Hydrological Summary

for the United Kingdom

August 2023

General

With the exception of a few periods of respite, August was largely characterised by a continuation of the unseasonably cool, windy and wet weather that dominated July – although it was nowhere near as exceptional. The August temperature and rainfall for the UK as a whole was near-average but, with low pressure holding sway, a series of Atlantic depressions bought widespread heavy rainfall and surface water flooding, albeit with limited fluvial flood responses. The storms included two named events that were surprisingly late first entries of the 2022-2023 season, highlighting the quiescence of the previous winter. In contrast, much of summer 2023 had a distinctly autumnal feel – following the exceptionally dry and warm June, July and August were unsettled and at times very wet. Correspondingly, soils were unseasonably moist for late summer in many areas, and river flows and groundwater levels were largely in the normal range or above. Reservoir stocks at the end of August were healthy at the national scale (5% above average for England & Wales, and 22% above for Northern Ireland) although a few impoundments continued to track below-average (below average stocks persist at Colliford and Roadford, while Loch Thom, Ardingly and Celyn & Brenig also saw stocks more than 10% below average). While ongoing vigilance is required in these localities, the early autumn water resource picture is favourable at the national scale. September began with a remarkably arid episode for the time of year, but the current Hydrological Outlook suggests largely normal flows and groundwater levels for autumn.

Rainfall

The first week of August was very unsettled, under the influence of some unseasonably deep areas of low pressure. On the 5th, storm 'Antoni' tracked eastwards across the country, bringing strong winds, heavy showers (with a daily total of 40mm at Scarborough) and associated surface water flooding, with transport disruption and some property damage reported (e.g. in North Yorkshire). While mid-month saw some very brief anticyclonic interludes, low pressure dominated and the unsettled conditions continued through the month. On the 18th/19th a second named storm, 'Betty', bought very heavy rainfall, especially to Northern Ireland (with 83mm on the 18th at Trassey Slievenaman, Co. Down), while the 25th to 27th saw surface water flooding in northwest England (with two fatalities in Liverpool). Despite the sustained unsettled weather, much of the rainfall came in sporadic downpours and overall rainfall totals were near-average for most regions – the overall UK rainfall for August was 95% of average. Northern Ireland registered 127% of average, adding to an exceptionally wet July, and the third wettest July-August average (165%) in a series from 1890. Much of northern England and parts of the south also saw notable accumulations over this two-month timeframe, but accumulations for summer as a whole were typically less remarkable given the dry June. Rainfall accumulations since the start of spring (March-August) were above average across most of England, Wales and Northern Ireland (over 130% of average in Thames, Wessex and Northern Ireland) but below average in Scotland.

River Flows

In most responsive catchments, August began with unseasonably high river flows following the wet end to July, and flows remained elevated during the first week. In northern and western catchments, only very muted recessions commenced before further flow responses in response to storm 'Betty' and other frontal incursions that characterised the rest of August. However, while there was significant surface water flooding in response to intense summer downpours, there were relatively few fluvial flood alerts. The Colne (Essex) registered its highest August flow on record (from 1960) but elsewhere there no notable peak flows. Correspondingly, mean monthly flows were in the normal range in Scotland, and normal or moderately above normal across most of England, Wales and Northern Ireland. Flows were typically above average in the west (with notably high August flows in some catchments, e.g. twice the typical August flow in the Brue and Annacloy) but below average in East Anglia, with notably low flows persisting in the Waveney. Unsurprisingly, given rainfall patterns, the mean flows for July-August were substantially above average across most of the country. For the summer (June-August), average flows were largely unremarkable, with a muted north-south contrast that becomes more pronounced over longer periods: over the six month (March-August) timeframe, flow deficiencies across Scotland contrast with notable accumulations across the far south of England. The Carron in northwest Scotland saw its lowest flow on record for this period (in a record from 1979) while the Dorset Stour saw its highest (in a record from 1973).

Soil Moisture and Groundwater

Soil moisture was generally higher than is typical for much of August, with many COSMOS-UK sites above the normal range, although soils began to dry out later in the month in parts of eastern England. While end-month Soil Moisture Deficits (SMDs) were below average across much of the country, they were near-average across the Chalk outcrop, especially in East Anglia. Groundwater levels fell at all Chalk sites, with levels returning to the normal range at Killyglen following last month's record high. Levels were in the normal to above normal range at most sites but continued tracking below normal at Dial Farm in East Anglia. In the Jurassic limestones, levels fell at New Red Lion and were stable at Ampney Crucis but became above normal and notably high for the time of year. In the Magnesian Limestone, levels were stable at Aycliffe and fell slightly at Brick House Farm, remaining in the normal range. Levels returned to the normal range in the Carboniferous Limestone at Pant y Lladron and remained so elsewhere in this aquifer. Normal to above normal levels continued in the Permo-Triassic Sandstones, with little change in observed levels. End of month data were unavailable for Newbridge and Annan, and there were operational problems with the Nuttalls Farm site. Levels fell and remained in the normal range at Lime Kiln Way in the Lower Greensand and Royalty Observatory in the Fell Sandstone. Below normal levels persisted in the Devonian Sandstones (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.

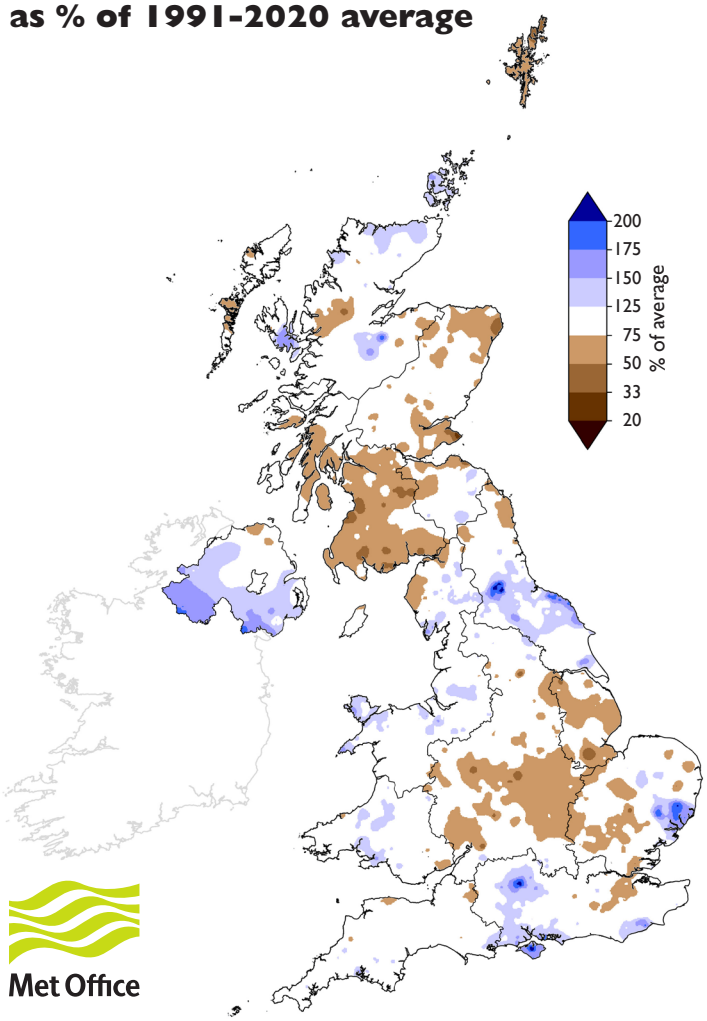
Region	Rainfall	Aug 2023	Jul23 – Aug23	RP	Jun23 – Aug23	RP	Mar23 – Aug23	RP	Sept22 – Aug23	RP
United Kingdom	mm	**89**	229		281		522		1227	
	%	**95**	130	5-10	111	2-5	109	5-10	106	8-12
England	mm	**72**	193		233		455		981	
	%	**97**	136	5-10	113	2-5	121	10-15	113	8-12
Scotland	mm	**103**	258		327		570		1531	
	%	**86**	115	2-5	103	2-5	91	2-5	98	2-5
Wales	mm	**120**	296		343		662		1566	
	%	**107**	141	5-10	113	2-5	114	5-10	107	5-10
Northern Ireland	mm	**127**	312		384		674		1319	
	%	**127**	165	30-50	142	15-25	133	>100	114	>100
England & Wales	mm	**79**	207		248		483		1061	
	%	**99**	137	5-10	113	2-5	119	8-12	112	8-12
North West	mm	**113**	321		395		640		1423	
	%	**102**	154	15-25	134	10-15	120	15-25	111	15-25
Northumbria	mm	**87**	215		262		426		951	
	%	**105**	137	5-10	114	2-5	104	2-5	104	2-5
Severn-Trent	mm	**55**	168		218		425		866	
	%	**79**	124	2-5	108	2-5	115	5-10	108	2-5
Yorkshire	mm	**84**	222		264		449		953	
	%	**109**	153	10-15	121	5-10	115	5-10	110	5-10
Anglian	mm	**52**	137		162		347		673	
	%	**86**	118	2-5	95	2-5	116	2-5	107	2-5
Thames	mm	**61**	150		187		418		873	
	%	**99**	130	2-5	112	2-5	131	10-20	120	8-12
Southern	mm	**69**	153		181		419		1049	
	%	**110**	132	2-5	107	2-5	129	10-15	128	20-35
Wessex	mm	**74**	202		235		515		1130	
	%	**102**	151	8-12	121	2-5	137	40-60	125	25-40
South West	mm	**94**	250		284		624		1450	
	%	**100**	142	5-10	112	2-5	127	15-25	116	10-20
Welsh	mm	**116**	286		332		643		1516	
	%	**107**	140	5-10	113	2-5	114	5-10	108	5-10
Highland	mm	**131**	286		366		601		1677	
	%	**100**	120	2-5	108	2-5	85	2-5	91	2-5
North East	mm	**74**	190		241		439		1083	
	%	**82**	110	2-5	95	2-5	95	2-5	102	2-5
Tay	mm	**91**	246		300		540		1455	
	%	**85**	120	2-5	103	2-5	96	2-5	105	5-10
Forth	mm	**78**	217		277		488		1268	
	%	**77**	112	2-5	99	2-5	94	2-5	102	5-10
Tweed	mm	**91**	229		277		465		1149	
	%	**97**	128	5-10	107	2-5	99	2-5	106	5-10
Solway	mm	**83**	285		353		653		1668	
	%	**65**	119	2-5	105	2-5	103	2-5	106	10-20
Clyde	mm	**109**	291		383		682		1821	
	%	**74**	107	2-5	101	2-5	92	2-5	96	2-5

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

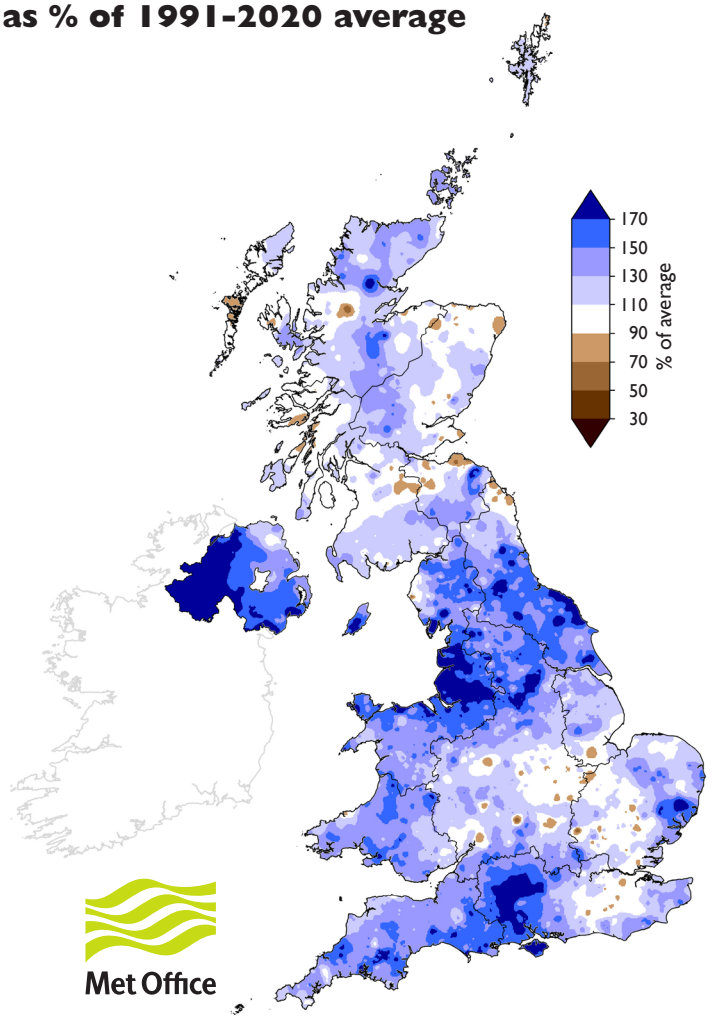
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability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

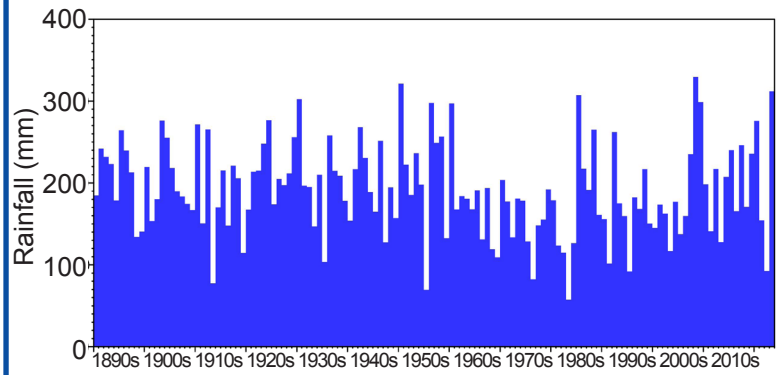
August 2023 rainfall
as % of 1991-2020 average



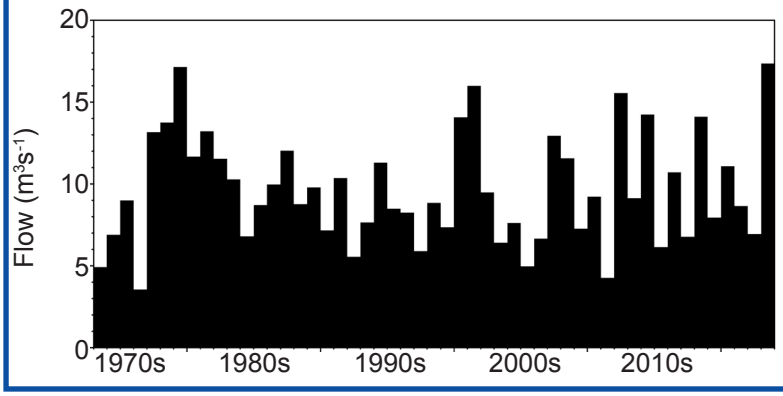
July 2023 - August 2023 rainfall
as % of 1991-2020 average



July - August rainfall for Northern Ireland



March - August average river flows on the Stour



UK Hydrological Outlook

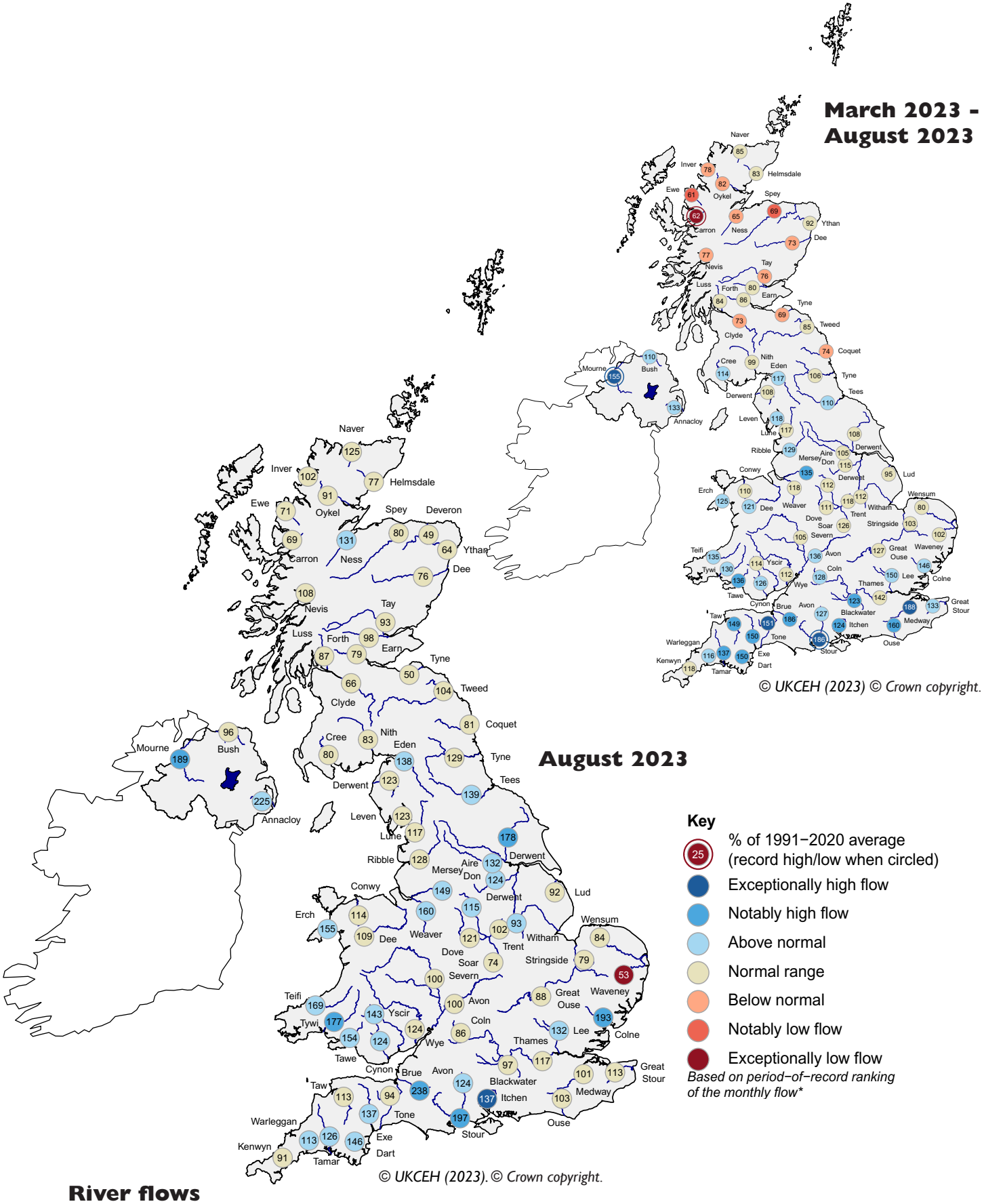
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from September 2023**
Issued: **08.09.2023**
using data to the end of August 2023

The outlook for September is for normal to above normal river flows in southern England, and normal to below normal for the rest of the country. Groundwater levels are expected to be mostly normal, except in the Southern Chalk and Jurassic Limestone where they are likely to be above normal. River flows and groundwater levels are expected to return to normal for the September-November period for most of the country.

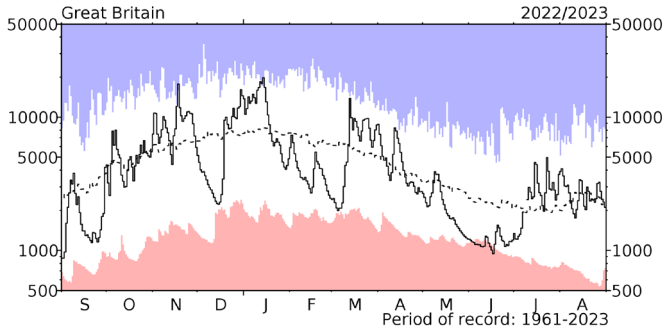
River flow . . . River flow . . .

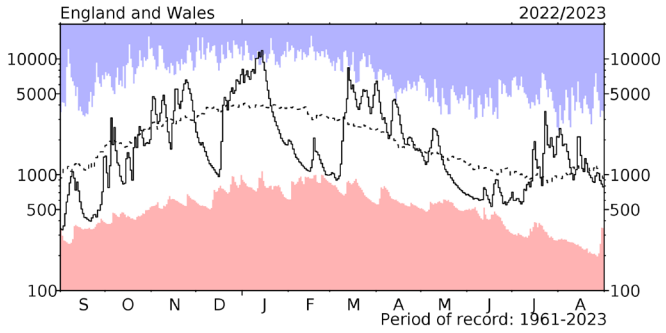


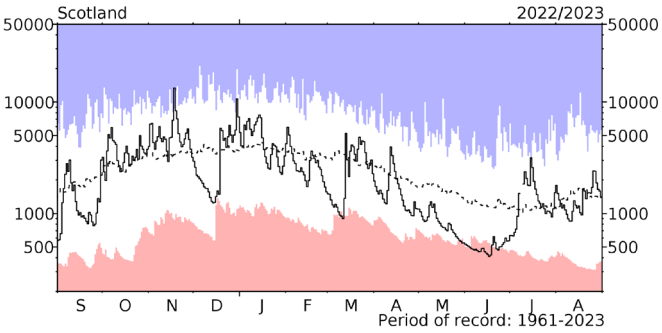
River flows

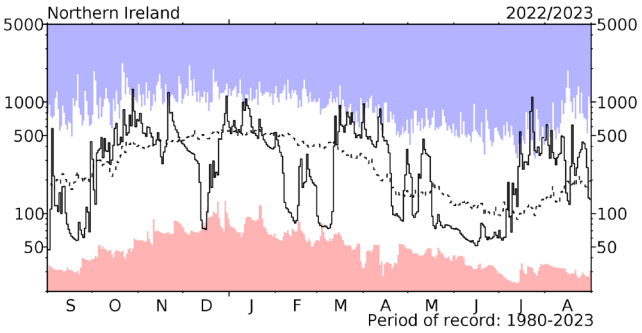
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

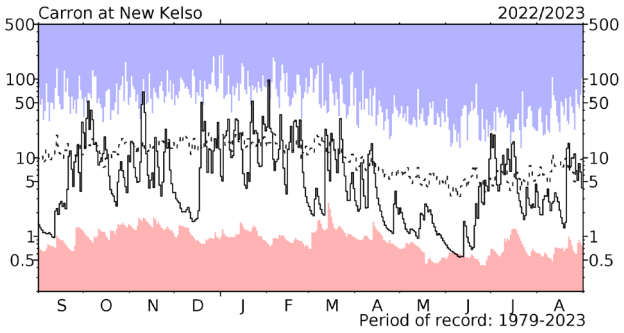
River flow . . . River flow . . .

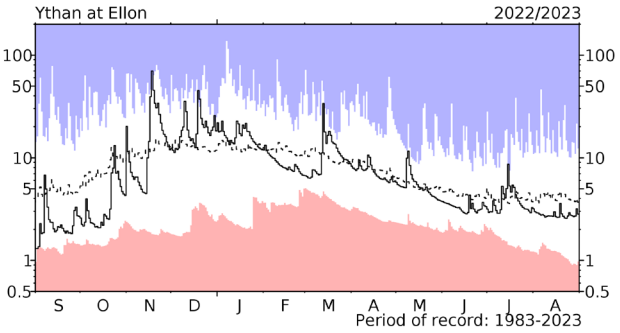


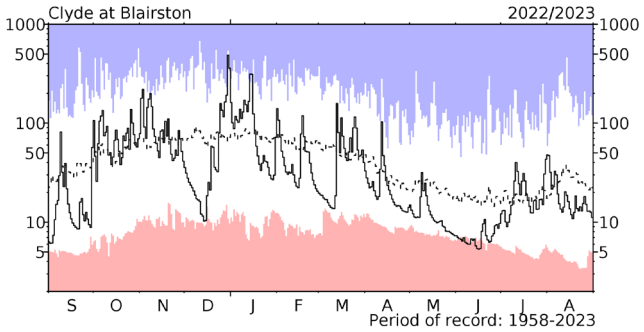


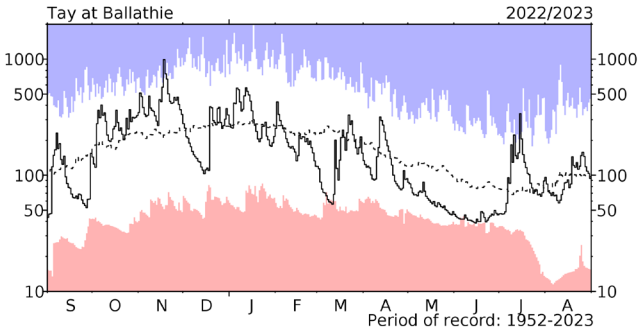


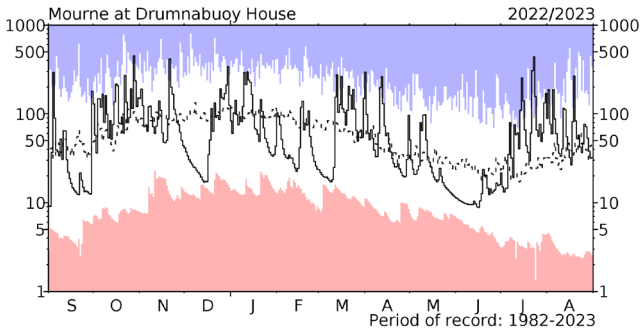


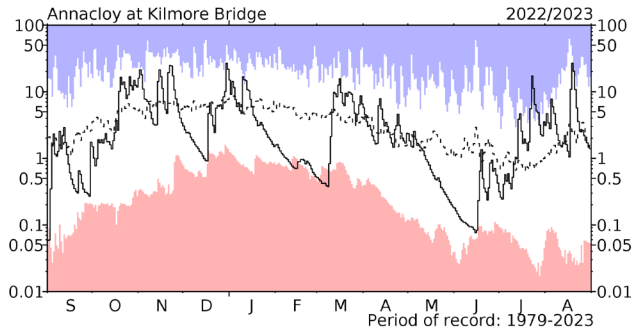








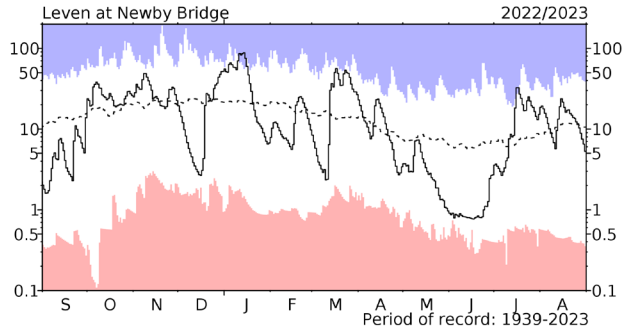


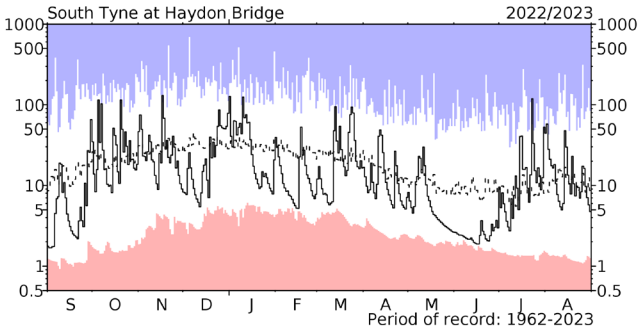


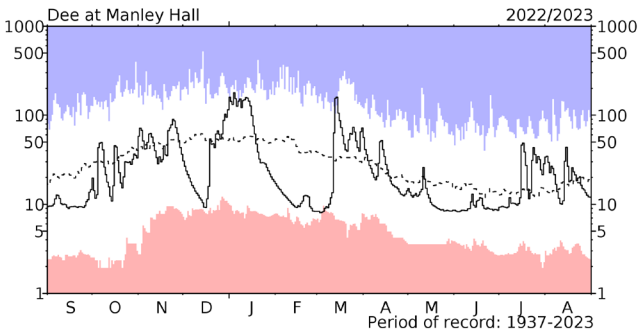
River flow hydrographs

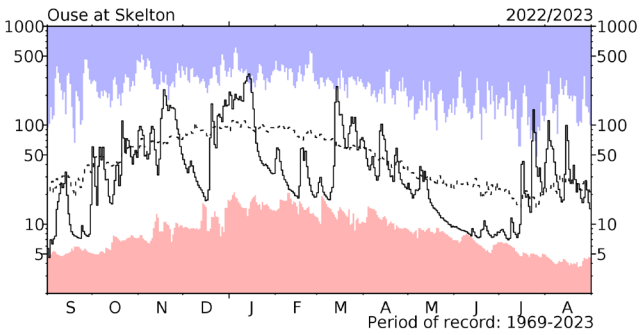
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to August 2022 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

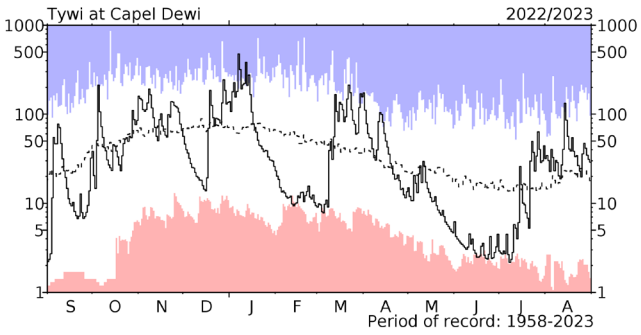
River flow . . . River flow . . .

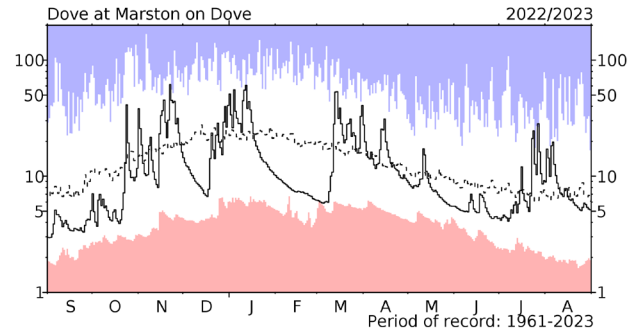


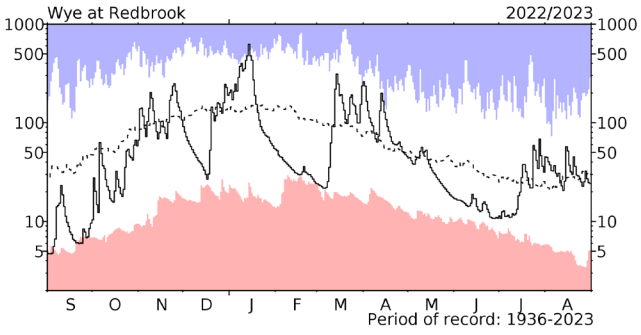


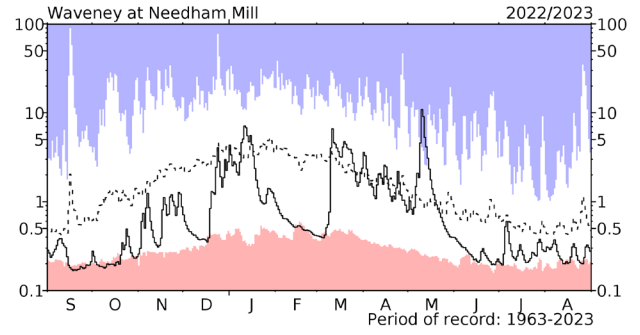


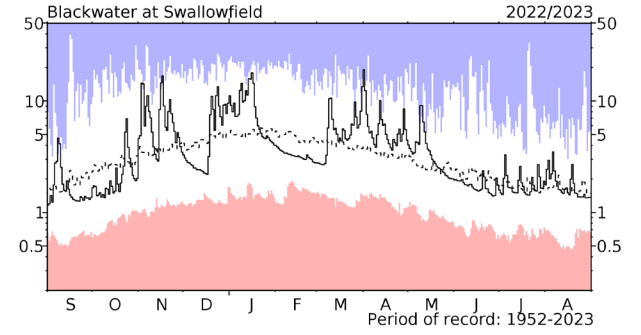


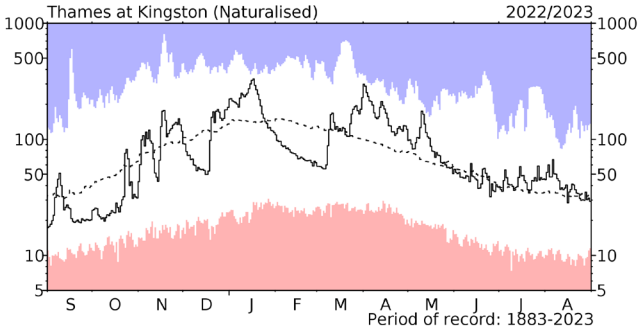


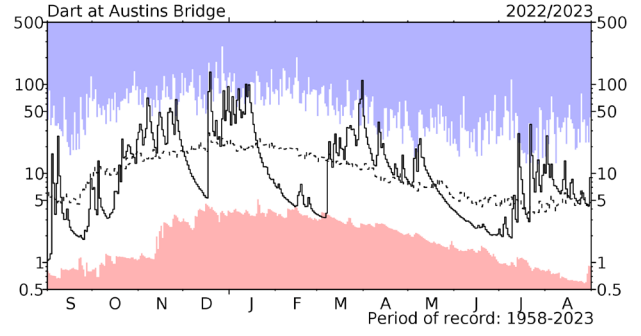


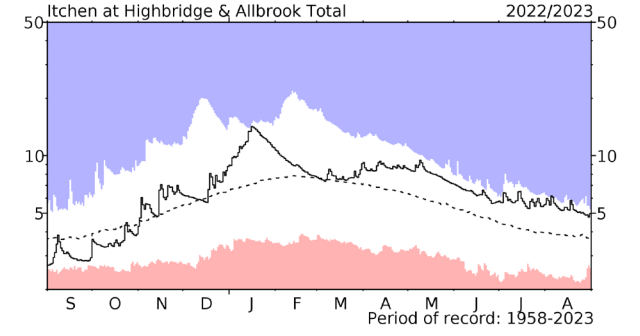




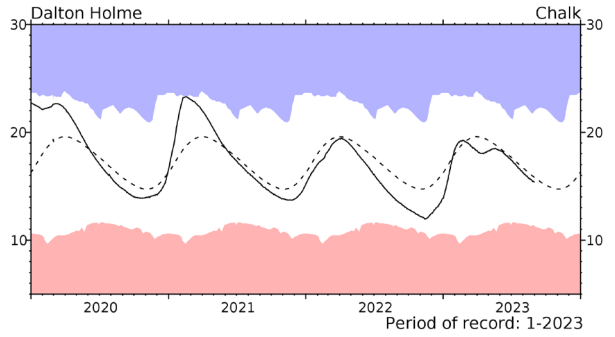


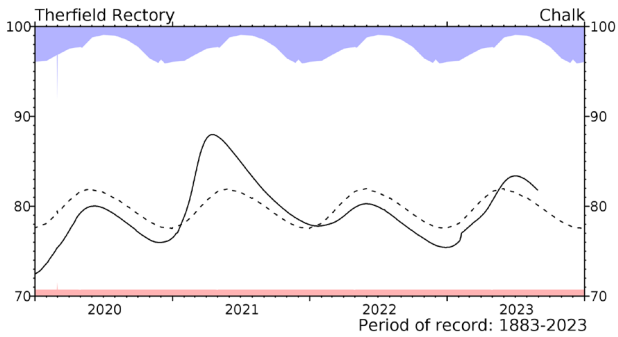


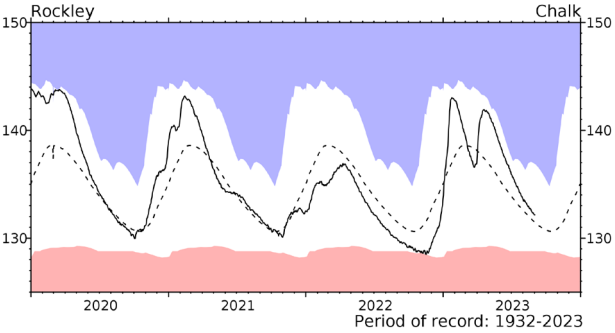


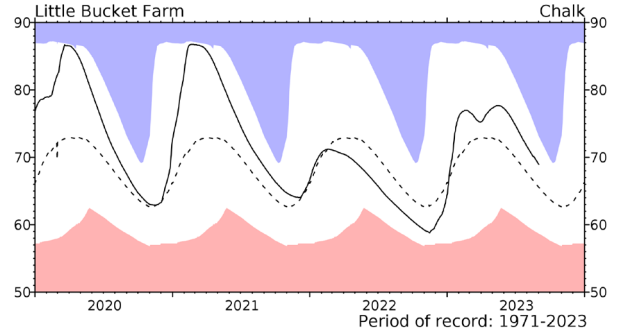


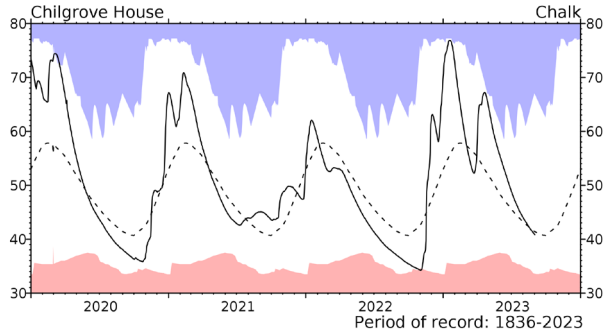
Groundwater…Groundwater

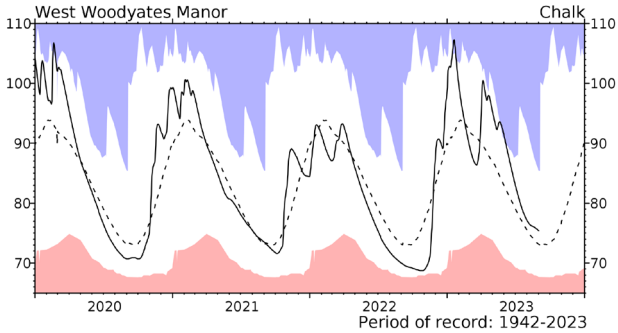


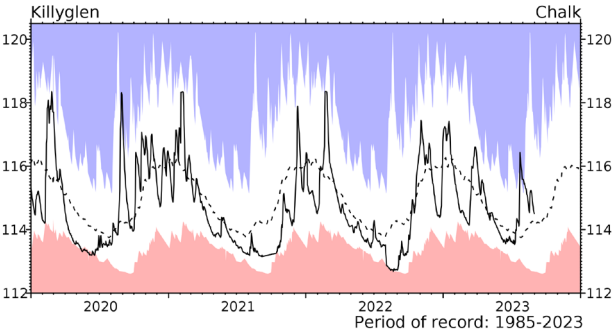


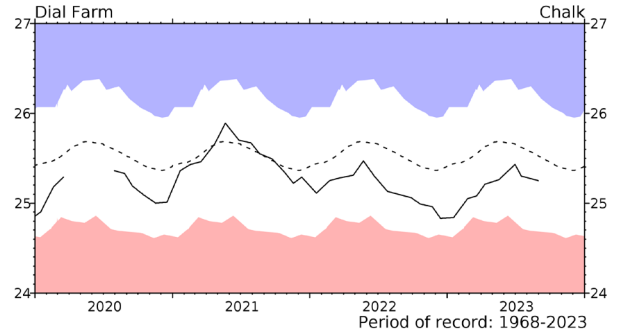


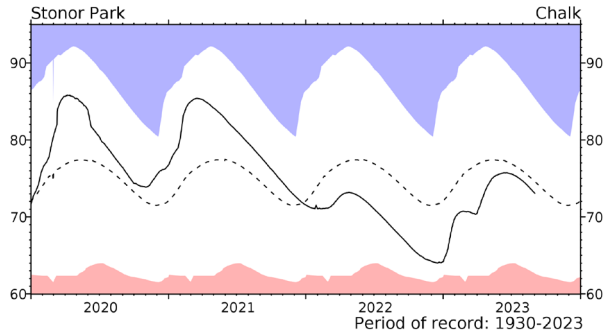


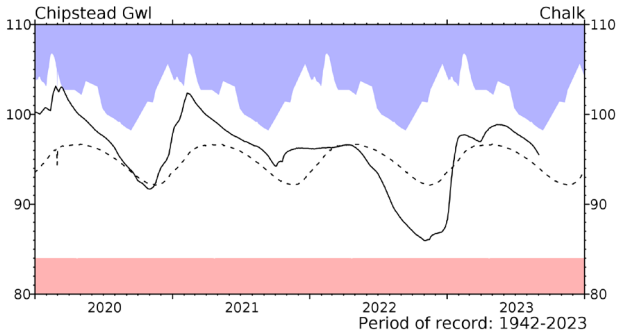






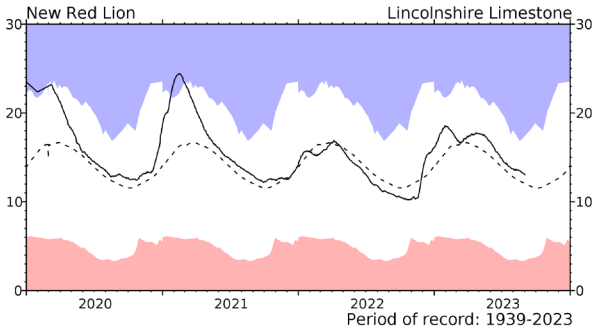


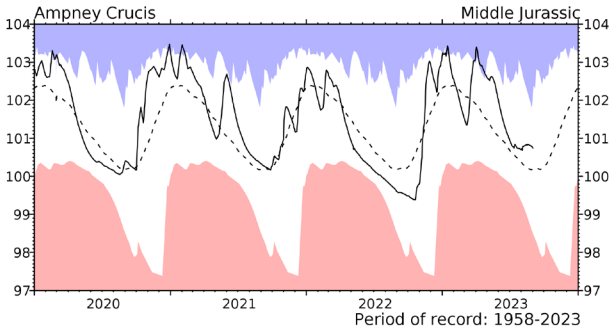


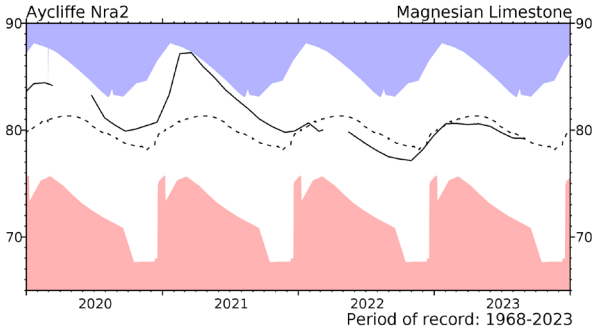


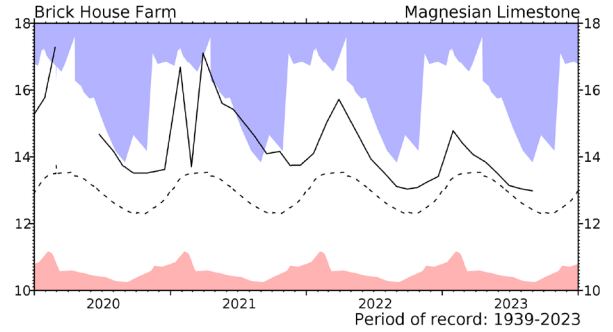
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

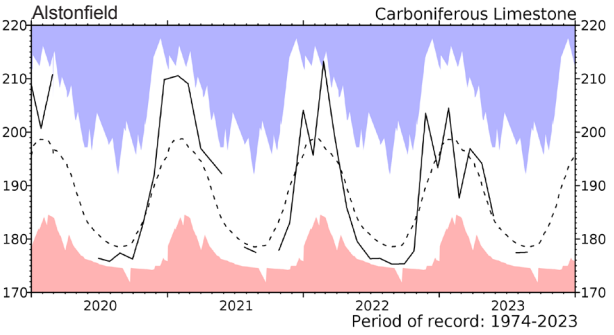
Groundwater… Groundwater

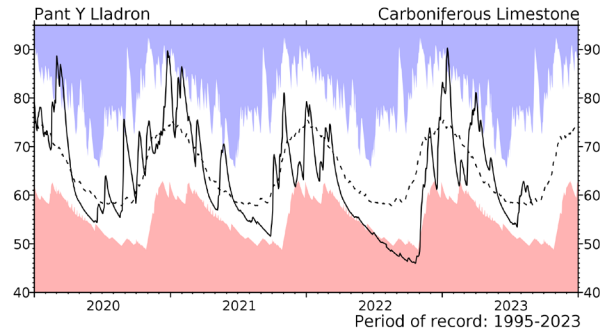


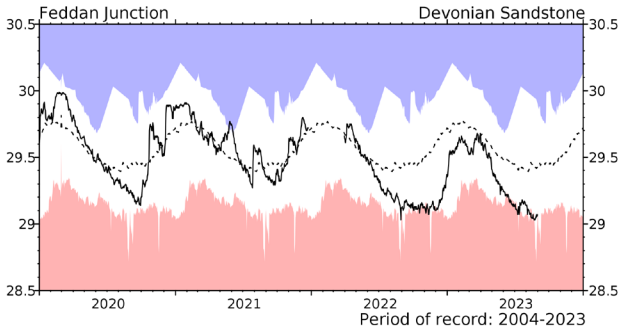


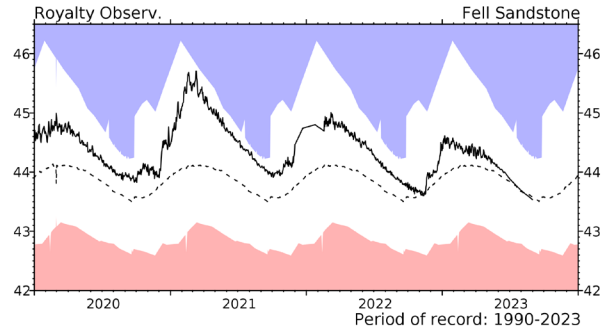


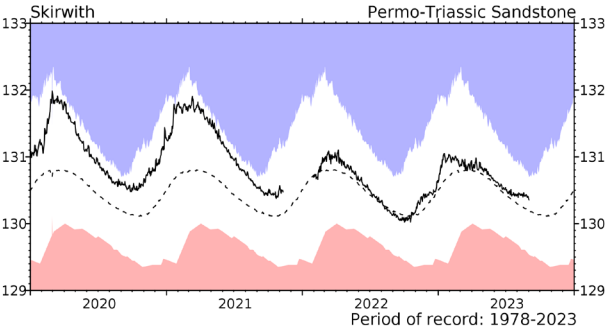


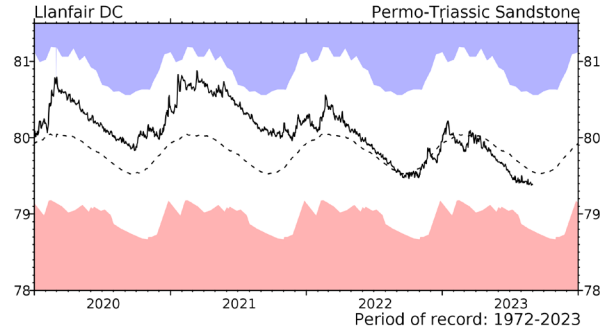


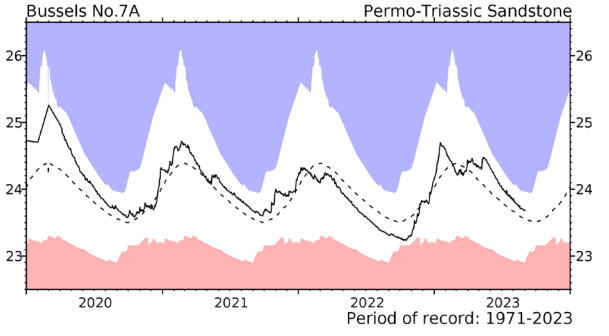


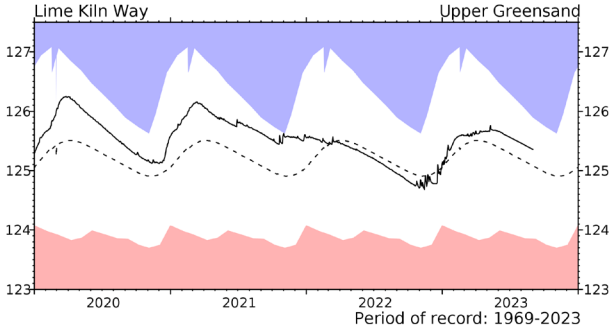










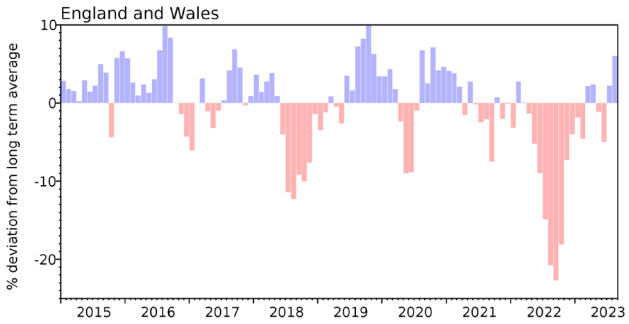


Groundwater levels - August 2023

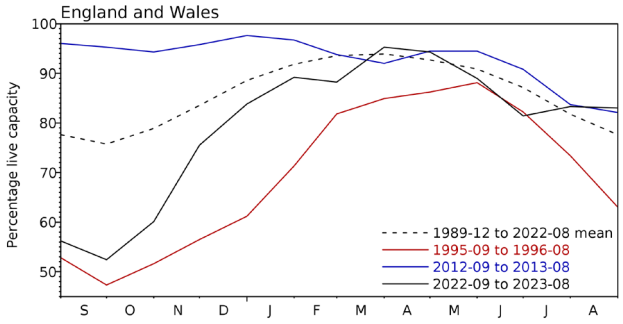
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Jun	2023 Jul	2023 Aug	Aug Anom.	Min Aug	Year* of min	2022 Aug	Diff 23-22
North West	N Command Zone	•	124929	63	68	73	14	15	1984	45	29
	Vyrnwy		55146	89	87	97	24	36	1995	46	51
Northumbrian	Teesdale	•	87936	66	76	87	16	38	1995	66	22
	Kielder		(199175)	89	98	85	-2	66	1989	79	6
Severn-Trent	Clywedog		49936	85	91	97	20	27	1976	52	46
	Derwent Valley	•	46692	70	79	79	13	34	1995	36	43
Yorkshire	Washburn	•	23373	76	78	82	13	34	1995	37	46
	Bradford Supply	•	40942	66	73	76	8	21	1995	35	41
Anglian	Grafham		(55490)	94	94	93	7	59	1997	66	28
	Rutland		(116580)	91	91	87	4	66	1995	76	12
Thames	London	•	202828	95	97	96	15	62	2022	62	34
	Farmoor	•	13822	98	99	99	6	64	1995	72	27
Southern	Bewl		31000	92	87	82	13	38	1990	57	25
	Ardingly		4685	91	77	62	-10	31	2022	31	30
Wessex	Clatworthy		5662	83	73	68	4	31	1995	45	23
	Bristol	•	(38666)	87	81	78	9	43	1990	53	25
South West	Colliford		28540	61	57	56	-14	31	2022	31	24
	Roadford		34500	62	57	55	-16	40	1995	47	8
	Wimbleball		21320	84	75	73	4	37	2022	37	36
	Stithians		4967	83	73	61	0	27	2022	27	34
Welsh	Celyn & Brenig	•	131155	76	71	68	-14	49	1989	55	14
	Brianne		62140	86	90	100	13	52	2022	52	48
	Big Five	•	69762	74	73	73	2	29	1995	40	33
	Elan Valley	•	99106	76	76	78	3	37	1976	39	39
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	82	87	89	10	45	1998	71	18
	East Lothian	•	9317	91	89	92	6	63	1989	67	25
Scotland(W)	Loch Katrine	•	110326	72	85	84	11	50	2021	79	5
	Daer		22494	62	77	84	7	41	1995	62	22
	Loch Thom		10721	70	70	59	-23	50	2021	75	-16
Northern Ireland	Total+	•	56800	80	92	97	20	40	1995	65	32
	Silent Valley	•	20634	80	92	99	26	33	2000	60	39

( ) figures in parentheses relate to gross storage

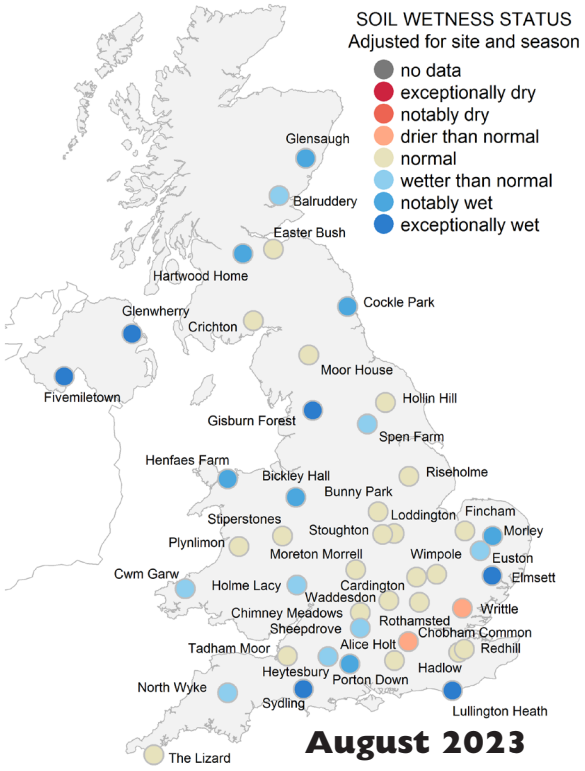
• denotes reservoir groups

*last occurrence

+ excludes Lough Neagh

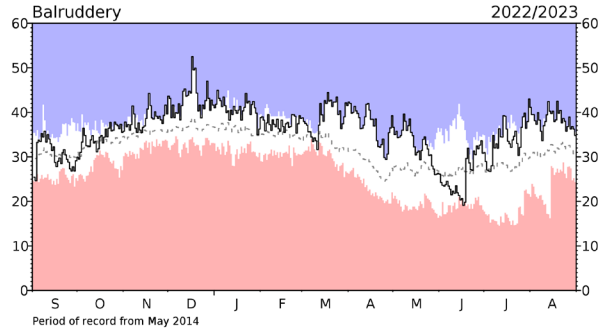
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed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

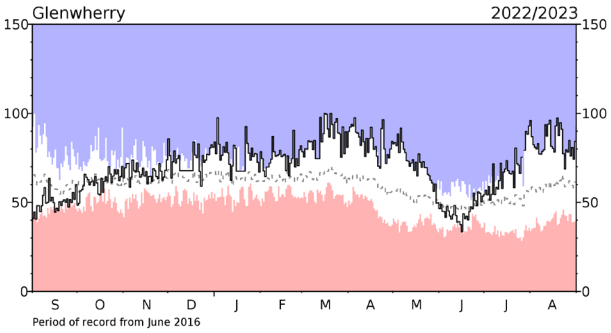
Soil Moisture . . . Soil Moisture

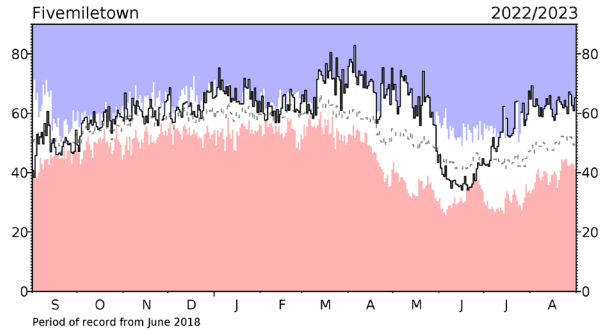


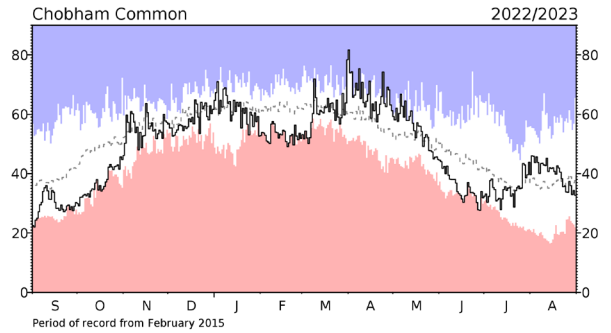
For most of August, soil moisture for most COSMOS-UK sites was above or within the normal range. The Glenwherry and Fivemiletown sites in Northern Ireland were quite saturated for most of the month, whereas Hillsborough fluctuated between field capacity, near-saturated and saturated conditions. Towards the end of the month, several sites in Southeast England had begun to dry out, particularly Chobham Common, Hadlow, Redhill, Waddesdon and Writtle. Soil moisture at most sites in Scotland remained above field capacity (e.g. Balruddery, Glensaugh) despite lower-than-average rainfall for the month.

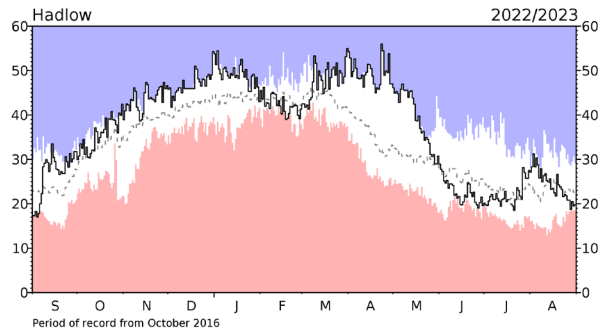
Overall, soils throughout the UK remained moist for most of the month due to a reasonably wet July and August.











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.

The monthly rainfall figures are provided by the Met Office NCIC and are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

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

Tel: 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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