Hydrological Summary

for the United Kingdom

March 2024

General

March was an unsettled and mostly wet month, although there were drier interludes and marked spatial variations in rainfall. Similarly, it was mild overall (1.0°C above average for the UK as whole) but saw wintry periods, with early-spring snowfall in places. Rainfall patterns echoed those of most months since mid-2023: exceptional rainfall totals in southern Britain contrasting with relatively dry conditions in northwest Scotland. Hence, following an exceptionally wet winter half year (October-March), March river flows were significantly above average for southern Britain and exceptionally high in many catchments, and flood alerts were widespread, although reported impacts were localised. Similarly, groundwater levels remained higher than normal for the time of year across most of the UK, with persistent groundwater flood alerts and warnings in place through March, particularly in the Wessex Chalk aquifers, where localised flooding was reported. Reservoir stocks were above average at the national scale, with many impoundments at or near capacity. Moderate deficits remain in a few reservoirs (e.g. Farmoor and Grafham) although stocks in these increased through March. Consequently, entering the summer half-year, the water resources position is very healthy across the UK, but flood risk remains elevated given above-normal flows and levels, and a wet start to April. The latest Outlook suggests normal to above-normal flows for the April-June period.

Rainfall

The first few days of March were cold and unsettled, with widespread wintry showers, while heavy snow brought localised transport disruption (e.g. in Northern Ireland and southwest England). An easterly spell in the second week kept northern and eastern areas cold but mostly dry, before a switch to westerly airflows from the 13th brought milder conditions that persisted until month-end in England. A series of Atlantic depressions crossed the UK, bringing persistent and sometimes heavy rainfall to all areas: northwestern areas were especially wet mid-month (with 94mm at Capel Curig on the 13th), while southern Britain saw sustained heavy rainfall in the final week, with intense downpours bringing localised transport disruption due to surface water flooding (e.g. in parts of the Thames valley). The March rainfall for the UK as a whole was 127% of average but Southern Britain was notably wet – large areas of central southern England saw around double the typical March rainfall (Wessex region received 206% of average). Eastern Scotland also saw substantially above-average rainfall, but in contrast the Highland region received 66% of average. The wet March adds to the long run of months with above-average rainfall. February-March rainfall accumulations were exceptionally high across southern Britain (and the highest on record for England). For most regions away from western Scotland rainfall accumulations over the last 6-9 months were exceptionally high (the highest October-March and July-March rainfalls on record for England, in records from 1890).

River Flows

March began with high flows in many catchments, particularly in southern England, following the exceptionally wet February and previous winter months – on the 4th, the Thames registered its fourth highest March peak flow, in a record from 1883. With elevated flows and heavy rainfall in the opening days, the first week saw widespread flood alerts across England. The threat diminished (although groundwater-flooding alerts continued, with corresponding sustained high flows in many groundwater-fed catchments) as river flows declined slowly through the first ten days of March, although they typically remained well above average. Thereafter, many catchments saw rapid flow increases following the downpours from mid-month, with further localised flood alerts and warnings, particularly in southern Britain in the final week. On the 25th/26th heavy rain in Cornwall triggered flooding (with reports of drivers rescued from stranded cars) and the Gannel registered its third highest March peak flow on record. More widespread heavy rainfall across southwest England triggered flow responses in the final days, especially when falling on rivers with significant groundwater contributions: on the 29th, the Hampshire Avon and Dorset Stour registered their highest March peak flows in records from 1965 and 1973. The Annacloy in Northern Ireland also saw its third highest March flow on record on the 28th. The March average river flows were notably or exceptionally high across Southern Britain, with many catchments seeing twice the typical March flow, and new maxima were registered in catchments in the southwest (the Kenwyn, Warleggan, Brue, Avon and Stour). In northern Britain flows were typically normal or moderately above, but in western Scotland flows were below normal, with less than 60% of average in some catchments (e.g. the Carron and Ewe). Over the winter half-year (October-March), runoff accumulations were exceptional across much of the UK, except western Scotland, with widespread new maxima, stretching from southwest England to eastern Scotland. Correspondingly, the October-March outflows were the highest on record for England and the second highest for Wales and Northern Ireland.

Soil Moisture and Groundwater

After the wet winter, soil moisture levels were high at the majority of COSMOS-UK sites and remained so through March, with a few exceptions. Soil Moisture Deficits (SMDs) remained zero or negligible across all aquifer areas, enabling further recharge in responsive aquifers. Groundwater levels remained above normal across the Chalk, with the exception of Killyglen where they were in the normal range. Levels fell and became above normal to notably high in the Chalk of Yorkshire, Lincolnshire and southern East Anglia. Levels fell, but remained exceptionally high, in the Wessex Chalk, Marlborough Downs and the South Downs. Another record high level was observed at Ashton Farm (in record from 1974). Levels continued to rise in the Chilterns, Cambridgeshire and northern East Anglian Chalk. Levels in the Jurassic Limestones fell from last months' record high at New Red Lion, while they were fairly stable at Ampney Crucis. Magnesian Limestone levels fell but remained notably high at Aycliffe and set a new March record at Brick House Farm (in a record from 1979). Groundwater levels fell across the Carboniferous Limestone and were notably high at all sites. In the Permo-Triassic Sandstones, levels fell at Skirwith and moved into the notably high range. Elsewhere levels continued to rise, with record highs at both Weir Farm and Bussels No.7a. At Lime Kiln Way in the Upper Greensand, the level fell and became exceptionally high (following last months' record high). In the Fell Sandstone, levels rose and remained exceptionally high. The groundwater level was relatively stable and remained normal in the Devonian sandstones at Easter Lathrisk.

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

Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1991-2020 average.

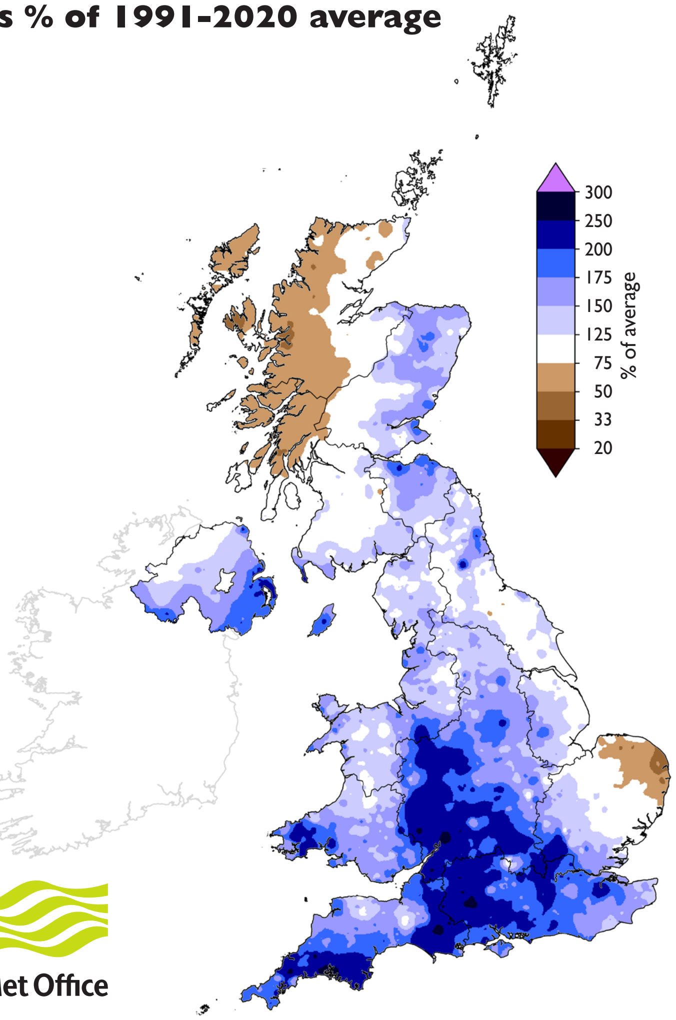
Region	Rainfall	Mar 2024	Feb24 – Mar24		Oct23 – Mar24		Jul23 – Mar24		Apr23 – Mar24	
				RP		*RP*		*RP*		*RP*
United	mm	**108**	248		844		1193		1354	
Kingdom	%	**127**	137	20-30	126	80-120	127	>>100	117	50-80
England	mm	**94**	224		712		986		1130	
	%	**162**	180	>100	149	>100	144	>100	131	80-120
Scotland	mm	**113**	262		994		1420		1602	
	%	**90**	99	2-5	105	5-10	110	10-20	102	5-10
Wales	mm	**158**	364		1167		1619		1778	
	%	**153**	163	40-60	134	60-90	136	>100	122	40-60
Northern	mm	**129**	214		753		1210		1421	
Ireland	%	**149**	120	5-10	116	20-30	131	>>100	123	>>100
England &	mm	**103**	243		774		1073		1218	
Wales	%	**160**	176	>100	146	>100	142	>100	129	80-120
North West	mm	**126**	264		968		1447		1615	
	%	**139**	135	10-20	132	>100	139	>>100	127	>100
Northumbria	mm	**79**	146		673		971		1098	
	%	**126**	110	2-5	137	>100	135	>100	121	20-35
Severn-Trent	mm	**96**	214		663		904		1046	
	%	**178**	192	>100	157	>100	146	>100	131	60-90
Yorkshire	mm	**79**	176		692		998		1128	
	%	**133**	137	8-12	148	>100	147	>100	130	50-80
Anglian	mm	**47**	153		493		687		809	
	%	**118**	187	40-60	156	>100	143	60-90	129	30-50
Thames	mm	**91**	219		612		831		973	
	%	**197**	220	80-120	154	80-120	147	>100	135	30-50
Southern	mm	**96**	253		774		981		1125	
	%	**185**	221	80-120	160	80-120	149	80-120	138	40-60
Wessex	mm	**129**	295		832		1116		1280	
	%	**206**	225	>100	158	>100	154	>100	142	>100
South West	mm	**171**	410		1078		1436		1618	
	%	**190**	208	>100	141	70-100	140	80-120	129	40-60
Welsh	mm	**157**	358		1127		1561		1718	
	%	**158**	167	50-80	135	70-100	137	>100	123	50-80
Highland	mm	**102**	298		1127		1597		1788	
	%	**66**	90	2-5	98	2-5	104	5-10	96	2-5
North East	mm	**96**	183		820		1113		1271	
	%	**131**	121	5-10	140	>>100	132	>>100	120	>100
Tay	mm	**119**	229		1008		1414		1588	
	%	**111**	101	2-5	121	15-25	125	50-80	114	20-30
Forth	mm	**117**	218		835		1186		1329	
	%	**122**	107	2-5	115	15-25	118	25-40	107	8-12
Tweed	mm	**112**	187		735		1070		1194	
	%	**143**	112	2-5	119	20-30	123	70-100	110	10-15
Solway	mm	**152**	288		928		1406		1592	
	%	**127**	113	5-10	99	2-5	109	8-12	101	5-10
Clyde	mm	**125**	311		1100		1602		1829	
	%	**83**	96	2-5	95	2-5	102	5-10	97	2-5

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

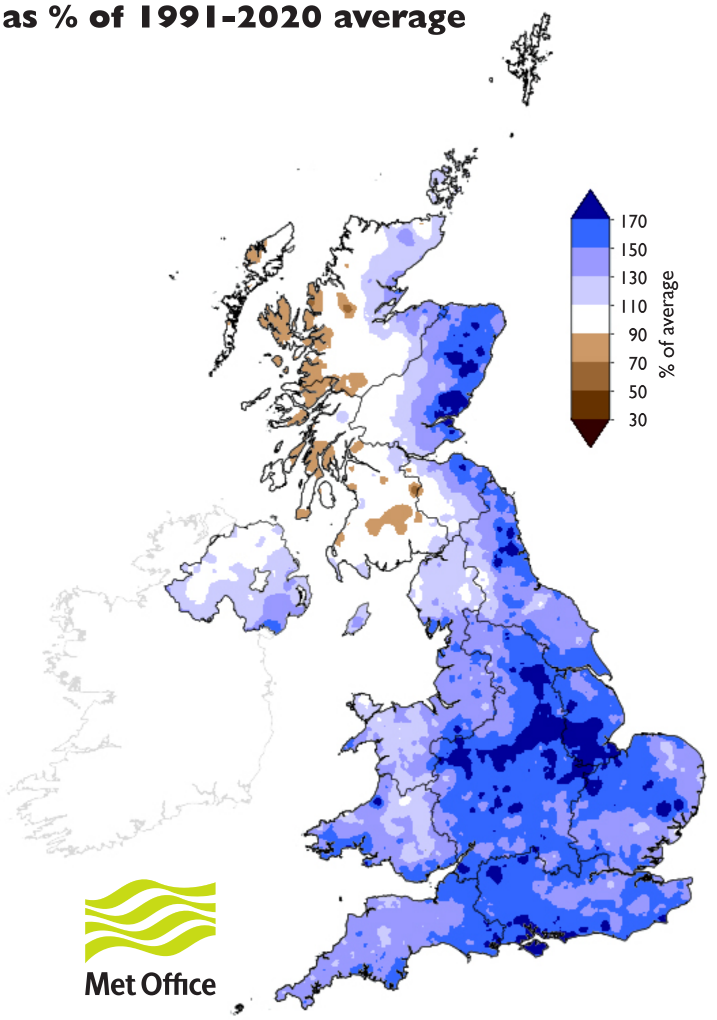
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1890; 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 . . .

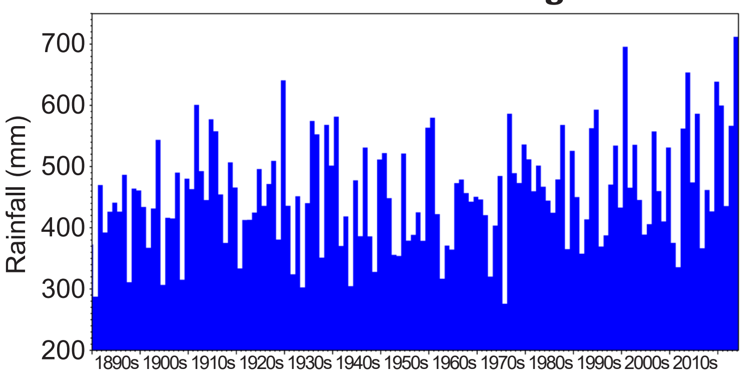
March 2024 rainfall as % of 1991-2020 average



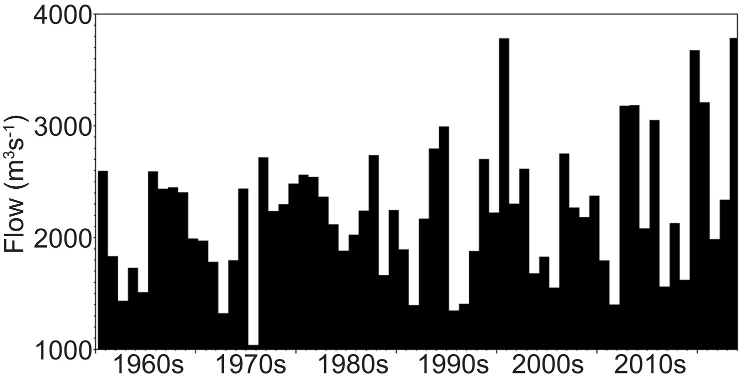
October 2023 - March 2024 rainfall as % of 1991-2020 average



October - March rainfall for England



October - March outflows for England



UK Hydrological Outlook

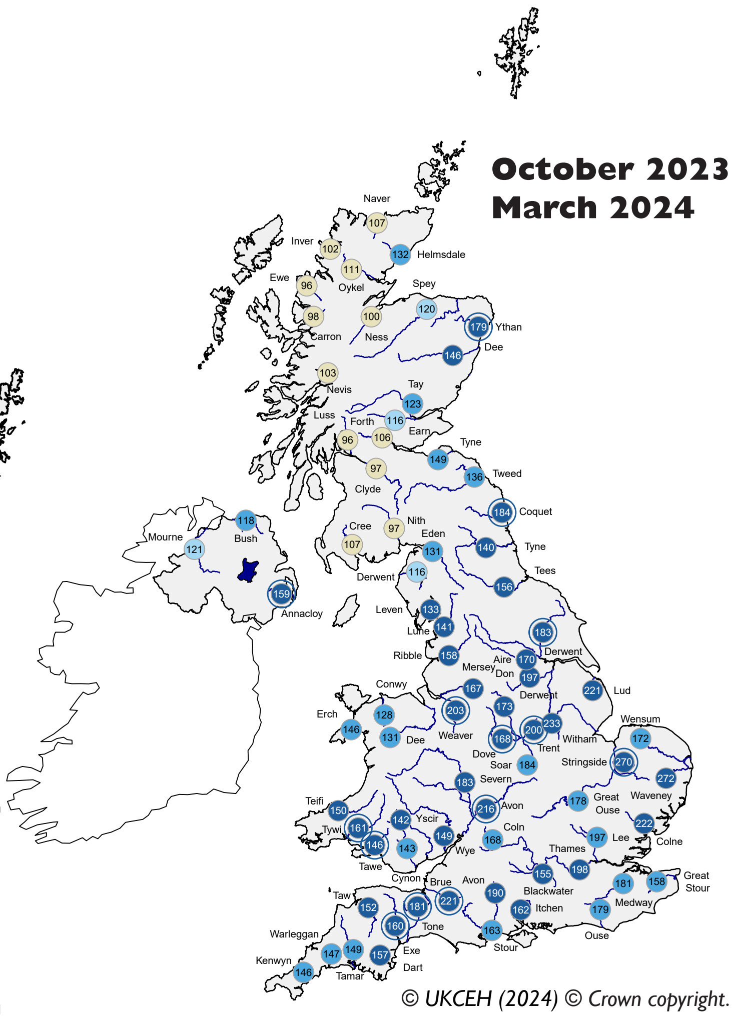
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

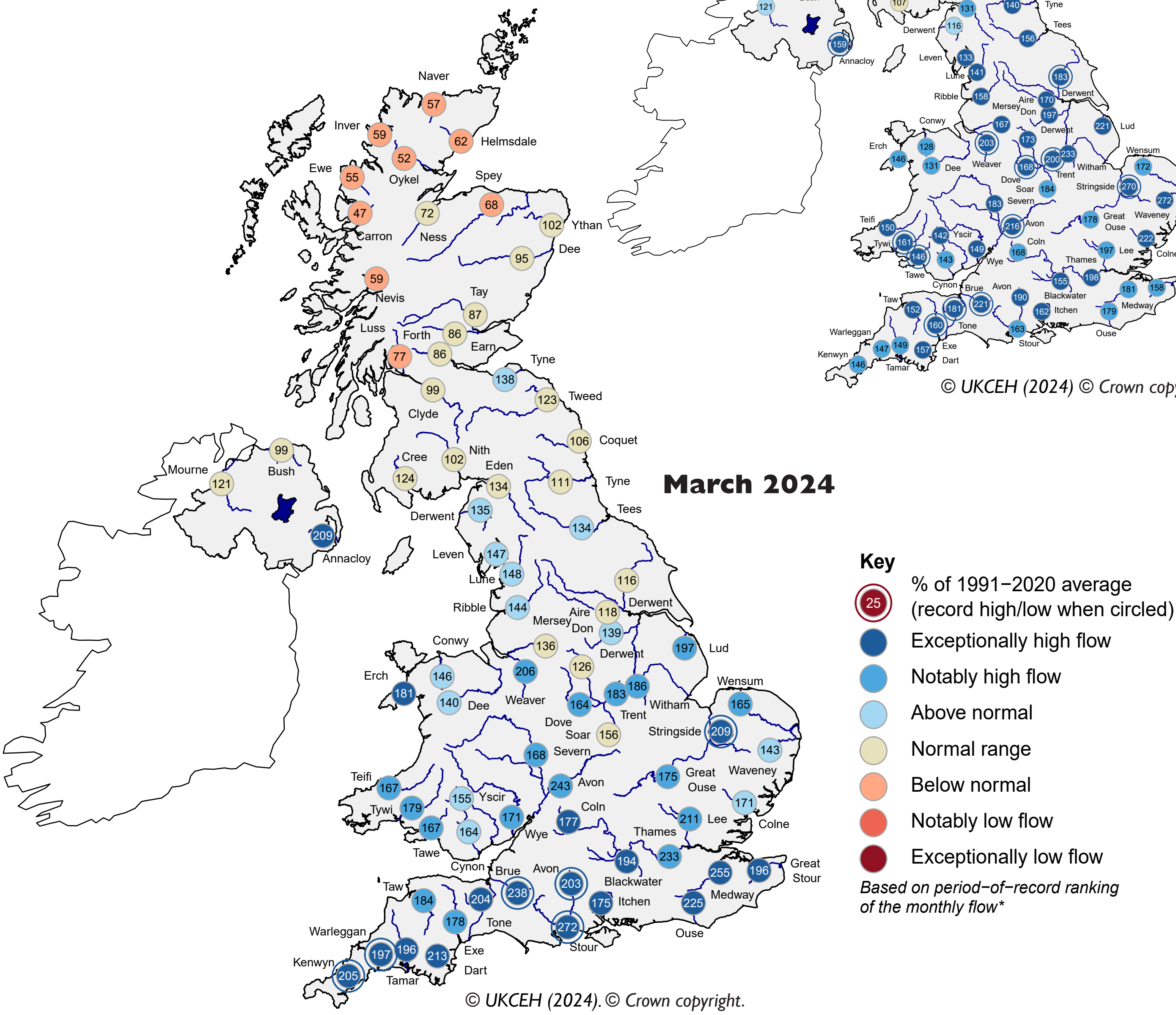
Period: **from April 2024**
Issued: **09.04.2024**
using data to the end of March 2024

The outlook for April is for above normal river flows in central, southern and eastern England. These areas are likely to see normal to above normal river flows over the April-June period. In the north and west of the UK, normal to above normal river flows are most likely in April and for April June. For groundwater levels, above normal levels are likely to persist for most of the UK through April, and for the April-June period.

October 2023 - March 2024



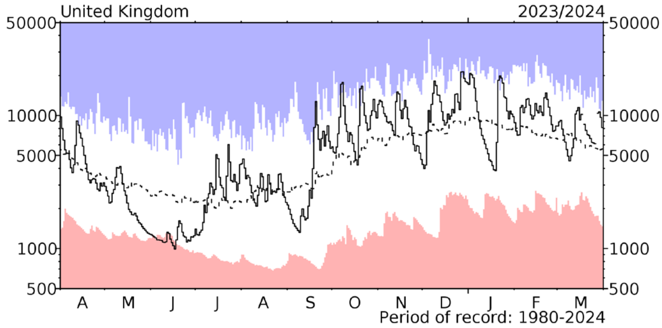
March 2024

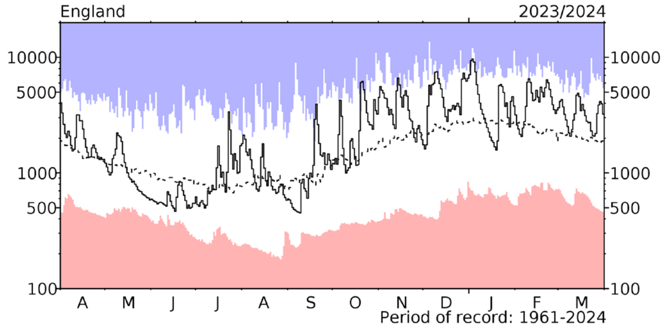


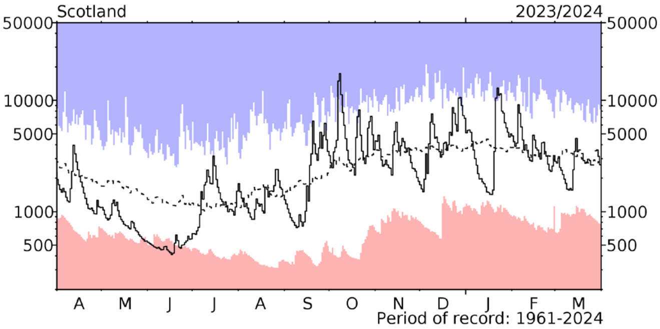
River flows

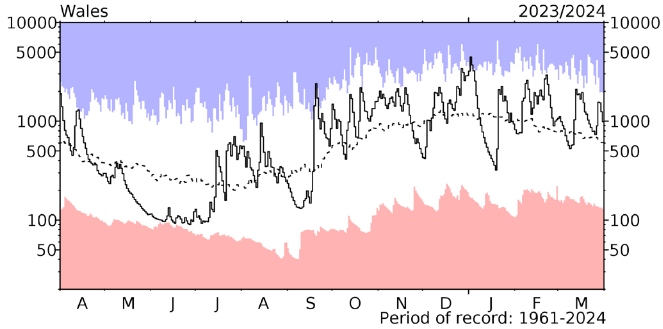
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much 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.

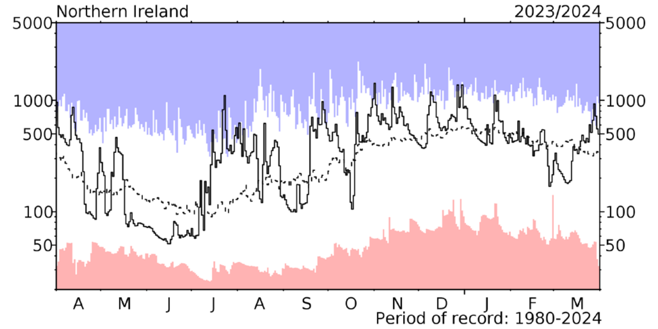
River flow . . . River flow . . .

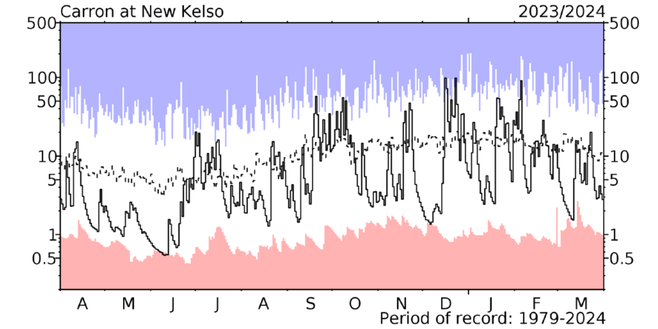


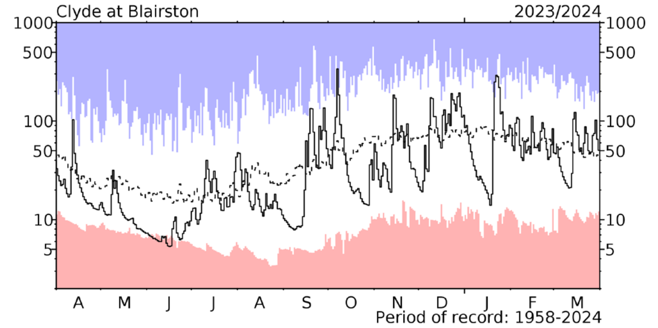


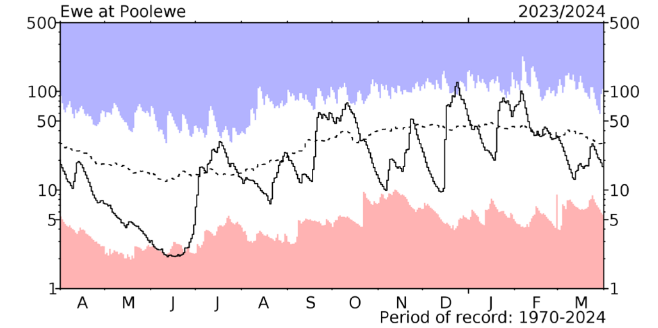


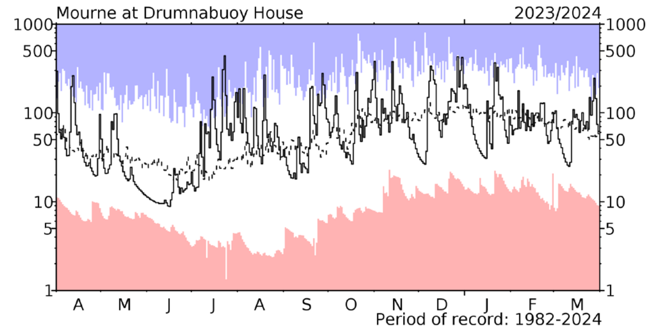


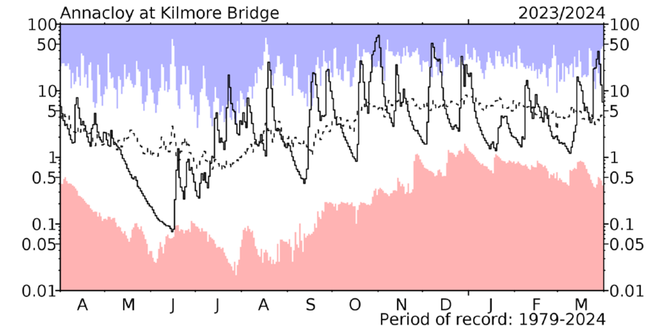








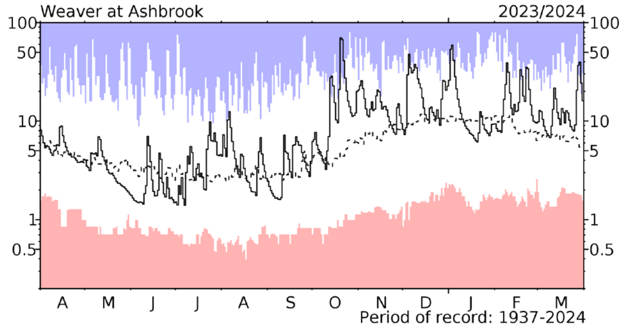


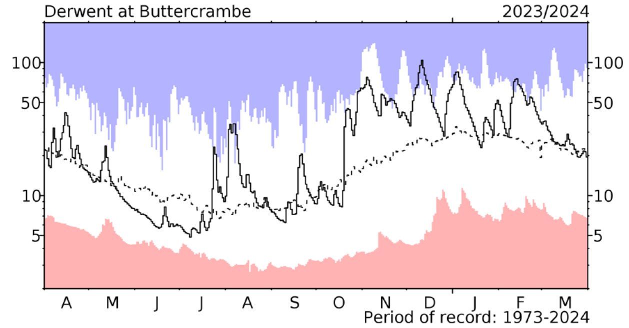


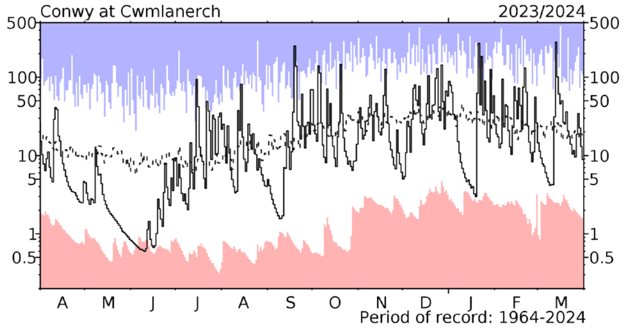
River flow hydrographs

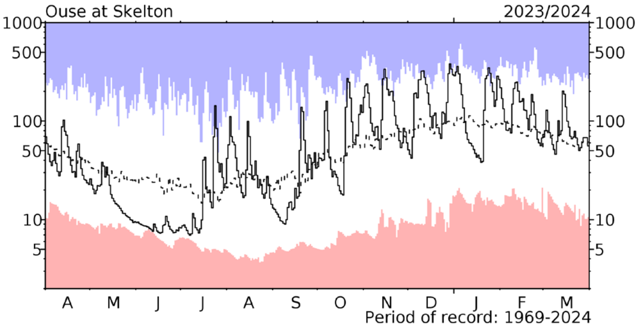
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to March 2023 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

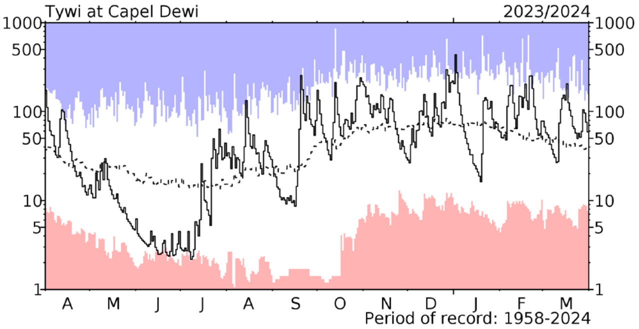
River flow . . . River flow . . .

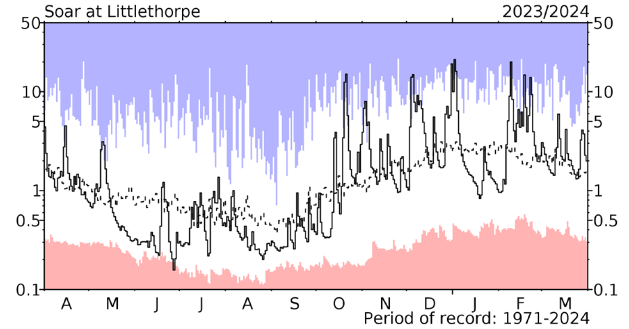


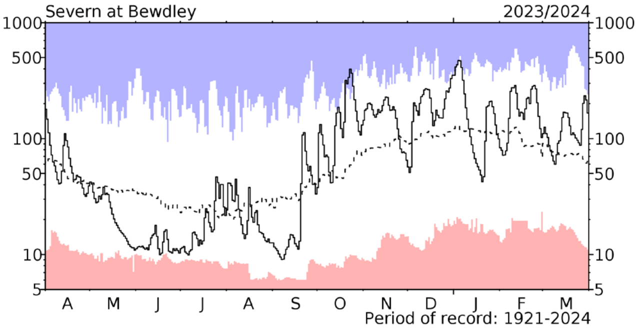


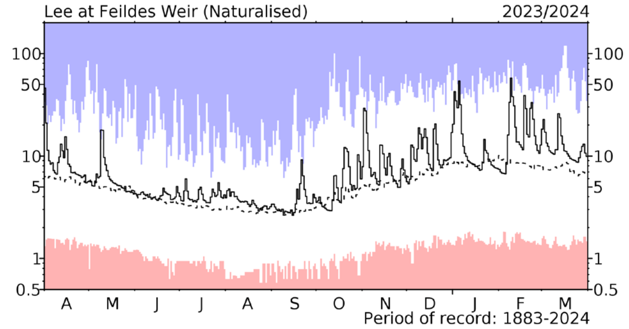


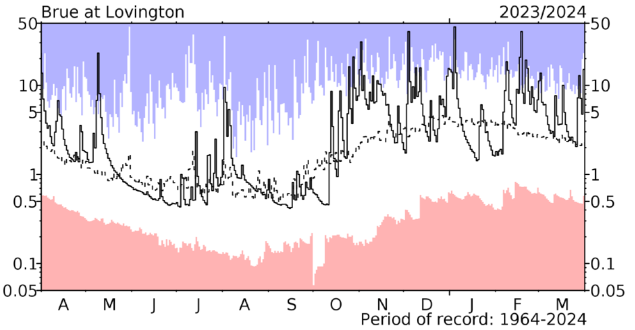


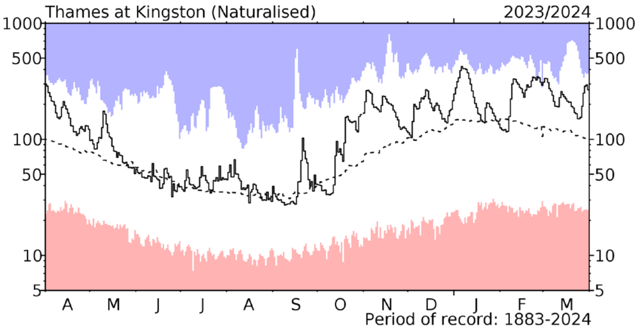


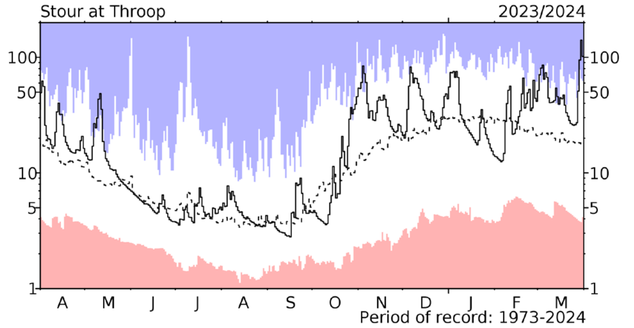


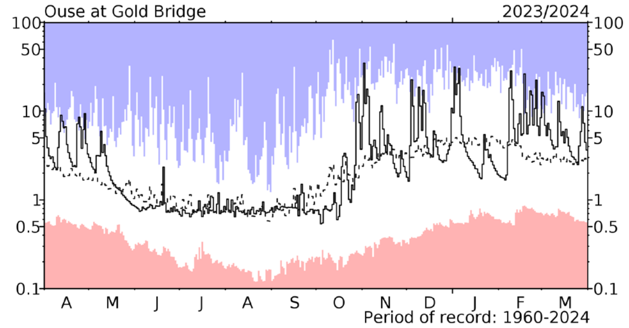




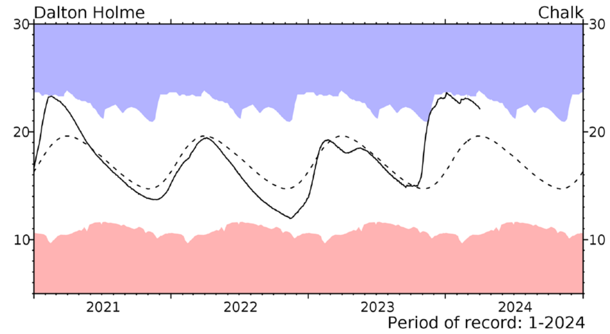


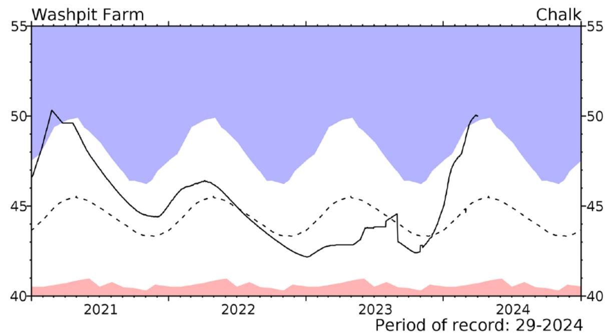


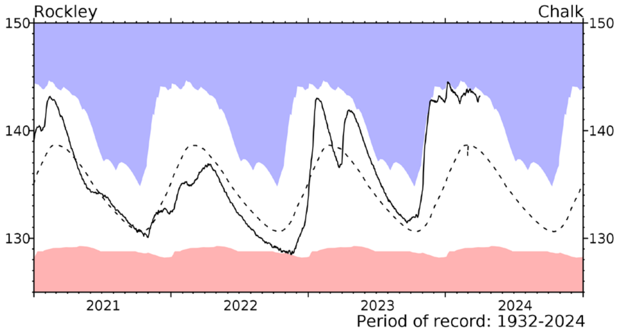


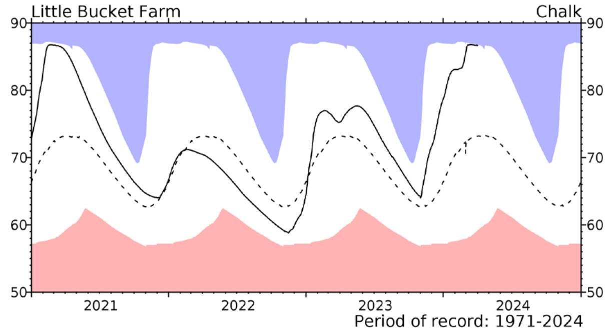


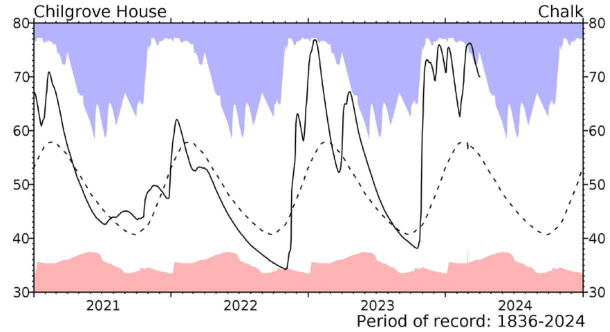
Groundwater . . . Groundwater

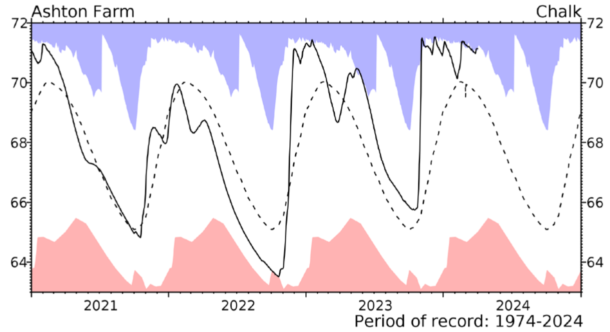


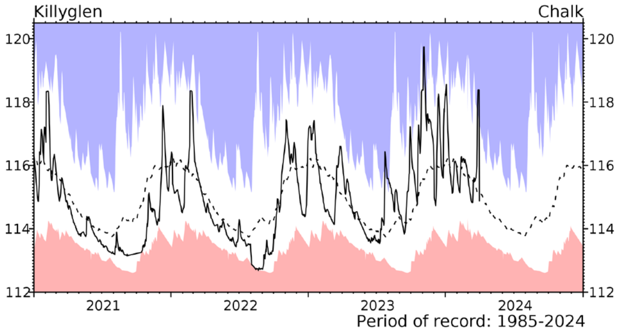


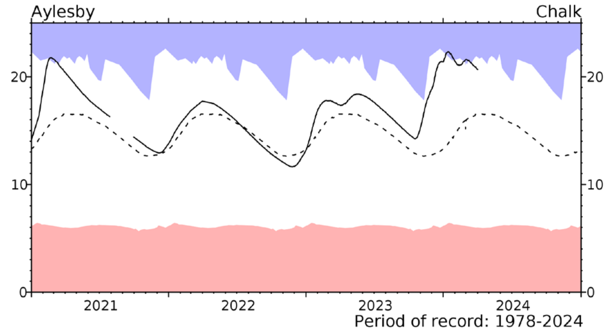


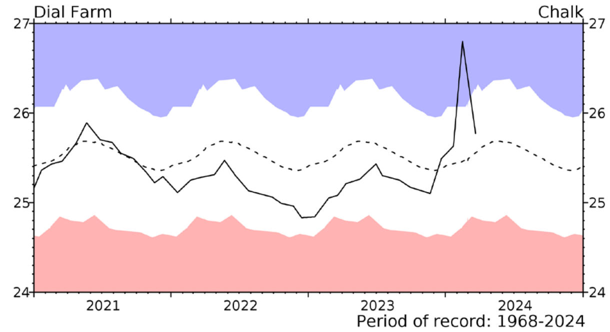


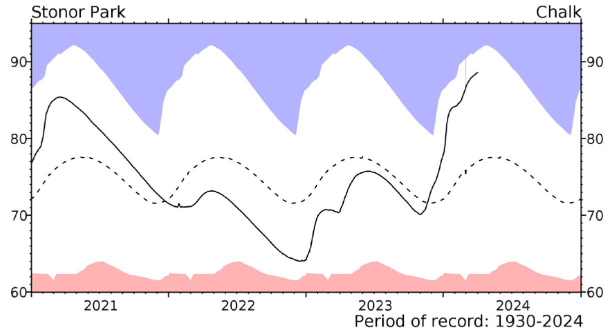






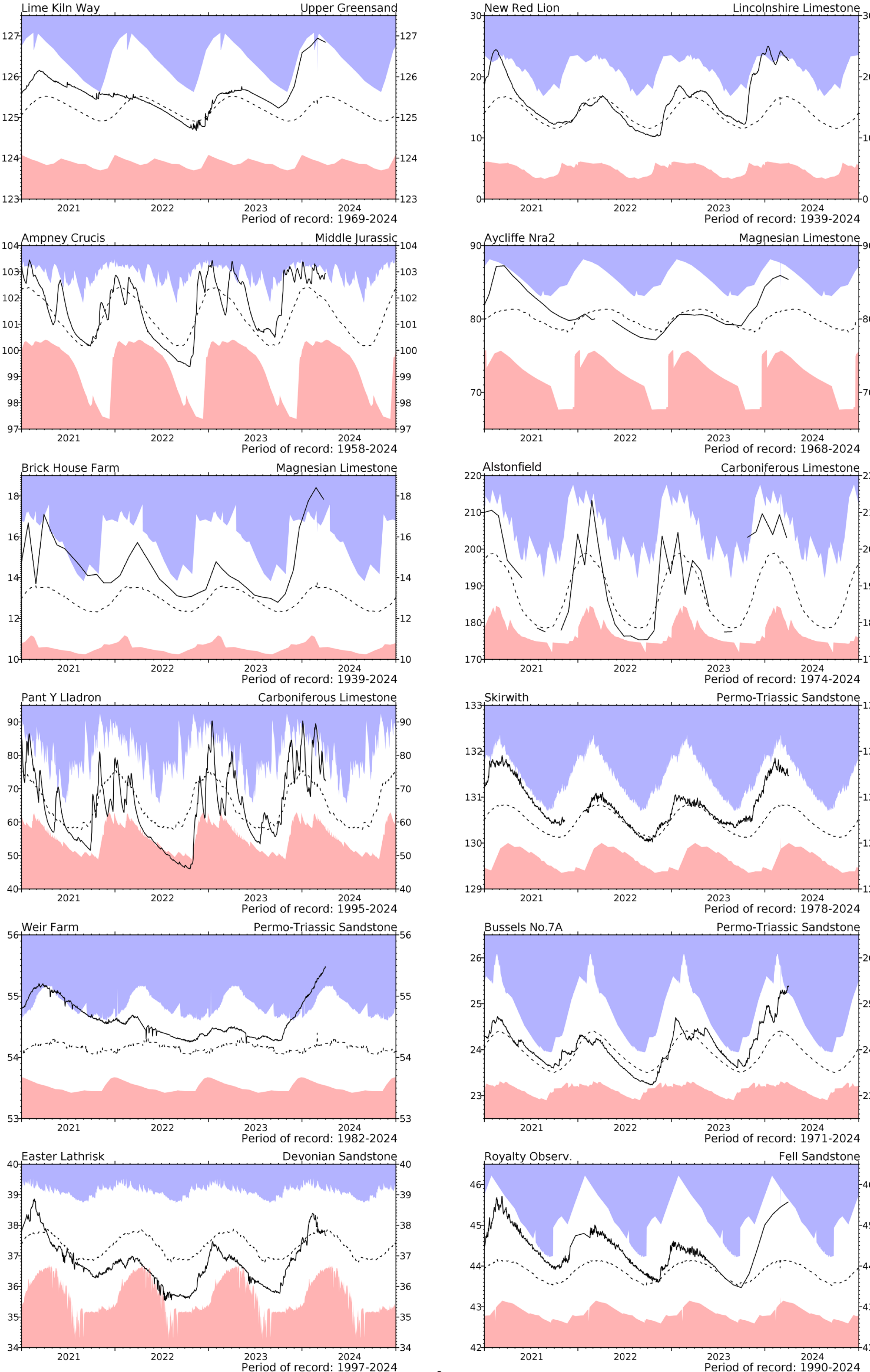


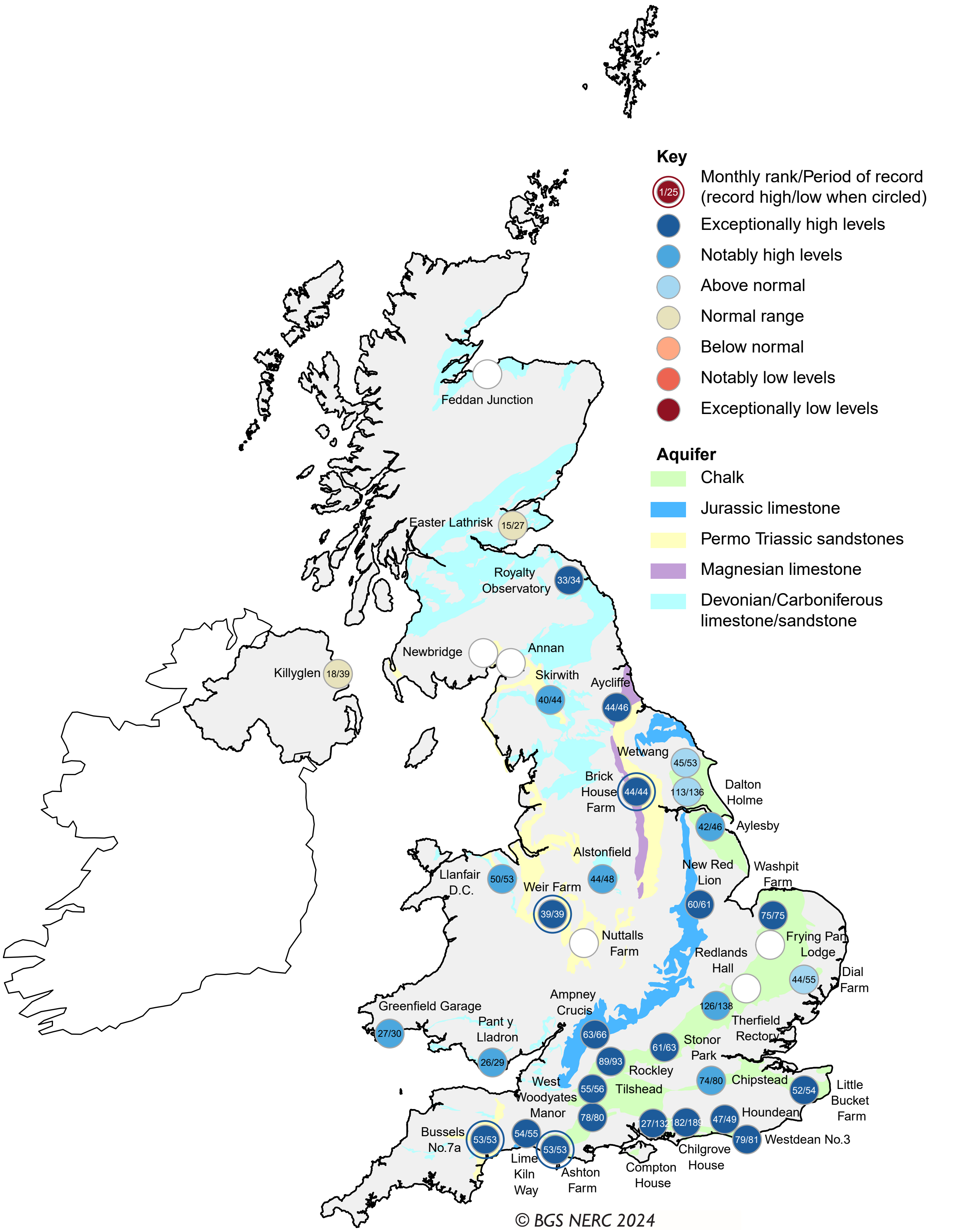




Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is 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 2020. 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



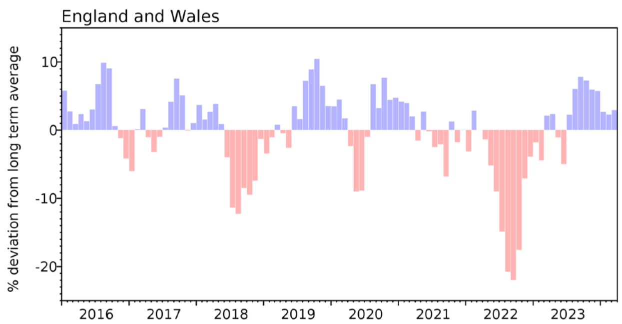


Groundwater levels - March 2024

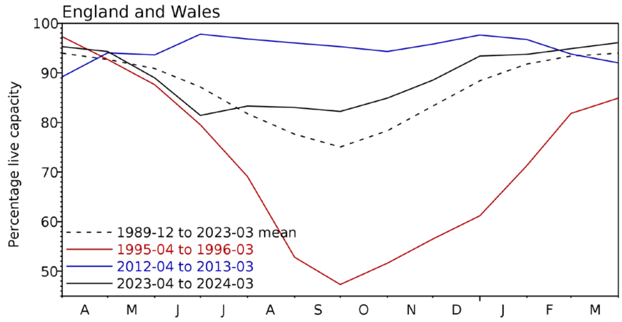
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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

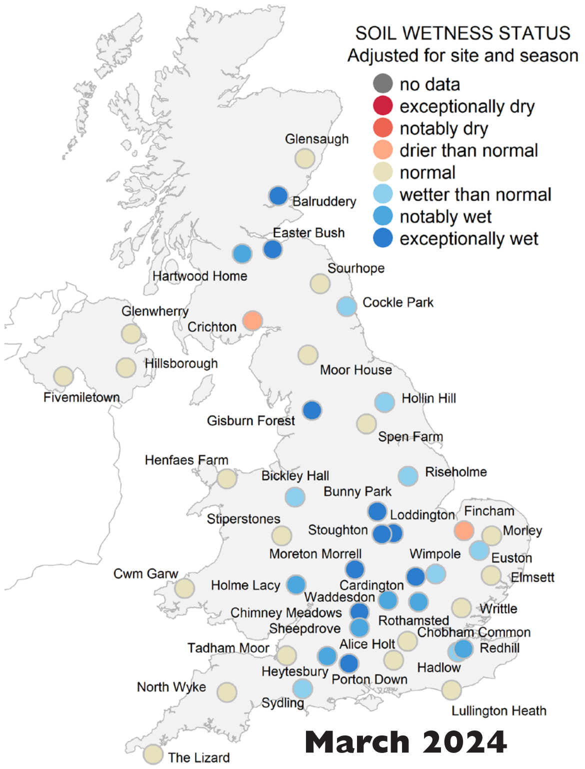
Area	Reservoir		Capacity (Ml)	2024 Jan	2024 Feb	2024 Mar	Mar Anom.	Min Mar	Year* of min	2023 Mar	Diff 24-23
North West	N Command Zone	•	124929	99	100	98	6	77	1993	99	-1
	Vyrnwy		55146	100	100	100	5	64	1996	100	0
Northumbrian	Teesdale	•	87936	100	99	99	5	77	2003	100	-2
	Kielder		(199175)	98	95	95	3	81	1993	96	-1
Severn-Trent	Clywedog		49936	92	95	98	2	86	1996	98	0
	Derwent Valley	•	46692	96	100	99	4	54	1996	101	-1
Yorkshire	Washburn	•	23373	94	98	97	4	70	1996	99	-1
	Bradford Supply	•	40942	100	100	100	6	59	1996	92	8
Anglian	Grafham		(55490)	77	77	85	-7	77	1997	80	4
	Rutland		(116580)	90	90	93	2	73	2012	97	-3
Thames	London	•	202828	92	95	96	1	88	1990	98	-2
	Farmoor	•	13822	92	84	88	-7	80	2013	89	-2
Southern	Bewl		31000	66	86	100	9	49	2012	100	0
	Ardingly		4685	100	100	100	2	51	2012	100	0
Wessex	Clatworthy		5662	100	100	100	2	82	1992	100	0
	Bristol	•	(38666)	99	99	97	3	71	1992	100	-3
South West	Colliford		28540	78	89	98	10	58	1997	60	38
	Roadford		34500	89	100	100	14	37	1996	68	32
	Wimbleball		21320	100	100	100	3	78	1996	100	0
	Stithians		4967	100	100	100	5	52	1992	99	1
Welsh	Celyn & Brenig	•	131155	84	85	88	-10	72	1996	89	-1
	Brianne		62140	100	100	100	2	90	1993	100	0
	Big Five	•	69762	99	100	100	4	78	1993	100	0
	Elan Valley	•	99106	100	100	100	3	89	1993	100	0
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	99	98	99	4	71	1998	98	1
	East Lothian	•	9317	100	100	100	1	95	2012	100	0
Scotland(W)	Loch Katrine	•	110326	100	100	100	7	74	2010	100	0
	Daer		22494	87	88	88	-8	77	2013	90	-2
	Loch Thom		10721	99	100	100	4	83	2020	99	1
Northern Ireland	Total+	•	56800	100	99	98	6	83	2002	98	-1
	Silent Valley	•	20634	100	100	100	11	57	2000	100	0

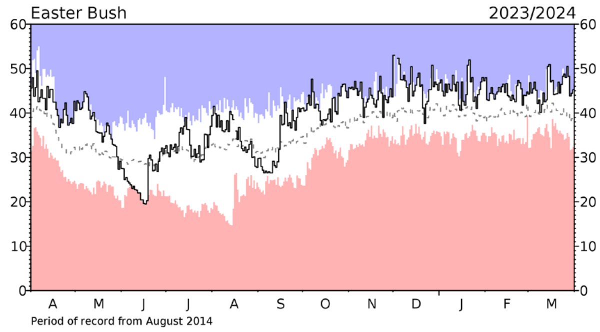
( ) figures in parentheses relate to gross storage • denotes reservoir groups *last occurrence

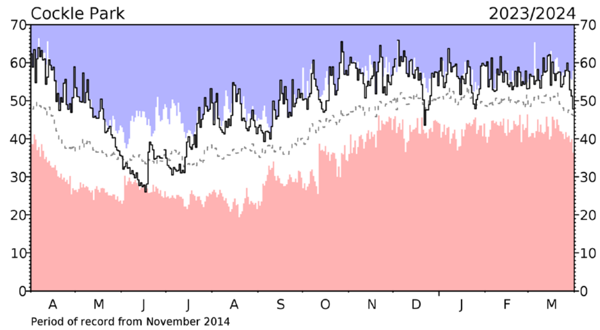
+ excludes Lough Neagh

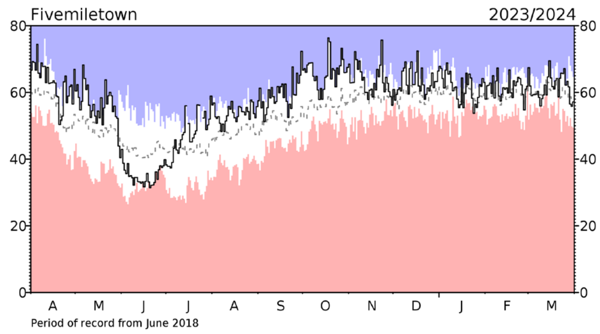
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed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

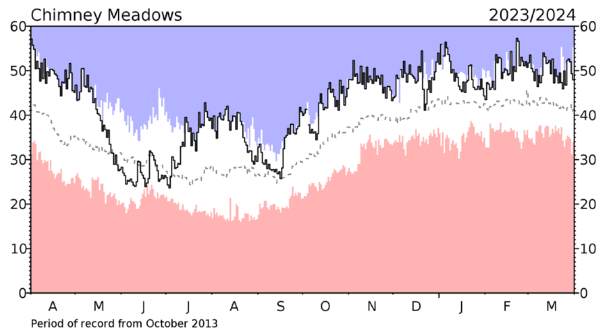
Soil Moisture . . . Soil Moisture

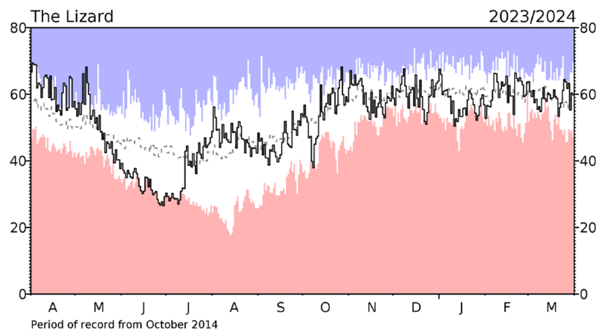












Unsettled weather brought more rain to many regions, maintaining reasonably high soil moisture at most COSMOS-UK sites. Wetter than usual sites existed in Southern England (e.g. Chimney Meadows, Porton Down), Northern England (e.g. Cockle Park), and Eastern Scotland (e.g. Easter Bush). Several sites were within their normal range for most of the month, e.g. Chobham Common, Fincham, Fivemiletown. Crichton and The Lizard fluctuated between drier than usual and within their normal range throughout the month.

Overall, soil moisture remains high for much of the COSMOS-UK network, following a wetter-than-average March and mild temperatures.

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

04/2024

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UKRI Natural Environment Research Council