Hydrological Summary
for the United Kingdom

February 2023

General

February was a dry and mild month, with large swathes of England and Wales receiving less than a fifth of the average rainfall, and Scotland and Northern Ireland seeing their second and fourth warmest February, respectively, since records began (in 1884). River flow recessions that were established in mid-January continued throughout February, and below average flows were widespread, with exceptions where flows were sustained in the normal range by rainfall (Scotland and north-west England) or groundwater (southern England). Unseasonal soil moisture deficits developed across England and Wales, and groundwater levels fell in over two-thirds of index wells, with levels at most sites normal or below normal for the time of year. Reservoir stocks fell, and whilst close to average overall in Scotland, Northern Ireland and the English Lowlands, Wales had its lowest February stocks since 1996. Whilst unsettled weather in March has rewetted soils, a return to dry conditions could lead to water resource pressures in the summer. Unseasonably sustained rainfall will be needed during the coming months in those areas where reservoir stocks or groundwater resources are depleted following the dry winter and drought status persists (South West England and East Anglia).

Rainfall

Although February began changeable in the north (there were gales on the 1st in northern Scotland and rain in the north and west on the 2nd), high pressure brought dry conditions elsewhere and for much of the first fortnight. Westerly airflows from 8th-10th delivered bands of frontal rain, again affecting the north and west, but elsewhere high pressure dominated. The mild airflows became more unsettled from the 15th, with blustery conditions and outbreaks of rain which intensified into storm 'Otto' on 16th-17th. Strong winds caused power outages and travel disruption in northern and eastern Scotland and north-east England leaving 26,000 homes without power and closing over 100 schools. Thereafter, anticyclonic conditions returned (with clear skies that facilitated widespread sightings of the Aurora Borealis as far south as Wiltshire on the 26th), interspersed with northerly airflows that brought temperatures closer to average, and some showers and longer outbreaks of rain that were wintry at times in the north. With only brief unsettled spells and no notable daily totals, February rainfall was just 45% of average for the UK as a whole. North-west Scotland received average rainfall, but elsewhere there were widespread deficits, with most of the country receiving less than half of the usual rainfall. Thames and Southern regions, with just 12% of their respective averages, both registered their driest February since 1959. Despite wet conditions in January, total winter rainfall (December-February) was below average across much of the UK (Anglian and Severn Trent regions both had their driest winter since 2004-2005). Longer-term rainfall deficits over 12 months were similarly greatest in central and eastern England (the driest over this period since 2011-2012 for Yorkshire, Severn Trent and Anglian).

River Flows

February saw sustained flow recessions in many rivers across the country, that started from near-average flows in Scotland and Northern Ireland, and below average in England and Wales. On some rivers in Northern Ireland, England and Wales, flows approached or eclipsed daily minima, some for prolonged periods. For example, the Teifi (1st-17th, in a series from 1959), the Lagan (from 7th-28th, in a series from 1972), and notably by mid-month, large rivers with records of 65 years or more (the Severn, from 13th-16th, and the Trent, from 13th-22nd). Responses to rainfall associated with storm 'Otto' took flows briefly above average in the north and west, and thereafter, except in parts of Scotland where the unsettled conditions continued, flows receded again. Accordingly, February average flows were in the normal range or above normal in the north of Scotland, and below normal elsewhere, notably or exceptionally so in Northern Ireland, the Midlands, Wales (where many rivers recorded around a third of their average monthly flow) and the south-west. New monthly minima were recorded on the Annacloy (in a series from 1979), and the Trent, Erch and Warleggan (all in series of 50 years or more). The large footprint of the low flows took outflows in England close to daily minima at month-end, and in Wales, below daily minima for three days (12th-15th), resulting in February outflows for Wales that were the lowest on record (in a series from 1961). Winter flows (December-February) were widely in the normal range, although below normal in Northern Ireland and parts of the Midlands, and above normal in southern coastal areas.

Soil Moisture and Groundwater

Soil moisture was generally in the normal range for COSMOS-UK sites in Scotland, Northern Ireland and northern England, but was below normal in most parts of southern England. Groundwater levels were falling in the majority of Chalk sites at the end of February, which could mean an early end to the recharge season unless significant rain occurs in the coming months. The southern Chalk moved from being predominantly above normal last month to being mainly in the normal range in February. Levels rose in the eastern Chilterns, Cambridgeshire Chalk and in East Anglia, but remained below normal in East Anglia with notably low levels at Frying Pan Lodge and Dial Farm. Levels fell to below normal at Killyglen. In the Jurassic limestones and Magnesian Limestone levels fell, except at Aycliffe. In the Carboniferous Limestone, levels fell at all sites, and a record February minimum was recorded at Greenfield Garage. Levels remained in the normal range at Pant y Lladron, but were below normal at Alstonfield. Levels fell at most sites in the Permo-Triassic Sandstones, moving into the normal or below normal range. In the Upper Greensand at Lime Kiln Way the groundwater level rose slightly and remained in the normal range. Groundwater levels fell across the Devonian and Carboniferous sandstones, becoming below normal at Feddan Junction but remaining in the normal range elsewhere.

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

Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Percentages are from the 1991-2020 average.

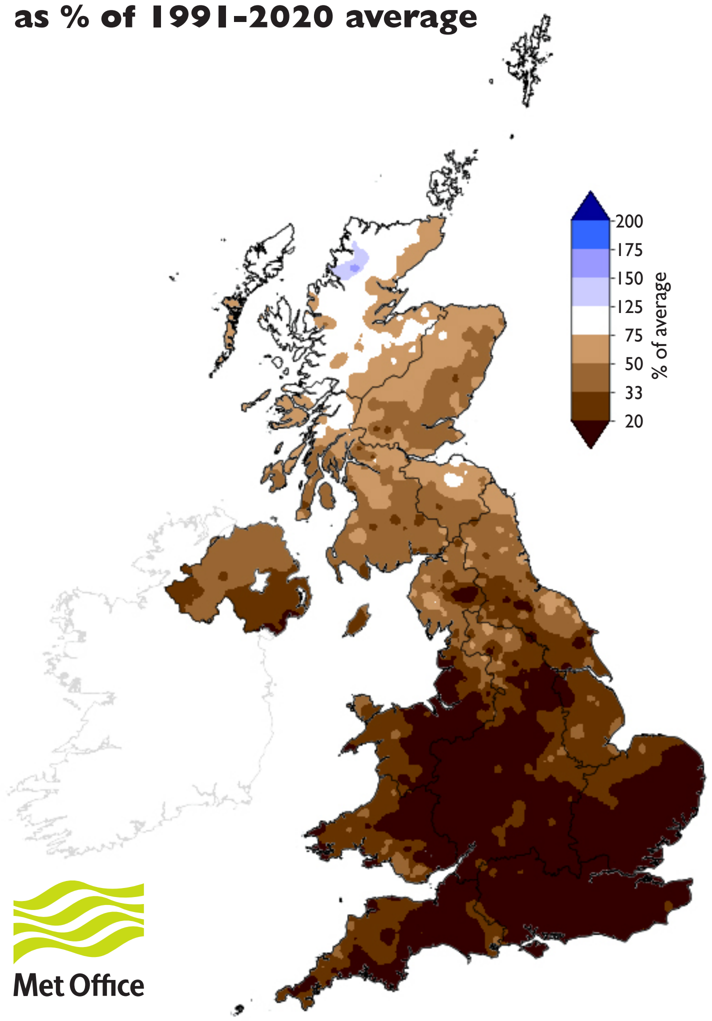
Region	Rainfall	Feb 2023	Jan23 – Feb23	RP	Dec22 – Feb23	RP	Sep22 – Feb23	RP	Mar22 – Feb23	RP
United	mm	**43**	169		280		683		1013	
Kingdom	%	**45**	78	2-5	82	2-5	101	2-5	87	2-5
England	mm	**15**	106		195		504		724	
	%	**23**	71	5-10	81	2-5	103	2-5	84	5-10
Scotland	mm	**97**	269		405		935		1441	
	%	**69**	84	2-5	82	2-5	99	2-5	91	2-5
Wales	mm	**26**	221		386		875		1200	
	%	**22**	80	2-5	86	2-5	100	2-5	83	5-10
Northern	mm	**31**	127		216		649		1034	
Ireland	%	**34**	61	10-15	66	10-20	100	2-5	90	2-5
England &	mm	**17**	122		221		555		789	
Wales	%	**23**	73	2-5	83	2-5	102	2-5	84	5-10
North West	mm	**36**	199		330		758		1123	
	%	**34**	86	2-5	88	2-5	101	2-5	88	2-5
Northumbria	mm	**29**	100		190		486		742	
	%	**41**	65	5-10	77	2-5	97	2-5	82	5-10
Severn-Trent	mm	**10**	82		147		417		624	
	%	**17**	63	5-10	70	5-10	96	2-5	78	10-20
Yorkshire	mm	**22**	103		186		461		690	
	%	**32**	70	5-10	79	2-5	96	2-5	80	10-15
Anglian	mm	**8**	53		101		304		462	
	%	**18**	55	10-20	67	5-10	92	2-5	74	20-30
Thames	mm	**7**	82		158		436		614	
	%	**12**	66	2-5	80	2-5	107	2-5	85	5-10
Southern	mm	**7**	112		228		607		783	
	%	**12**	74	2-5	94	2-5	123	5-10	96	2-5
Wessex	mm	**11**	129		243		599		813	
	%	**16**	79	2-5	93	2-5	113	2-5	90	2-5
South West	mm	**22**	192		358		837		1114	
	%	**21**	78	2-5	91	2-5	110	2-5	89	2-5
Welsh	mm	**25**	208		367		846		1163	
	%	**22**	79	2-5	86	2-5	101	2-5	83	5-10
Highland	mm	**154**	362		505		1049		1664	
	%	**87**	91	2-5	83	2-5	92	2-5	89	2-5
North East	mm	**48**	144		241		629		996	
	%	**61**	80	2-5	86	2-5	105	2-5	94	2-5
Tay	mm	**61**	194		316		878		1332	
	%	**51**	68	2-5	73	2-5	106	5-10	96	2-5
Forth	mm	**59**	177		309		744		1101	
	%	**54**	72	2-5	82	2-5	103	5-10	89	2-5
Tweed	mm	**43**	137		262		648		941	
	%	**48**	70	2-5	84	2-5	105	5-10	87	2-5
Solway	mm	**53**	242		397		1004		1472	
	%	**40**	80	2-5	83	2-5	107	5-10	94	2-5
Clyde	mm	**102**	322		475		1112		1707	
	%	**59**	83	2-5	79	2-5	97	2-5	90	2-5

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

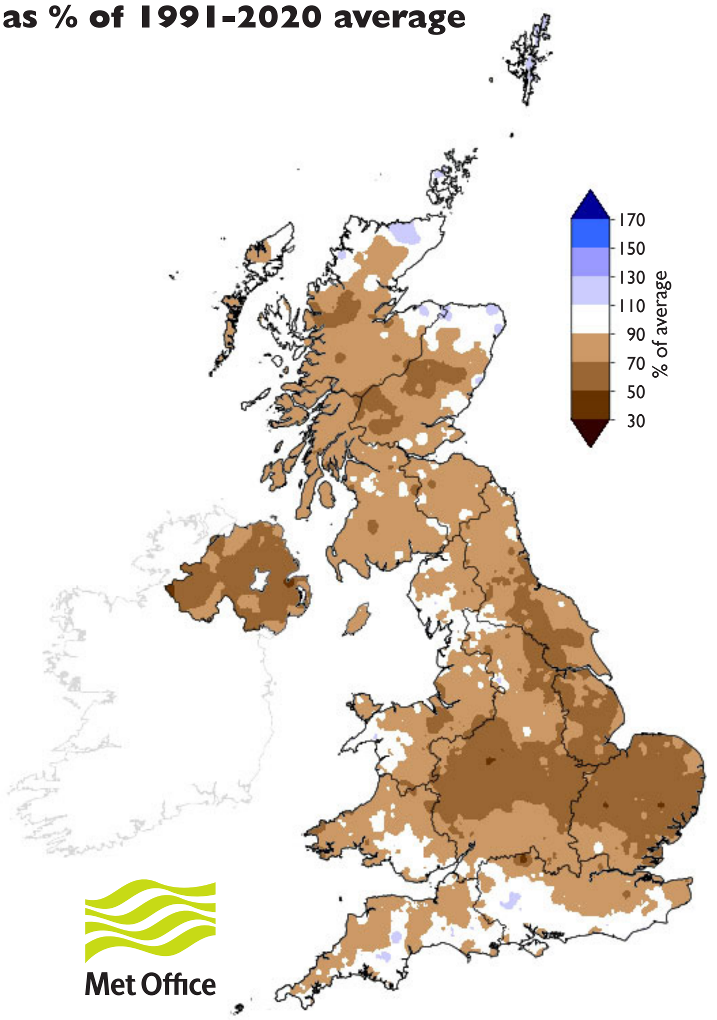
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability 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 2022 are provisional. Source: Data from HadUK-Grid dataset at 1km resolution v1.1.0.0.

Rainfall . . . Rainfall . . .

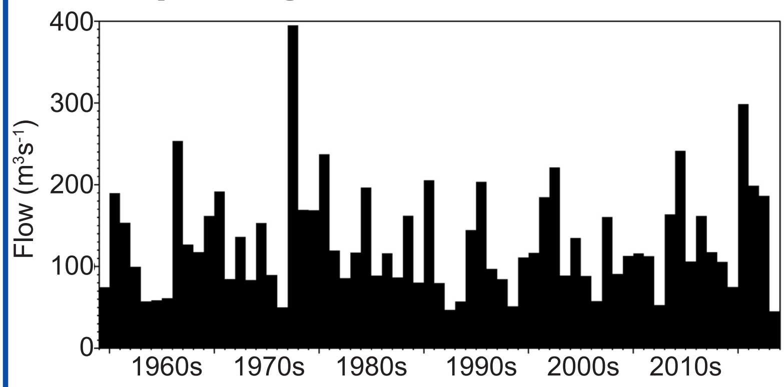
February 2023 rainfall as % of 1991-2020 average



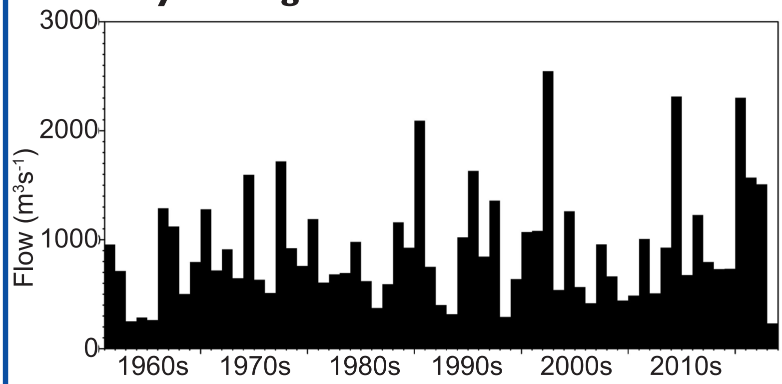
December 2022 - February 2023 rainfall as % of 1991-2020 average



February average river flows on the Trent



February average outflows for Wales



UK Hydrological Outlook

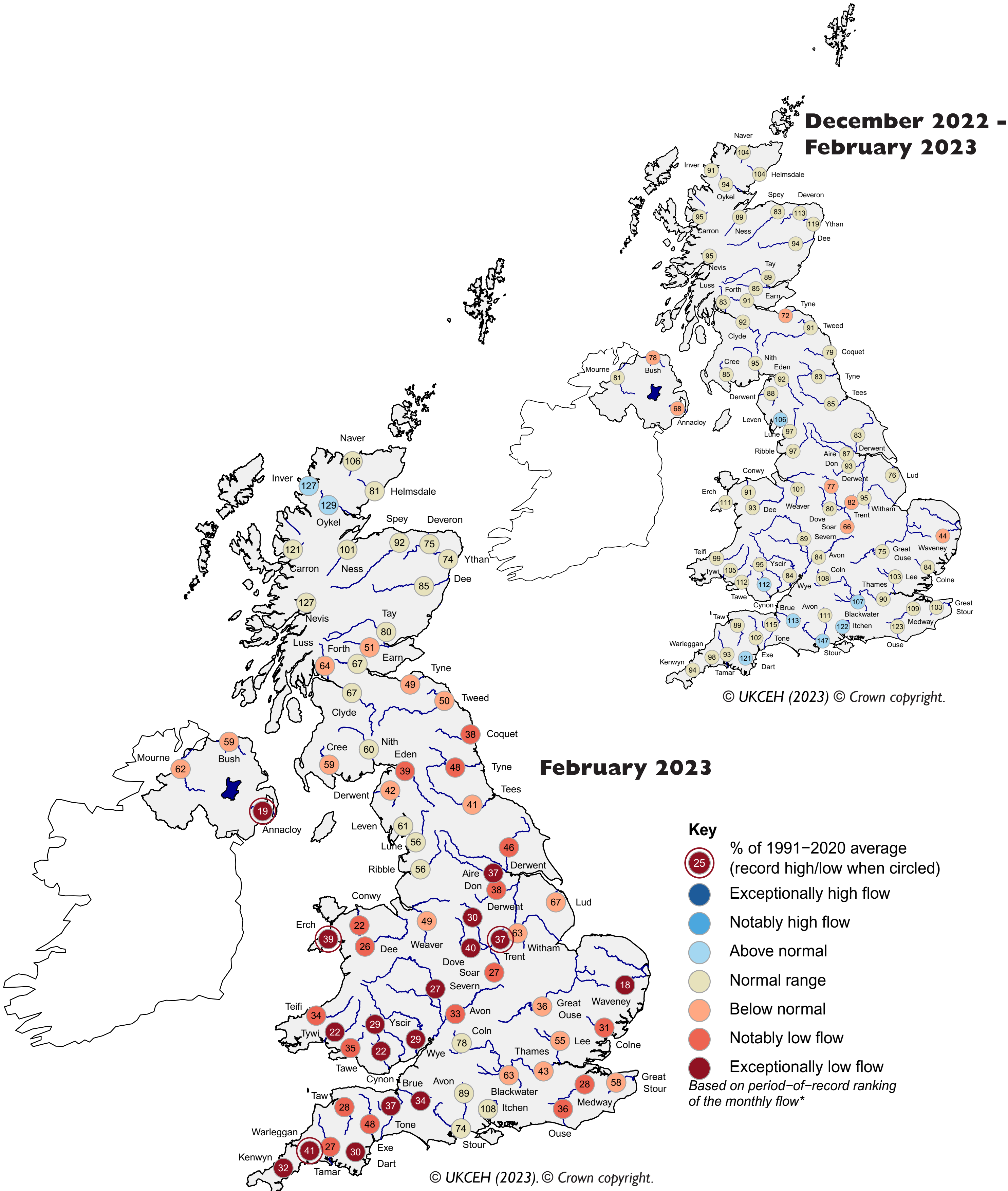
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from March 2023**
Issued: **08.03.2023**
using data to the end of February 2023

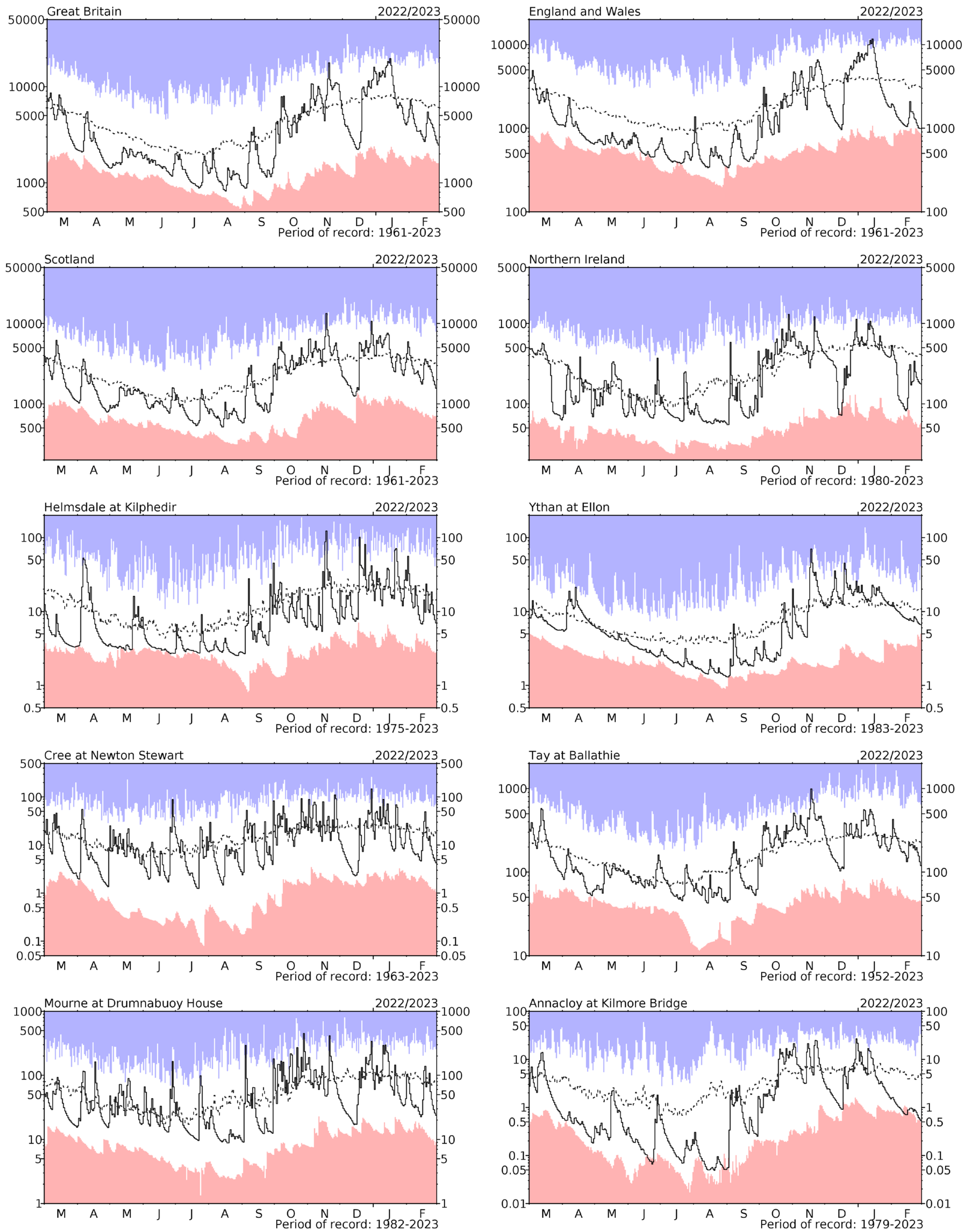
The Outlook for March and for March-April-May as a whole is for river flows and groundwater levels to be normal to below normal across the UK. Notably low river flows and groundwater levels may persist across large parts of central and southern England. Above normal groundwater levels are likely in some parts of the Chalk and Permo-Triassic sandstones.

River flow . . . River flow . . .



River flows

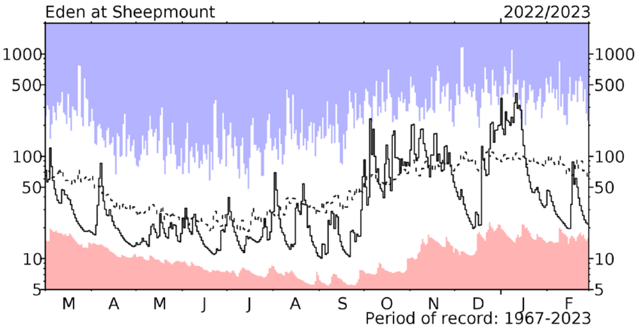
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

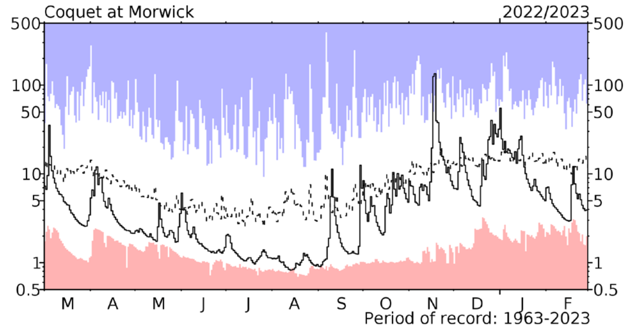


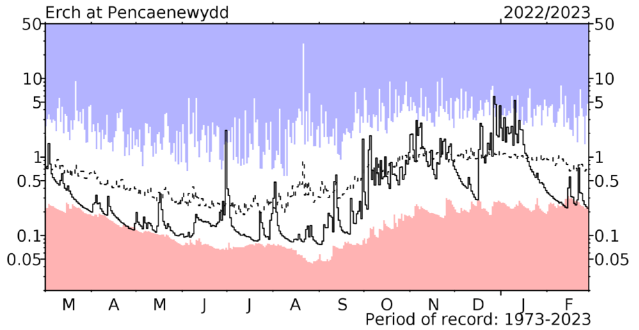
River flow hydrographs

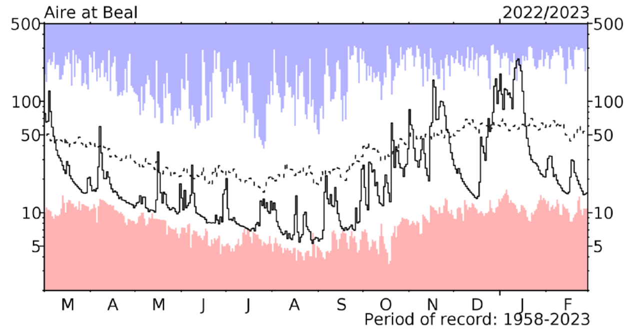
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to March 2022 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

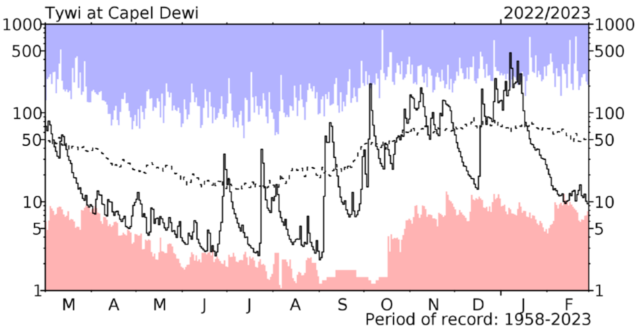
River flow . . . River flow . . .

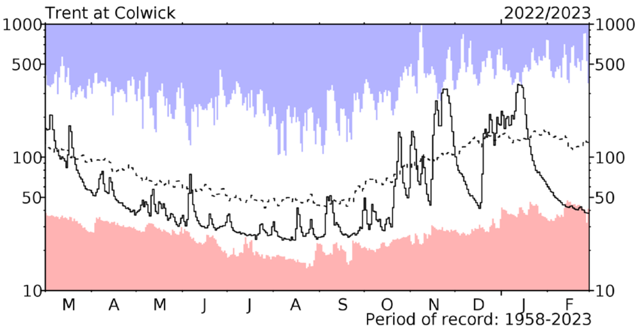


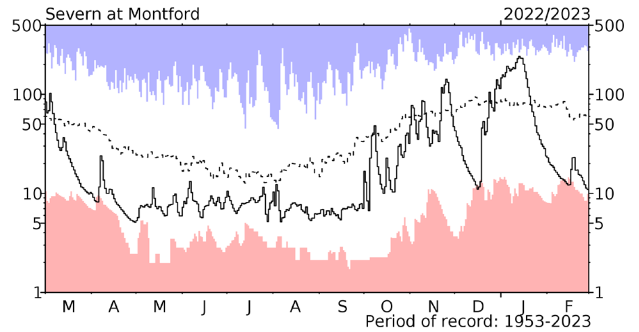


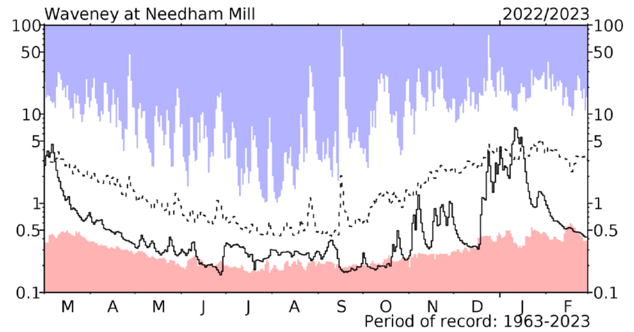


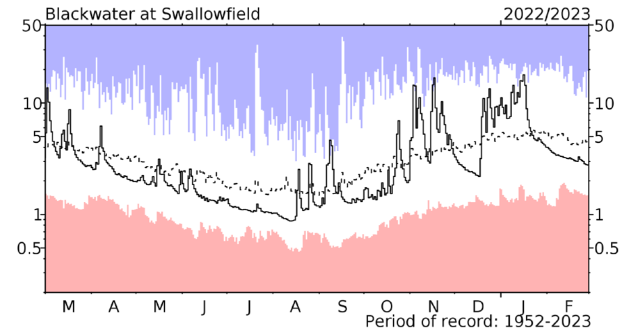


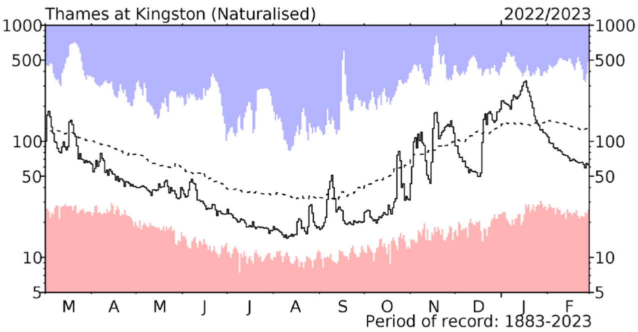


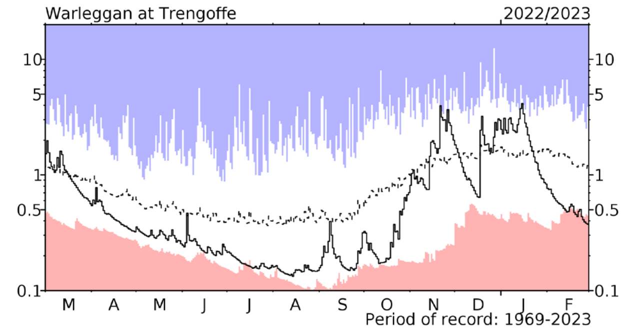


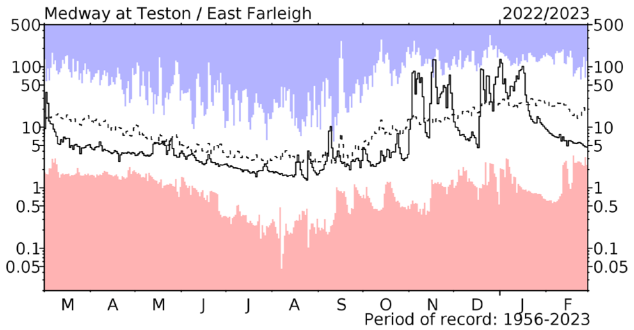




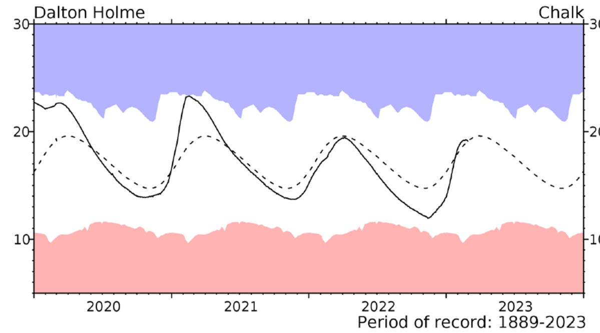


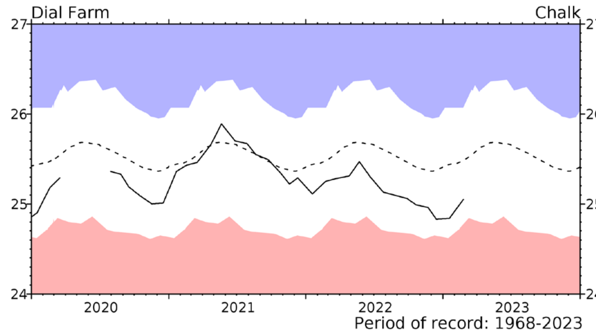


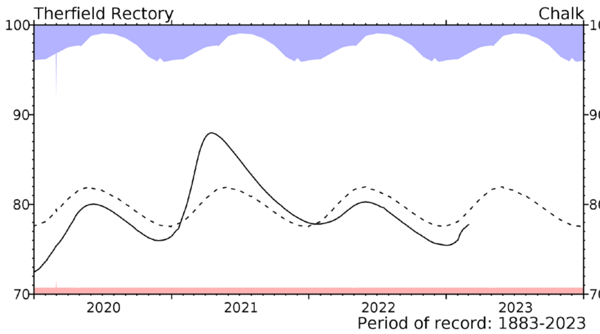


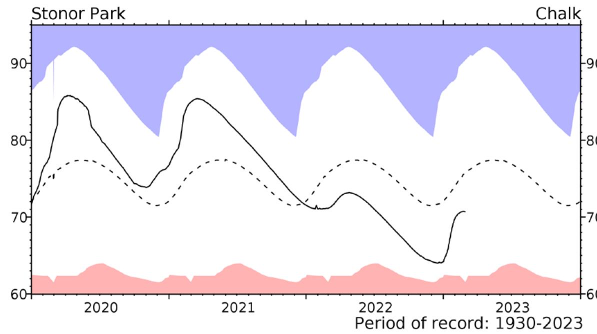


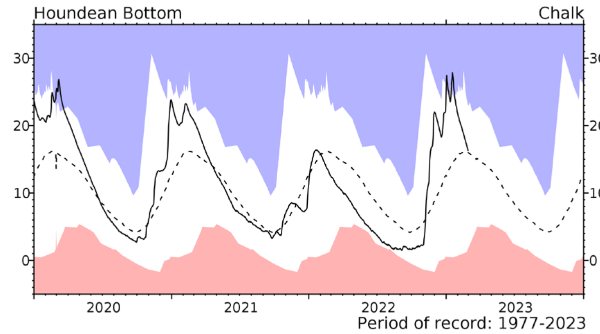
Groundwater . . . Groundwater

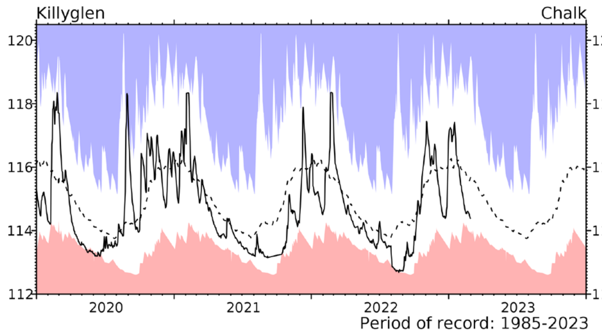


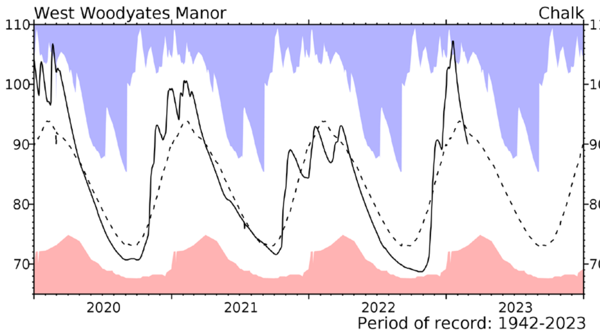


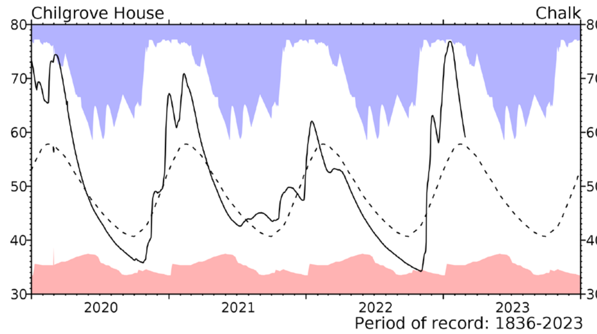


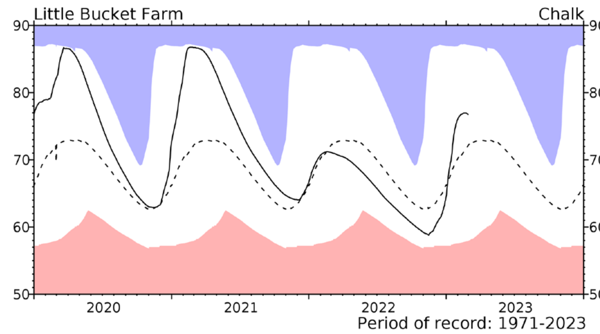


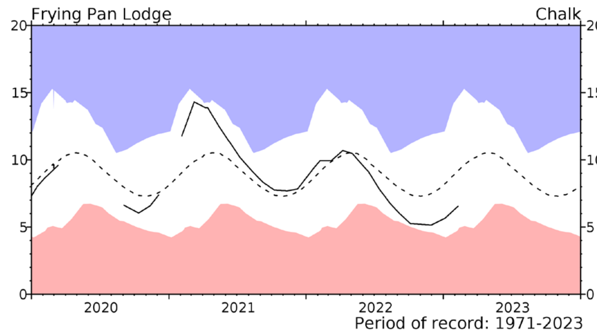




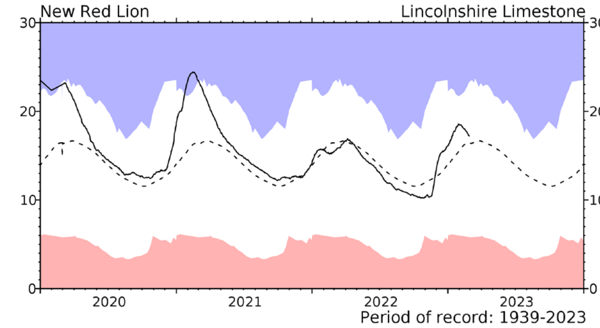


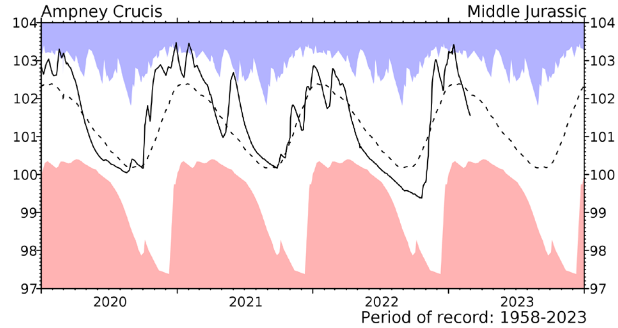


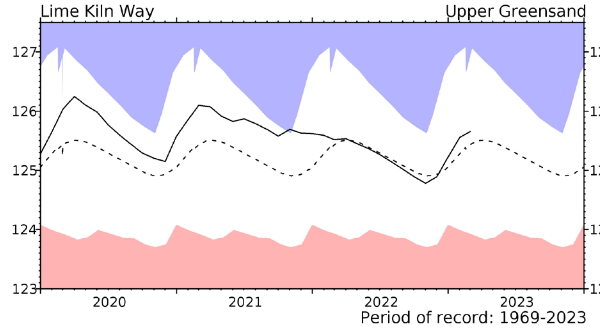


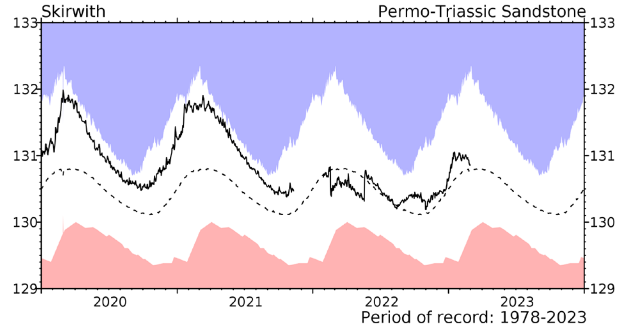


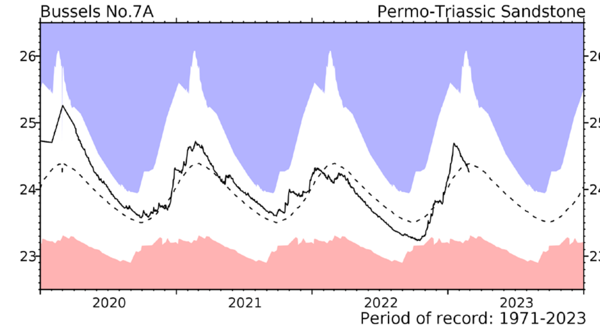
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

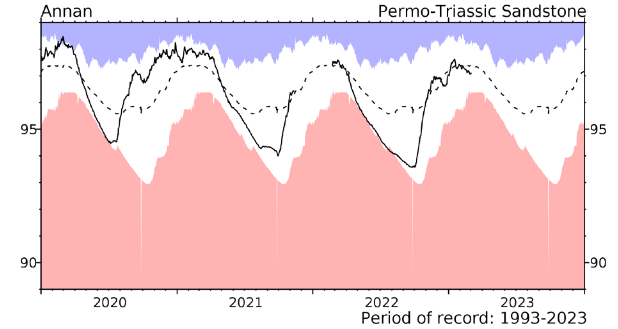

New Red Lion
Lincolnshire Limestone
2020
2021
2022
2023
Period of record: 1939-2023

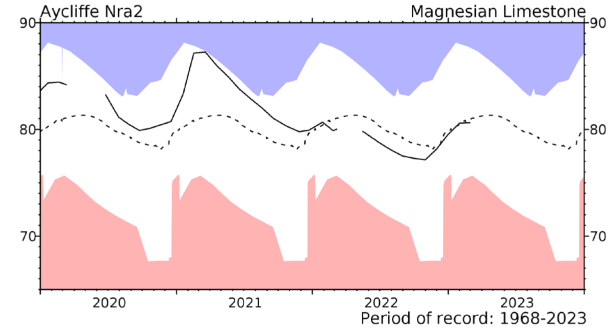

Ampney Crucis
Middle Jurassic
2020
2021
2022
2023
Period of record: 1958-2023

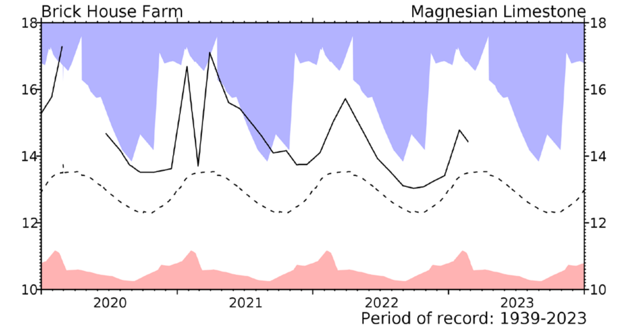

Lime Kiln Way
Upper Greensand
2020
2021
2022
2023
Period of record: 1969-2023

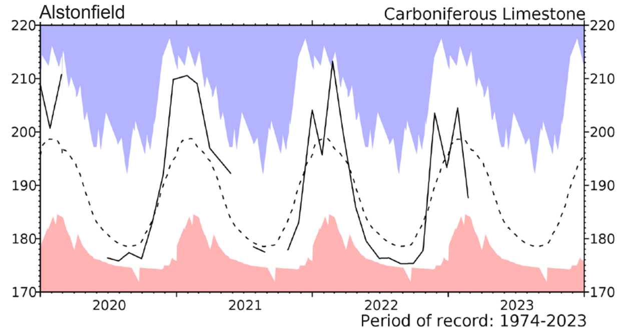

Skirwith
Permo-Triassic Sandstone
2020
2021
2022
2023
Period of record: 1978-2023

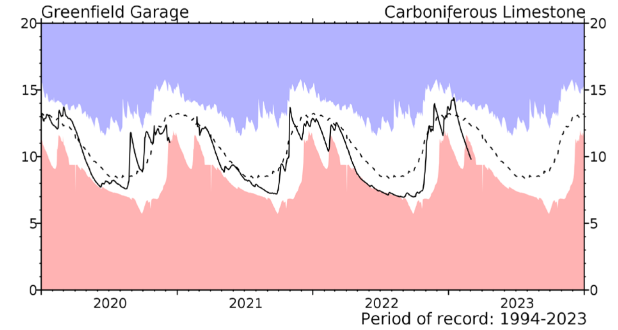

Bussels No.7A
Permo-Triassic Sandstone
2020
2021
2022
2023
Period of record: 1971-2023

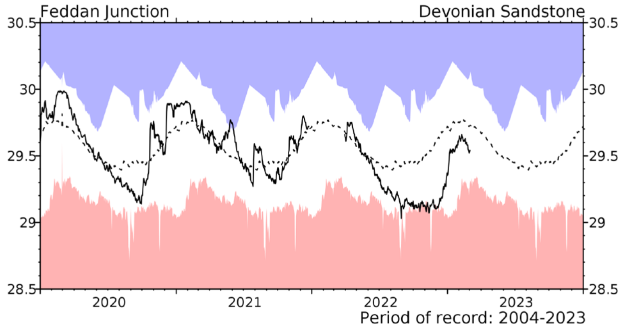

Annan
Permo-Triassic Sandstone
2020
2021
2022
2023
Period of record: 1993-2023

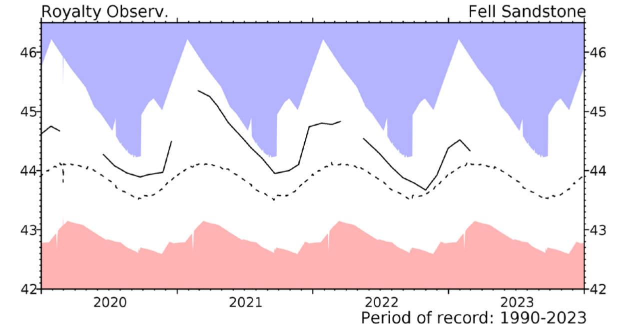

Aycliffe Nra2
Magnesian Limestone
2020
2021
2022
2023
Period of record: 1968-2023


Brick House Farm
Magnesian Limestone
2020
2021
2022
2023
Period of record: 1939-2023


Alstonfield
Carboniferous Limestone
2020
2021
2022
2023
Period of record: 1974-2023


Greenfield Garage
Carboniferous Limestone
2020
2021
2022
2023
Period of record: 1994-2023


Feddan Junction
Devonian Sandstone
2020
2021
2022
2023
Period of record: 2004-2023

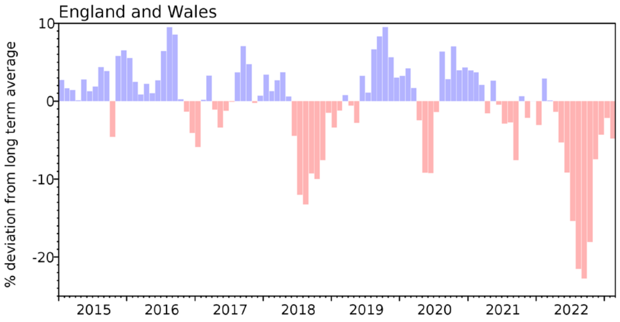

Royalty Observ.
Fell Sandstone
2020
2021
2022
2023
Period of record: 1990-2023

Groundwater levels - February 2023

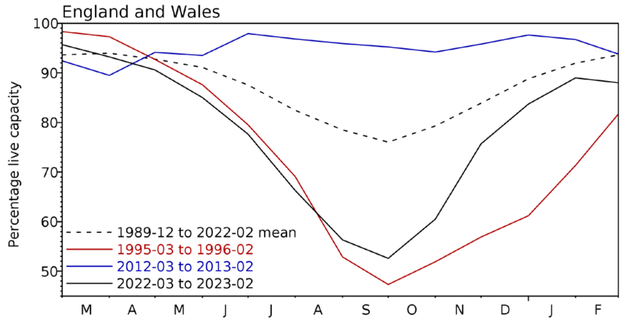
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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)	2022 Dec	2023 Jan	2023 Feb	Feb Anom.	Min Feb	Year* of min	2022 Feb	Diff 23-22
North West	N Command Zone	•	124929	82	95	88	-5	78	1996	99	-11
	Vyrnwy		55146	88	100	86	-10	59	1996	99	-14
Northumbrian	Teesdale	•	87936	89	92	87	-5	72	1996	100	-12
	Kielder		(199175)	92	90	90	-4	81	1993	96	-6
Severn-Trent	Clywedog		49936	86	87	89	-3	77	1996	92	-3
	Derwent Valley	•	46692	85	93	89	-7	46	1996	100	-11
Yorkshire	Washburn	•	23373	94	97	95	2	53	1996	96	-1
	Bradford Supply	•	40942	75	87	83	-12	53	1996	100	-17
Anglian	Grafham		(55490)	67	75	80	-8	72	1997	93	-13
	Rutland		(116580)	87	96	96	7	71	2012	90	6
Thames	London	•	202828	82	87	93	0	83	1988	96	-3
	Farmoor	•	13822	97	96	99	6	64	1991	87	12
Southern	Bewl		31000	78	96	96	10	40	2012	82	14
	Ardingly		4685	100	100	100	4	46	2012	100	0
Wessex	Clatworthy		5662	100	100	92	-6	82	1992	100	-8
	Bristol+	•									
South West	Colliford		28540	35	47	49	-38	49	2023	77	-28
	Roadford		34500	51	61	58	-27	35	1996	100	-42
	Wimbleball		21320	69	100	97	2	72	1996	100	-3
	Stithians		4967	61	91	92	-2	45	1992	91	1
Welsh	Celyn & Brenig	•	131155	76	78	79	-19	69	1996	92	-13
	Brianne		62140	100	92	89	-9	89	2023	99	-10
	Big Five	•	69762	88	94	93	-3	85	1988	100	-7
	Elan Valley	•	99106	95	96	93	-5	88	1993	100	-7
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	99	98	98	2	73	1999	97	1
	East Lothian	•	9317	100	100	100	1	91	1990	100	0
Scotland(W)	Loch Katrine	•	110326	100	96	98	3	76	2010	100	-2
	Daer		22494	94	90	88	-11	88	2023	97	-9
	Loch Thom		10721	97	100	99	0	90	2004	100	-1
Northern Ireland	Total++	•	56800	95	96	92	0	81	2004	88	4
	Silent Valley	•	20634	100	99	89	0	57	2002	99	-10

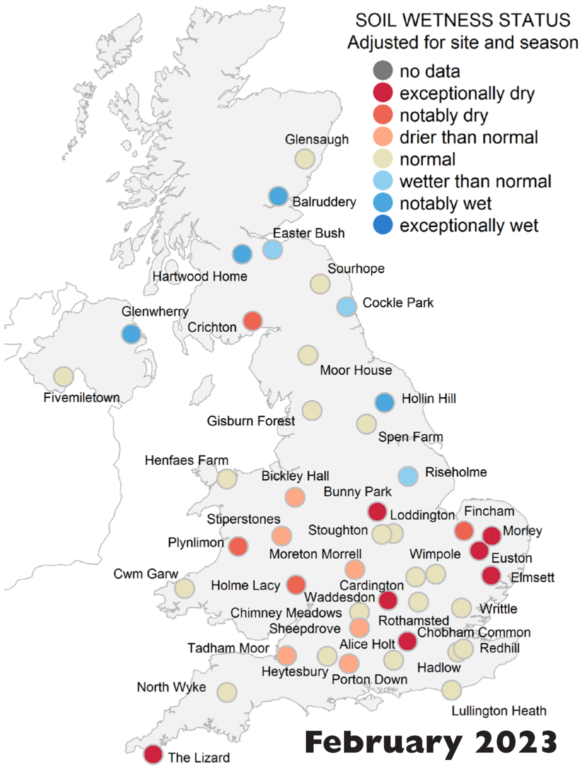
( ) figures in parentheses relate to gross storage • denotes reservoir groups *last occurrence

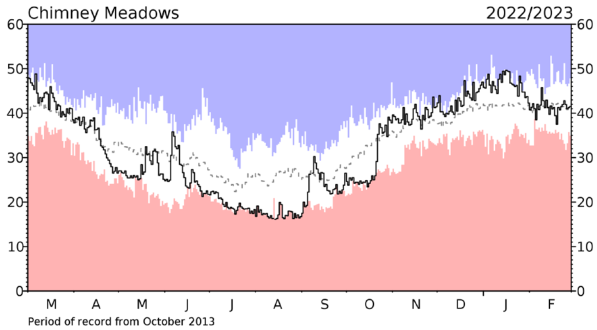
+ no data are available for Bristol

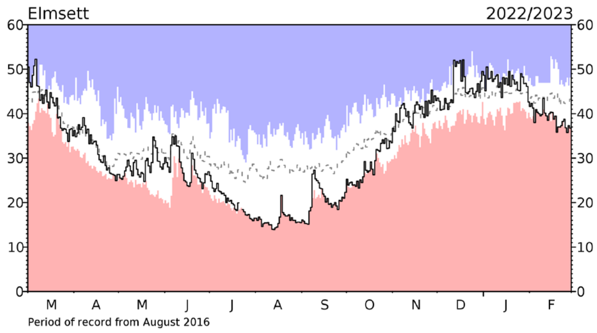
++ excludes Lough Neagh

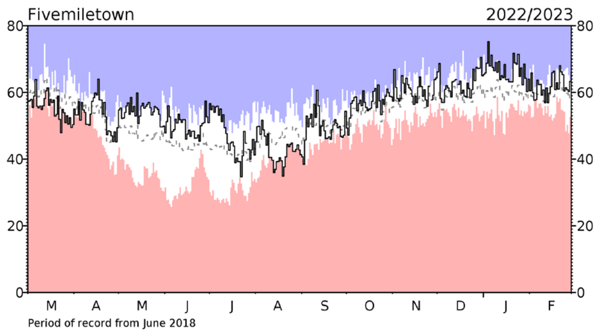
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed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

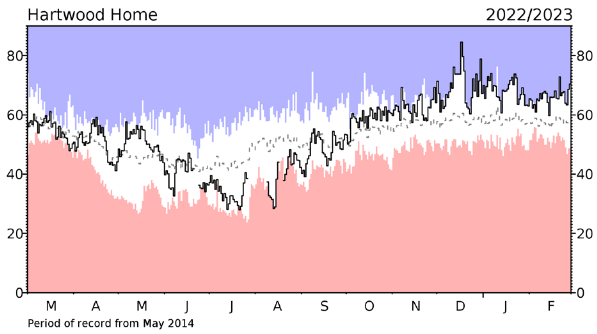
Soil Moisture . . . Soil Moisture

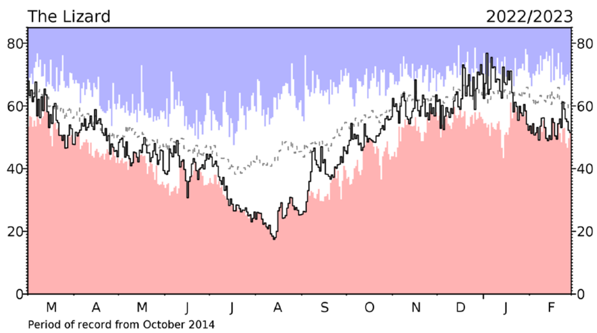












February was a very dry month across much of the UK, with many COSMOS-UK sites seeing a drop in soil moisture from the previous month.

The specific soil moisture conditions at each site generally reflected the regional precipitation status, with low soil moisture levels in regions that received below average precipitation during the month. Sites in northern England and Scotland were generally within or above their normal range. Sites in Wales, eastern and southern England were drier, for example The Lizard and Elmsett experienced very dry conditions. Despite below average precipitation, some sites across central England and Northern Ireland maintained soil moisture in their normal range, for example Chimney Meadows and Fivemiletown.

Soil moisture data

These data are from UKCEH's COSMOS-UK network. The time series graphs show volumetric water content as a percentage in black together with the maximum and minimum daily values for the period-of-record of the sites. The dashed line represents the period-of-record mean VWC. For more information visit cosmos.ceh.ac.uk.

NHMP

The National Hydrological Monitoring Programme (NHMP) was started in 1988 and is undertaken jointly by the UK Centre for Ecology & Hydrology (UKCEH) and the British Geological Survey (BGS). The NHMP aims to provide an authoritative voice on hydrological conditions throughout the UK, to place them in a historical context and, over time, identify and interpret any emerging hydrological trends. Hydrological analysis and interpretation within the Programme is based on the data holdings of the National River Flow Archive (NRFA; maintained by UKCEH) and National Groundwater Level Archive (NGLA; maintained by BGS), including rainfall, river flows, borehole levels, and reservoir stocks.

The Hydrological Summary is supported by the Natural Environment Research Council award number NE/R016429/1 as part of the UK-SCAPE programme delivering National Capability.

Data Sources

The NHMP depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged. A location map of all sites used in the Hydrological Summary can be found on the NHMP website. River flow and groundwater level data are provided by the Environment Agency (EA), Natural Resources Wales - Cyfoeth Naturiol Cymru (NRW), the Scottish Environment Protection Agency (SEPA) and, for Northern Ireland, the Department for Infrastructure - Rivers and the Northern Ireland Environment Agency. In all cases the data are subject to revision following validation (high flow and low flow data in particular may be subject to significant revision).

Details of reservoir stocks are provided by the Water Service Companies, the EA, Scottish Water and Northern Ireland Water.

The Hydrological Summary and other NHMP outputs may also refer to and/or map soil moisture data for the UK. These data are provided by the Meteorological Office Rainfall and Evaporation Calculation System (MORECS). MORECS provides estimates of monthly soil moisture deficit in the form of averages over 40 x 40 km grid squares over Great Britain and Northern Ireland. The monthly time series of data extends back to 1961.

Rainfall data are provided by the Met Office. To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA, NRW and SEPA. The areal rainfall figures have been produced by the Met Office National Climate Information Centre (NCIC), and are based on the HadUK-Grid 1km resolution gridded data from rain gauges. The majority of the full rain gauge network across the UK is operated by the EA, NRW, SEPA and Northern Ireland Water; supplementary rain gauges are operated by the Met Office. The Met Office NCIC monthly rainfall series extend back to 1836 and form the official source of UK areal rainfall statistics which have been adopted by the NHMP. The gridding technique used is described in Hollis, 2019 available at https://doi.org/10.1002/gdj3.78

Long-term averages are based on the period 1991-2020 and are derived from the monthly areal series.

The regional figures for the current month in the hydrological summaries are based on a limited rain gauge network so these (and the associated return periods) should be regarded as a guide only.

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

Tel: 0370 900 0100
Email: enquiries@metoffice.gov.uk

Enquiries

Enquiries should be directed to the NHMP:

Tel: 01491 692599
Email: nhmp@ceh.ac.uk

A full catalogue of past Hydrological Summaries can be accessed and downloaded at:

http://nrfa.ceh.ac.uk/monthly-hydrological-summary-uk