Hydrological Summary

for the United Kingdom

May 2023

General

Although May was dry and warm overall, it was a month of contrasts. The first half was unsettled, bringing strong winds and rainfall (including some intense localised downpours that led to severe flash flooding) especially in southern Britain, continuing the wet theme of the previous spring months in the south. From mid-month, sustained anticyclonic conditions brought a decisive change: the latter half was sunny, dry and increasingly warm. Correspondingly, soil moisture levels declined (with reports of wildfires in upland areas in Scotland, Wales and the Pennines late in the month), river flows receded sharply, and groundwater levels declined in some more responsive boreholes. Across the north and west, May average river flows were notably or exceptionally low in many catchments. In contrast, healthier river flows and groundwater levels in southern England largely reflect the wetter preceding winter and spring months – much of 2023 has seen a reversal of the usual northwest-southeast rainfall gradient. At the national scale, reservoir stocks for the end of May were moderately below average but decreasing stocks in many northern and western reservoirs led to more pronounced deficits (e.g. Daer was 15% below, Derwent was 20% below). While stocks increased at Colliford and Roadford they remain 17% and 16% below average, respectively. Following the intense late May drydown (which continued and intensified in early June) there is an increased risk of environmental and agricultural stress entering summer, especially in northern and western areas where river flows are low, and where current Outlooks suggest low flows are likely to continue into the early summer. The wet spring means the water resources situation in the southeast is relatively favourable, but vigilance will be required as evaporation rates climb.

Rainfall

The first few days of May were dominated by anticyclonic conditions, but from the 4th a series of low pressure systems moved in from the west, bringing a spell of sustained wet and windy weather to many areas of the UK. The 9th-11th saw intense thundery downpours across large areas of southern and eastern England. Localised surface water flooding incidents and transport disruption were widely reported, particularly in the southwest. A major incident was declared in Somerset (with homes evacuated in North Cadbury) while property flooding by surface water was also reported in eastern England (e.g. Harlow, Essex). From the 12th, anticyclonic conditions dominated and many areas saw little appreciable rainfall thereafter. Hence, in spite of the downpours, May was a dry month overall, with 55% of the typical May rainfall for the UK as a whole. Only localised areas of eastern and central southern England saw above average rainfall, while across the north and west it was exceptionally dry, with less than 30% of average in some upland areas: the Highland region of Scotland saw its eighth driest May since 1890. Rainfall totals for spring (March-May) were also below average for northwest Scotland. In contrast, most southern regions received over 140% of average rainfall: the Wessex region registered its fifth wettest spring since 1890. For longer accumulations, above normal rainfall anomalies in the south contrast with modest deficits in the north and west, which can be traced back as far as the start of winter.

River Flows

River flows in many catchments climbed steadily through the unsettled first week of May, with further rapid increases following the intense downpours from 9th-11th, leading to widespread flood alerts across southwest England, the Midlands, East Anglia and parts of Scotland. Locally, floodplain inundation aggravated surface water flooding impacts, but fluvial flooding was relatively limited and generally, peak flows were modest. However, the Tone registered its second highest May peak flow (in a record from 1961) while several other southern rivers saw peak flows in the top five on record for May. After the 12th, steep recessions were established in a majority of rivers and by month-end, flows in some catchments in the driest areas of northwest Scotland approached or equalled their May minima. Correspondingly, May average river flows show a significant regional north-south contrast. Northern areas saw below-average flows, with notably or exceptionally low flows in many Scottish catchments – the Nevis registered its lowest May flow (in a record from 1983) and the Ewe its second lowest (in a record from 1971). Across southern, central and eastern England flows were above normal or notably high, exceptionally so in parts of Dorset and Somerset: the Brue, Tone and Stour all saw over twice the average May flow, with the Stour registering the highest in a record from 1973. In these areas, and parts of East Anglia, the monthly average flows reflect the early May downpours, but elsewhere in southern England the elevated flows are a response to the wetter early spring. The spring (March-May) average flows reflect this albeit with above normal flows across a larger area of southern Britain and increased numbers of exceptionally high spring flows across the far south.

Soil Moisture and Groundwater

Generally, soil moisture levels tracked the May rainfall, with increases early in the month and marked declines thereafter, which were especially pronounced in Wales and western England. Soil moisture levels were generally well below average by month-end at most COSMOS-UK sites, and soil moisture deficits increased across the UK, although were close to the May average across the Chalk aquifer. Correspondingly, Chalk groundwater levels mostly decreased during May, but remained high in southern England, reflecting longer-term rainfall accumulations. A record May maximum was observed at West Woodyates Manor (in a record from 1942). Although unusual for May, these are seasonal highs and are well below groundwater flooding thresholds. In contrast, levels remained below normal in East Anglia. Levels declined but remained above normal and notably high in the Jurassic limestones at New Red Lion and Ampney Crucis, respectively. In the Magnesian Limestone and Carboniferous Limestone levels fell and remained mostly in the normal range. Groundwater levels in the Permo-Triassic sandstones mostly decreased and were in the normal to above normal range except at Bussels No.7a where they were notably high. There was no overall change in level in the Upper Greensand at Lime Kiln Way, where the groundwater level remained in the normal range. Groundwater levels fell and remain below normal in the Devonian sandstone at Feddan Junction and Easter Lathrisk. At Royalty Observatory (Fell Sandstone), levels fell and remained in the normal range.

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 1991-2020 average.

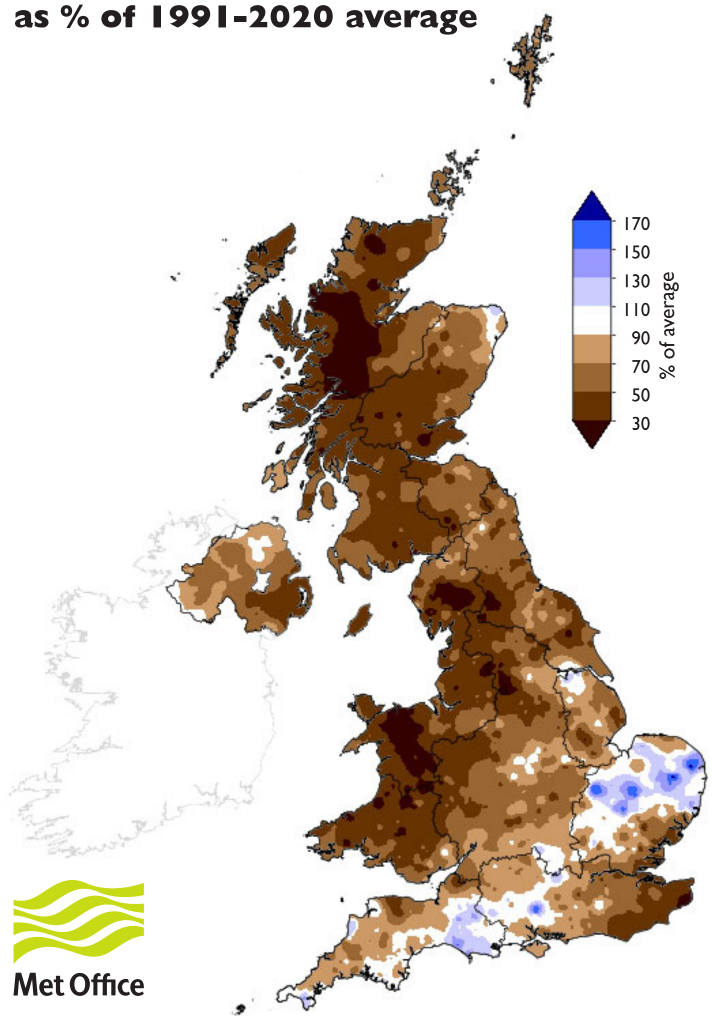
Region	Rainfall	May 2023	Mar23 – May23	RP	Dec22 – May23	RP	Sep22 – May23	RP	Jun22 – May23	RP
United	mm	**39**	241		526		946		1108	
Kingdom	%	**55**	106	2-5	92	2-5	104	5-10	96	2-5
England	mm	**39**	222		419		748		853	
	%	**68**	129	5-10	102	2-5	113	5-10	99	2-5
Scotland	mm	**39**	243		659		1204		1456	
	%	**44**	79	2-5	82	2-5	96	2-5	93	2-5
Wales	mm	**35**	319		712		1223		1396	
	%	**40**	114	2-5	98	2-5	106	2-5	96	2-5
Northern	mm	**49**	290		504		935		1111	
Ireland	%	**67**	123	8-12	90	2-5	106	5-10	96	2-5
England &	mm	**38**	235		459		813		927	
Wales	%	**62**	126	5-10	101	2-5	112	5-10	98	2-5
North West	mm	**32**	245		577		1027		1231	
	%	**43**	103	2-5	94	2-5	104	2-5	97	2-5
Northumbria	mm	**32**	164		364		689		808	
	%	**56**	91	2-5	86	2-5	101	2-5	89	2-5
Severn-Trent	mm	**33**	207		357		647		749	
	%	**56**	123	5-10	95	2-5	108	2-5	94	2-5
Yorkshire	mm	**28**	185		376		689		796	
	%	**51**	107	2-5	92	2-5	106	2-5	92	2-5
Anglian	mm	**42**	185		291		510		592	
	%	**88**	144	8-12	104	2-5	112	2-5	95	2-5
Thames	mm	**43**	230		389		685		762	
	%	**79**	152	15-25	112	2-5	123	8-12	106	2-5
Southern	mm	**33**	238		466		868		940	
	%	**64**	153	15-25	117	5-10	134	20-30	115	5-10
Wessex	mm	**53**	280		530		896		981	
	%	**90**	154	25-40	119	5-10	126	15-25	109	2-5
South West	mm	**59**	340		679		1166		1289	
	%	**83**	143	15-25	107	2-5	116	8-12	103	2-5
Welsh	mm	**35**	312		684		1184		1352	
	%	**42**	116	2-5	98	2-5	107	2-5	97	2-5
Highland	mm	**37**	236		760		1311		1603	
	%	**35**	64	5-10	78	2-5	87	2-5	86	2-5
North East	mm	**43**	198		445		842		1001	
	%	**63**	94	2-5	91	2-5	104	2-5	95	2-5
Tay	mm	**34**	239		565		1154		1378	
	%	**41**	88	2-5	80	2-5	105	5-10	99	2-5
Forth	mm	**32**	211		531		992		1186	
	%	**44**	88	2-5	86	2-5	103	5-10	96	2-5
Tweed	mm	**36**	188		460		872		1009	
	%	**55**	89	2-5	88	2-5	105	5-10	93	2-5
Solway	mm	**40**	300		699		1315		1569	
	%	**45**	100	2-5	89	2-5	106	10-15	100	2-5
Clyde	mm	**47**	299		782		1438		1750	
	%	**46**	83	2-5	81	2-5	95	2-5	93	2-5

% = percentage of 1991-2020 average *RP = Return period*

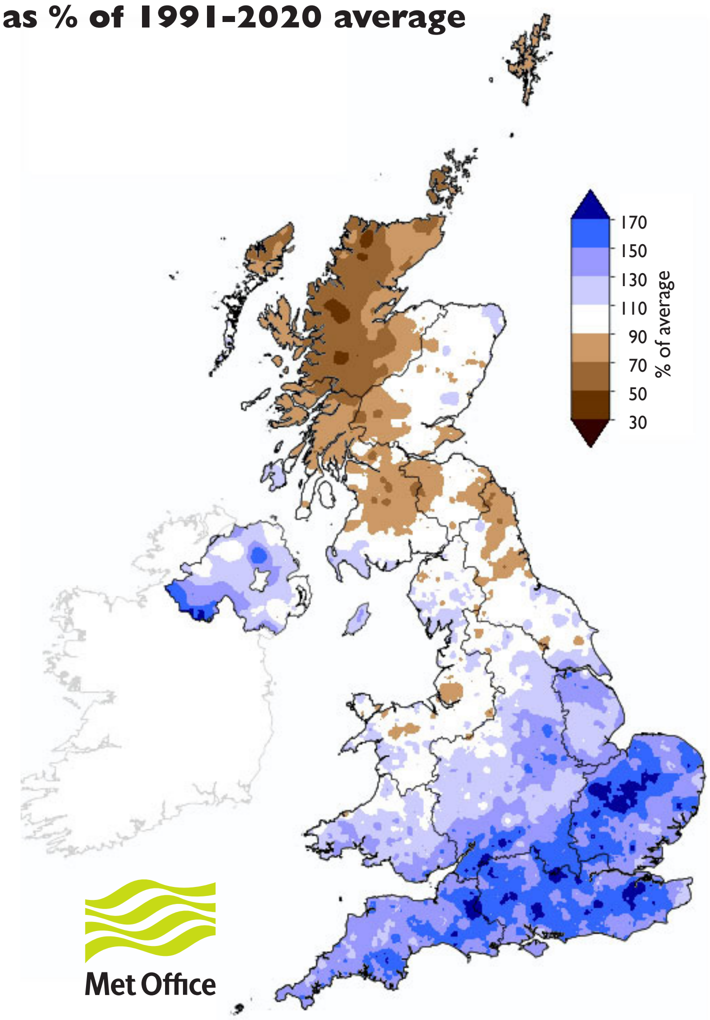
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1836; 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 2023 are provisional. Source: Data from HadUK-Grid dataset at 1km resolution v1.2.0.0.

Rainfall . . . Rainfall . . .

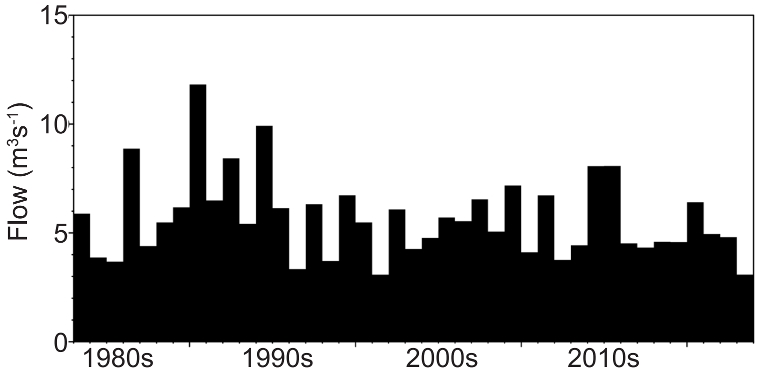
May 2023 rainfall as % of 1991-2020 average



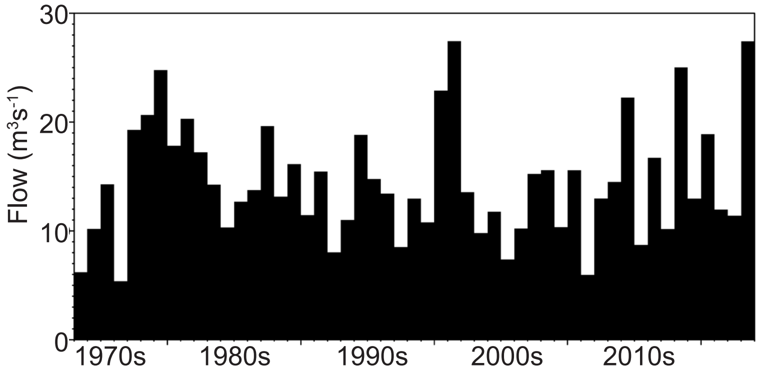
March 2023 - May 2023 rainfall as % of 1991-2020 average



Spring (Mar-May) average flows for the Nevis



Spring (Mar-May) average flows for the Dorset Stour



UK Hydrological Outlook

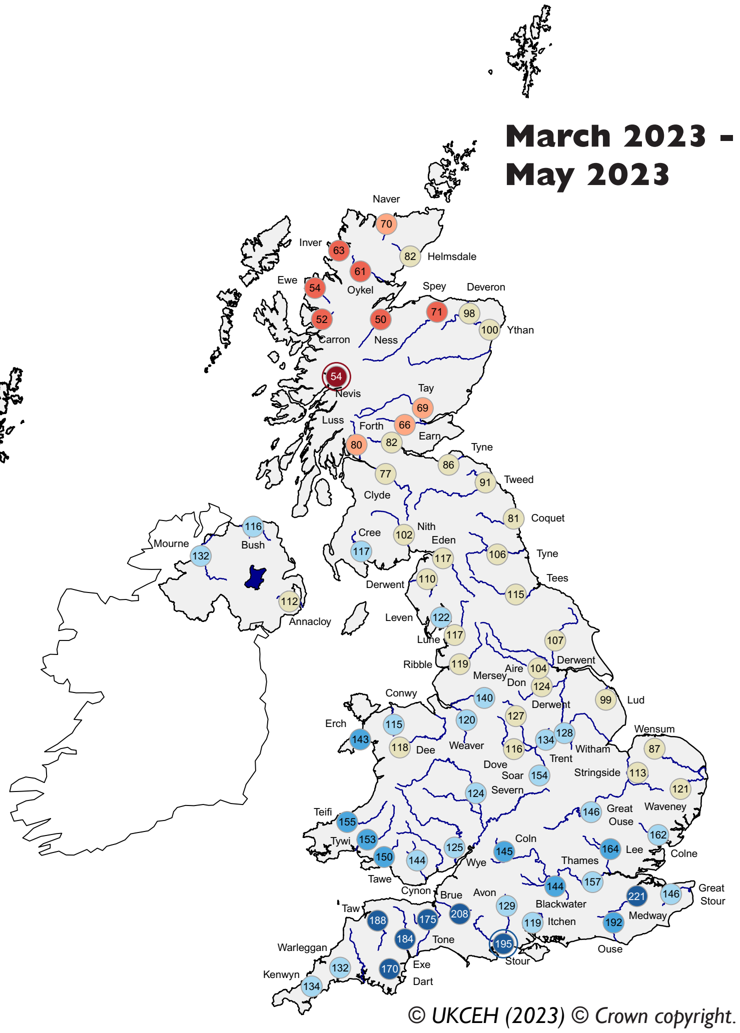
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

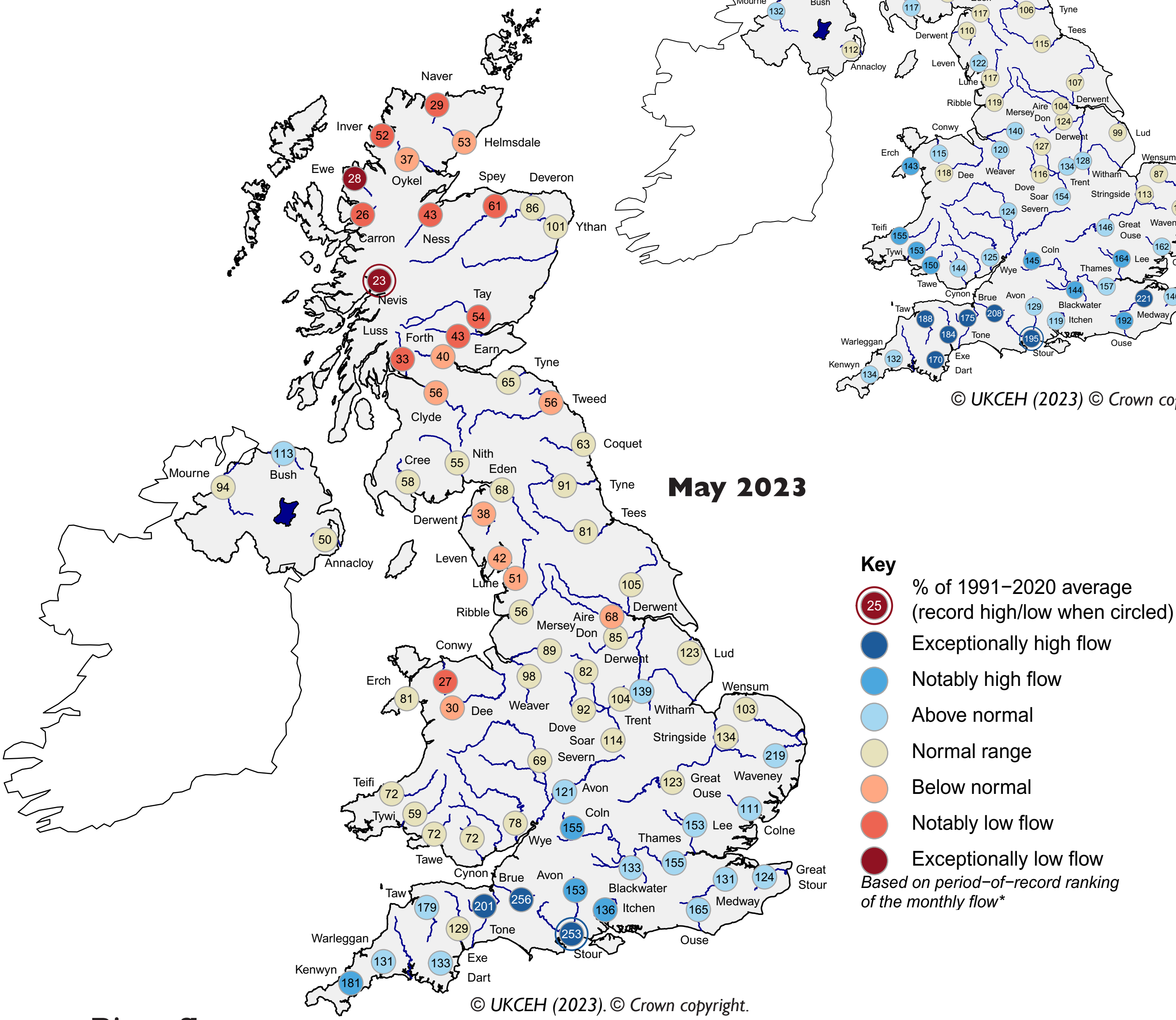
The complete version of the Hydrological Outlook UK can be found at: www.hydoutuk.net/latest-outlook/

Period: **from June 2023**
Issued: **08.06.2023**
using data to the end of May 2023

The outlook for June is for below normal river flows in the north and west, and normal to below normal river flows elsewhere. For groundwater, normal to above normal levels are expected, with above normal levels most likely in the far south. For summer, the outlook is for normal to below normal flows across the UK, and normal to above normal groundwater levels. In parts of the far south, above normal groundwater levels and flows are likely to persist through the summer.

River flow . . . River flow . . .

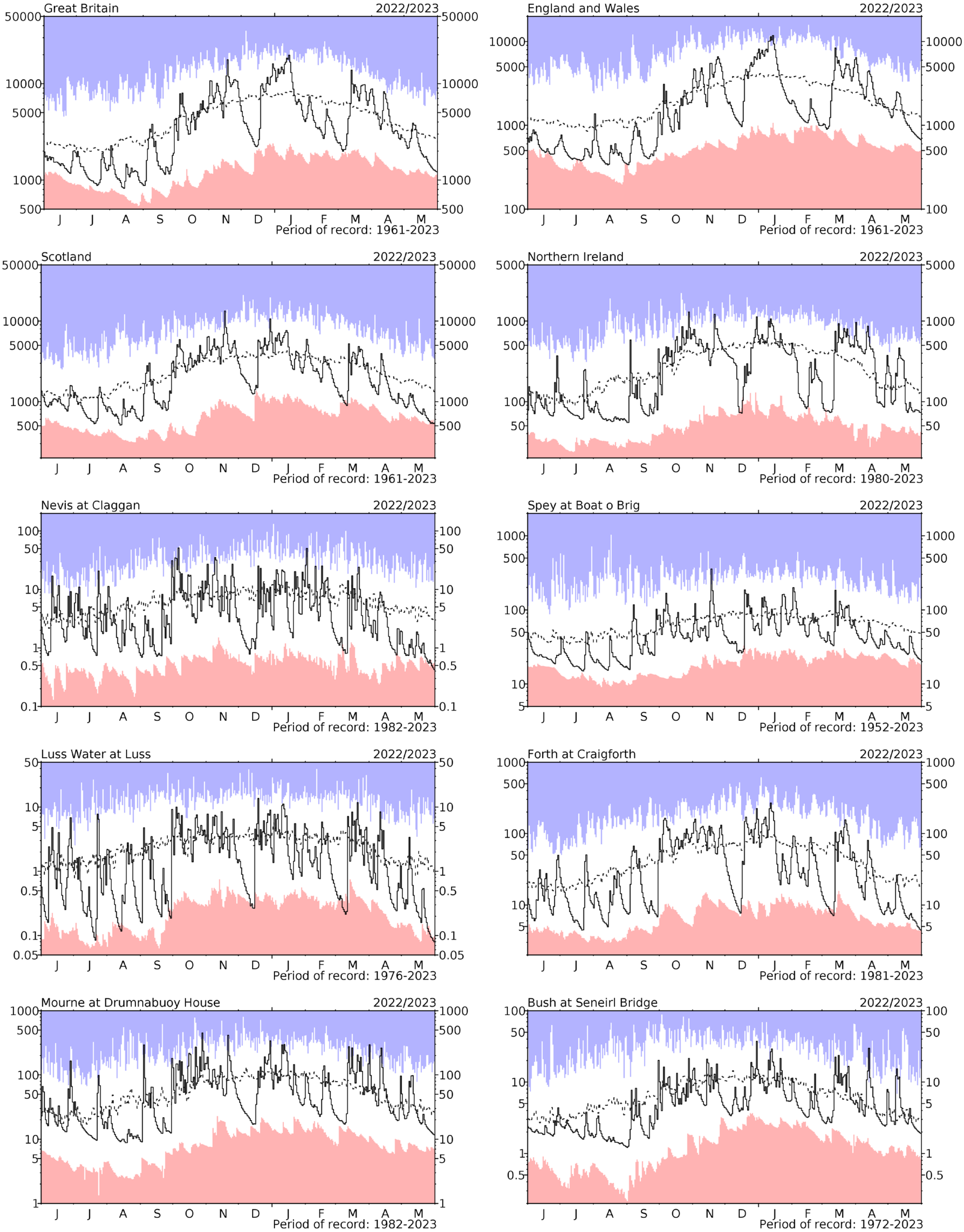




River flows

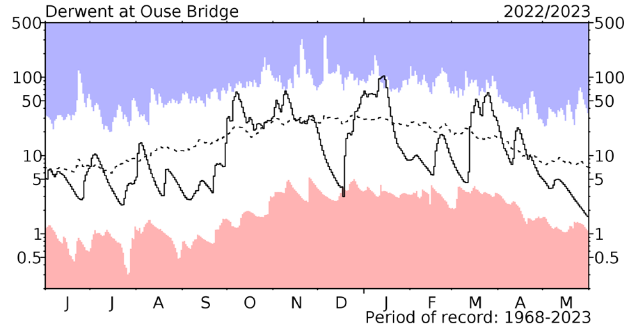
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. The categories of the spots are based on the full period-of-record data whereas the percentages are based on the 1991-2020 averaging period for consistency between rainfall and river flows. Percentages may be omitted where flows are under review.

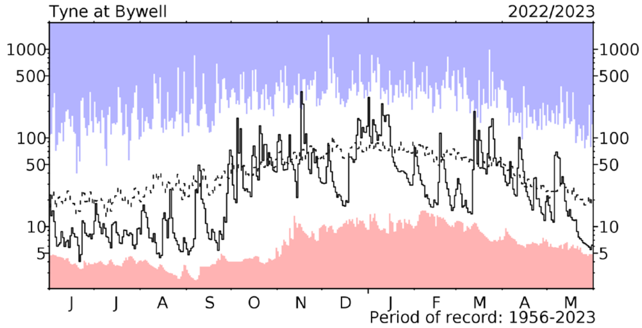
River flow . . . River flow . . .

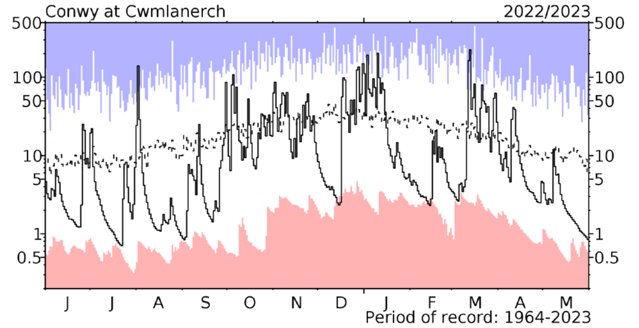


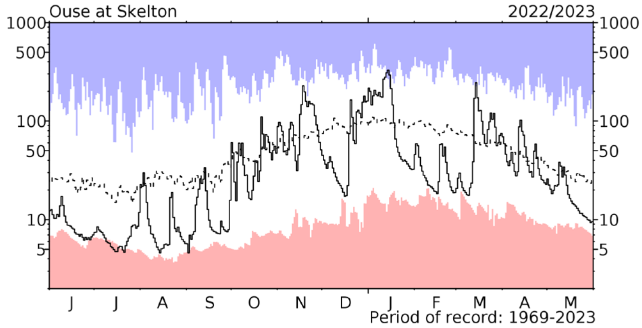
River flow hydrographs

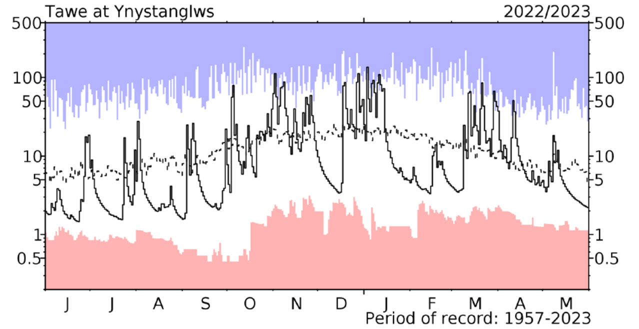
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to June 2022 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

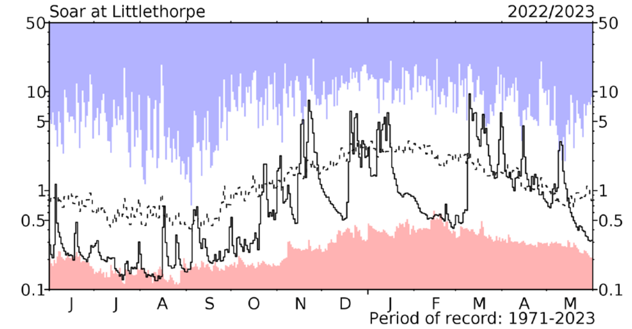

Derwent at Ouse Bridge
2022/2023
J J A S O N D J F M A M
Period of record: 1968-2023

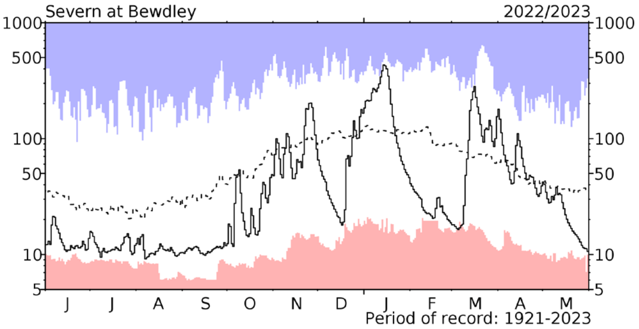

Tyne at Bywell
2022/2023
J J A S O N D J F M A M
Period of record: 1956-2023

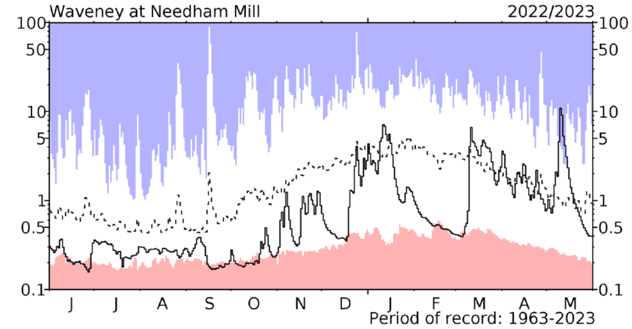

Conwy at Cwmlanerch
2022/2023
J J A S O N D J F M A M
Period of record: 1964-2023

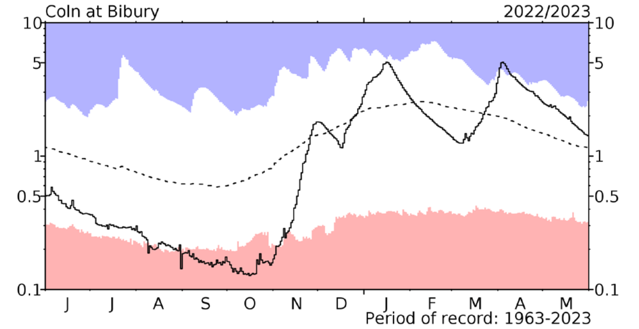

Ouse at Skelton
2022/2023
J J A S O N D J F M A M
Period of record: 1969-2023

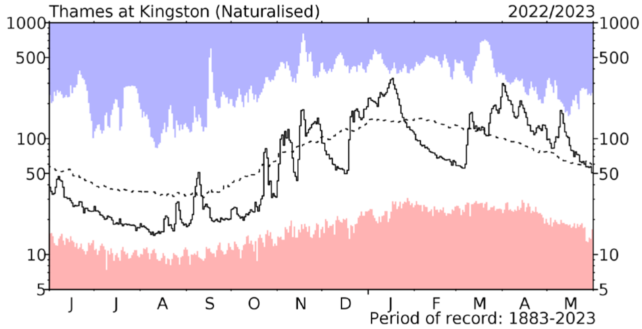

Tawe at Ynystanglws
2022/2023
J J A S O N D J F M A M
Period of record: 1957-2023

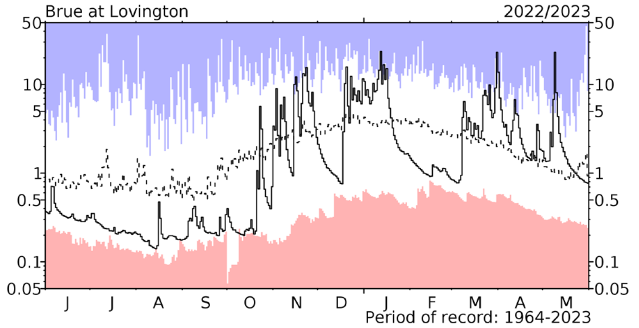

Soar at Littlethorpe
2022/2023
J J A S O N D J F M A M
Period of record: 1971-2023


Severn at Bewdley
2022/2023
J J A S O N D J F M A M
Period of record: 1921-2023


Waveney at Needham Mill
2022/2023
J J A S O N D J F M A M
Period of record: 1963-2023


Coln at Bibury
2022/2023
J J A S O N D J F M A M
Period of record: 1963-2023


Thames at Kingston (Naturalised)
2022/2023
J J A S O N D J F M A M
Period of record: 1883-2023


Brue at Lovington
2022/2023
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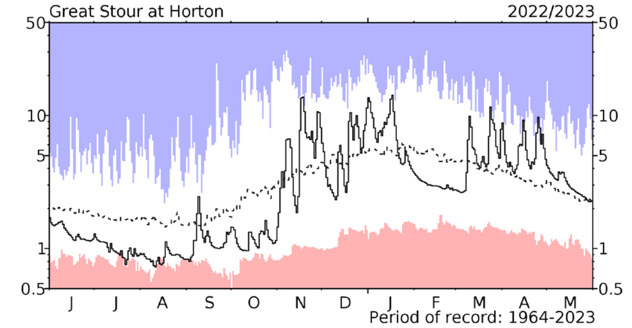
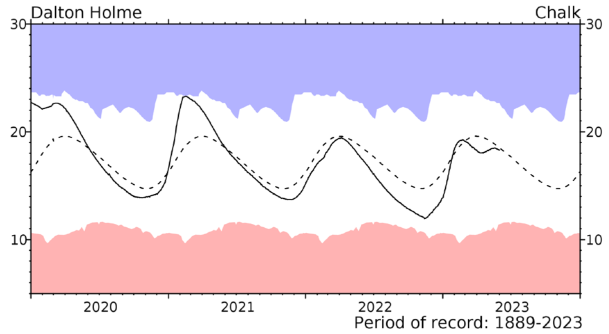
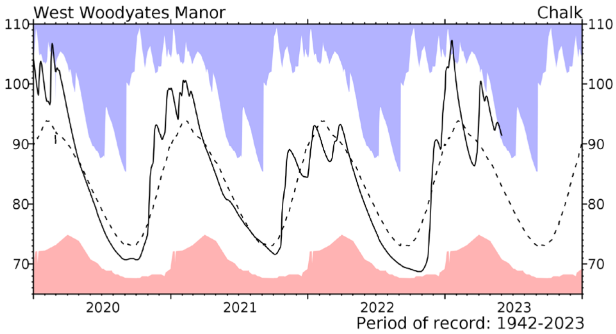
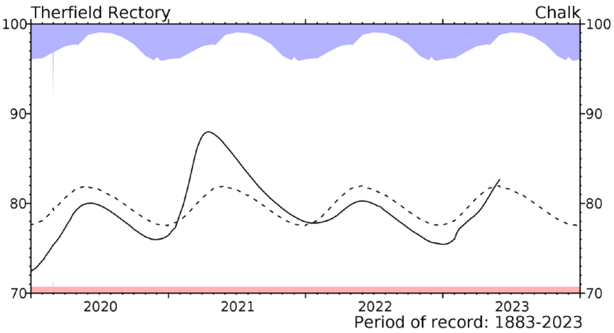
Period of record: 1964-2023

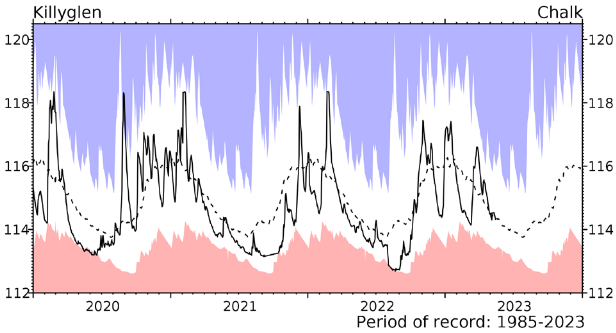

Great Stour at Horton
2022/2023
J J A S O N D J F M A M
Period of record: 1964-2023

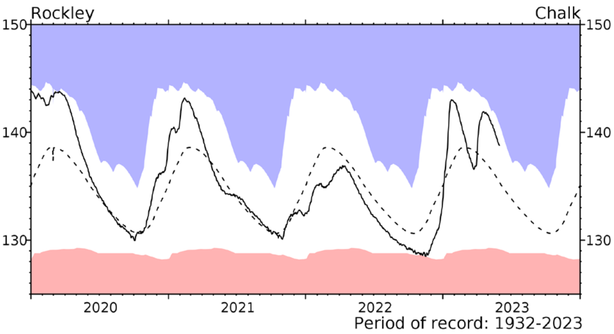
Groundwater ... Groundwater

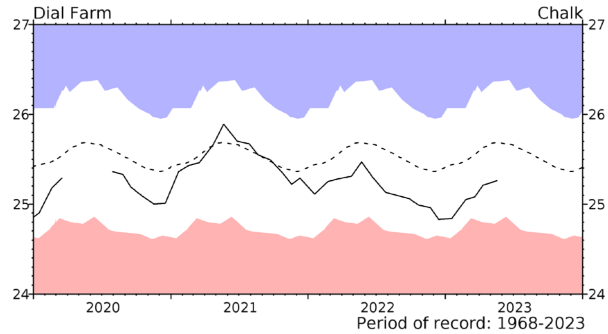


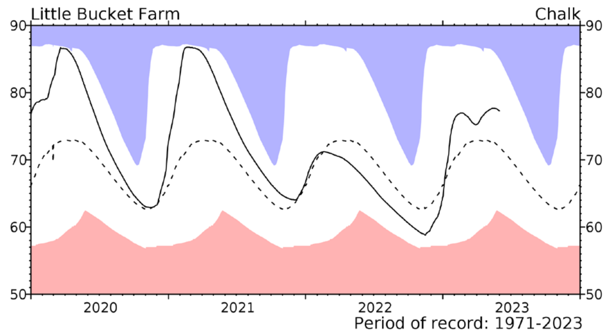


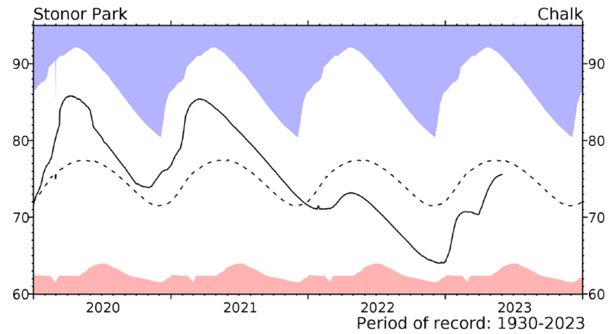


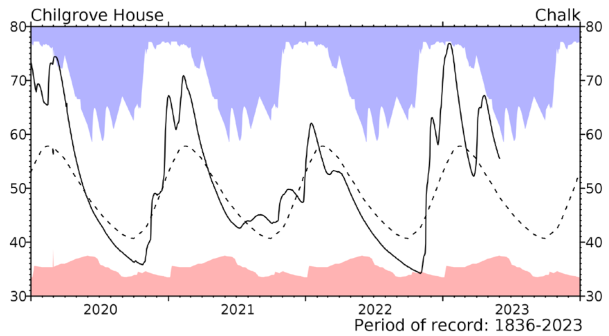


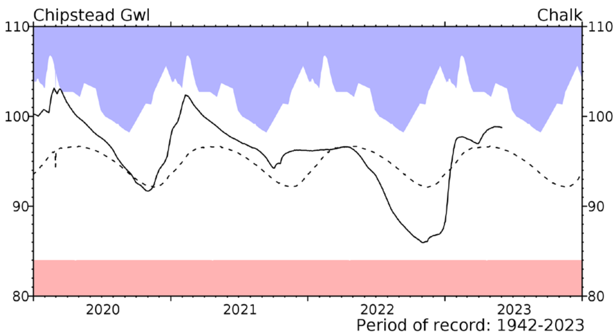






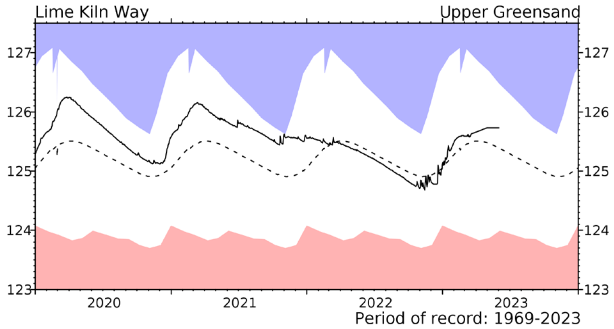


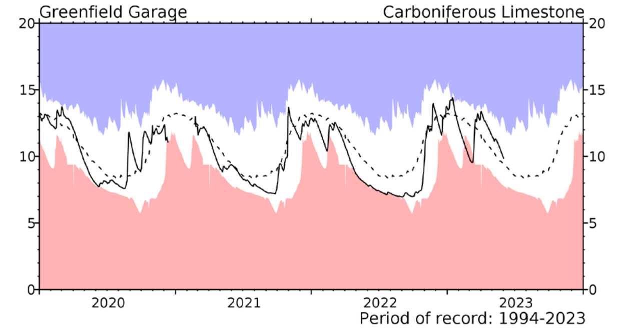


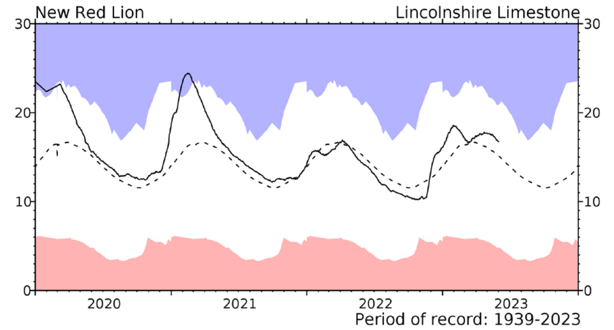


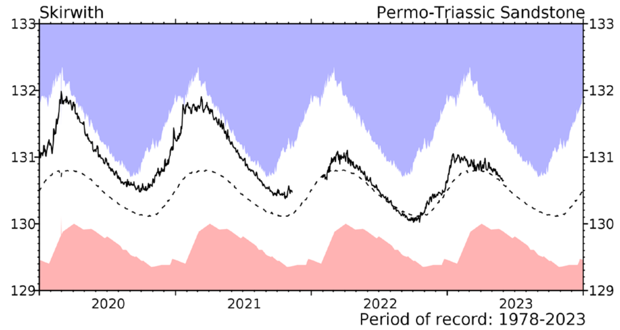
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is 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 2019. 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.

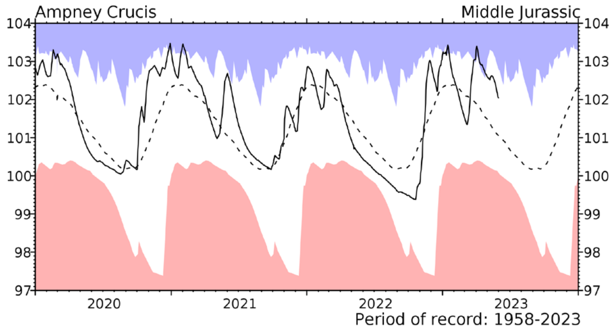
Groundwater ... Groundwater

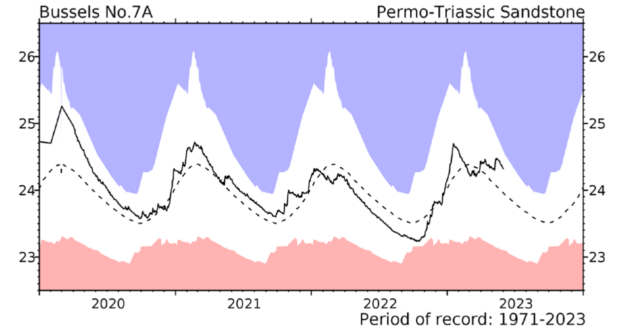


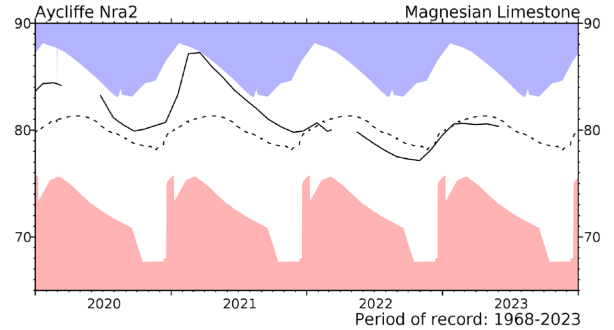


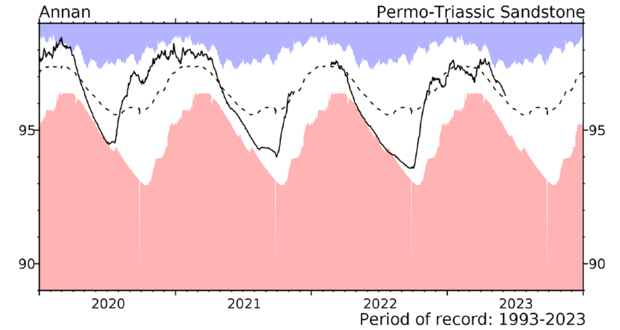


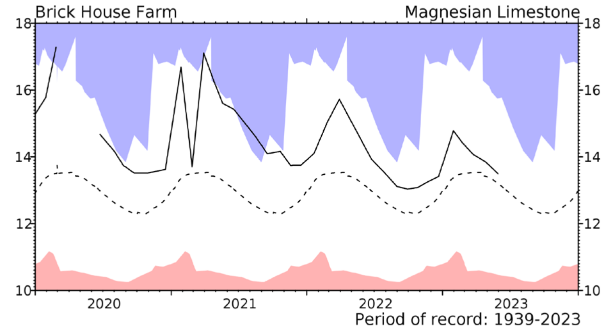


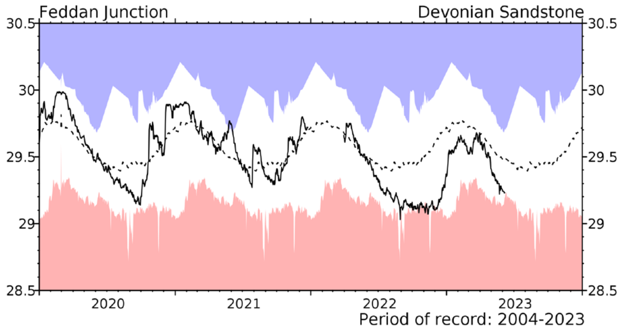


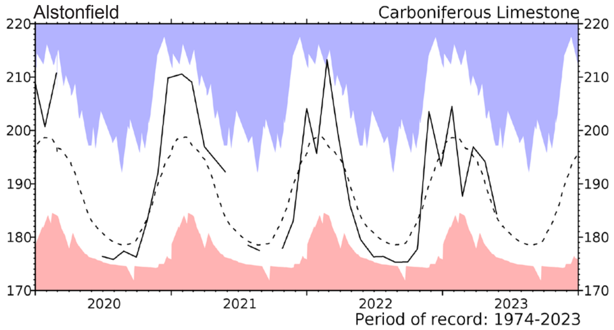


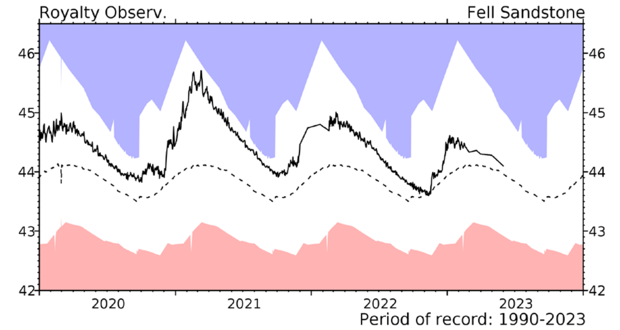












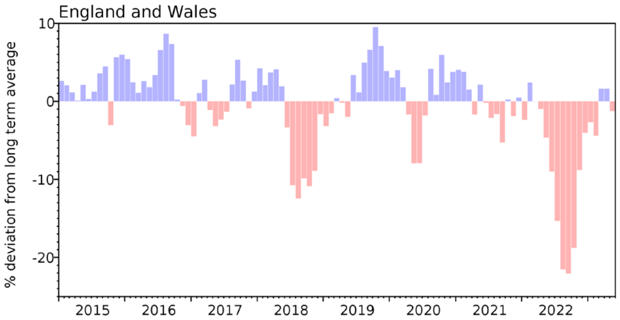
Groundwater...Groundwater

Groundwater levels - May 2023

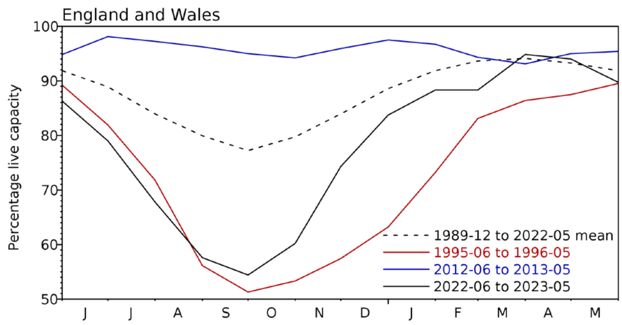
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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)	2023 Mar	2023 Apr	2023 May	May Anom.	Min May	Year* of min	2022 May	Diff 23-22
North West[+]	Haweswater and Thirlmere	•	111132	99	91	74	-4	62	2020	77	-3
	Pennines		126991	90	88	75	-3	64	2020	72	3
Northumbrian	Teesdale	•	87936	100	94	77	-8	62	2020	92	-15
	Kielder		(199175)	96	91	93	1	85	1989	91	2
Severn-Trent	Clywedog		49936	98	99	99	2	83	1989	96	4
	Derwent Valley	•	46692	101	97	67	-20	56	1996	72	-5
Yorkshire	Washburn	•	23373	99	98	93	7	71	2020	77	16
	Bradford Supply	•	40942	92	92	84	-1	68	2020	74	10
Anglian	Grafham		(55490)	80	87	94	0	72	1997	96	-2
	Rutland		(116580)	97	96	93	1	75	1997	94	-1
Thames	London	•	202828	98	97	97	3	83	1990	96	1
	Farmoor	•	13822	89	95	99	2	90	2002	93	6
Southern	Bewl		31000	100	99	98	10	57	1990	80	18
	Ardingly		4685	100	100	100	2	88	2022	88	12
Wessex	Clatworthy		5662	100	100	97	11	67	1990	81	16
	Bristol	•	(38666)	100	100	97	9	70	1990	81	16
South West	Colliford		28540	60	67	68	-17	52	1997	68	1
	Roadford		34500	68	69	68	-16	48	1996	88	-20
	Wimbleball		21320	100	100	96	5	74	2011	80	16
	Stithians		4967	99	99	94	7	66	1990	77	17
Welsh	Celyn & Brenig	•	131155	89	92	85	-12	79	2020	83	1
	Brianne		62140	100	100	96	1	76	2022	76	20
	Big Five	•	69762	100	99	88	-1	70	1990	77	11
	Elan Valley	•	99106	100	97	90	-3	75	2022	75	15
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	98	96	89	-1	52	1998	90	-1
	East Lothian	•	9317	100	100	100	3	84	1990	98	2
Scotland(W)	Loch Katrine	•	110326	100	97	78	-9	66	2001	95	-17
	Daer		22494	90	84	73	-15	69	2020	79	-6
	Loch Thom		10721	99	96	83	-7	70	2020	92	-9
Northern Ireland	Total[++]	•	56800	98	97	93	7	69	2008	84	9
	Silent Valley	•	20634	100	98	94	12	56	2000	82	12

( ) figures in parentheses relate to gross storage

• denotes reservoir groups

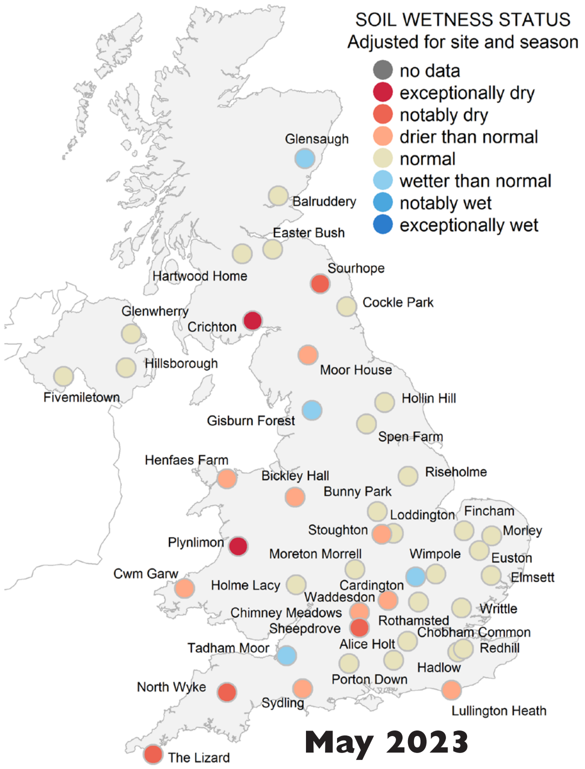
*last occurrence

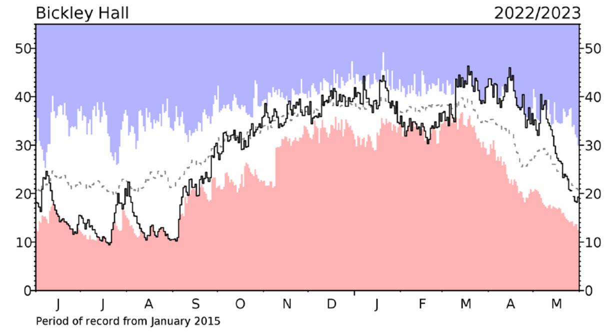
[+] excludes Northern Command Zone and Vyrnwy.

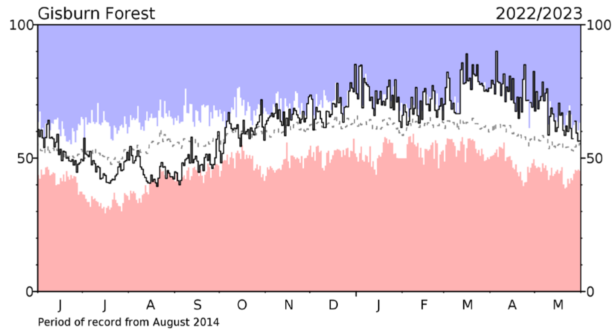
[++] excludes Lough Neagh

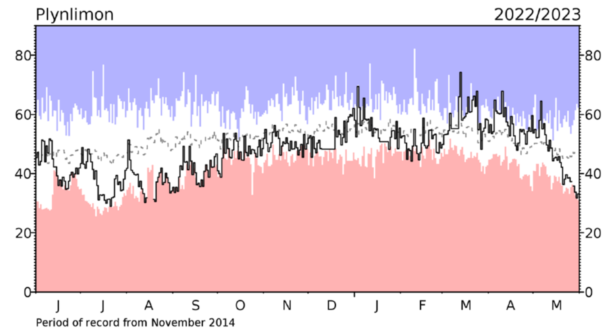
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed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

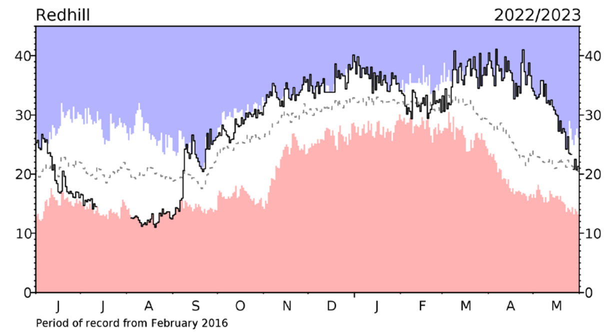
Soil Moisture . . . Soil Moisture

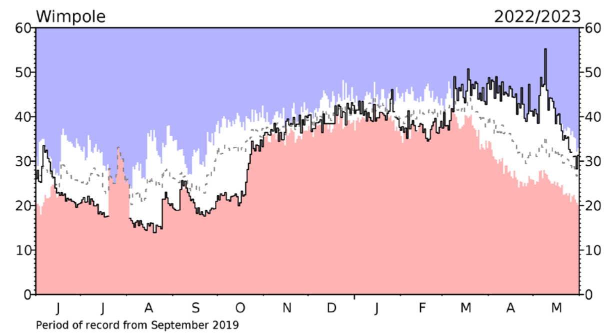












At the end of May, soil moisture levels at most COSMOS-UK sites are low after a dry end to the month, despite wetter conditions at the start of the month.

Soil moisture levels at most COSMOS-UK sites largely followed the pattern of precipitation, with wet soils at the start of the month, dropping to drier levels at the end of the month. Some sites, particularly those in Wales and western England (e.g. Cym Garw, Plynlimon, Bickley Hall), showed a marked decline in soil moisture through the month, dropping from very wet to very dry conditions. Other sites saw soil moisture levels decrease, but from very wet to more normal conditions for the time of year, such as Redhill, Riseholme and Wimpole along eastern England. A few sites remain wet, despite the dry conditions, such as Glensaugh in Scotland, Glenwherry in Northern Ireland, and Gisburn Forest in northwest England.

Overall, soil moisture declined through May following a period of dry and warmer conditions.

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. A location map of all sites used in the Hydrological Summary can be found on the NHMP website. 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 the HadUK-Grid 1km 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 1836 and form the official source of UK areal rainfall statistics which have been adopted by the NHMP. The gridding technique used is described in Hollis, 2019 available at https://doi.org/10.1002/gdj3.78

Long-term averages are based on the period 1991-2020 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.

For further details on rainfall or MORECS data, please contact the Met Office:

Tel: 0370 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