Aug	2021 Sep	Sep Anom.	Min Sep	Year* of min	2020 Sep	Diff 21-20
North West	Haweswater & Thirlmere	•	111132	65	46	37	-34	37	2021	72	-35
	Pennines		126991	79	73	67	-9	52	2018	83	-16
Northumbrian	Teesdale	•	87936	57	53	41	-30	31	1995	65	-23
	Kielder		(199175)	85	81	76	-9	59	1989	80	-4
Severn-Trent	Clywedog		49936	87	81	73	-1	24	1989	87	-14
	Derwent Valley	•	46692	65	58	47	-17	24	1989	78	-31
Yorkshire	Washburn	•	23373	76	79	66	-1	24	1995	91	-25
	Bradford Supply	•	40942	69	65	51	-17	15	1995	86	-35
Anglian	Grafham		(55490)	96	96	92	8	46	1997	90	2
	Rutland		(116580)	93	91	86	5	61	1995	88	-2
Thames	London	•	202828	89	89	81	4	53	1997	84	-3
	Farmoor	•	13822	98	95	84	-7	54	2003	97	-13
Southern	Bewl		31000	82	78	74	11	32	1990	60	14
	Ardingly		4685	95	89	73	9	21	2020	21	52
Wessex	Clatworthy		5662	79	67	60	3	25	2003	60	0
	Bristol	•	(38666)	72	65	58	-5	31	1990	51	7
South West	Colliford		28540	77	69	59	-9	38	2006	57	2
	Roadford		34500	87	84	79	10	26	1995	61	18
	Wimbleball		21320	84	81	69	4	30	1995	50	19
	Stithians		4967	74	66	52	-5	22	1990	54	-2
Welsh	Celyn & Brenig	•	131155	84	77	71	-11	39	1989	86	-15
	Brianne		62140	78	77	80	-8	48	1995	84	-4
	Big Five	•	69762	66	62	61	-9	19	1995	65	-4
	Elan Valley	•	99106	73	68	66	-9	33	1976	67	-1
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	74	68	64	-15	43	1998	86	-22
	East Lothian	•	9317	96	96	91	8	52	1989	100	-9
Scotland(W)	Loch Katrine	•	110326	58	50	41	-35	41	2021	88	-47
	Daer		22494	54	45	37	-43	32	1995	94	-57
	Loch Thom		10721	55	50	40	-44	40	2021	59	-19
Northern	Total+	•	56800	66	69	63	-13	29	1995	90	-27
Ireland	Silent Valley	•	20634	59	58	51	-22	27	1995	87	-36

( ) 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 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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