Hydrological Summary

for the United Kingdom

June 2023

General

June – provisionally the warmest June on record for the UK (in a series from 1884) – was a month of two halves – the first, notable for dry weather incidents such as wildfires and fish rescues and the second, localised heavy rainfall and surface water flooding. River flows were generally in the normal range to exceptionally low, with a number of new June minima established in Scotland. High temperatures limited the effectiveness of rainfall and soils were drier than average in all regions at month-end. The mixed groundwater situation of recent months persisted, with seasonally high levels in the southern Chalk. In other aquifers, levels were in the normal range in the majority of the Permo Triassic aquifers and below normal across parts of Scotland, Wales and central England. Reservoir stocks were 81% of average for England & Wales, and although stocks at several impoundments across the UK remained substantially below average (e.g. Daer, South Lanarkshire, was 21% below average, setting a new June minimum in a series from 1994), stocks generally increased relative to average. The latest Hydrological Outlook suggests that river flows are likely to continue to be below normal over the coming months, meaning that continued vigilance is required in areas away from the south-east where flows are still bolstered by the wet spring. However, wet weather at the start of July has alleviated immediate concerns and pressures on the environment and agricultural sector.

Rainfall

The first half of June was dominated by the anticyclonic conditions established in mid-May, bringing settled conditions. This period was interrupted by a series of convective thunderstorms between the 10th-13th in a band from north Wales to London where damage to buildings and trees was caused by lightning and surface water flooding resulted in transport disruption. From the 17th, an Atlantic low brought frontal systems and unsettled conditions to the UK until month-end, with some notable totals recorded on the 18th (e.g. 70mm at Wiley Sike, Cumbria) and surface water flooding in Wrexham, Greater Manchester, Sheffield, Norfolk and Devon. Further rain and thunderstorms between the 20th and 22nd caused road and rail disruption (e.g. on the West Coast Mainline on the 20th) and flooded properties in Leicester on the 22nd. Despite the numerous thunderstorms, most of the UK received below average rainfall for June with large parts less than 70% of average. Less than half the average was recorded in parts of eastern England and south Wales, with localised patches receiving less than a third of average. Above average rainfall was registered in a band from London to the Wirral, over high ground in Cumbria, and localised parts of Scotland and Northern Ireland, although this had little impact on regional rainfall totals. At the national scale, June rainfall for the UK was 68% of average – many regions received less than two-thirds, and some around half the average, notably Anglian and South West regions with 46% and 44% of average, respectively. Over the two-month period (May-June) rainfall was again below average across the UK, intensifying the deficits registered in June, e.g. in Wales (45% of average, fifth driest since 1890) and Scotland (60% of average) – both drier than the same period in 2018. In Scotland, all regions but the North East registered the driest May-June since 2010.

River Flows

Recessions that started mid-May continued into June across the UK – in some catchments they extended throughout the whole of June (e.g. western catchments in Wales, Cumbria and Scotland). Elsewhere, flow responses from mid-month tracked the passage of rainfall throughout the month with varying responses, although flows rarely peaked above average. Recessions continued steadily in groundwater-dominated catchments, but often from an above average position, and showed muted responses to rainfall. The prolonged nature of the recessions can be seen in the number of catchments setting new daily flow minima in June across Scotland, north-west England and north Wales. Some notably so, for example the Bervie for 25 days and the Forth for 19 days continuously from the 2nd. June monthly mean flows were mostly below normal to exceptionally low across the UK, with new June minima registered on the Tywi and in several catchments in Scotland – the Ewe, Forth and Tweed with less than a third of their June average flows. Exceptionally low flows on the Derwent and Leven (both Cumbria) ranked as the second and third lowest June flows in records from 1968 and 1939, respectively. In contrast, flows in the south-east of England were generally in the normal range with some catchments recording flows near or above average. The widespread low flows are reflected in the national outflow series, with June 2023 setting a new minimum outflow from Great Britain in a series from 1961. Over the last two months, more record low flows were set across northern Scotland – where many flows either approached or were less than half the average, whilst above normal to exceptionally high flows extended across southern England. Mean outflows from Scotland for May and June were the lowest on record (in a series from 1961), almost 20% lower than the previous record from 2010.

Soil Moisture and Groundwater

Soil moisture deficits (SMDs) across most of Great Britain during June persisted, reflecting relatively low rainfall and high rates of evapotranspiration; SMDs for Wales were the third highest in series from 1961. However, COSMOS-UK sites registered an increase in soil wetness towards month-end in response to rainfall. Most groundwater levels in the Chalk receded; in the Southern Chalk the wet spring conditions meant the recession started from seasonally high levels, and most levels remained notably high. Levels at Tilshead were the third highest June levels in a series from 1966. Further north in the Chilterns and across East Anglia levels continued to rise and ranged from below normal (Washpit Farm) to above normal (Redlands Hall). In Yorkshire, Chalk levels remained in the normal to above normal range. In the Jurassic limestones levels throughout June were close to or above the long-term average, as in most of the Magnesian and Carboniferous limestones, although a steep recession at Pant y Lladron brought levels below normal. In the Permo Triassic sandstones, where levels tend to reflect aggregate recharge over multiple years, levels were generally in the normal range except for Bussels No. 7a where levels remained notably high. With continued recession at Feddan Junction in the Devonian Sandstone a new June minimum level was recorded (in a series from 2005). Elsewhere in the northern sandstone aquifers levels were in the normal range.

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

Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1991-2020 average.

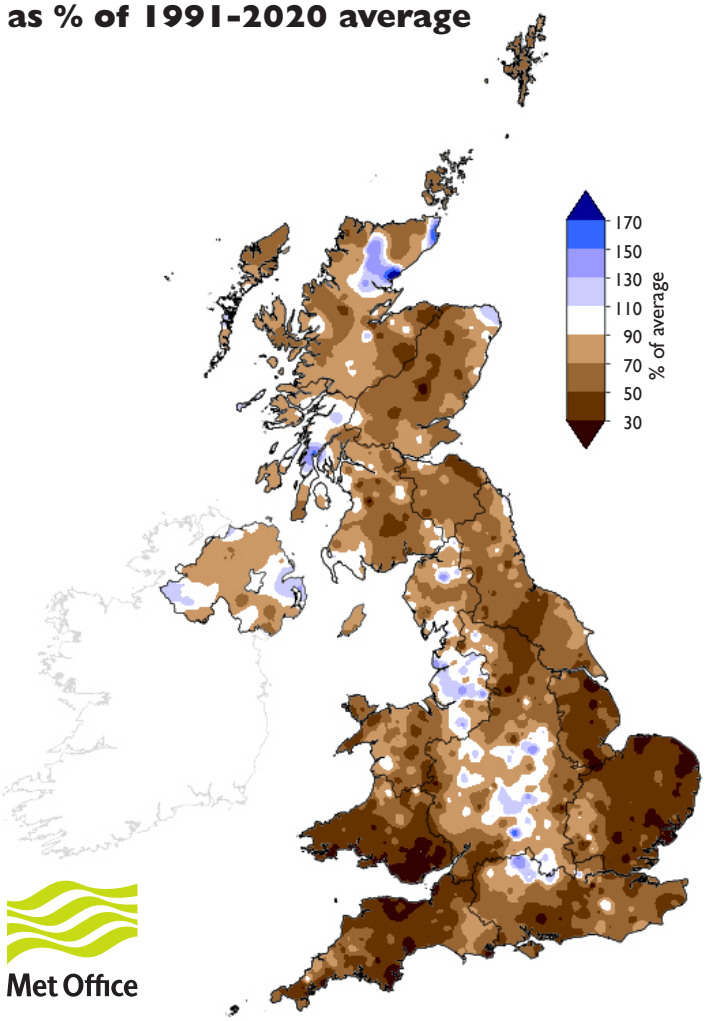
Region	Rainfall	Jun 2023	May23 – Jun23	RP	Mar23 – Jun23	RP	Jan23 – Jun23	RP	Jul22 – Jun23	RP
United Kingdom	mm	**52**	91		293		462		1098	
	%	**68**	62	10-15	96	2-5	88	2-5	95	2-5
England	mm	**41**	80		263		368		848	
	%	**63**	65	5-10	111	2-5	96	2-5	98	2-5
Scotland	mm	**69**	109		312		581		1444	
	%	**74**	60	10-15	78	2-5	81	2-5	92	2-5
Wales	mm	**47**	81		366		587		1366	
	%	**51**	45	25-40	99	2-5	91	2-5	94	2-5
Northern Ireland	mm	**72**	121		362		489		1100	
	%	**89**	78	2-5	114	5-10	93	2-5	95	2-5
England & Wales	mm	**42**	80		277		398		919	
	%	**61**	61	8-12	109	2-5	95	2-5	97	2-5
North West	mm	**74**	106		319		518		1232	
	%	**86**	66	5-10	99	2-5	93	2-5	97	2-5
Northumbria	mm	**47**	79		212		311		813	
	%	**65**	61	5-10	84	2-5	77	5-10	90	2-5
Severn-Trent	mm	**50**	83		257		339		754	
	%	**76**	67	2-5	110	2-5	93	2-5	94	2-5
Yorkshire	mm	**42**	70		227		330		800	
	%	**58**	55	8-12	93	2-5	84	2-5	92	2-5
Anglian	mm	**25**	67		210		263		580	
	%	**46**	65	5-10	114	2-5	94	2-5	93	2-5
Thames	mm	**38**	80		268		350		762	
	%	**71**	75	2-5	131	8-12	106	2-5	105	2-5
Southern	mm	**29**	62		267		378		935	
	%	**54**	59	5-10	128	5-10	105	2-5	115	5-10
Wessex	mm	**32**	85		313		442		962	
	%	**54**	72	2-5	129	10-15	109	2-5	106	2-5
South West	mm	**33**	92		374		565		1257	
	%	**44**	62	5-10	119	5-10	101	2-5	100	2-5
Welsh	mm	**46**	81		357		566		1322	
	%	**51**	47	20-35	100	2-5	91	2-5	95	2-5
Highland	mm	**80**	117		315		677		1598	
	%	**80**	57	10-20	67	8-12	78	2-5	86	2-5
North East	mm	**51**	94		249		392		1016	
	%	**63**	63	5-10	85	2-5	83	2-5	96	2-5
Tay	mm	**55**	88		294		488		1357	
	%	**63**	52	10-20	82	2-5	76	2-5	98	2-5
Forth	mm	**60**	92		271		448		1183	
	%	**69**	58	5-10	83	2-5	79	2-5	96	2-5
Tweed	mm	**48**	84		236		373		1014	
	%	**61**	58	8-12	82	2-5	77	5-10	94	2-5
Solway	mm	**69**	108		369		611		1541	
	%	**71**	58	5-10	93	2-5	87	2-5	98	2-5
Clyde	mm	**91**	138		390		712		1722	
	%	**85**	66	5-10	84	2-5	83	2-5	91	2-5

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

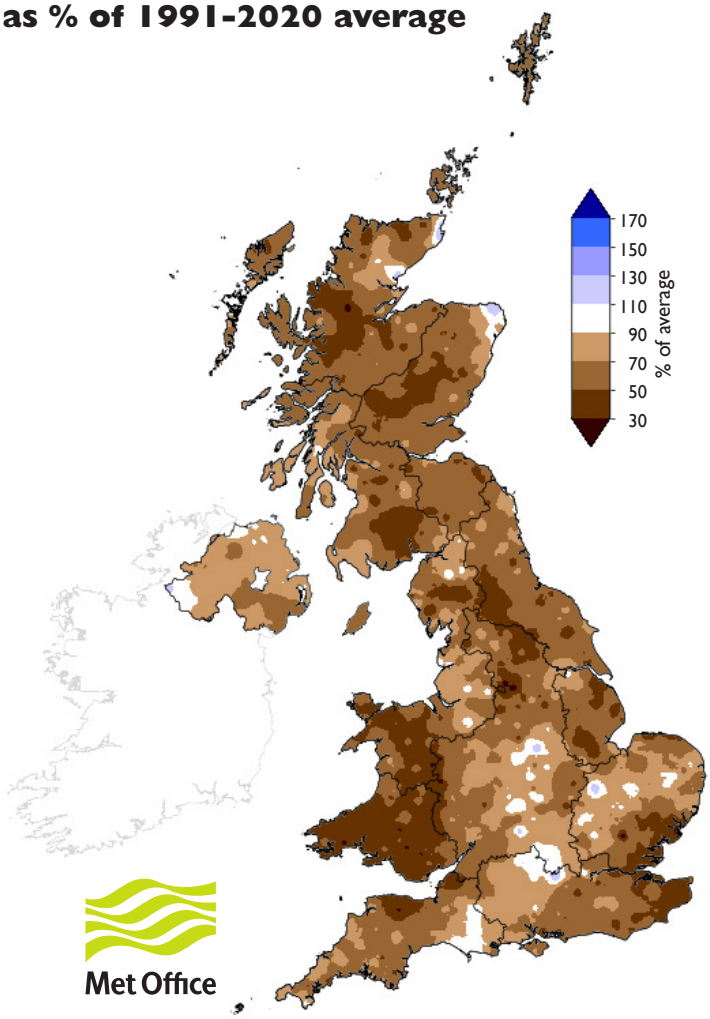
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability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

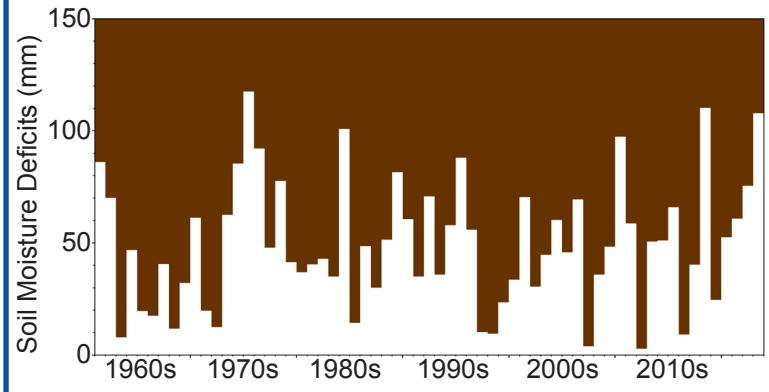
June 2023 rainfall
as % of 1991-2020 average



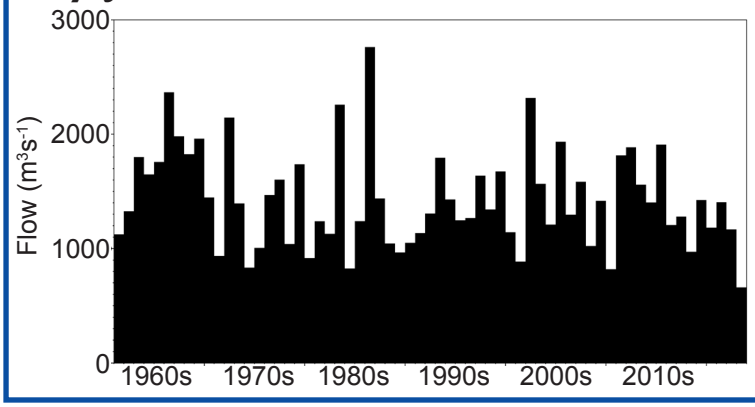
May 2023 - June 2023 rainfall
as % of 1991-2020 average



End of June SMDs for Wales



May-June Mean Outflows for Scotland



UK Hydrological Outlook

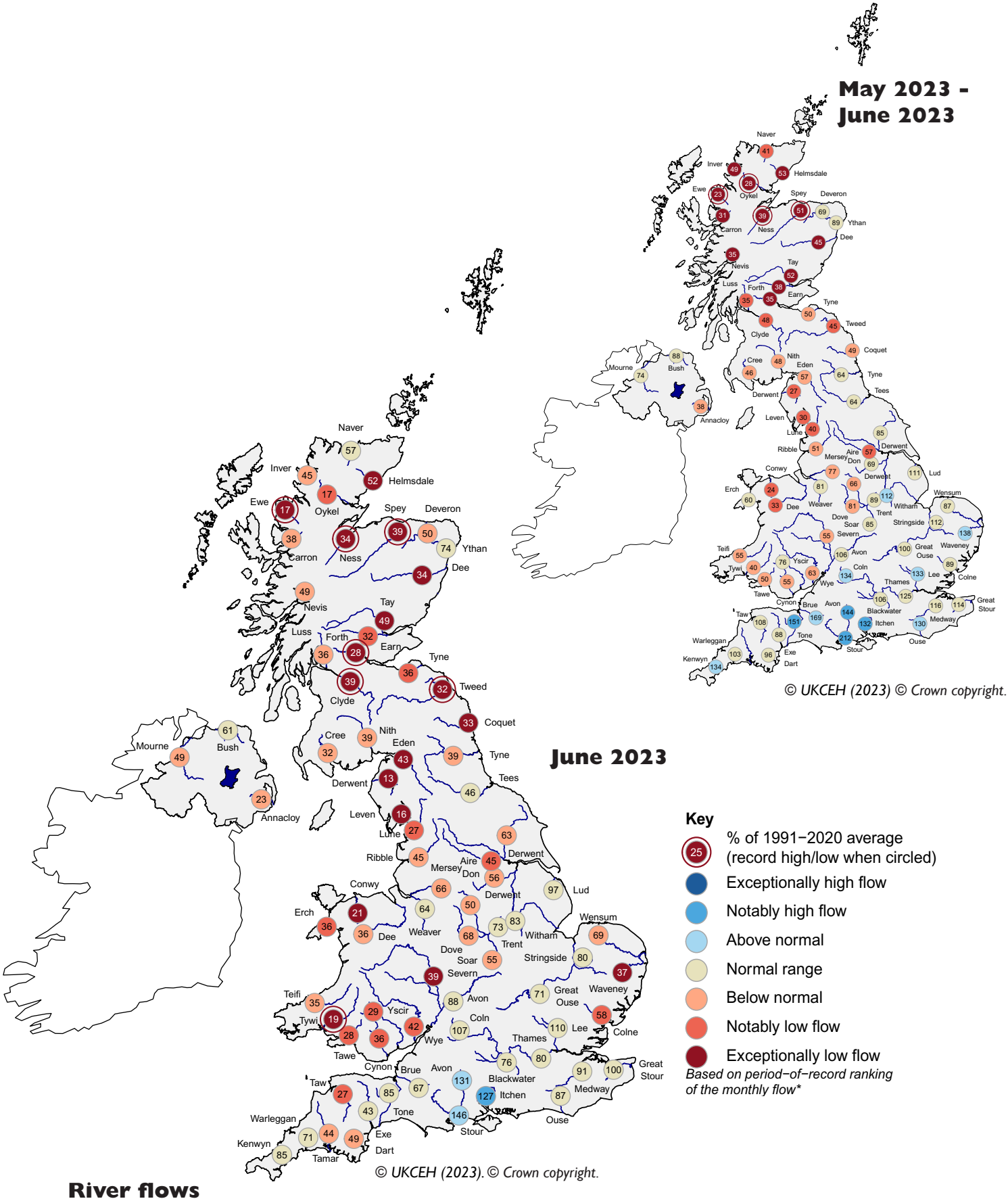
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from July 2023**
Issued: **11.07.2023**
using data to the end of June 2023

The outlook for July is for below normal river flows in the north and west of the UK, and for normal to below normal river flows elsewhere. For groundwater, normal to below normal levels are expected, with the exception of in southern England where normal to above normal levels are most likely. For July-September, the outlook is for normal to below normal river flows and groundwater levels across the UK although normal to above normal groundwater levels are likely to persist in parts of southern England.

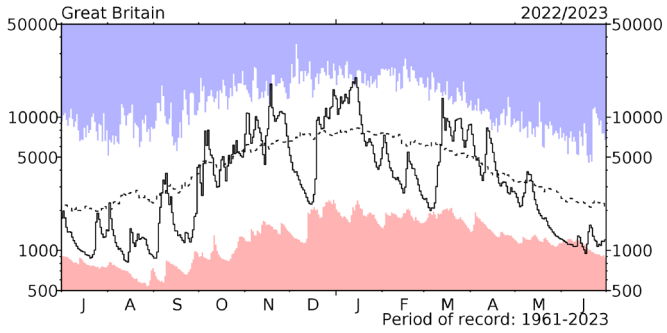
River flow . . . River flow . . .

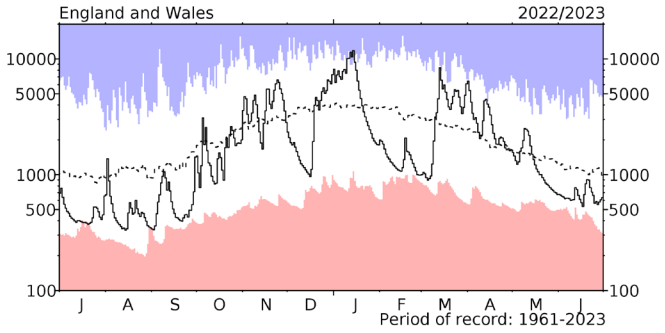


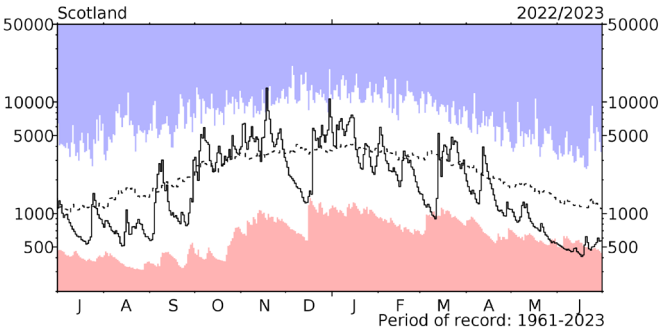
River flows

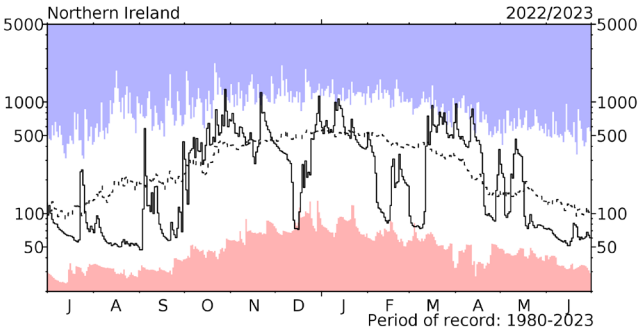
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

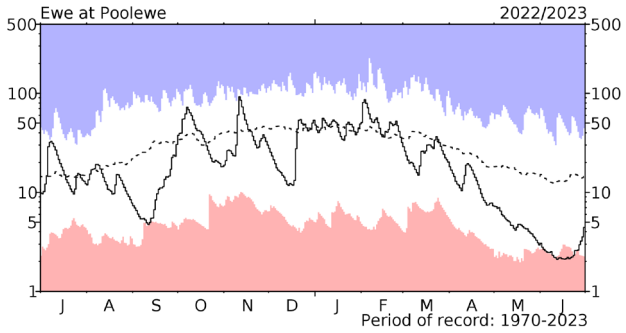
River flow . . . River flow . . .

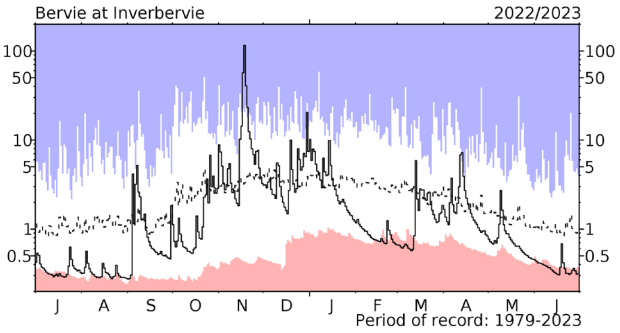


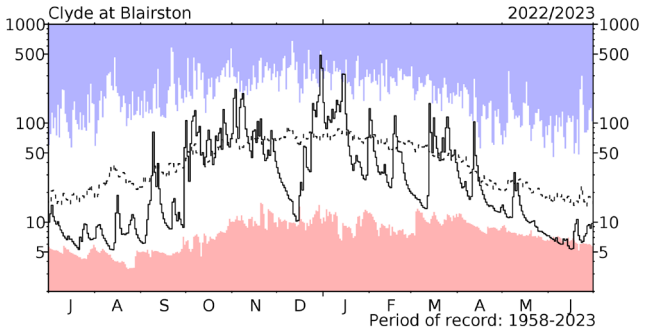


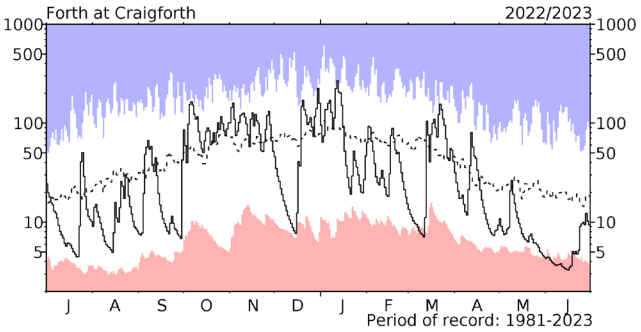


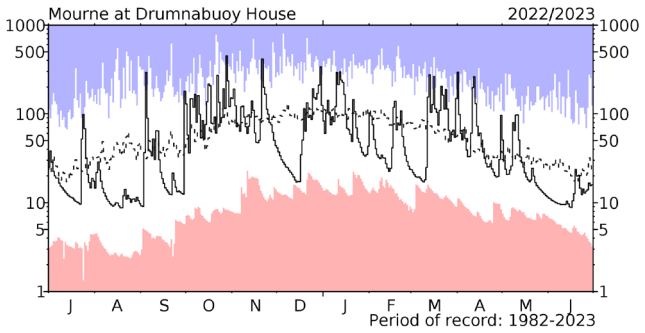


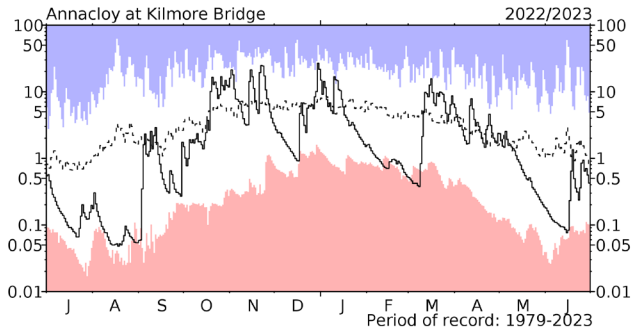








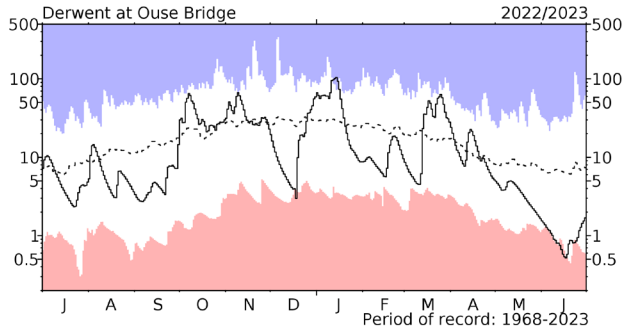


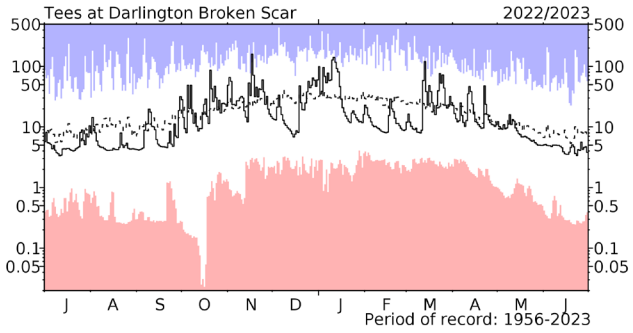


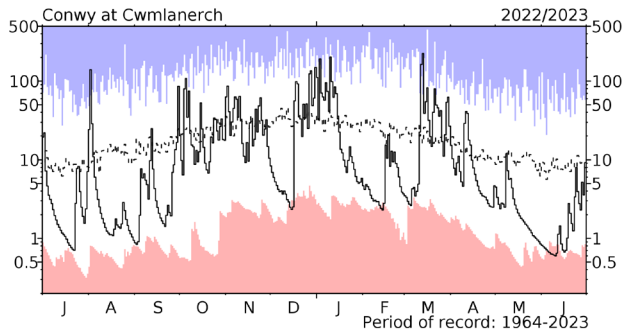
River flow hydrographs

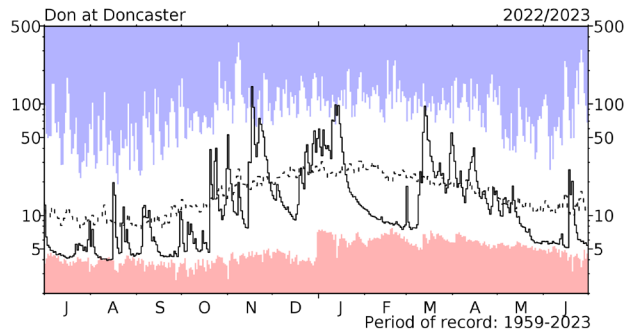
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to July 2022 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

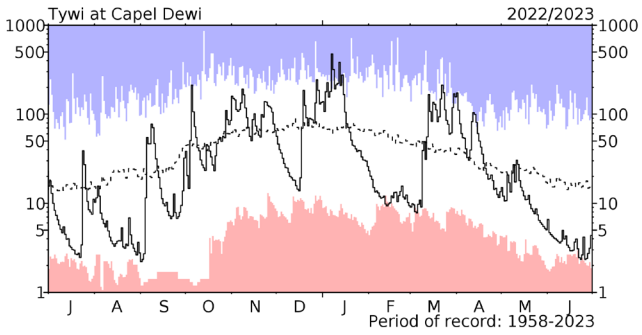
River flow . . . River flow . . .

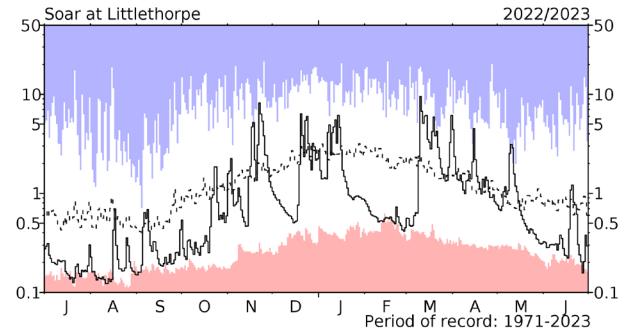


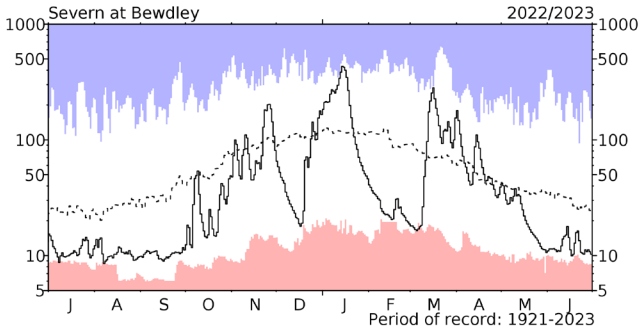


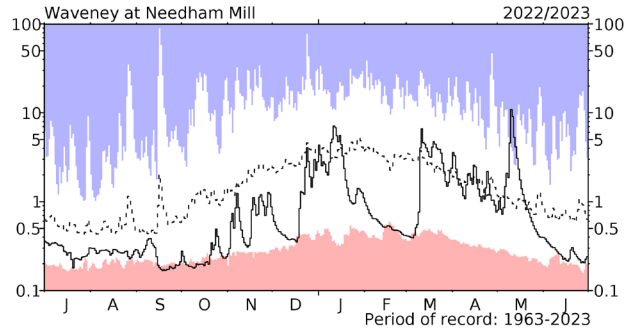


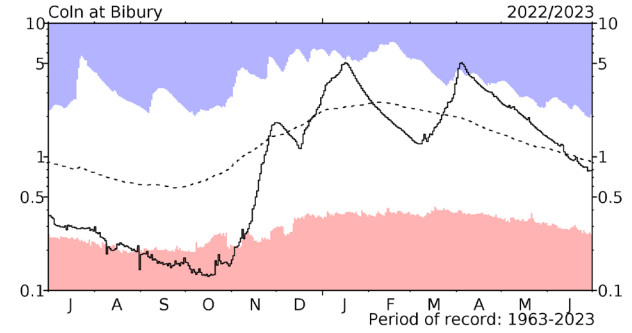


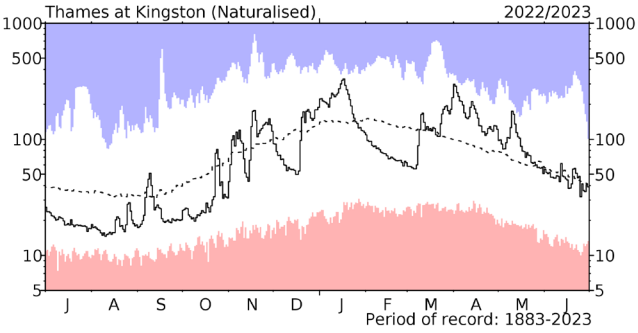


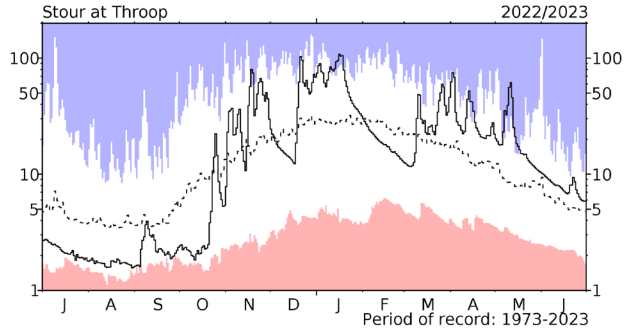


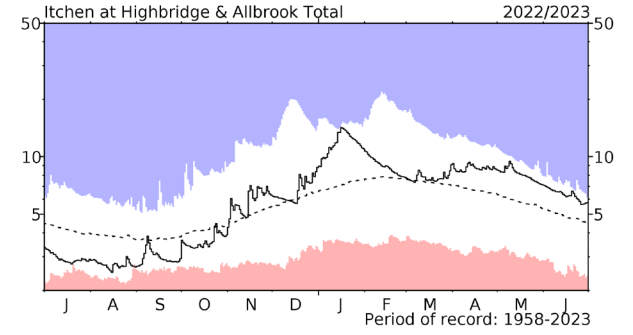




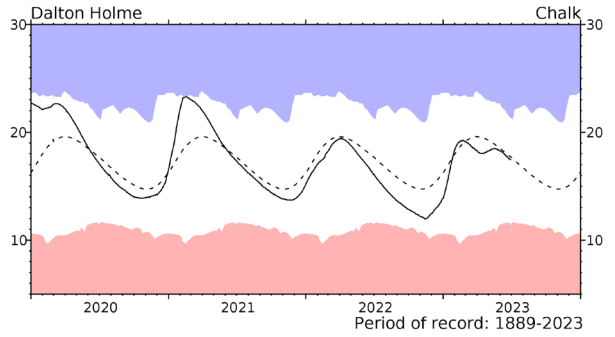


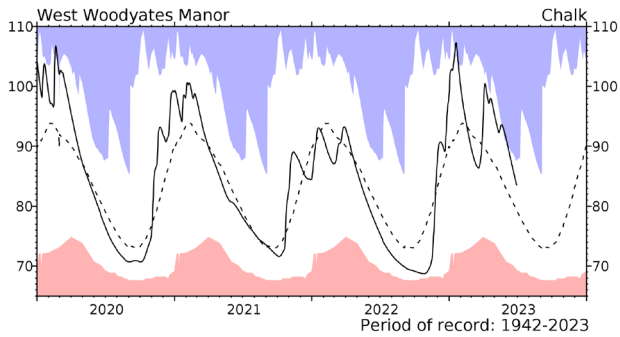


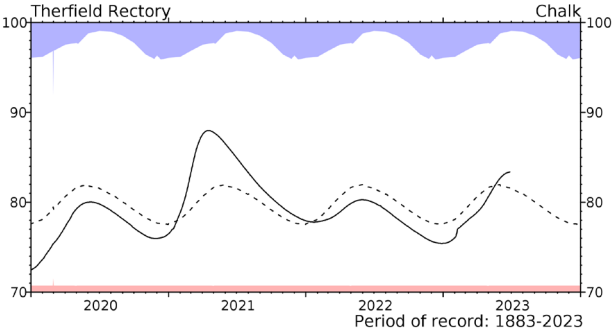


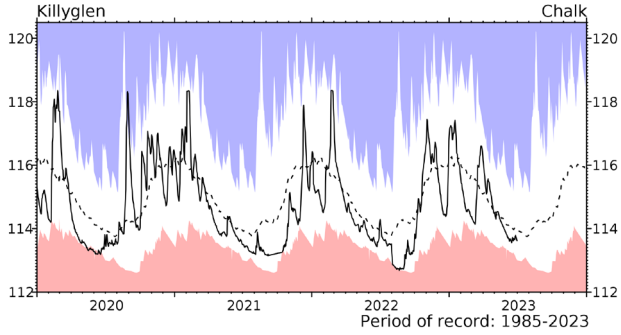


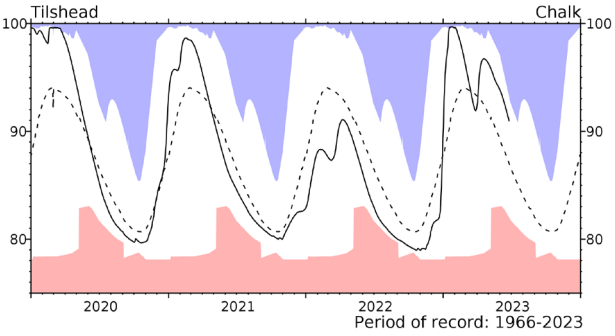
Groundwater…Groundwater

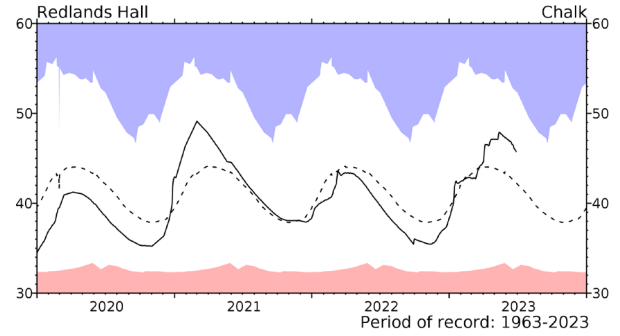


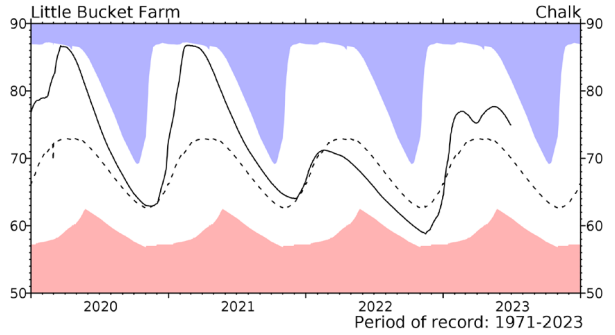


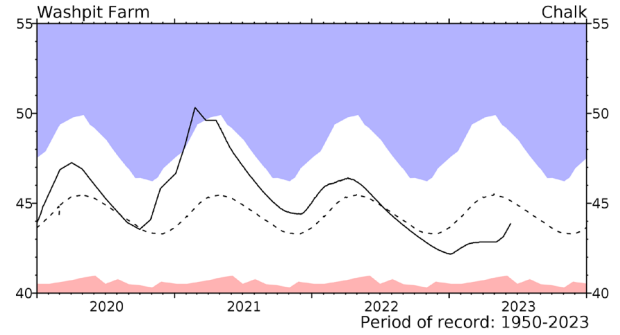


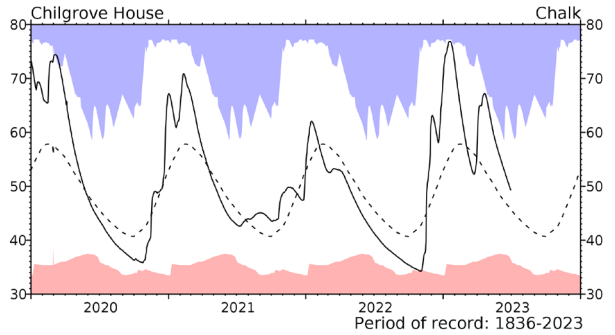


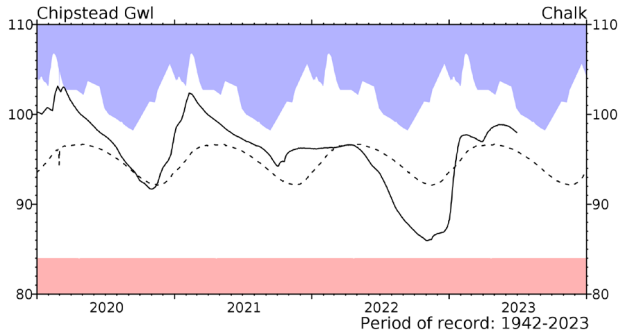






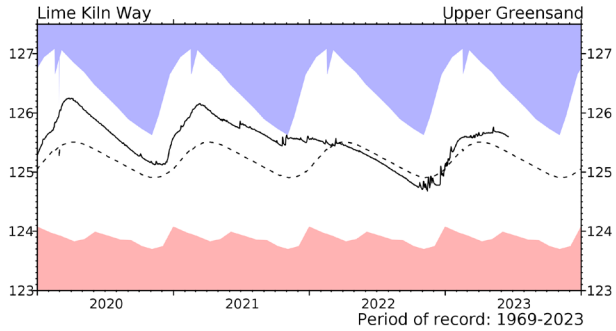


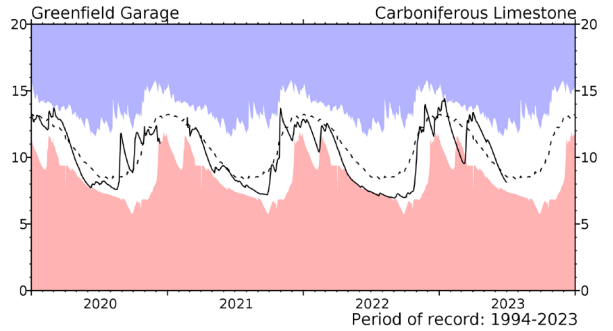


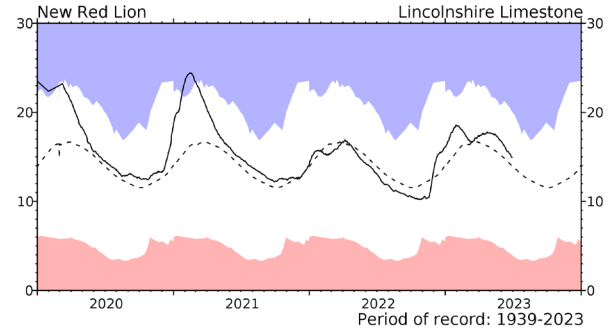


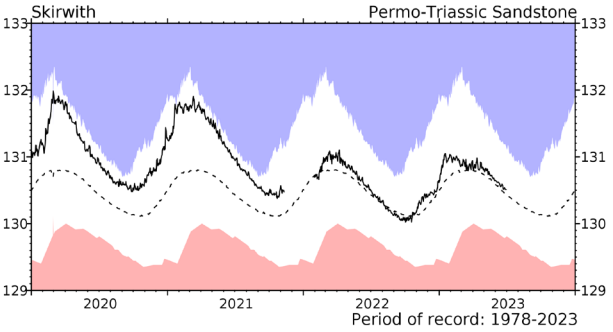
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

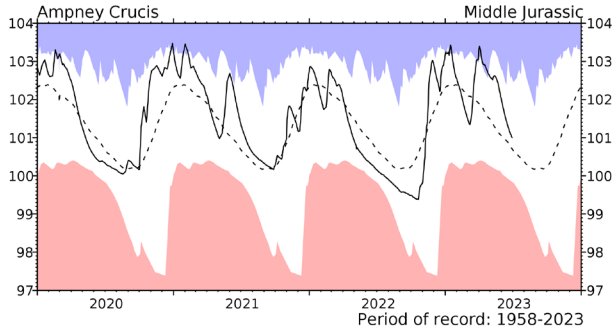
Groundwater… Groundwater

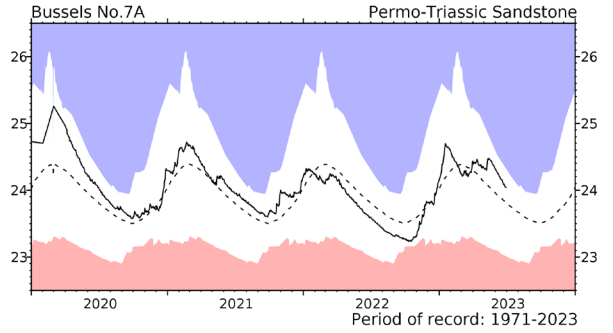


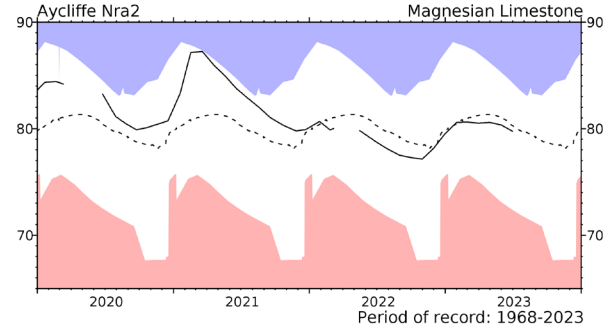


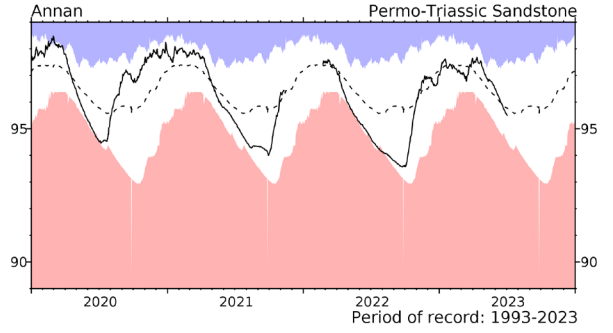


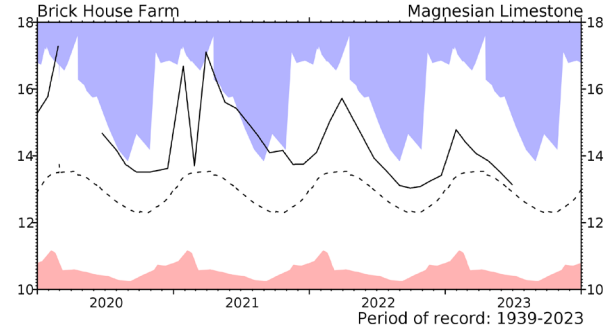


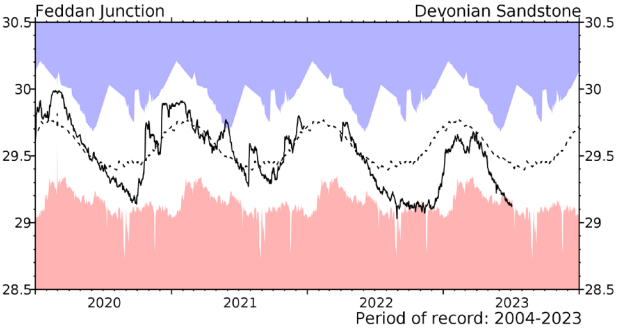


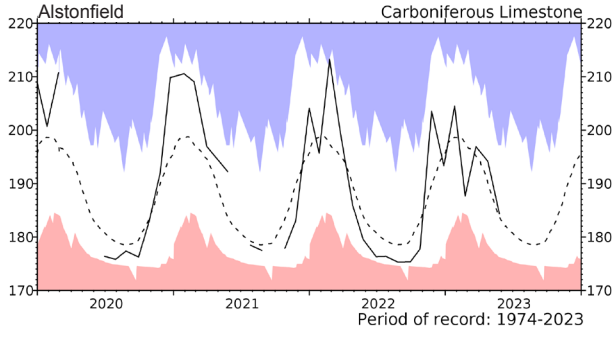


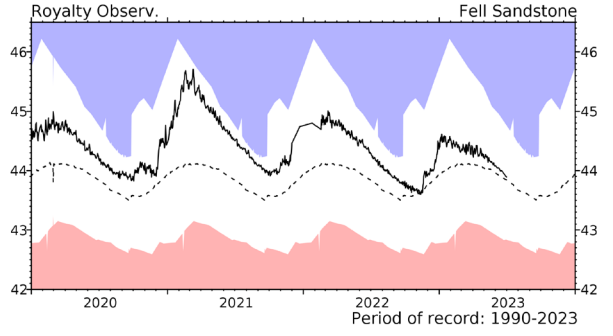










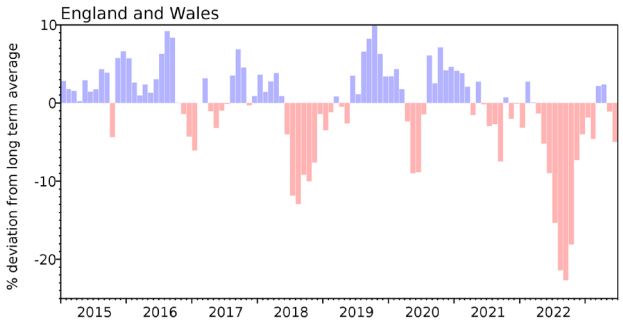


Groundwater levels - June 2023

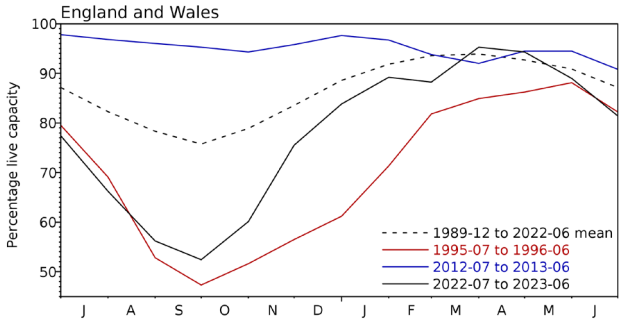
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Apr	2023 May	2023 Jun	Jun Anom.	Min Jun	Year* of min	2022 Jun	Diff 23-22
North West	N Command Zone	•	124929	94	80	63	-8	38	1984	63	0
	Vyrnwy		55146	100	92	89	6	58	1984	73	16
Northumbrian	Teesdale	•	87936	94	77	66	-13	58	1989	83	-17
	Kielder		(199175)	91	93	89	-1	71	1989	88	0
Severn-Trent	Clywedog		49936	99	99	85	-7	32	1976	85	1
	Derwent Valley	•	46692	97	67	70	-9	53	1996	59	11
Yorkshire	Washburn	•	23373	98	93	76	-4	63	1995	68	9
	Bradford Supply	•	40942	92	84	66	-12	54	1995	61	5
Anglian	Grafham		(55490)	87	94	94	2	70	1997	91	4
	Rutland		(116580)	96	93	91	1	75	1997	90	0
Thames	London	•	202828	97	97	95	3	85	1990	91	4
	Farmoor	•	13822	95	99	98	1	92	2022	92	6
Southern	Bewl		31000	99	98	92	9	52	1990	72	20
	Ardingly		4685	100	100	91	-3	75	2022	75	16
Wessex	Clatworthy		5662	100	97	83	1	61	1995	71	12
	Bristol	•	(38666)	100	97	87	4	64	1990	73	14
South West	Colliford		28540	67	68	61	-21	51	1997	56	5
	Roadford		34500	69	68	62	-18	49	1996	74	-12
	Wimbleball		21320	100	96	84	-1	63	2011	64	20
	Stithians		4967	99	94	83	3	53	1990	61	21
Welsh	Celyn & Brenig	•	131155	92	85	76	-17	70	2020	75	2
	Brianne		62140	100	96	86	-5	68	2022	68	18
	Big Five	•	69762	99	88	74	-10	61	1989	67	7
	Elan Valley	•	99106	97	90	76	-11	65	2022	65	11
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	96	89	82	-5	54	1998	84	-2
	East Lothian	•	9317	100	100	91	-4	81	1992	90	1
Scotland(W)	Loch Katrine	•	110326	97	78	72	-9	55	2010	93	-21
	Daer		22494	84	73	62	-21	62	2023	77	-15
	Loch Thom		10721	96	83	70	-17	65	2021	84	-15
Northern Ireland	Total+	•	56800	97	93	80	-1	61	2008	79	1
	Silent Valley	•	20634	98	94	80	1	54	1995	76	4

( ) figures in parentheses relate to gross storage

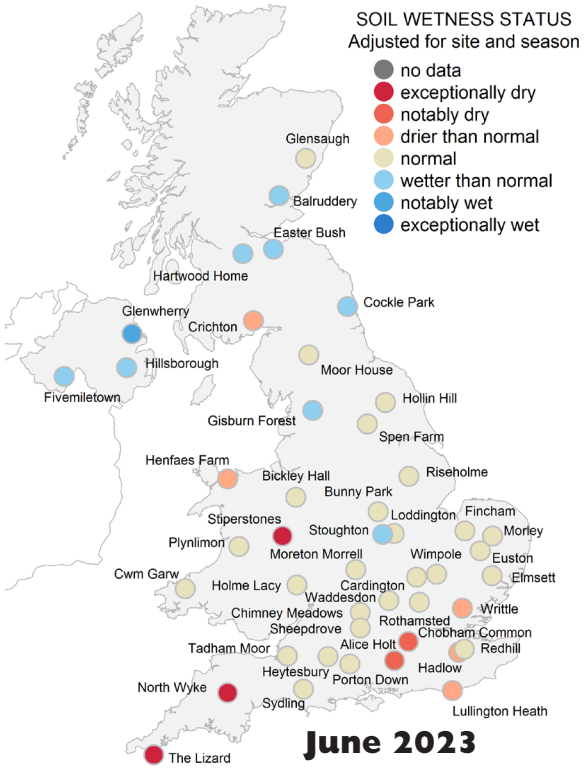
• denotes reservoir groups

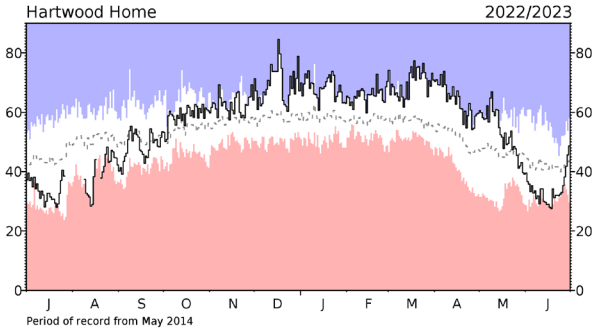
*last occurrence

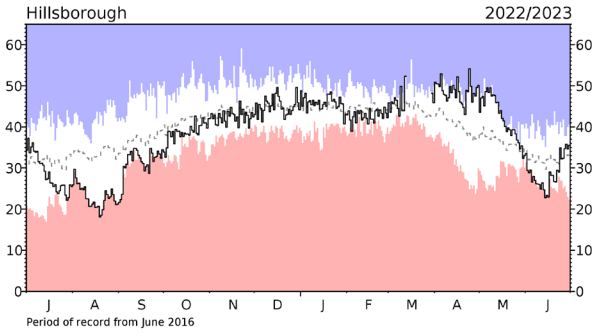
+ excludes Lough Neagh

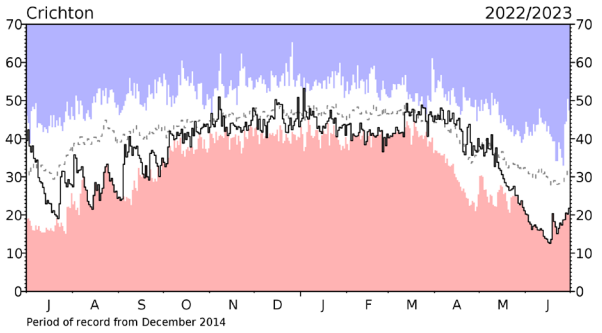
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed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

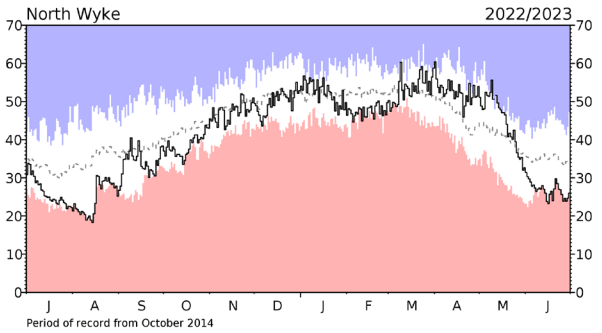
Soil Moisture . . . Soil Moisture

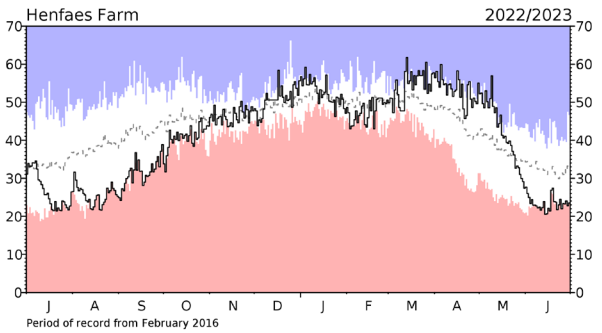












After a month of record high temperatures, the soil moisture index is below field capacity for the majority of sites across the UK, with particularly dry soils in the south of the country.

The lack of precipitation in early June led to very low soil moisture levels at most COSMOS-UK sites by the middle of the month. The second half of June gave a mixed picture, with increased rainfall raising soil moisture levels at some sites such as Hartwood Home in Scotland, Hillsborough in Northern Ireland, Euston in Eastern England, and Stoughton in the Midlands. At other sites, however, soil levels remained very dry through to the end of the month, particularly in Southern Scotland (e.g. Crichton and Sourhope), Southwest England (e.g. North Wyke) and Henfaes in Wales.

Overall, soil moisture levels tended to reach their lowest point of the year so far around the middle of June. Since then, moisture levels have either remained low or started to rise again following an increase in 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/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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