Hydrological Summary

for the United Kingdom

September 2024

General

September was mild and unsettled with a marked spatial variation in rainfall. Parts of England received exceptional rainfall, contrasting with below average conditions in Scotland and Northern Ireland. Total rainfall was twice the average across most of central and southern England, and more than three times the average in some areas. Correspondingly, September average river flows were above normal to exceptionally high across central and southern England, with sustained incursions into the maximum daily flow envelope at month-end. Soils were saturated across most of the UK, particularly in the south. Groundwater levels were in the normal range to exceptionally high, and recharge was observed in a number of sites. Elsewhere, levels either continued to fall or bottomed out, the latter indicating the imminent onset of the recharge season. The October-December Outlook is for normal to above normal river flows and groundwater levels across the UK, with high flows persisting for catchments in southern England. The water resources situation remains healthy with above average reservoir stocks at the national scale. Flood risk remains elevated following a wet start to October and eastern England had already received more than half of the average October rainfall in the first week.

Rainfall

September started with heavy showers for Scotland, Wales, and northwest England on the 1st and 2nd. South Wales and southern England saw outbreaks of heavy rain between the 5th and 8th (e.g. 59mm recorded at Victoria Park, Swansea, on the 6th) with flooding of roads and properties in Hampshire and south Wales. Central and southwest England had already received three-quarters of average September rainfall by the 10th. Following a drier third week, frontal systems brought persistent and heavy rain from 20th-23rd across Wales, and central and southern England. Some places in the south (e.g. Bedfordshire and Oxfordshire) received the average September rainfall in the 24 hours across 22nd-23rd. Surface water flooding closed the A421 in Bedfordshire on the 22nd and affected 250 properties in Northamptonshire, Hertfordshire and Bedfordshire on the 23rd. Further outbursts of heavy rainfall affected central England and south Wales (25th-26th) and southwest England and northwest England (29th-30th; 120mm recorded at White Barrow, Devon on the 29th). Surface water flooding led to the closure of a stretch of the M5 on 27th and had affected 850 properties across England by the 28th. Total UK September rainfall was 125% of average, with anomalies greatest for England (195% of average), including some areas in central and southern England receiving over 300%. There was a strong geographical gradient with above average rainfall for England (sixth wettest September in a series from 1890) but deficits in Northern Ireland and Scotland (82% and 63%, respectively). It was the wettest September on record for Thames region and among the top three wettest for Severn Trent and Wessex regions (all in series from 1890). The hydrological year (October 2023-September 2024) was the wettest on record for the UK, with September being the wettest month of the year for Thames and Wessex (all in series from 1890).

River Flows

River flows were generally in the normal range to below normal at the start of September, with some above average flows in central and southern Scotland and in groundwater-dominated catchments in southern England. Flows across Scotland climbed in response to rainfall on the 1st/2nd but receded thereafter, ending the month widely below average. Rainfall from 5th-6th led to increases in flows across southern England and high flows persisted with further responses to rainfall from 7th-8th (e.g. the Itchen recorded new daily maximum flows for eight consecutive days from 7th-14th). River flows across the UK generally receded from mid-month before rapid increases across central and southern England in response to exceptional rainfall in the last week of September. The Bedford Ouse recorded its highest peak flow in any month on the 27th (in a series from 1972), with new September peak flow records registered for many rivers across southern England over this period, including on the Mole (23rd), Thames (27th), Hampshire Avon (28th), Itchen (29th) and Don (30th), all in series of at least 30 years. September monthly mean flows were above normal to exceptionally high across central and southern England. The Great Ouse, Thames, Brue and Medway each recorded flows over four times their September average and many rivers recorded two to four times their average. New September maxima were established for the Soar, Great Ouse, Hampshire Avon and Itchen (all in series of 50 years or more). In contrast, flows in Scotland and Northern Ireland were in the normal range to below normal with some catchments registering less than half of their respective averages (e.g. Luss, Cree and Mourne). Average flows over the hydrological year (October 2023-September 2024) were exceptional across most of the UK with widespread new maxima recorded. Accordingly, mean outflows for the same 12-month period were the highest on record for the UK (in a series from 1980).

Soil Moisture and Groundwater

Soil moisture generally increased throughout the month, but some deficits remained in the east. Groundwater levels continued to recede across most of the Chalk sites, although recharge was observed in several sites in the south of England towards month-end. Levels were in the normal range to exceptionally high across the Chalk aquifer, with a record high for September at Westdean No.3. Levels increased in the Jurassic limestones, becoming notably high at New Red Lion, while at Ampney Crucis a record high for September was observed (in a 66-year series). In the Magnesian Limestone, levels fell and were exceptionally high. Levels rose in the Carboniferous Limestone of south Wales, most notably at Pant y Lladron where a rise of over 13 metres was observed in an 8-day period, moving into the above normal range (a stark contrast to exceptionally low levels at the end of August). At Alstonfield, the level fell and remained in the normal range. Some recharge was observed in the Permo-Triassic Sandstones at Llanfair D.C. and Bussels No.7a. Levels were relatively stable at Weir Farm and continued to fall at Skirwith, yet both registered new September maxima. A record high for September was also recorded at Lime Kiln Way in the Upper Greensand (in a 55-year series). Levels in the Fell Sandstone at Royalty Observatory fell and remained exceptionally high. Groundwater levels were in the normal range in the Devonian sandstones at both Feddan Junction and Easter Lathrisk.

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.

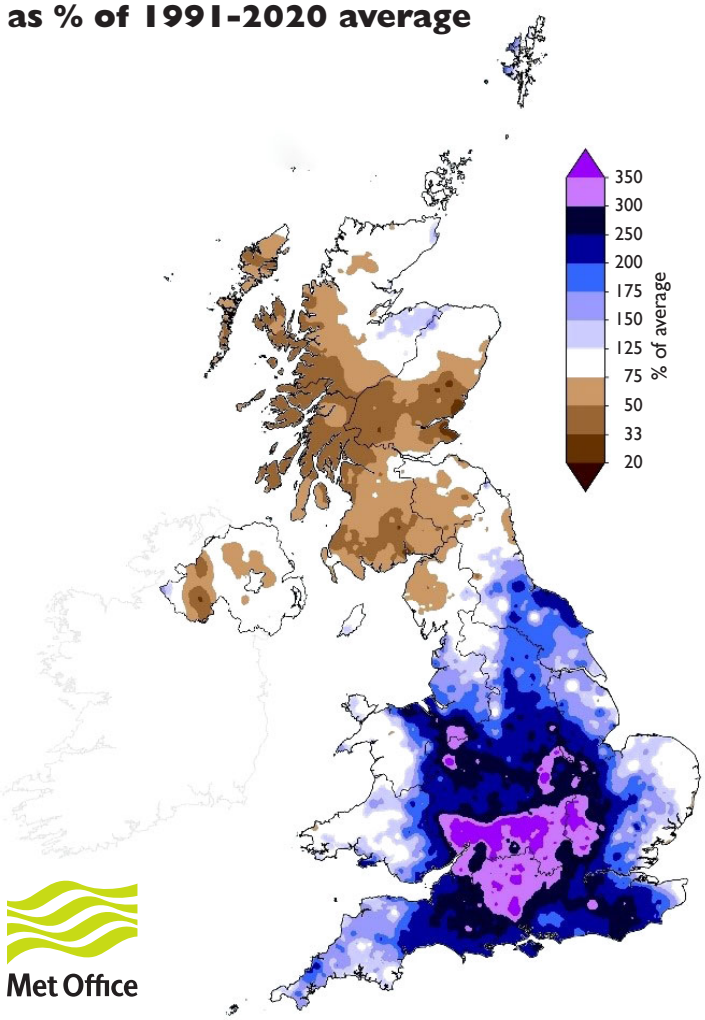
Region	Rainfall	Sep 2024	Jul24 – Sep24	RP	Apr24 – Sep24	RP	Jan24 – Sep24	RP	Oct23 – Sep24	RP
United Kingdom	mm	**114**	300		549		914		1393	
	%	**125**	112	2-5	113	5-10	116	30-50	120	>100
England	mm	**133**	258		462		771		1174	
	%	**194**	123	5-10	119	5-10	129	>100	135	>>100
Scotland	mm	**78**	360		683		1110		1677	
	%	**63**	104	2-5	110	5-10	104	5-10	107	10-20
Wales	mm	**154**	347		626		1152		1793	
	%	**139**	108	2-5	106	2-5	119	15-25	123	50-80
Northern Ireland	mm	**72**	276		488		788		1241	
	%	**82**	100	2-5	96	2-5	99	2-5	107	8-12
England & Wales	mm	**136**	270		484		823		1258	
	%	**183**	120	2-5	117	5-10	127	80-120	133	>>100
North West	mm	**129**	362		694		1122		1663	
	%	**119**	114	2-5	126	15-25	129	80-120	130	>100
Northumbria	mm	**86**	231		472		716		1145	
	%	**118**	101	2-5	113	2-5	113	5-10	126	>>100
Severn-Trent	mm	**151**	253		443		722		1106	
	%	**237**	127	5-10	117	5-10	128	30-50	138	>>100
Yorkshire	mm	**118**	222		447		724		1139	
	%	**167**	103	2-5	111	2-5	119	10-20	131	>100
Anglian	mm	**101**	193		348		551		840	
	%	**192**	114	2-5	111	2-5	123	10-20	134	>100
Thames	mm	**165**	280		447		734		1059	
	%	**294**	164	20-30	136	10-20	147	>100	146	>>100
Southern	mm	**145**	254		416		750		1190	
	%	**233**	143	5-10	124	5-10	140	>100	146	>100
Wessex	mm	**177**	306		496		878		1328	
	%	**265**	153	10-20	131	10-15	145	>>100	147	>>100
South West	mm	**142**	301		533		1055		1611	
	%	**161**	114	2-5	109	2-5	128	60-90	128	80-120
Welsh	mm	**158**	341		612		1124		1740	
	%	**147**	110	2-5	107	2-5	121	15-25	124	60-90
Highland	mm	**100**	408		745		1256		1872	
	%	**68**	106	2-5	106	2-5	100	2-5	101	5-10
North East	mm	**82**	259		532		823		1352	
	%	**98**	101	2-5	112	2-5	113	8-12	128	>>100
Tay	mm	**48**	265		564		944		1572	
	%	**48**	87	2-5	101	2-5	99	2-5	113	15-25
Forth	mm	**58**	273		602		950		1437	
	%	**62**	94	2-5	116	5-10	111	8-12	116	30-50
Tweed	mm	**55**	252		558		866		1294	
	%	**69**	97	2-5	119	5-10	116	10-20	119	>100
Solway	mm	**65**	401		771		1209		1699	
	%	**54**	112	2-5	121	10-20	114	15-25	108	10-15
Clyde	mm	**71**	452		813		1291		1914	
	%	**47**	107	2-5	110	5-10	101	2-5	101	5-10

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

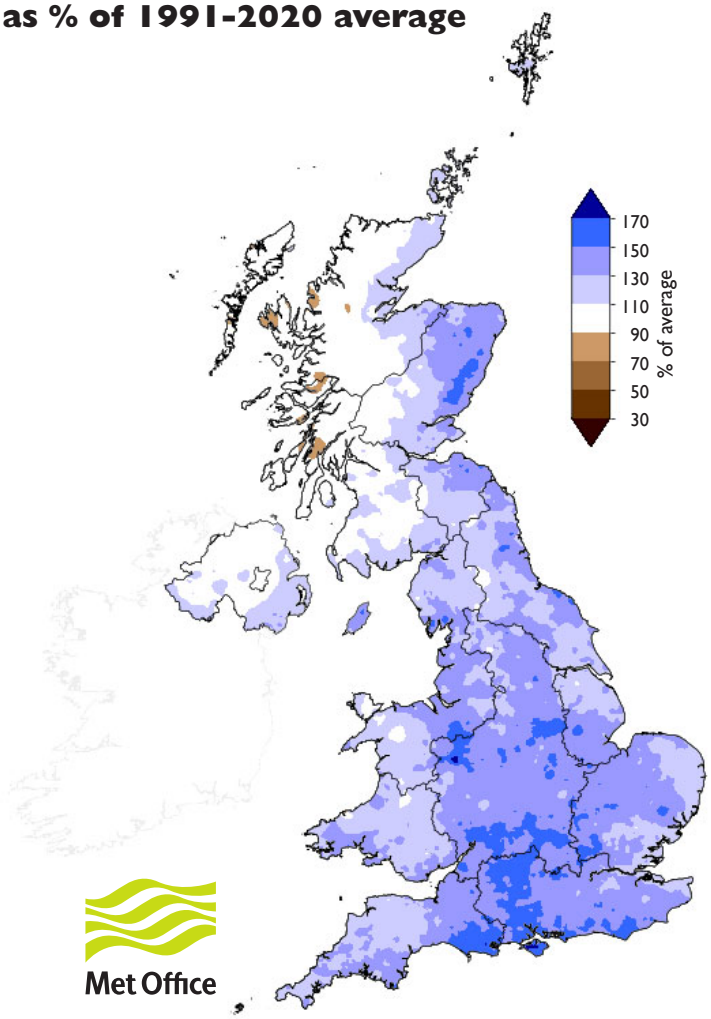
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability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

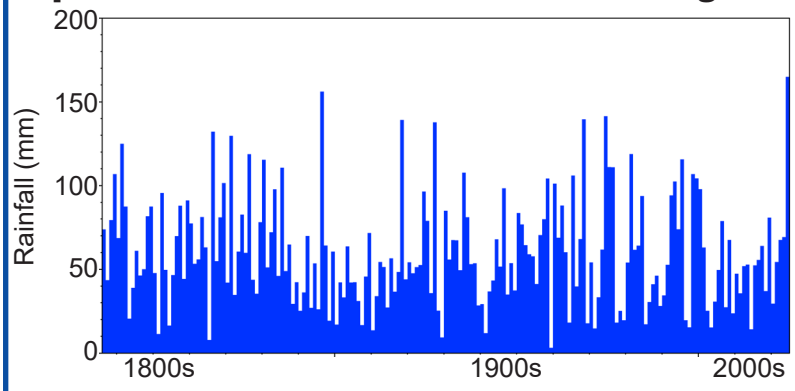
September 2024 rainfall as % of 1991-2020 average



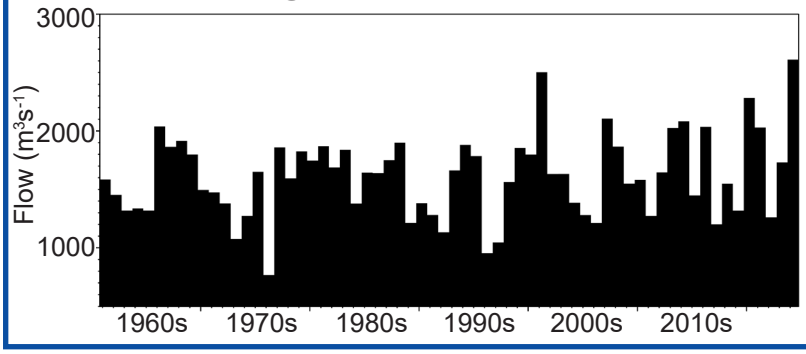
October 2023 - September 2024 rainfall as % of 1991-2020 average



September rainfall totals for Thames region



Water year (October-September) mean outflows for England



UK Hydrological Outlook

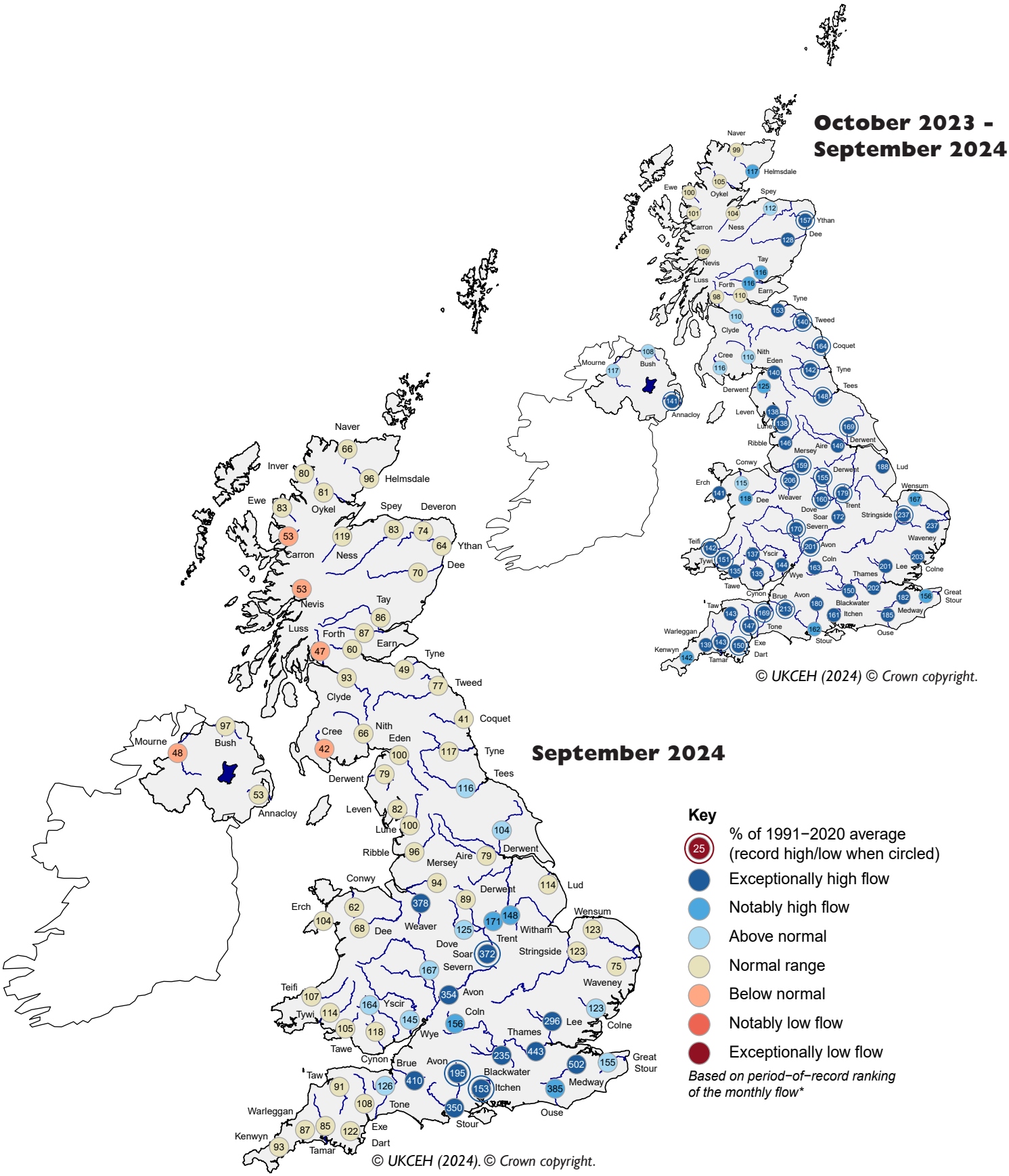
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from October 2024**
Issued: **09.10.2024**
using data to the end of September 2024

The outlook for October is for above normal river flows in central and southern England, and some of these flows will be exceptionally high. Elsewhere river flows are likely to be in the normal range. For groundwater levels, above normal levels are expected, with the exception of east Yorkshire and south Wales where normal levels are most likely. For October-December, the outlook is for normal to above normal river flows and groundwater levels across the UK.

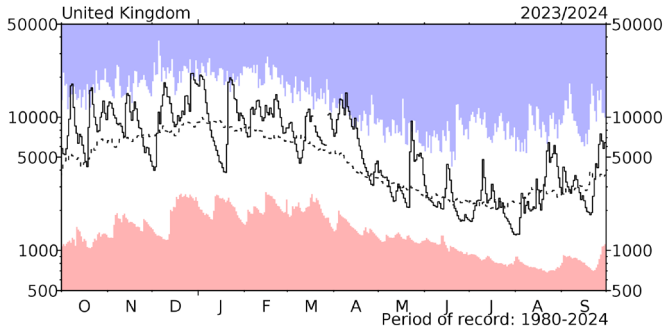
River flow . . . River flow . . .

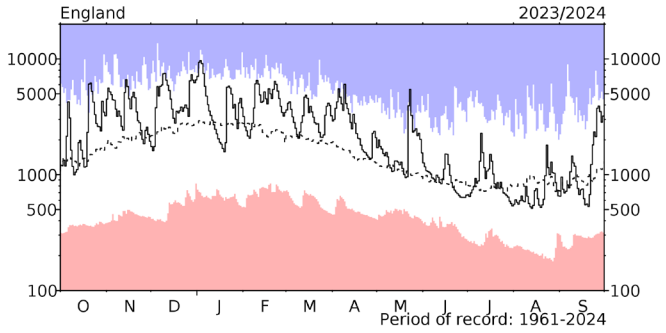


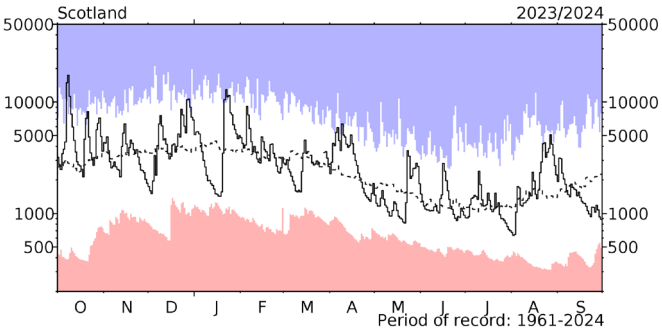
River flows

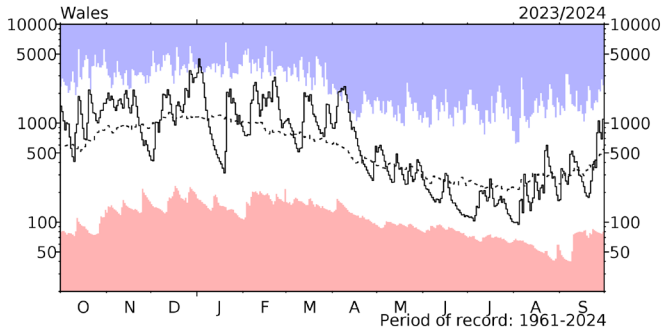
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

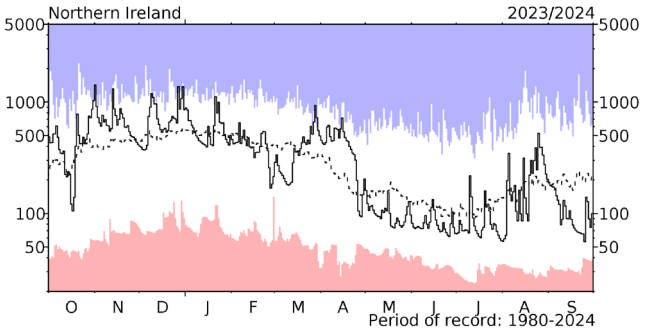
River flow . . . River flow . . .

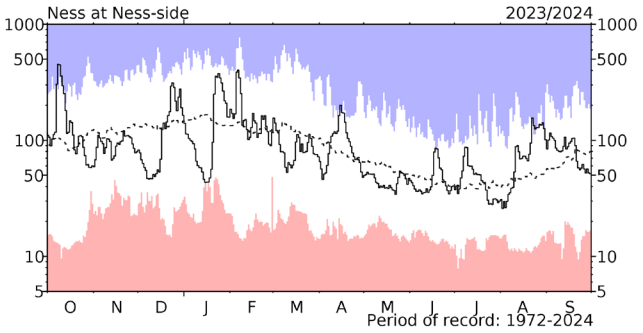


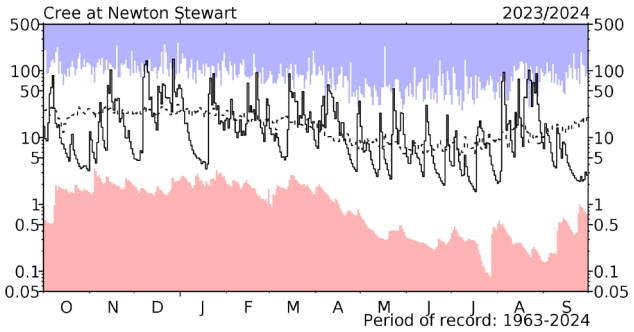


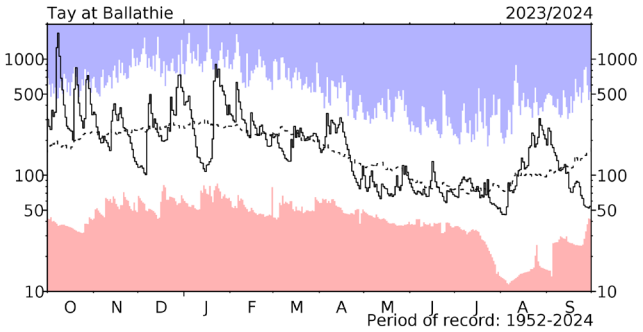


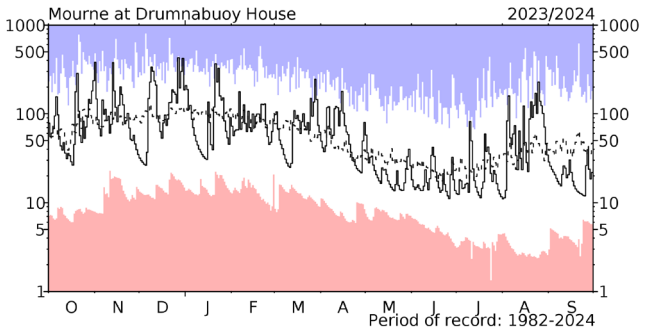


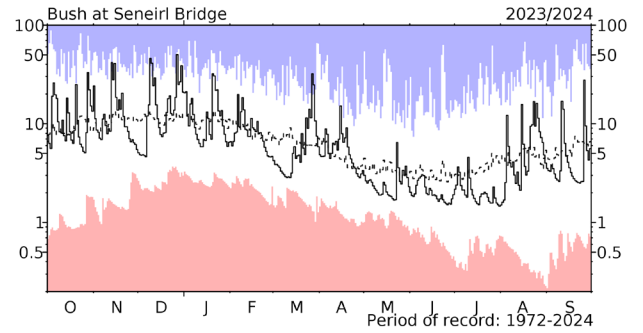








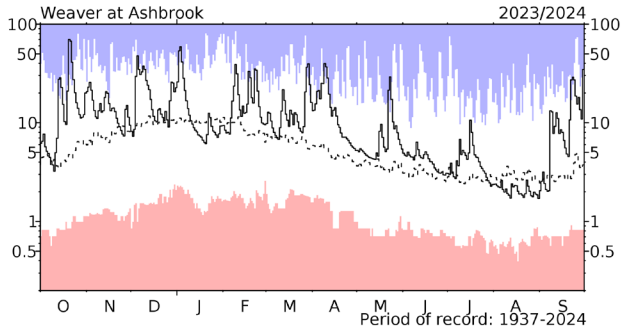


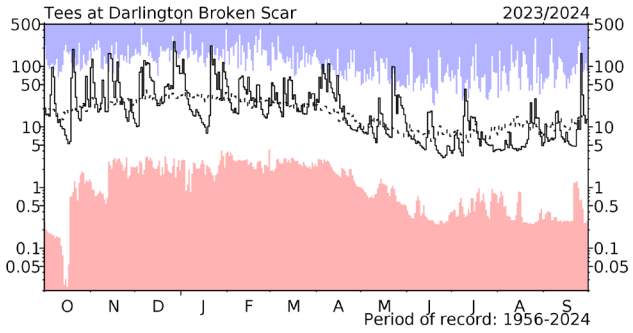


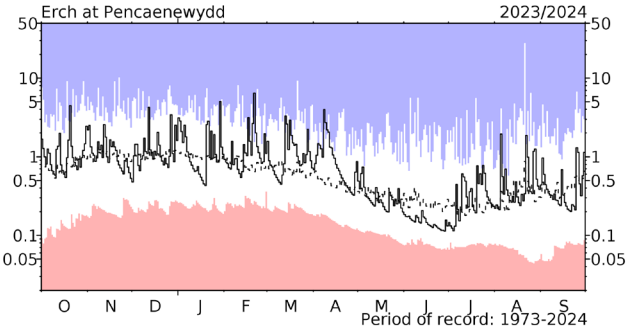
River flow hydrographs

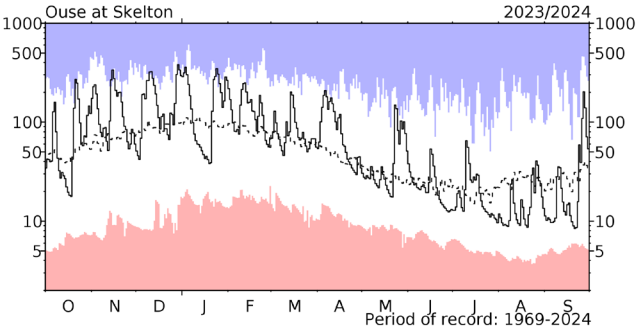
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to August 2023 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

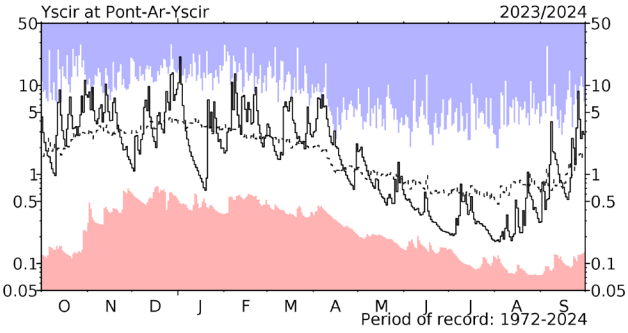
River flow . . . River flow . . .

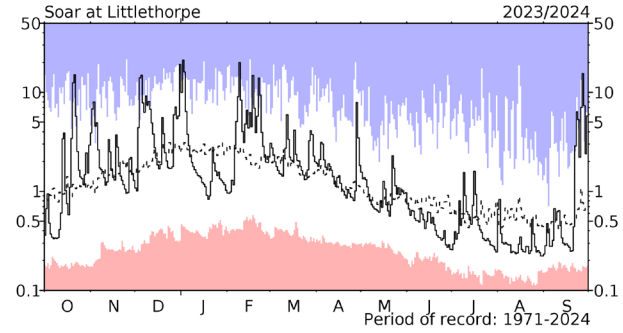


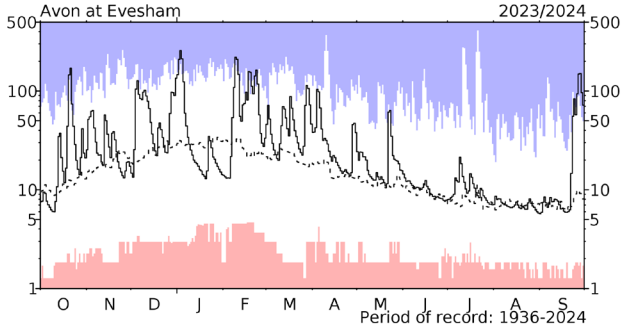


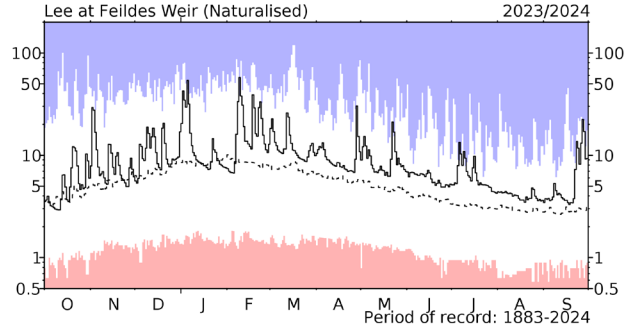


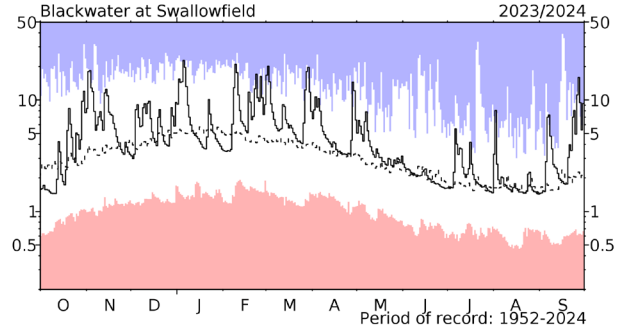


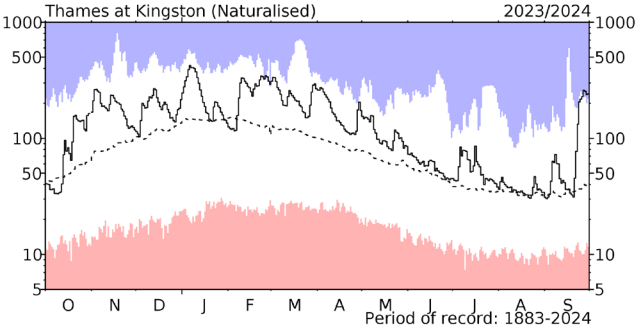


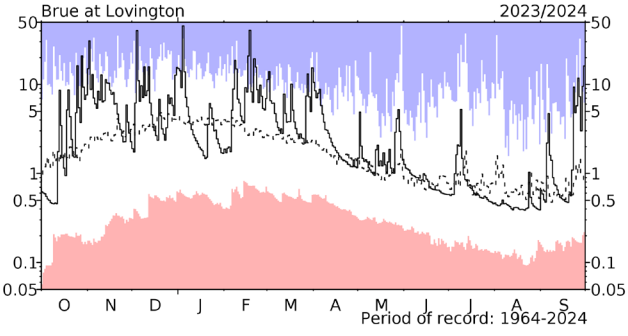


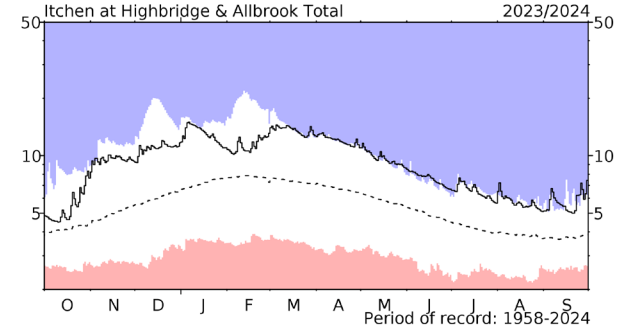




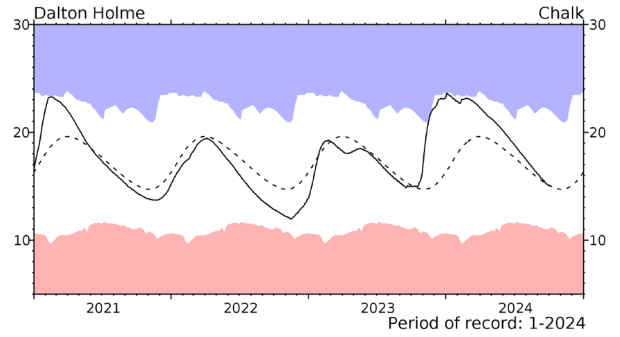


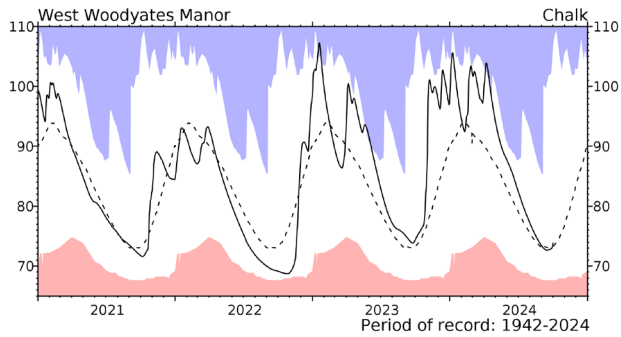


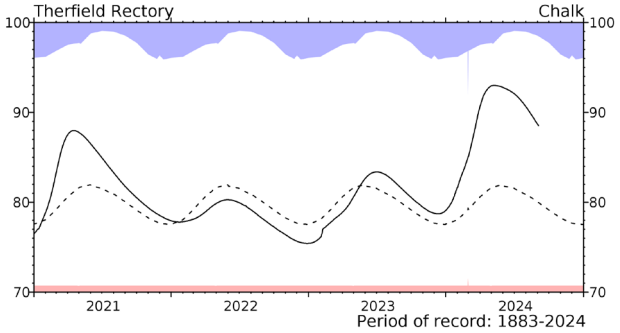


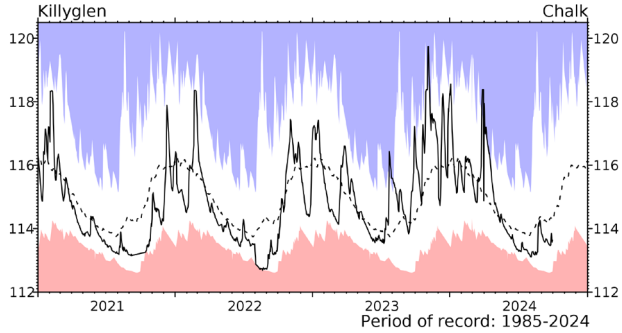


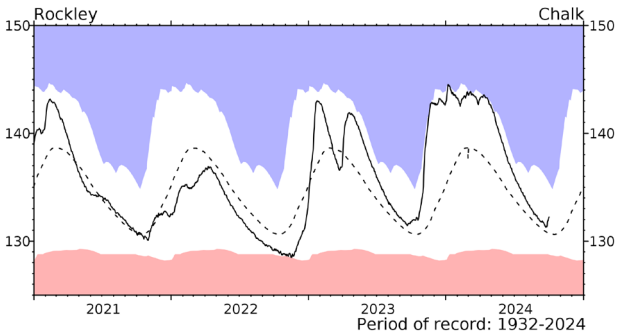
Groundwater…Groundwater

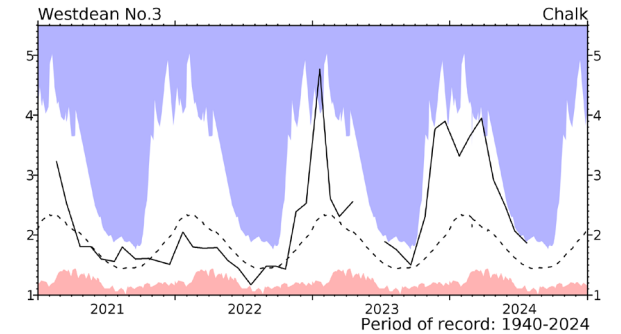


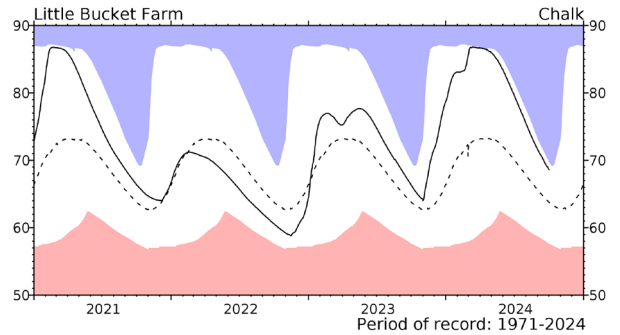


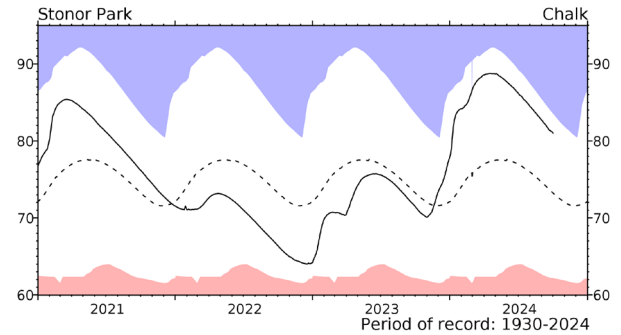


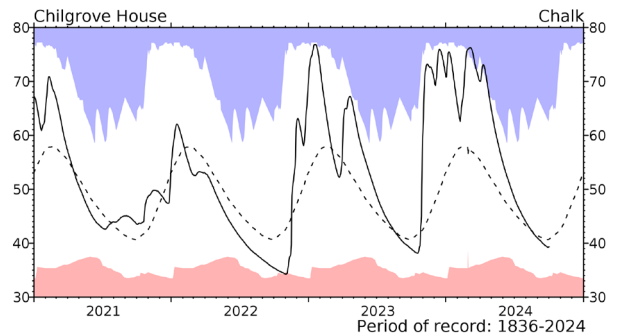


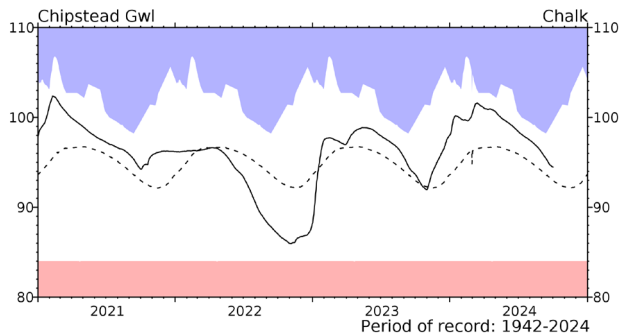






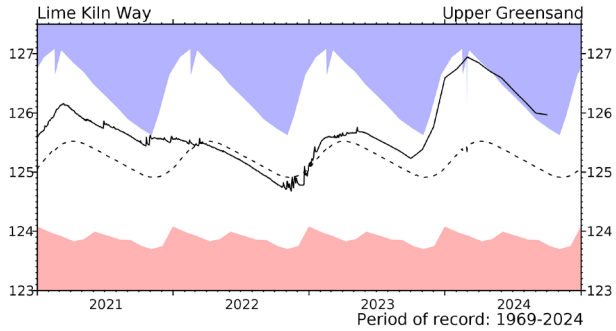


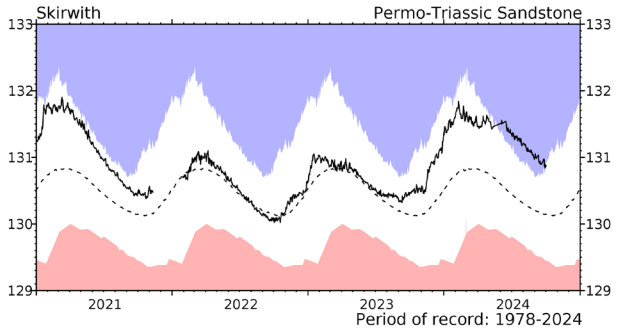


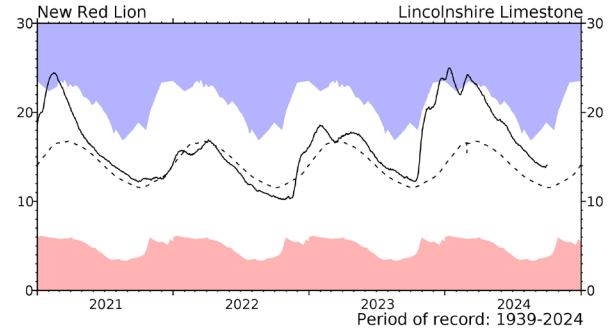


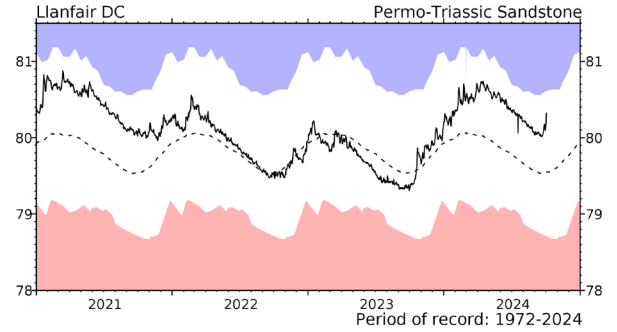
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

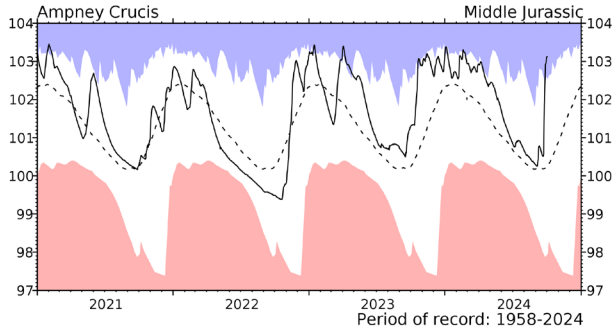
Groundwater … Groundwater

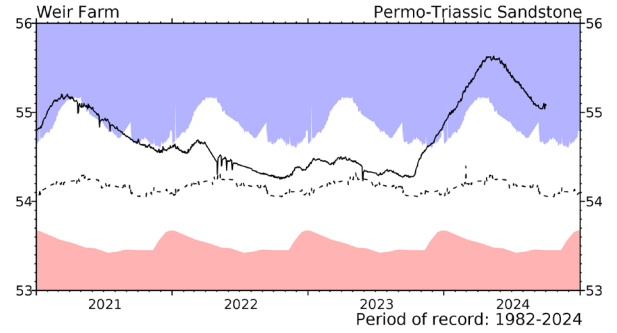


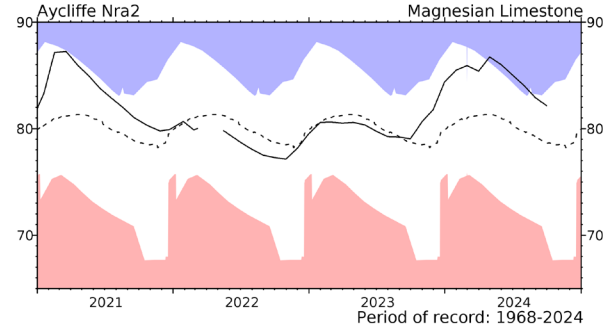


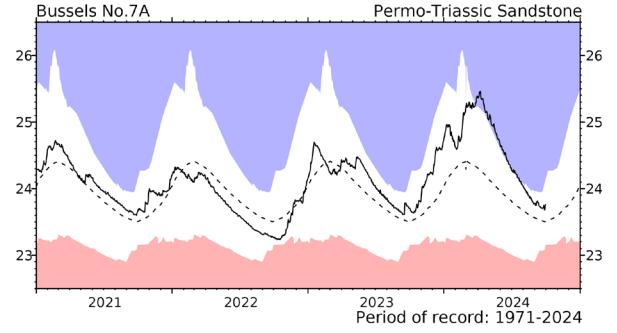


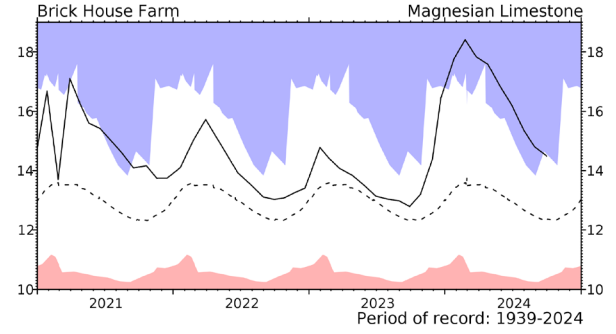


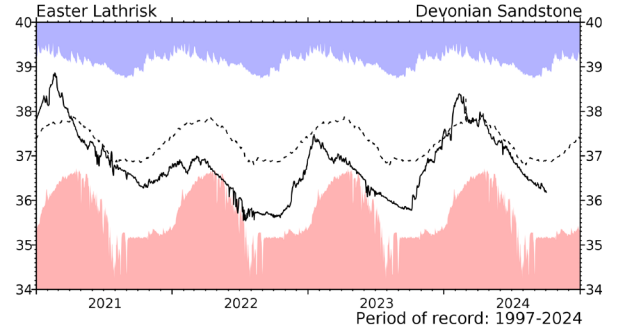


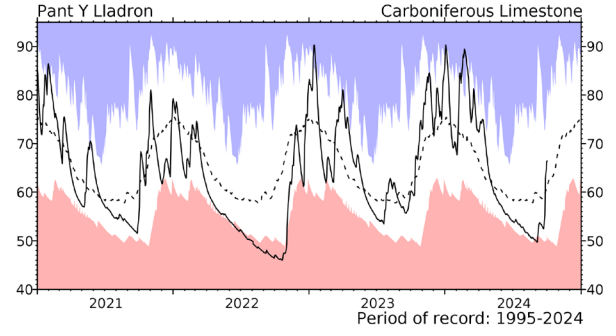


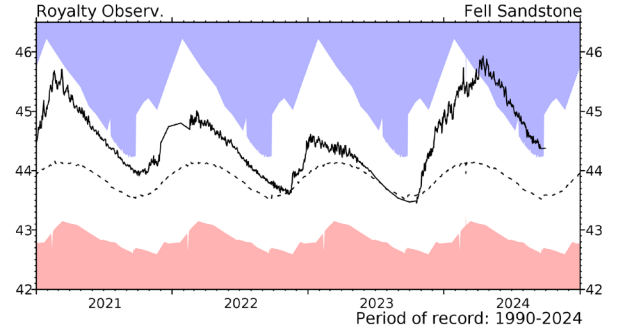


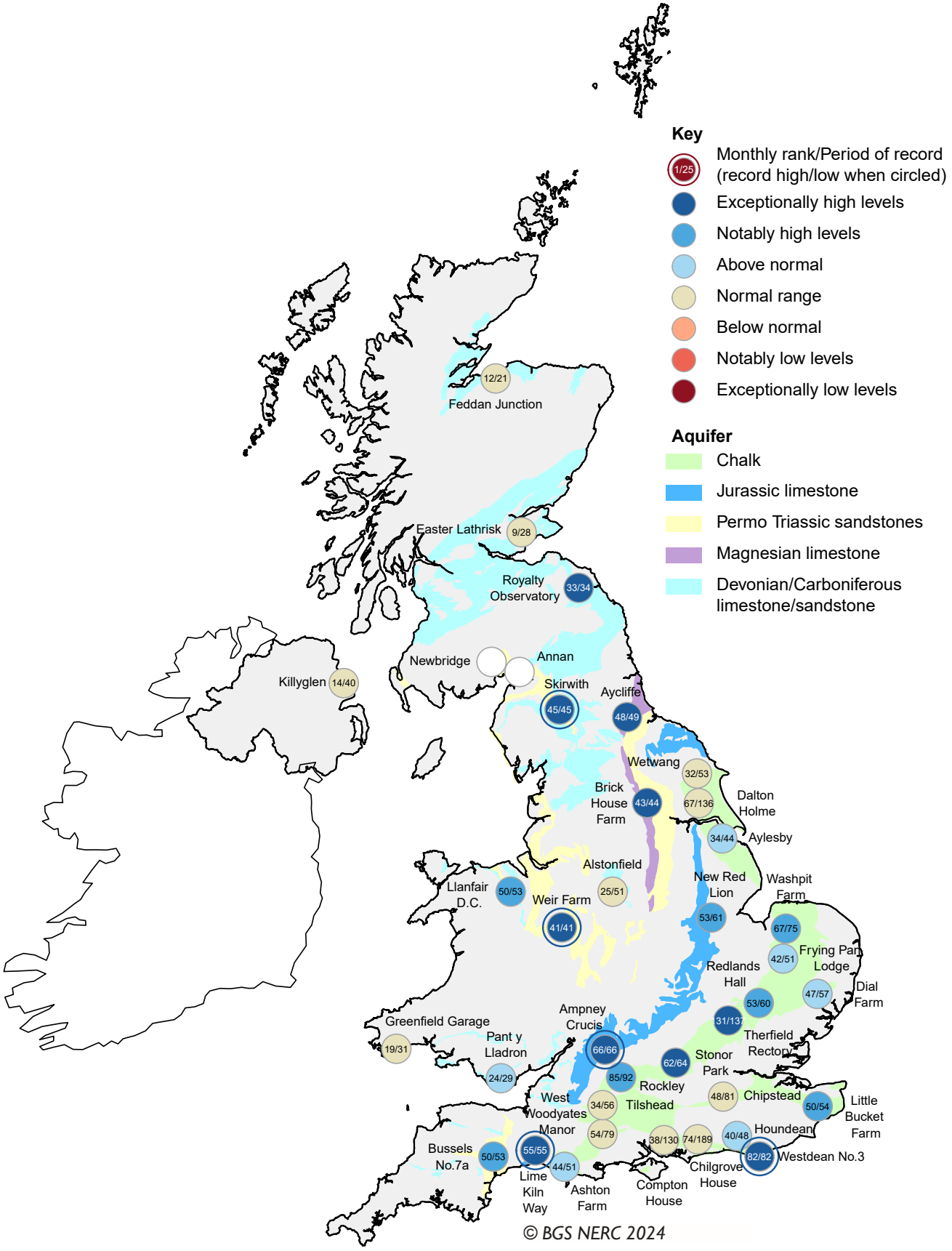










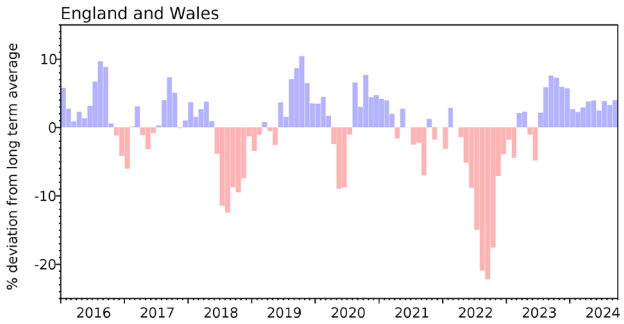


Groundwater levels - September 2024

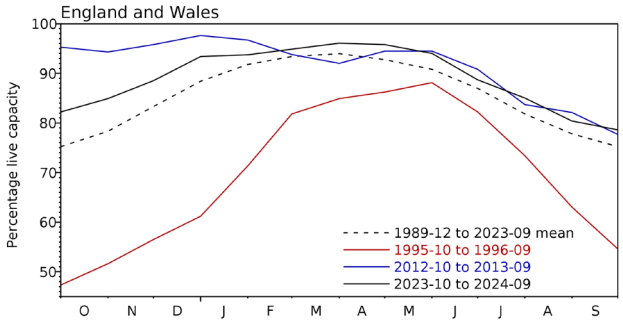
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Jul	2024 Aug	2024 Sep	Sep Anom.	Min Sep	Year* of min	2023 Sep	Diff 24-23
North West	N Command Zone	•	124929	77	73	76	16	13	1995	76	-1
	Vyrnwy		55146	88	97	93	22	26	1995	95	-2
Northumbrian	Teesdale	•	87936	95	91	91	19	31	1995	98	-7
	Kielder		(199175)	86	89	80	-4	59	1989	85	-5
Severn-Trent	Clywedog		49936	99	97	90	17	24	1989	89	1
	Derwent Valley	•	46692	77	60	54	-9	24	1989	71	-17
Yorkshire	Washburn	•	23373	83	73	72	5	24	1995	81	-9
	Bradford Supply	•	40942	80	69	69	2	15	1995	74	-5
Anglian	Grafham		(55490)	95	91	86	2	46	1997	90	-5
	Rutland		(116580)	90	84	83	2	61	1995	85	-2
Thames	London	•	202828	93	83	82	5	53	1997	94	-11
	Farmoor	•	13822	99	96	88	-3	54	2003	96	-9
Southern	Bewl		31000	82	64	64	0	32	1990	71	-8
	Ardingly		4685	85	66	60	-3	21	2020	46	14
Wessex	Clatworthy		5662	70	60	55	-2	25	2003	75	-20
	Bristol	•	(38666)	74	61	62	-1	31	1990	71	-9
South West	Colliford		28540	83	76	67	1	38	2006	52	15
	Roadford		34500	90	87	83	16	20	2022	54	29
	Wimbleball		21320	75	66	58	-5	23	2022	74	-16
	Stithians		4967	69	60	51	-5	19	2022	56	-5
Welsh	Celyn & Brenig	•	131155	79	77	76	-4	39	1989	67	9
	Brianne		62140	92	94	100	13	48	1995	100	0
	Big Five	•	69762	73	70	70	1	19	1995	71	-1
	Elan Valley	•	99106	74	66	71	-3	31	2022	85	-14
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	89	93	90	12	43	1998	92	-2
	East Lothian	•	9317	99	95	89	6	52	1989	91	-2
Scotland(W)	Loch Katrine	•	110326	72	97	83	7	41	2021	93	-10
	Daer		22494	74	96	84	6	32	1995	89	-5
	Loch Thom		10721	83	100	91	10	40	2021	73	18
Northern Ireland	Total+	•	56800	79	77	77	2	29	1995	99	-21
	Silent Valley	•	20634	82	79	83	11	27	1995	100	-17

( ) figures in parentheses relate to gross storage

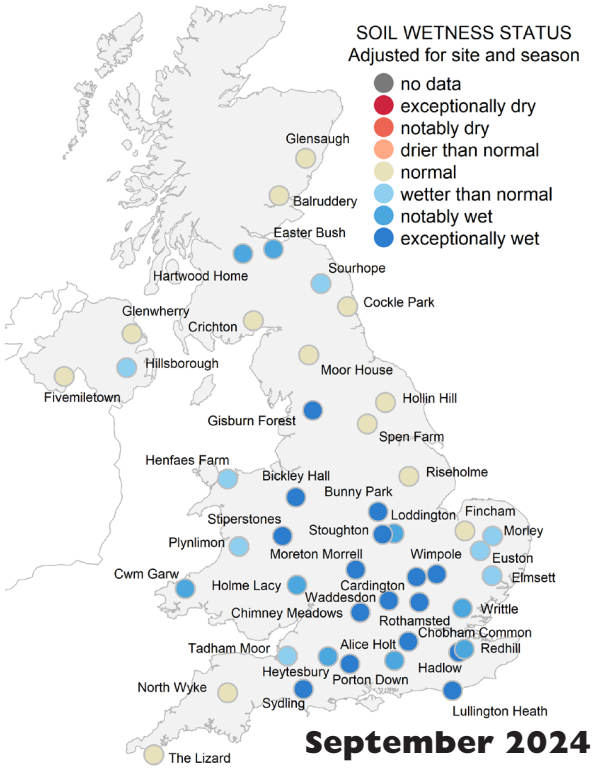
• denotes reservoir groups

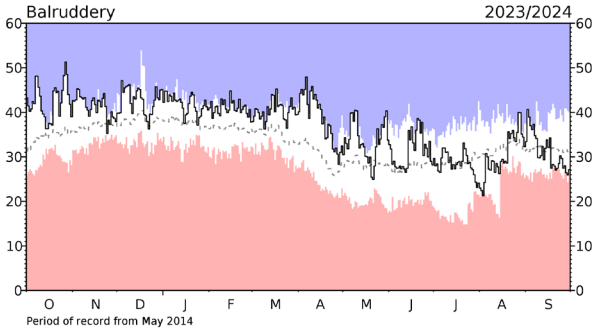
*last occurrence

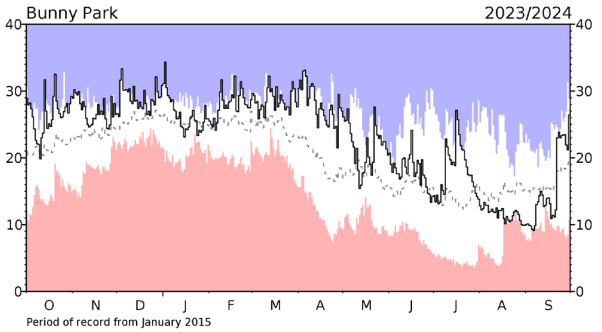
+ excludes Lough Neagh

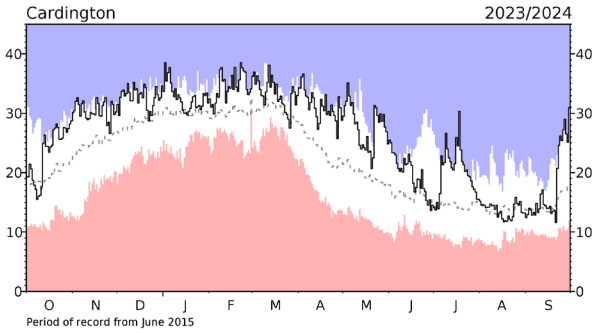
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes. Monthly figures may be artificially low due to routine maintenance or turbidity effects in feeder rivers.

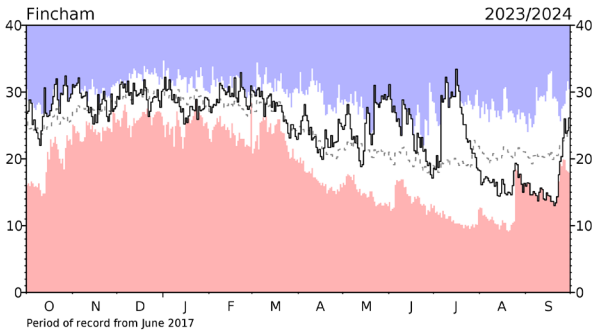
Soil Moisture . . . Soil Moisture

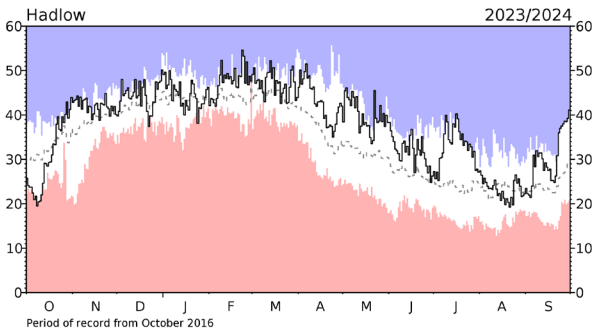












At the end of September, soil moisture was above field capacity for most of the UK after heavy rainfall in many regions, particularly in the South.

Several sites in England were drier than usual in the first few weeks of September (e.g. Bunny Park, Fincham), following on from the dry end to the summer. However, by the end of the month, soil moisture at the majority of COSMOS-UK sites across England and Wales were above field capacity. Only four sites were well below field capacity, located in Scotland (Balruddery, Crichton), north-west England (Hollin Hill), and the forest site of Alice Holt – however still within normal range for the time of year. Several sites experienced a sharp increase in soil moisture in the second half of the month following heavy rainfall (e.g. Bunny Park, Cardington, Chobham Common, Hadlow, Wimpole), reaching beyond their normal range and towards near-saturated conditions. Sites in Northern Ireland were generally within their normal range for the time of year.

Overall, soil moisture conditions across the UK were considerably wetter than the previous month, particularly in Southern regions that saw record breaking rainfall.

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/Y006208/1 as part of the NC-UK 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.

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. These are provisional totals calculated from a sub set of Met Office registered gauges and will be subject to change once data from the complete network of Met Office registered gauges has been quality assured and gridded within the annual process of updating the HadUK-Grid dataset.

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

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