Hydrological Summary

for the United Kingdom

April 2023

General

April was typical of the season with fine weather often interrupted by unsettled conditions, notably so mid-month. Rainfall for the UK was near average although this varied regionally with Scotland drier than average, and southern and eastern England notably wetter than average. River flows mirrored these rainfall gradients and for April as a whole, were notably low in northern Scotland, and above normal in southern and eastern areas, exceptionally so in some cases. As evaporation rates increase with the warmer weather, soil moisture levels began to fall, but remained above average for the time of year. Groundwater levels rose at about two thirds of sites, and relatively late recharge occurred at the majority of Chalk boreholes. Levels remained below normal in the Devonian sandstones and the Chalk of East Anglia. Reservoir stocks for England & Wales remained near-average for April, with most stocks slightly above average. Although stocks at Colliford and Roadford remained considerably below average, their recovery continued. Current outlooks suggest an increased likelihood of wetter than average conditions over coming months meaning that for most, the water resources situation is looking healthy. Caution is required however in areas where long-term deficits persist e.g. East Anglia and in localised areas of northern Scotland where concerns are heightened due to recent dry weather.

Rainfall

High- and low-pressure systems alternated throughout the month and the frontal systems that did affect the UK were most influential in southern and western areas. From the 11th a notable depression brought strong winds and high rainfall totals (e.g. 55mm on 11th at Seathwaite, Cumbria). On the 12th, Météo-France named 'Storm Noa', the second named storm of the 2022/2023 season, bringing unusually severe winds for April causing travel disruption in northern England, south-west England and south Wales. Following this unsettled period mid-month, high pressure returned although with some showers and thunderstorms in central and eastern areas. From the 21st, conditions became more unsettled again with longer spells of rain, e.g. 30mm on 24th at East Malling (Kent). For the UK as a whole, April rainfall was near-average (97%) although this masked regional differences. Rainfall was in excess of 170% of average in parts of Northern Ireland, Kent and the Norfolk coast, and was above average south of a line between the Severn and Humber estuaries. Conversely, across most of Wales and Scotland rainfall was below average with some areas in Scotland recording less than 70% of average. It was the second wettest March-April in the Southern, Thames and Wessex regions and the fifth wettest March-April for England (in a series from 1836). Over the last 12 months (May 2022-April 2023) rainfall was near average although deficits remained in East Anglia and northern Scotland whilst surpluses persisted in south-east England and the Western Isles.

River Flows

Following very high flows in March, high pressure during the first ten days of April meant recessions were established and away from southern England, river flows returned to near- or below average. Subsequent widespread rainfall between the 11th and 14th, meant flows across the UK peaked with almost all areas seeing flows rise substantially above average, exceptionally so in southern England. Hereafter, recessions commenced, and flows ended the month below average in northern Scotland and near-average in southern Scotland, Northern Ireland, Wales and northern and central England. In southern England however flows remained above average until month-end. Outflows for the UK responded to rainfall mid-month but following the unsettled interlude, receded and ended the month just below average. April average flows were in the normal range in southern and eastern Scotland and northern and central England. In northern Scotland, flows were below normal, notably so in some cases, with some catchments recording around half of the April average flow e.g. the Oykel and Carron – the latter recording the third lowest April flows in a series since 1978. In southern England and south Wales, flows were above normal, exceptionally so in Kent and the Thames Valley, and the Medway and Sussex Ouse recorded their highest April flows in records from 1958 and 1960, respectively. Some notably high flows were also recorded in south Wales and south-west England where flows approached or exceeded twice the average e.g. on the Teifi, Taw, Exe and Hampshire Stour – the latter recording the third highest April flows in a series from 1973. Flows for spring so far (March-April) were similar to those seen in April, with below normal flows in northern Scotland, and above normal flows elsewhere with some exceptionally high flows recorded in south Wales and southern England – the Exe registered its highest March-April flows in a record since 1957.

Soil Moisture and Groundwater

Soil moisture levels remained high for the time of year, with the lowest levels observed mainly on eastern coasts, the Central Belt of Scotland and East Anglia. Groundwater levels rose at almost all Chalk sites but remained below normal in East Anglia and at Dalton Holme. Late recharge at Wetwang interrupted the recession and brought levels back into the normal range. Above normal levels (with several exceptionally high) were observed in the Chalk of the Berkshire and Marlborough Downs, the Wessex Chalk, the South Downs and at Little Bucket Farm, marking a substantial change since the predominantly normal levels in these areas in March. In the Jurassic limestones, the level rose and was above normal at New Red Lion, while at Ampney Crucis levels fell and became notably high. Levels remained in the normal range in the Magnesian Limestone. In the Carboniferous Limestone groundwater levels fell and all sites moved into the above normal range. Levels mostly fell in the Permo-Triassic sandstones but became notably high at Annan; levels at other sites were in the normal or above normal range. In the Upper Greensand at Lime Kiln Way levels rose but remained in the normal range. The groundwater level remained stable and in the normal range at Royalty Observatory in the Fell Sandstone. Levels fell in the Devonian sandstones at Feddan Junction and Easter Lathrisk and were below normal.

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.

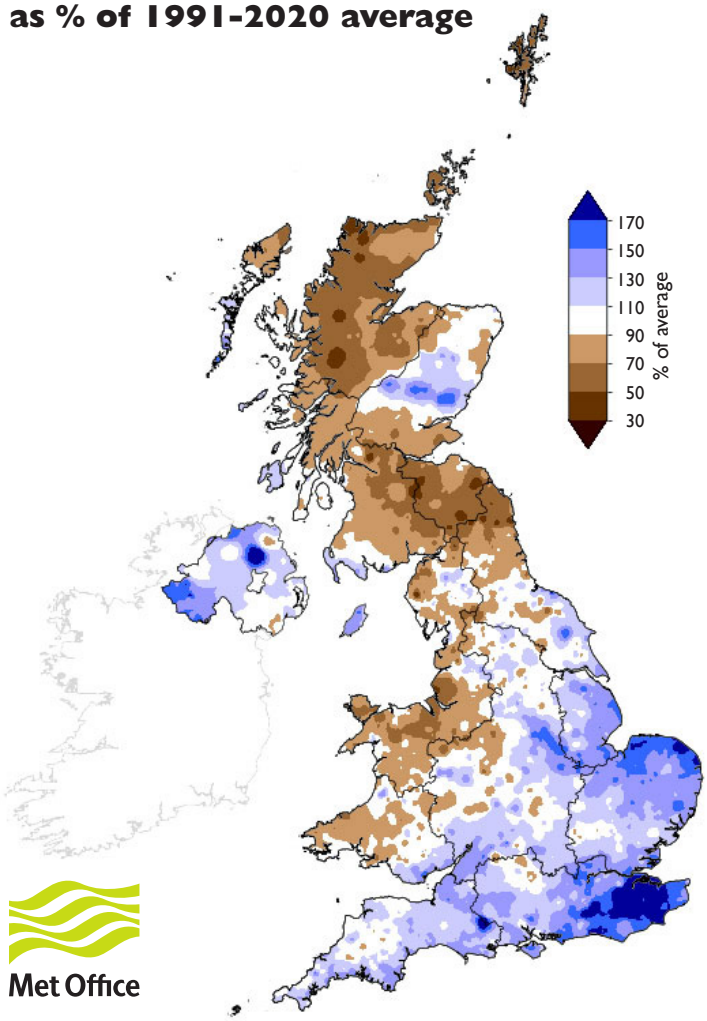
Region	Rainfall	Apr 2023	Mar23 – Apr23	RP	Feb23 – Apr23	RP	Nov22 – Apr23	RP	May22 – Apr23	RP
United Kingdom	mm	**70**	202		245		654		1146	
	%	**97**	129	10-15	97	2-5	105	5-10	99	2-5
England	mm	**64**	183		198		523		867	
	%	**114**	160	20-30	110	2-5	117	5-10	101	2-5
Scotland	mm	**74**	204		301		825		1537	
	%	**79**	94	2-5	84	2-5	94	2-5	98	2-5
Wales	mm	**78**	284		310		886		1425	
	%	**88**	148	10-15	100	2-5	110	5-10	98	2-5
Northern Ireland	mm	**90**	241		272		572		1152	
	%	**121**	150	60-90	108	2-5	94	2-5	100	2-5
England & Wales	mm	**66**	197		214		573		943	
	%	**109**	158	15-25	108	2-5	116	5-10	100	2-5
North West	mm	**63**	213		249		704		1273	
	%	**88**	131	5-10	93	2-5	105	2-5	100	2-5
Northumbria	mm	**49**	133		162		443		835	
	%	**80**	108	2-5	83	2-5	95	2-5	92	2-5
Severn-Trent	mm	**58**	174		183		445		766	
	%	**105**	159	15-25	110	2-5	112	2-5	96	2-5
Yorkshire	mm	**60**	157		179		469		821	
	%	**104**	134	5-10	96	2-5	106	2-5	95	2-5
Anglian	mm	**55**	143		151		349		592	
	%	**133**	177	15-25	122	2-5	118	2-5	95	2-5
Thames	mm	**62**	188		194		481		765	
	%	**122**	192	40-60	129	5-10	129	10-15	106	2-5
Southern	mm	**82**	205		212		652		960	
	%	**156**	197	70-100	127	5-10	147	40-60	118	5-10
Wessex	mm	**78**	227		239		650		981	
	%	**129**	185	>100	125	5-10	133	20-35	109	2-5
South West	mm	**90**	282		304		861		1288	
	%	**115**	168	30-50	111	2-5	122	10-15	103	2-5
Welsh	mm	**76**	276		301		854		1378	
	%	**89**	150	10-20	101	2-5	111	5-10	99	2-5
Highland	mm	**75**	199		352		936		1730	
	%	**67**	75	2-5	80	2-5	88	2-5	93	2-5
North East	mm	**64**	155		204		554		1032	
	%	**92**	109	2-5	92	2-5	103	2-5	97	2-5
Tay	mm	**86**	206		267		787		1441	
	%	**105**	109	2-5	86	2-5	102	2-5	104	5-10
Forth	mm	**52**	179		238		661		1230	
	%	**73**	108	2-5	87	2-5	100	2-5	99	2-5
Tweed	mm	**41**	152		195		563		1042	
	%	**61**	105	2-5	83	2-5	99	2-5	96	2-5
Solway	mm	**78**	261		314		881		1623	
	%	**84**	123	5-10	90	2-5	102	5-10	103	5-10
Clyde	mm	**89**	252		354		951		1847	
	%	**84**	98	2-5	82	2-5	90	2-5	98	2-5

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

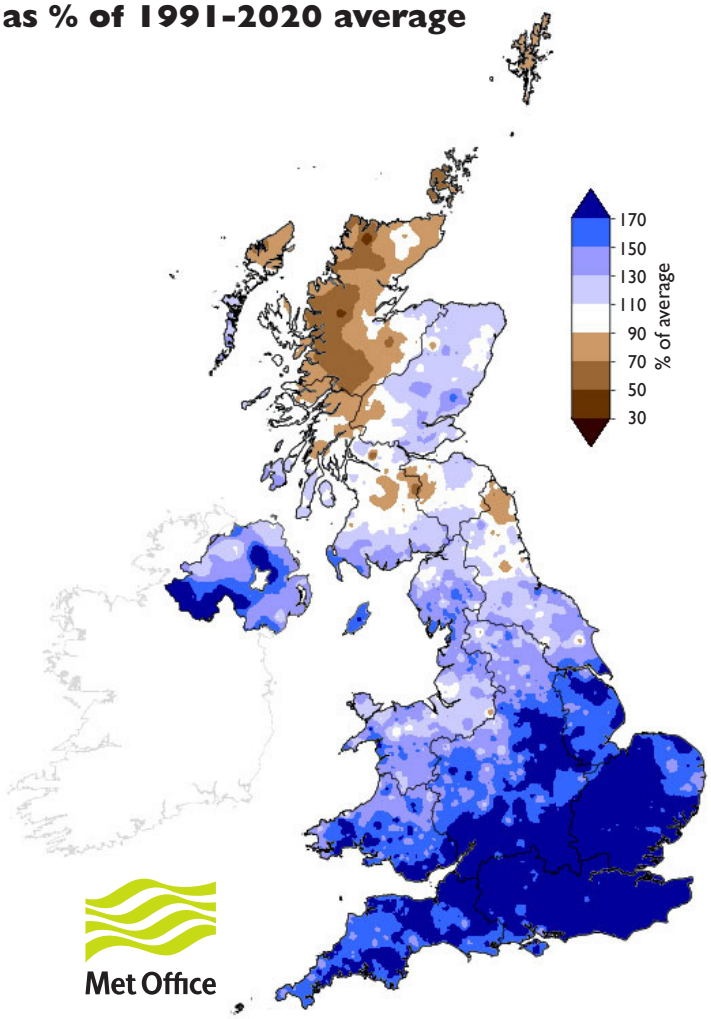
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability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

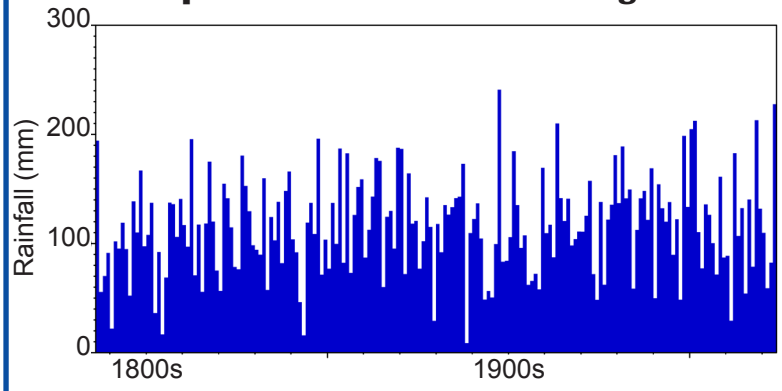
April 2023 rainfall
as % of 1991-2020 average



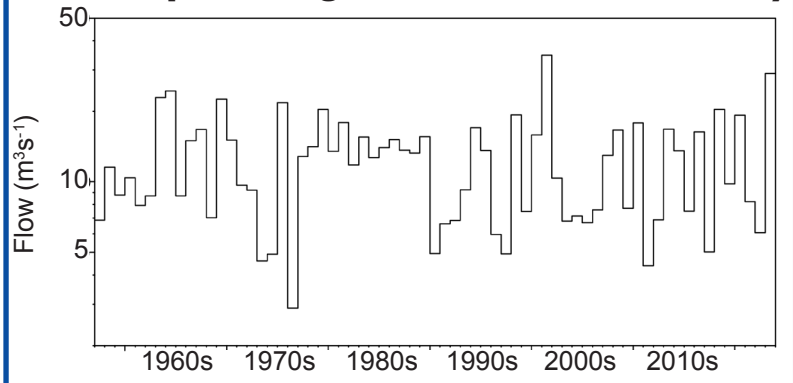
March 2023 - April 2023 rainfall
as % of 1991-2020 average



March - April rainfall for Wessex region



March - April average river flows on the Medway



UK Hydrological Outlook

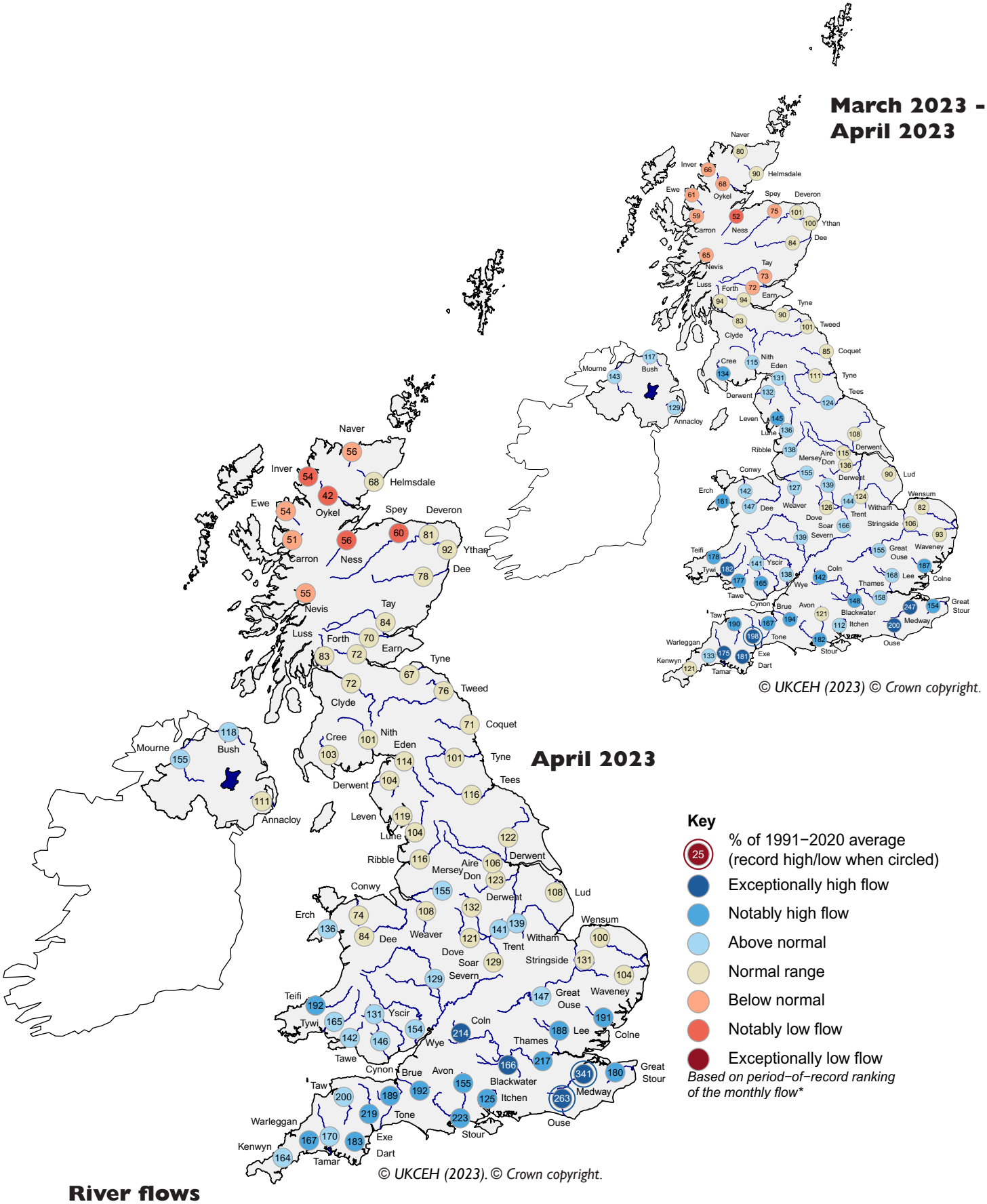
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from May 2023**
Issued: **10.05.2023**
using data to the end of April 2023

The outlook for the May-July as a whole is for river flows and groundwater levels to be normal to above normal across the majority of the UK. For May, normal to below normal flows are likely in northern Scotland. River flows and groundwater levels in southern England are likely to be above normal for May.

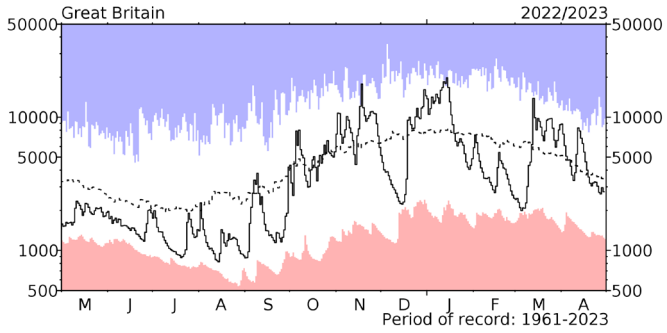
River flow . . . River flow . . .

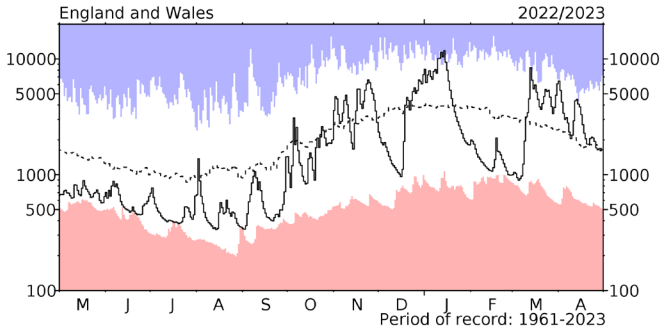


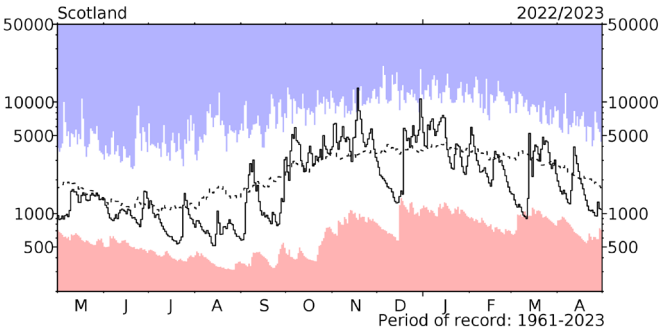
River flows

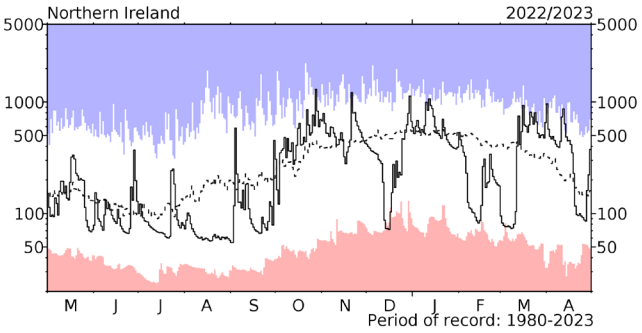
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

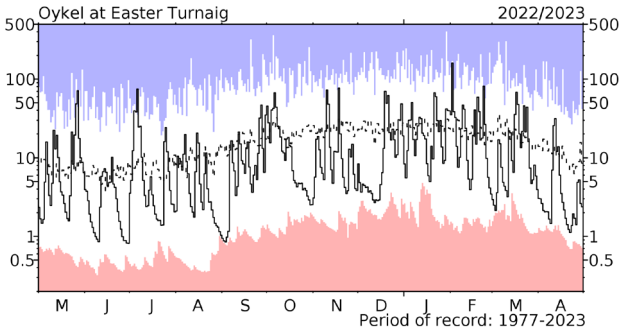
River flow . . . River flow . . .

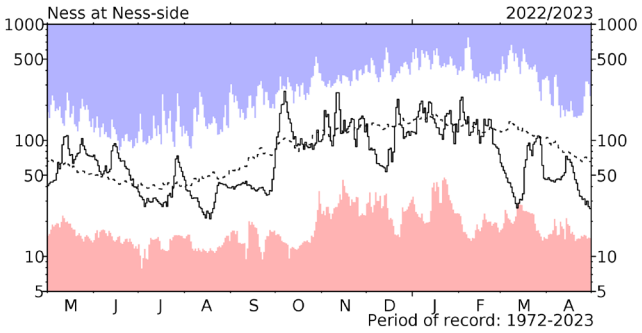


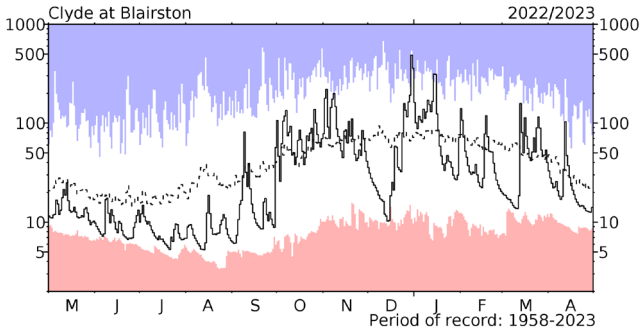


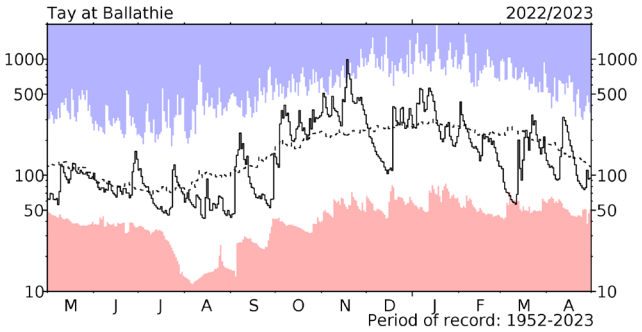


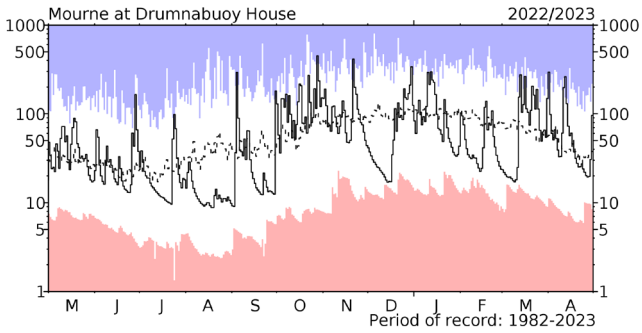


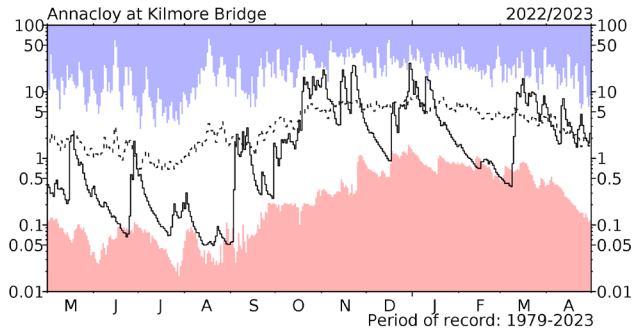








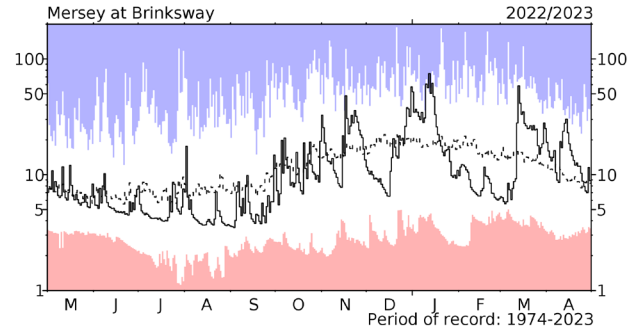


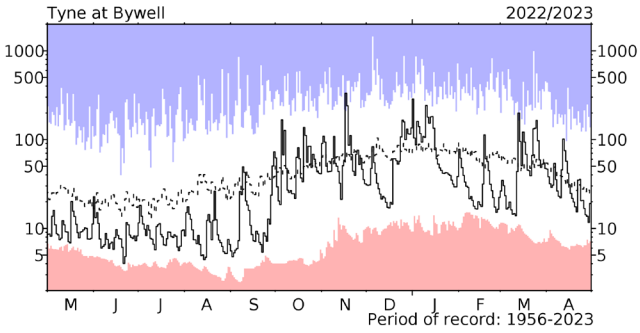


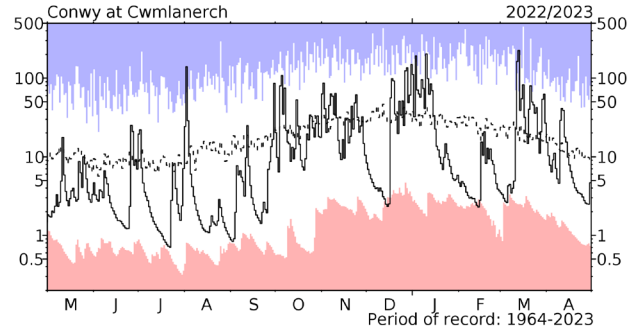
River flow hydrographs

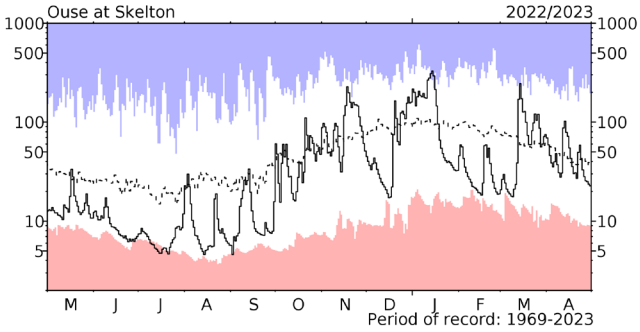
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to May 2022 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line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

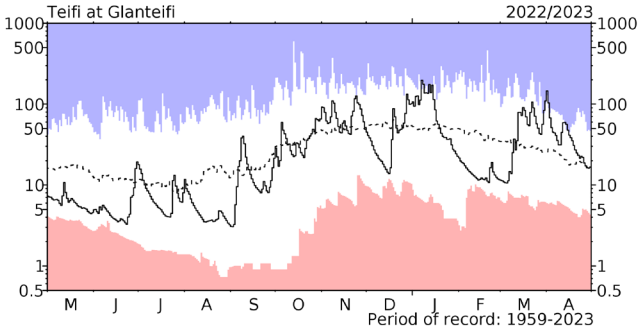
River flow . . . River flow . . .

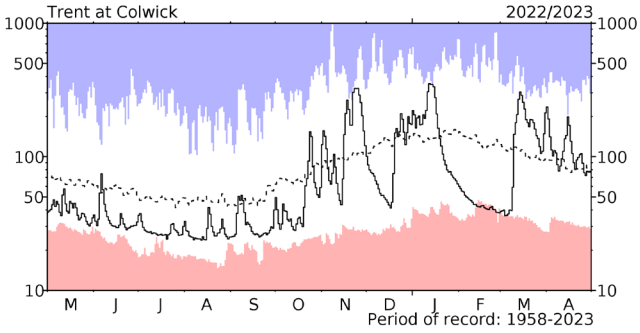


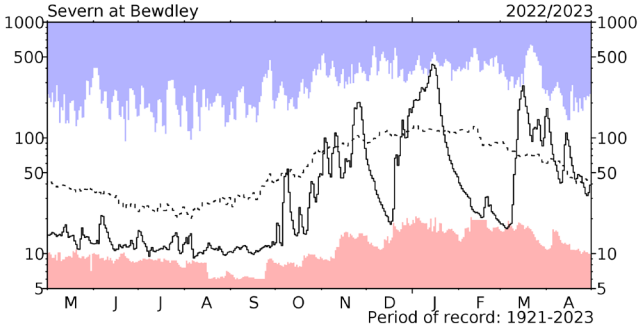


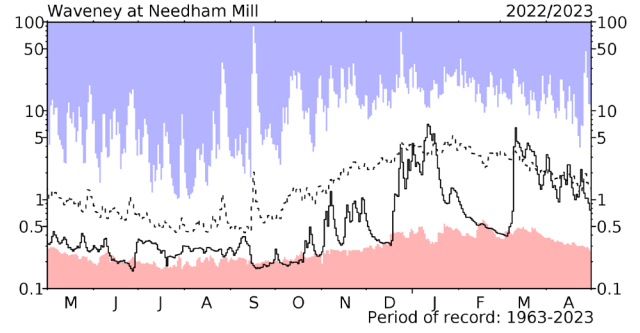


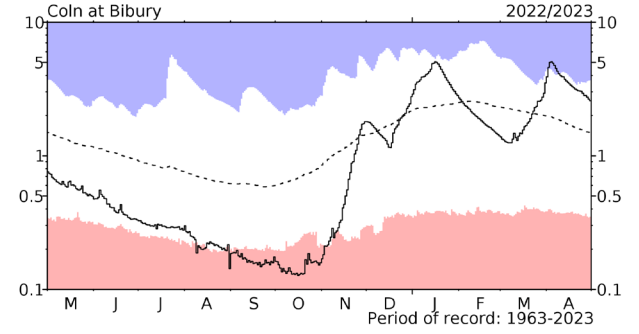


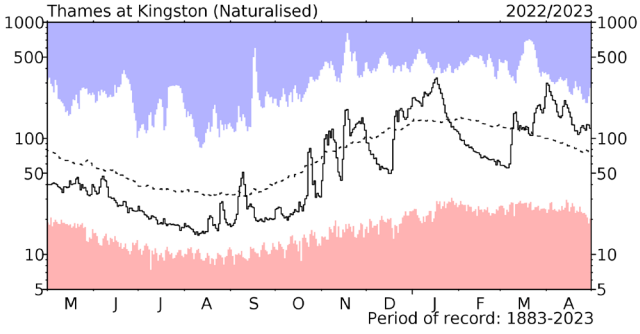


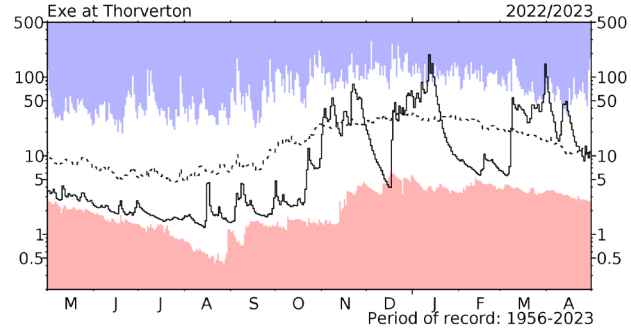


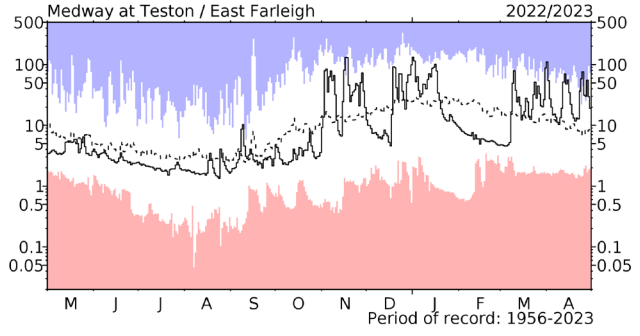




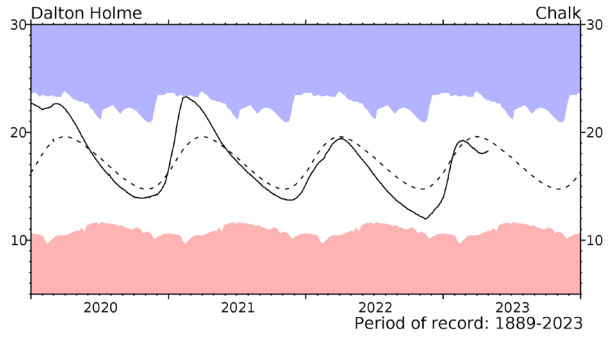


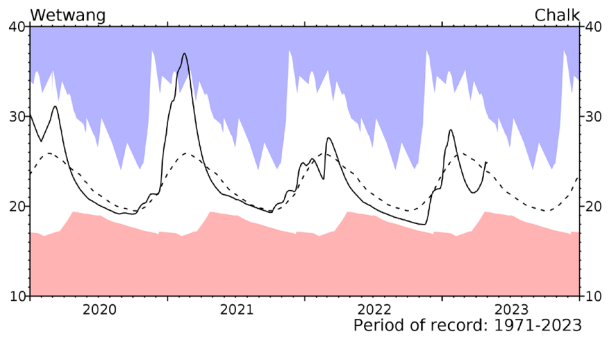


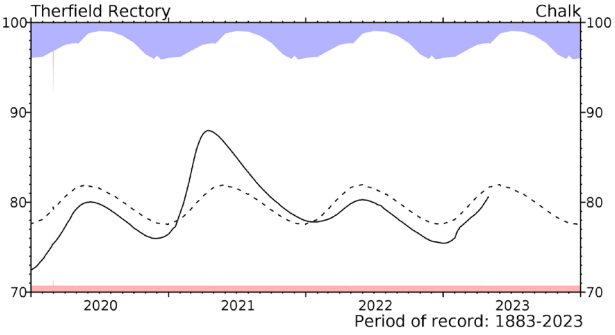


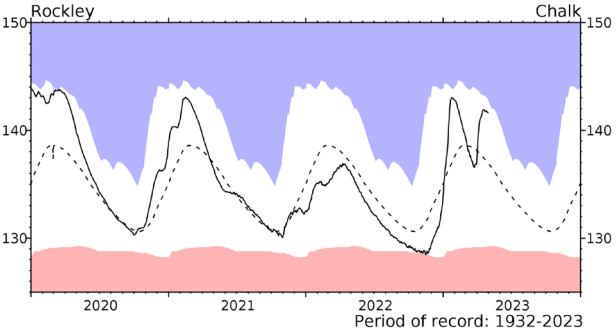


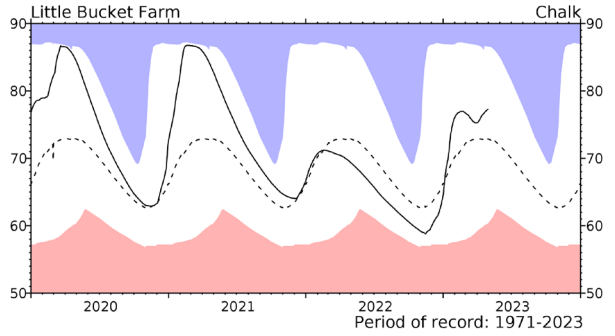
Groundwater…Groundwater

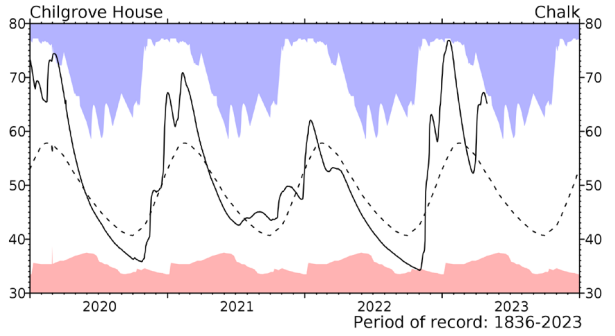


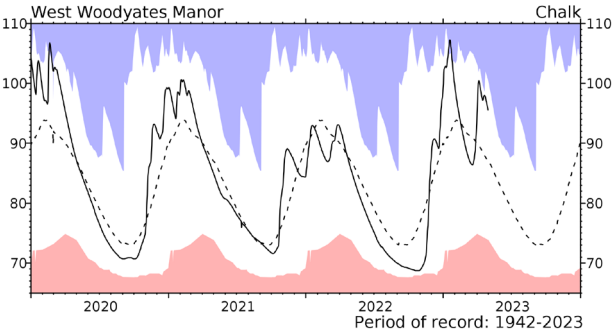


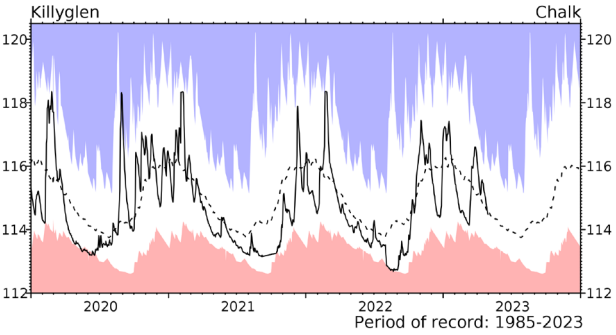


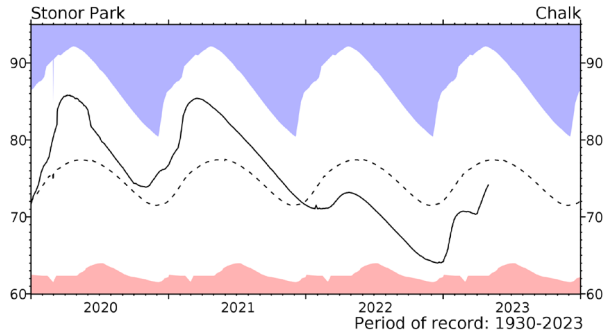


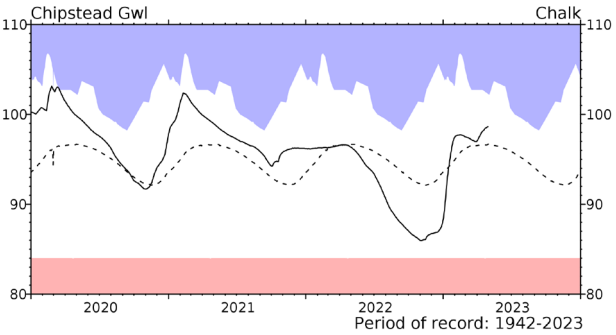






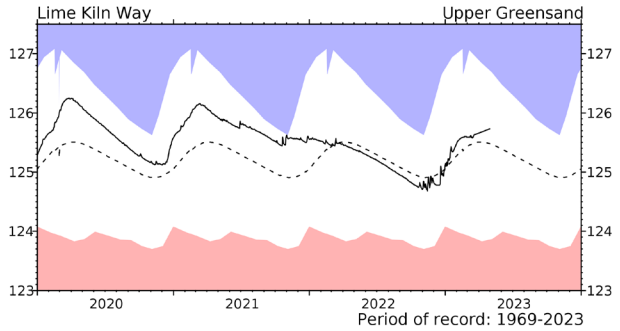


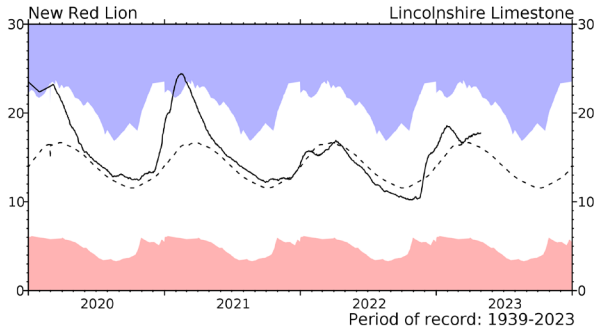


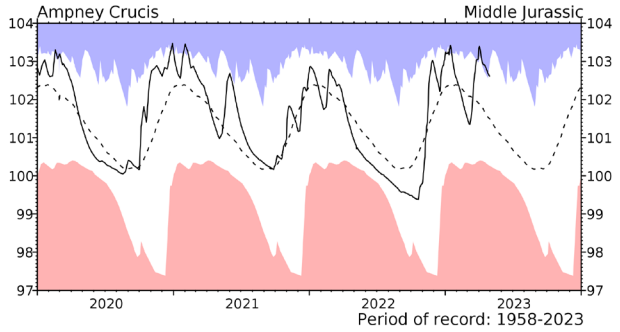


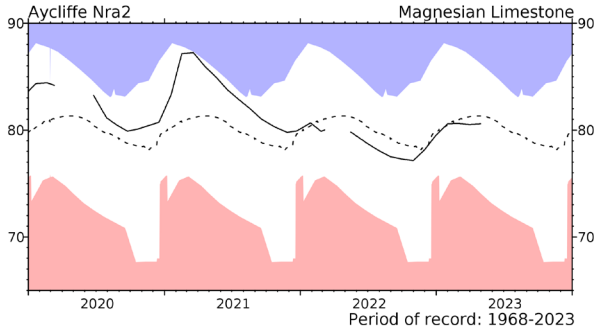
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

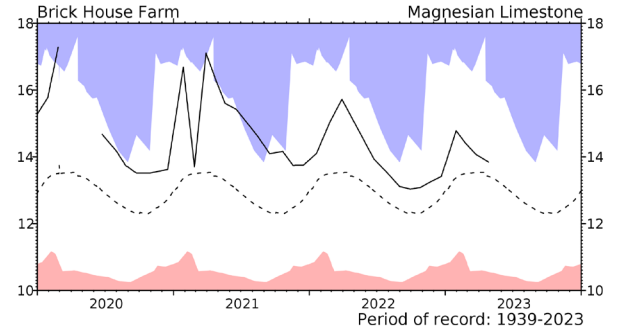
Groundwater… Groundwater

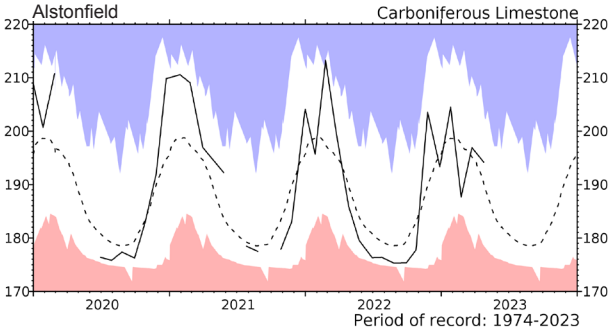


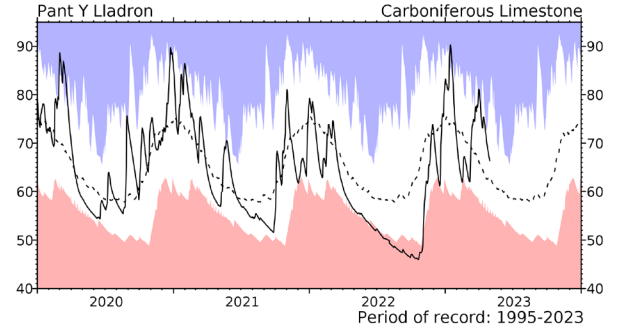


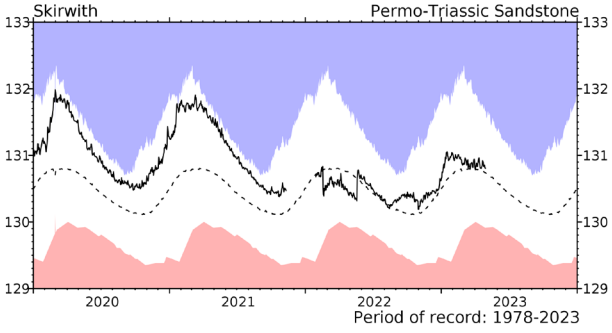


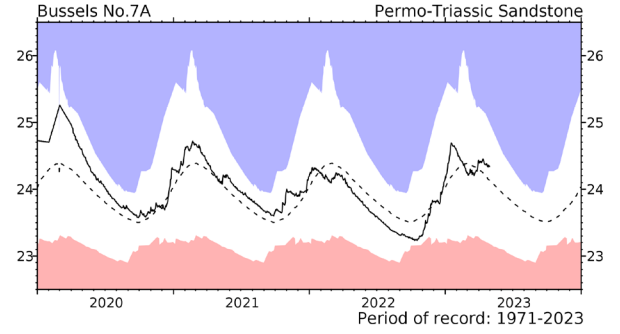


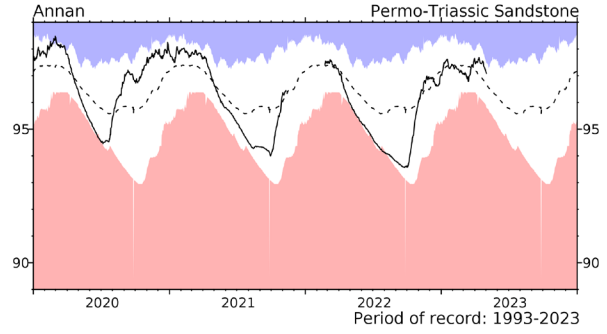


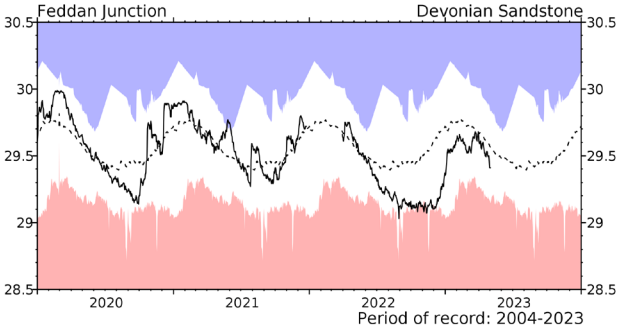


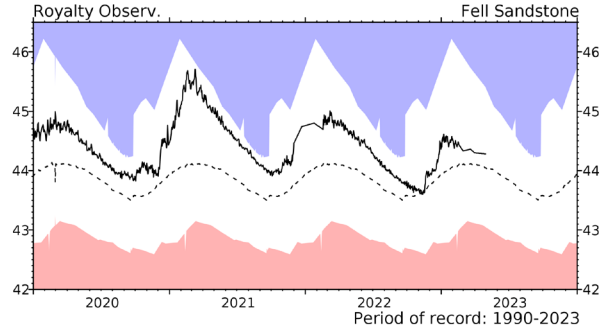










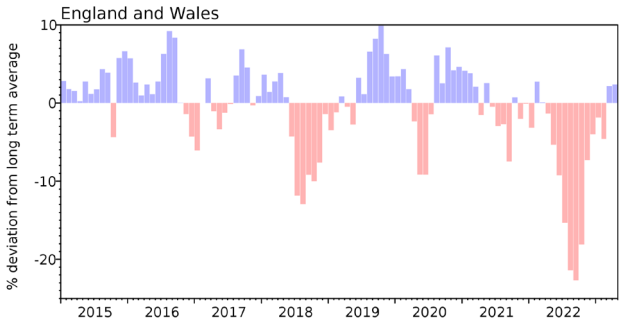


Groundwater levels - April 2023

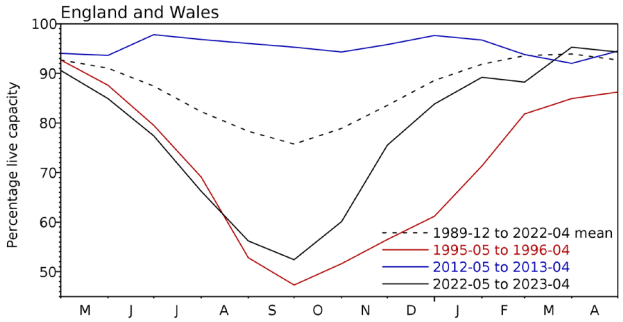
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Feb	2023 Mar	2023 Apr	Apr Anom.	Min Apr	Year* of min	2022 Apr	Diff 23-22
North West	N Command Zone	•	124929	88	99	94	7	65	1984	83	11
	Vyrnwy		55146	86	100	100	7	70	1996	87	13
Northumbrian	Teesdale	•	87936	87	100	94	4	73	2020	95	-1
	Kielder		(199175)	90	96	91	1	85	1990	90	1
Severn-Trent	Clywedog		49936	89	98	99	2	85	1988	99	0
	Derwent Valley	•	46692	89	101	97	5	54	1996	88	9
Yorkshire	Washburn	•	23373	95	99	98	9	76	1996	87	11
	Bradford Supply	•	40942	83	92	92	2	60	1996	83	9
Anglian	Grafham		(55490)	80	80	87	-7	73	1997	95	-8
	Rutland		(116580)	96	97	96	3	72	1997	95	1
Thames	London	•	202828	93	98	97	3	86	1990	97	0
	Farmoor	•	13822	99	89	95	-2	81	2000	99	-4
Southern	Bewl		31000	96	100	99	9	60	2012	88	11
	Ardingly		4685	100	100	100	1	69	2012	94	6
Wessex	Clatworthy		5662	92	100	100	8	81	1990	87	13
	Bristol	•	(38666)	96	100	100	7	83	2011	89	11
South West	Colliford		28540	49	60	67	-20	56	1997	75	-8
	Roadford		34500	58	68	69	-17	41	1996	94	-26
	Wimbleball		21320	97	100	100	5	79	1992	93	7
	Stithians		4967	92	99	99	8	65	1992	86	13
Welsh	Celyn & Brenig	•	131155	79	89	92	-6	75	1996	89	3
	Brianne		62140	89	100	100	4	86	1997	88	12
	Big Five	•	69762	93	100	99	6	85	2011	87	12
	Elan Valley	•	99106	93	100	97	1	83	2011	88	9
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	98	98	96	3	62	1998	95	1
	East Lothian	•	9317	100	100	100	1	89	1992	100	0
Scotland(W)	Loch Katrine	•	110326	98	100	97	6	80	2010	91	6
	Daer		22494	88	90	84	-8	78	2013	81	3
	Loch Thom		10721	99	99	96	3	72	2021	93	3
Northern Ireland	Total+	•	56800	92	98	97	9	77	2007	85	13
	Silent Valley	•	20634	89	100	98	14	58	2000	82	16

( ) figures in parentheses relate to gross storage

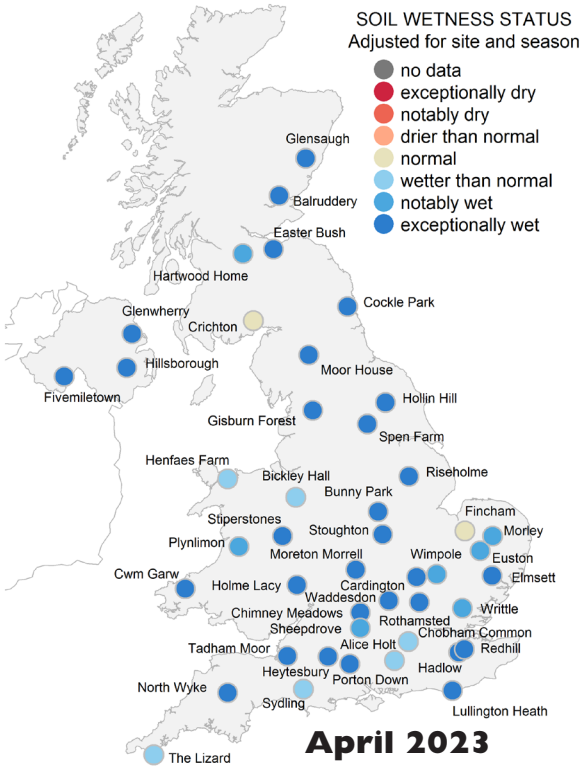
• denotes reservoir groups

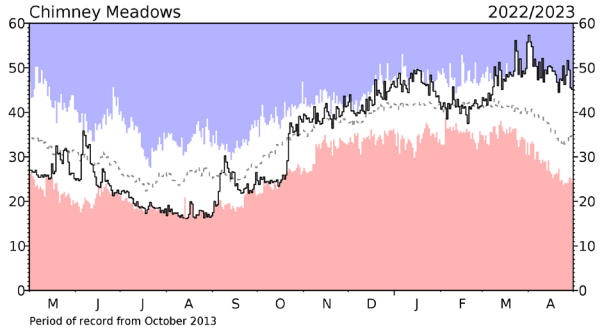
*last occurrence

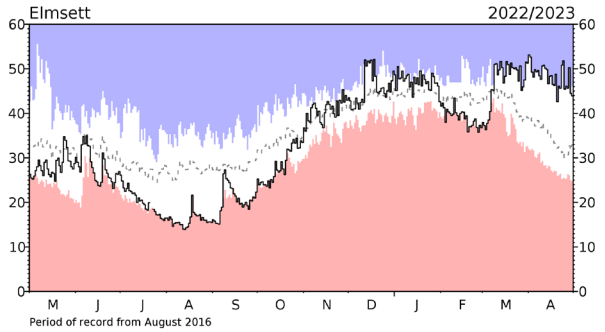
+ excludes Lough Neagh

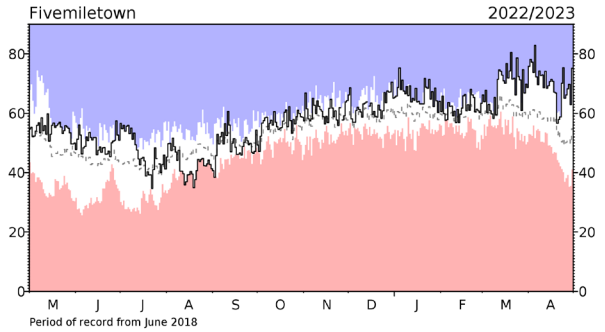
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed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

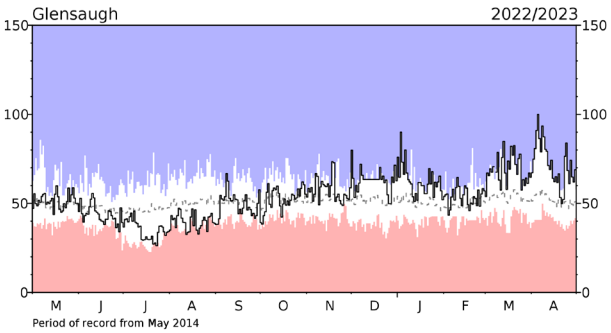
Soil Moisture . . . Soil Moisture

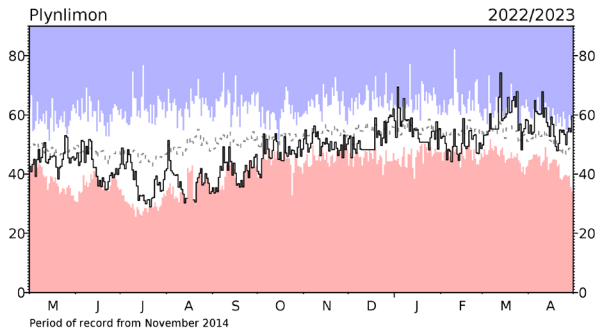












At the end of April, soil moisture levels at most COSMOS-UK sites remain high, following the large amounts of rainfall seen in March, and close to, or above, average rainfall across most areas in April.

Sites located in central and eastern England, such as Chimney Meadows, Elmsett and Rothamsted, continued to have wet soils above their normal range. Sites in northern England, such as Gisburn, and Fivemiletown in Northern Ireland, similarly recorded high soil moisture content. In Wales and the south-west of England, soils were generally drier and near their usual moisture level in mid-April but wetted up again at the end of the month (e.g. in Plynlimon, the Lizard, and Sydling). In Scotland, soil moisture varied between mid-range levels at Crichton in the south-west to very wet at Glensaugh in the north-east.

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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