Hydrological Summary

for the United Kingdom

October 2022

General

October was a mild and moderately wet month which brought further welcome rainfall amidst one of the more severe droughts of recent decades. Rainfall in October was above average across most of the UK, exceptionally so in parts of Northern Ireland. River flows in October were markedly above average in Northern Ireland, central Scotland and north-west England, but remained below average across central, southern and eastern England. Flows were notably or exceptionally low in some (mainly slowly responding) catchments in south-east England. Groundwater levels were predominantly below normal across the Chalk, with a new record October minimum at Chilgrove House. In the Permo-Triassic sandstones, levels were mostly within the normal range, and generally normal to notably low in other aquifers. Whilst reservoir stocks in Scotland and Northern Ireland were healthy, they remained substantially below average for England and Wales, despite some replenishment of stocks in the north and west. In the south-west, stocks at Wimbleball, Colliford and Stithians were all less than 20% of capacity (compared to October averages of 60-70%), establishing new minima in series from 1988. The wet weather of October and early November has certainly been welcome in providing some relief from drought conditions, with rebounding soil moisture enabling the commencement of groundwater recharge. More of this persistent rainfall is required to replenish low reservoir stocks in England and Wales; however, seasonal outlooks are not strongly indicative of wet weather over winter (and slightly favour dry conditions).

Rainfall

October was an unsettled month for most, featuring a procession of frontal rainfall systems interspersed with showery weather which was heavy and thundery at times. On the 3rd/4th, rail networks in Scotland were flooded (85mm at Achnagart, Ross & Cromarty on the 3rd) and there were delays and closures on roads in mid-Wales (88mm at Crai Reservoir, Powys on the 4th). On the 5th, 103mm was recorded at Honister Pass (Cumbria), and there was further flood-induced transport disruption in parts of Scotland on the 7th. On the 20th, intense rainfall traversed the south-east, flooding roads and properties in Nottinghamshire, Bedfordshire, Essex, Kent and Wiltshire. Towards month-end, on the 28th and 31st, there was substantial flooding of road networks across Northern Ireland. Overall, October rainfall exceeded 110% of average across most of the country, with between 130% and 170% of average recorded across parts of northern, central and southern England, and western and southern Scotland. Owing to intense downpours at times, rainfall anomalies in these regions demonstrated considerable local variability. Exceptional rainfall exceeding 170% of average was recorded in southern parts of Northern Ireland. The drier exceptions to the wet weather were northern Scotland, Cornwall and eastern fringes of Britain; parts of coastal Norfolk and Kent recorded less than 70% of the average. Rainfall anomalies for the autumn so far (Sep-Oct) were very similar to those for October; above average rainfall was recorded across most of the UK away from East Anglia and the far north of Scotland, and Northern Ireland was exceptionally wet -- the fourth wettest Sep-Oct in a series from 1836.

River flows

Following the stabilisation in September of drought-induced low flows, further wet weather in October promoted the recovery of river flows in some catchments. In responsive parts of the north and west, there was a swift return to near-average flows by the end of October, though noteworthy high flows were rare. These were generally confined to the English Lowlands (e.g. Derbyshire Dove) and Northern Ireland (e.g. Mourne) towards month-end, though reports of fluvial flood impacts were lacking. In contrast, sustained low flows continued in catchments of the English Lowlands, resulting in low outflows from this region. Daily flows on the Dorset Avon remained below average on every day since November 2021; the Coln last recorded above average daily flows in July 2021, and in October established its lowest daily flows in any month in a series from 1963. Overall, river flows for October were above average in Northern Ireland, the Lake District and central and southern Scotland, notably so for the Lune, Forth and Nevis, and twice the average on the Mourne. Below normal flows characterised parts of eastern and south-western England, with less than a third of average on the Taw, Exe and Waveney. Flows on the Coln were a fifth of the long-term average and the lowest October flows on record. Despite moderately wet weather for two consecutive months, river flows over the Sep-Oct timeframe were below average across most of England, Wales and northern Scotland. Flows in a number of catchments were notably or exceptionally low, less than a third of average on the Taw, Exe, Stringside and Waveney, and the lowest Sep-Oct flows on record for the Coln.

Groundwater

Wet weather over the last two months led to a return to normal soil moisture levels for most of the country, though extensive soil moisture deficits remained across East Anglia. Groundwater levels continued to recede in the majority of Chalk boreholes, with most below normal or notably low for the time of year. Chilgrove House recorded the lowest October level in a 187-year record (the longest continuous groundwater level record known). The recharge season may have commenced at West Woodyates Manor and Ashton Farm, as well as at Killyglen where levels rose into the normal range. In the Jurassic limestones and Magnesian Limestone, levels were below normal, except at Brick House Farm where they were above normal. A rapid rise in levels in the latter part of October may herald the onset of recharge at Ampney Crucis. Levels were normal or below normal across the Carboniferous Limestone, with a fifth successive new monthly minimum recorded at Pant y Lladron (in a 28-year series). Levels rose rapidly at Greenfield Garage towards the end of October. Levels were mainly in the normal range in the Permo-Triassic sandstones, and rose in many boreholes (including at Bussels No.7A where levels remained below normal). Levels rose rapidly from notably low into the normal range at Annan. Levels fell or were fairly stable in the Upper Greensand and Devonian / Carboniferous sandstones, within the normal range in the former and normal to notably low in the latter. Notably low levels at Feddan Junction were the second lowest for October in a 19-year record.

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.

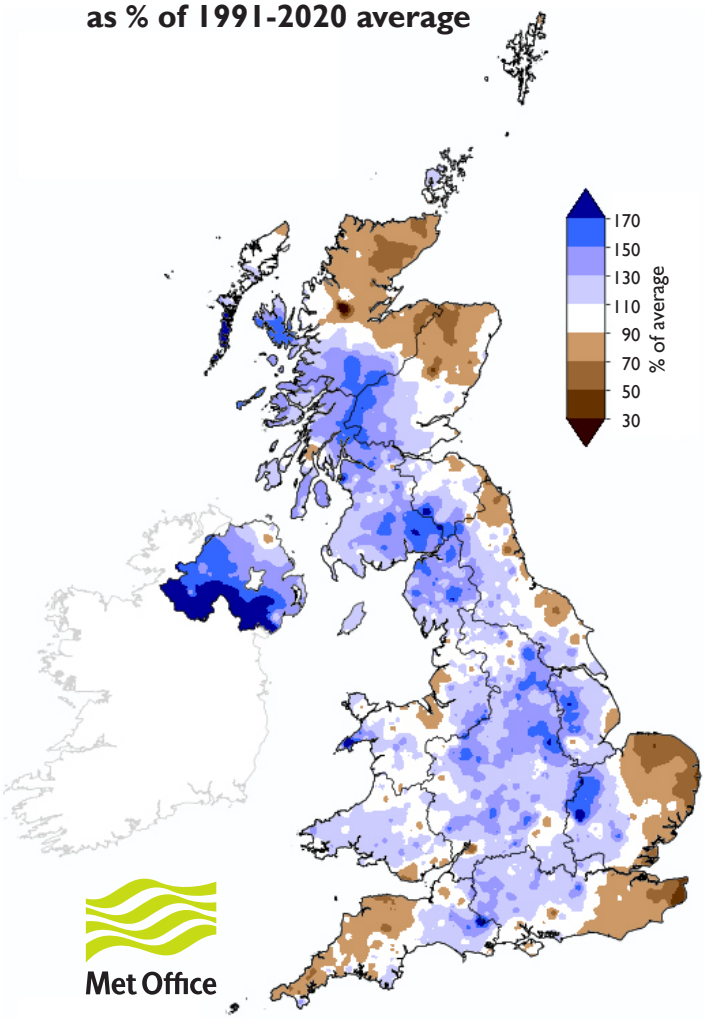
Region	Rainfall	Oct 2022	Sep22 – Oct22	RP	May22 – Oct22	RP	Jan22 – Oct22	RP	Nov21 – Oct22	RP
United Kingdom	mm	**141**	243		475		781		973	
	%	**115**	114	2-5	88	2-5	86	5-10	84	5-10
England	mm	**100**	175		328		523		653	
	%	**110**	110	2-5	78	5-10	76	10-20	75	15-25
Scotland	mm	**196**	331		688		1162		1439	
	%	**116**	113	2-5	99	2-5	94	2-5	92	2-5
Wales	mm	**175**	289		516		881		1141	
	%	**111**	107	2-5	78	5-10	78	10-15	78	10-20
Northern Ireland	mm	**176**	315		579		897		1098	
	%	**154**	156	30-50	106	2-5	98	2-5	95	2-5
England & Wales	mm	**110**	190		354		572		720	
	%	**110**	109	2-5	78	5-10	77	10-20	76	15-25
North West	mm	**166**	276		550		892		1125	
	%	**124**	114	2-5	90	2-5	89	2-5	88	2-5
Northumbria	mm	**94**	195		370		574		736	
	%	**108**	122	2-5	83	2-5	80	8-12	81	5-10
Severn-Trent	mm	**100**	161		306		502		624	
	%	**124**	111	2-5	76	5-10	78	8-12	78	10-20
Yorkshire	mm	**95**	168		326		563		696	
	%	**113**	109	2-5	76	5-10	81	5-10	80	5-10
Anglian	mm	**66**	108		224		345		440	
	%	**103**	92	2-5	67	10-15	67	20-35	70	30-50
Thames	mm	**91**	157		277		422		507	
	%	**117**	117	2-5	78	5-10	73	10-20	69	20-35
Southern	mm	**84**	182		305		444		549	
	%	**89**	117	2-5	81	2-5	70	15-25	67	30-50
Wessex	mm	**117**	187		319		505		604	
	%	**118**	112	2-5	76	5-10	72	15-25	67	50-80
South West	mm	**121**	239		418		692		890	
	%	**88**	106	2-5	76	5-10	72	20-30	71	40-60
Welsh	mm	**170**	282		502		848		1092	
	%	**111**	108	2-5	79	5-10	78	10-20	78	10-20
Highland	mm	**207**	332		776		1378		1733	
	%	**106**	97	2-5	99	2-5	95	2-5	94	2-5
North East	mm	**106**	237		466		754		932	
	%	**87**	116	2-5	89	2-5	89	2-5	88	2-5
Tay	mm	**185**	322		634		1027		1231	
	%	**123**	128	5-10	101	2-5	93	2-5	88	2-5
Forth	mm	**166**	287		552		893		1068	
	%	**127**	127	5-10	95	2-5	90	2-5	86	2-5
Tweed	mm	**136**	255		444		740		920	
	%	**119**	131	5-10	86	2-5	86	2-5	85	2-5
Solway	mm	**237**	389		717		1163		1420	
	%	**138**	134	5-10	100	2-5	94	2-5	90	2-5
Clyde	mm	**266**	429		868		1434		1749	
	%	**132**	123	5-10	104	2-5	97	2-5	93	2-5

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

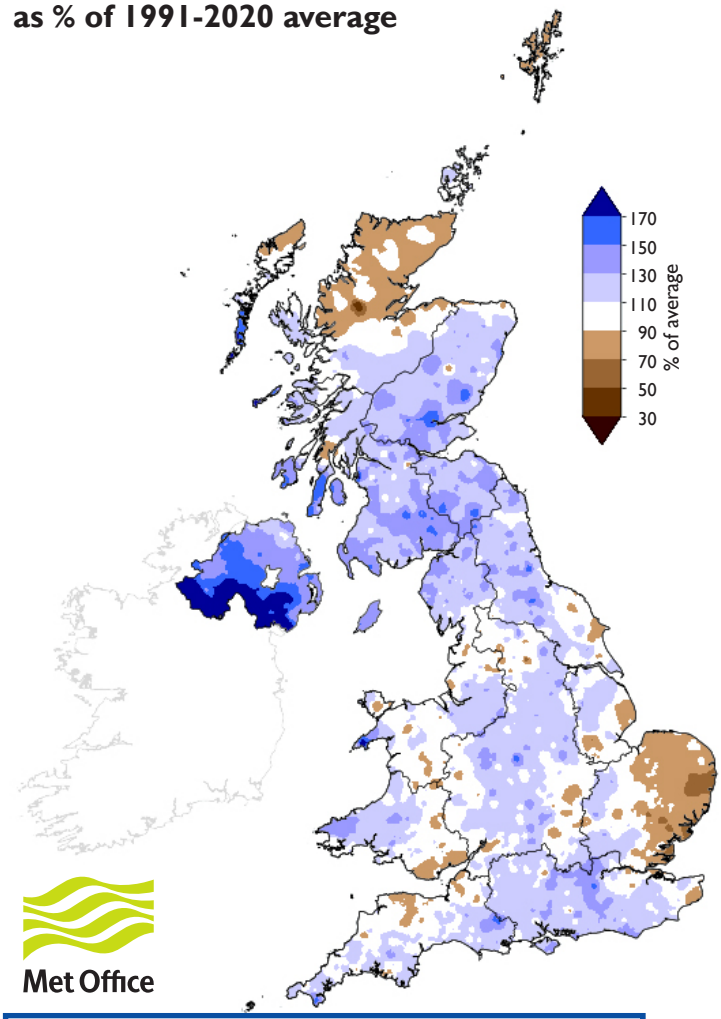
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability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

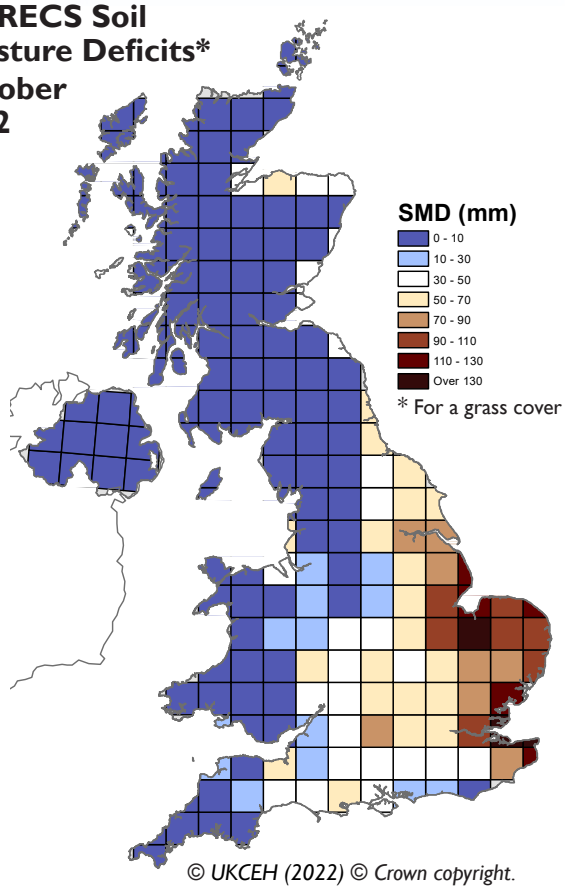
October 2022 rainfall as % of 1991-2020 average



September 2022 - October 2022 rainfall as % of 1991-2020 average



MORECS Soil Moisture Deficits* October 2022



UK Hydrological Outlook

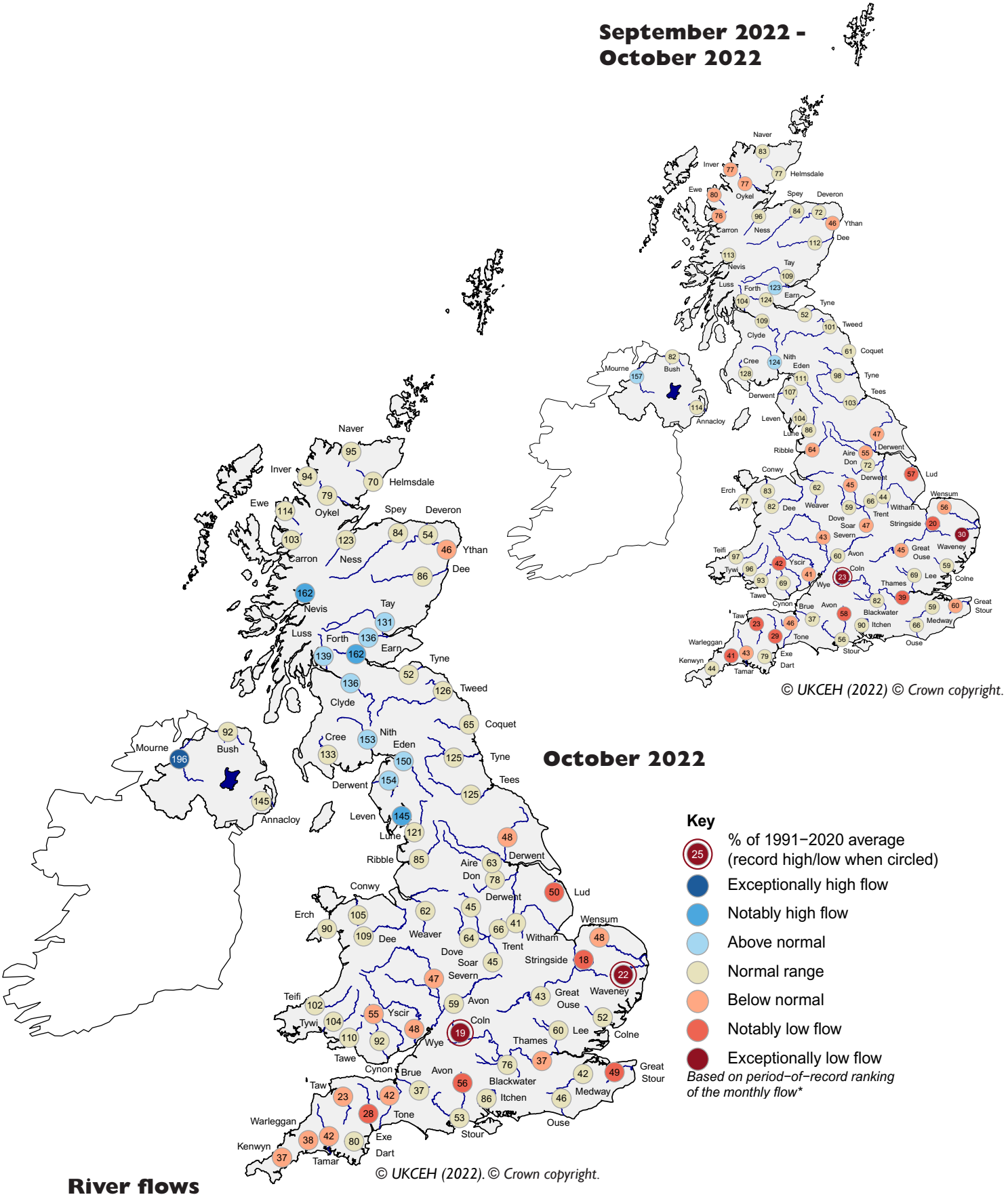
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from November 2022**
Issued: **08.11.2022**
using data to the end of October 2022

The outlook for November is for normal to below normal river flows in south-east England; flows elsewhere are most likely to be within the normal range. November groundwater levels are likely to be below normal in southern and eastern England. Over the three-month timeframe, the outlook for river flows is similar to the one-month outlook, but normal to below normal levels are likely for aquifers in the south-east.

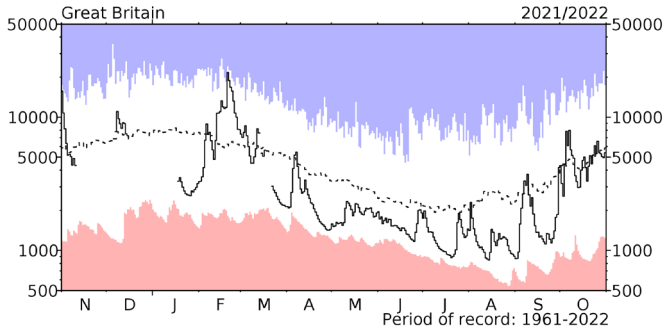
River flow . . . River flow . . .

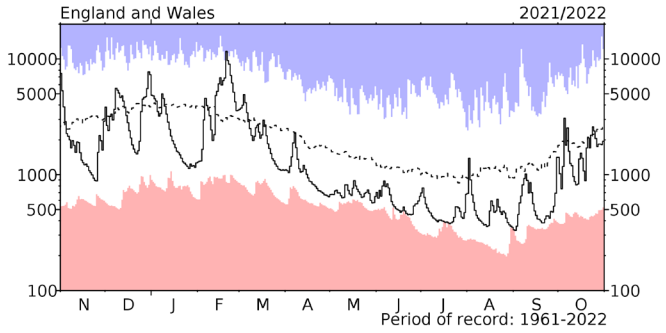


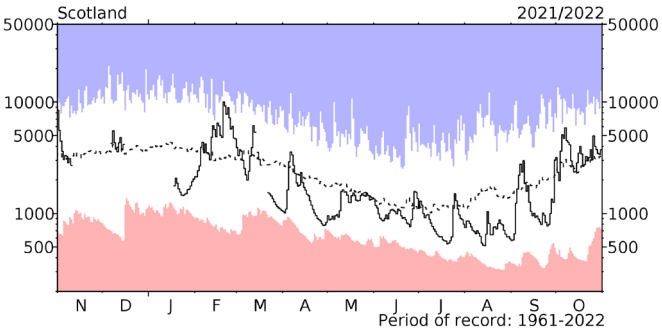
River flows

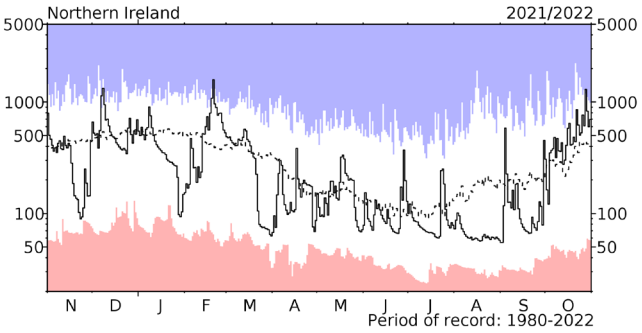
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much 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. Note the gauged flows plotted are for the Thames at Kingston (usually naturalised flows).

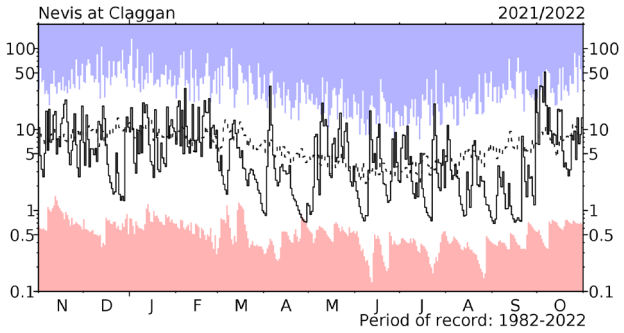
River flow . . . River flow . . .

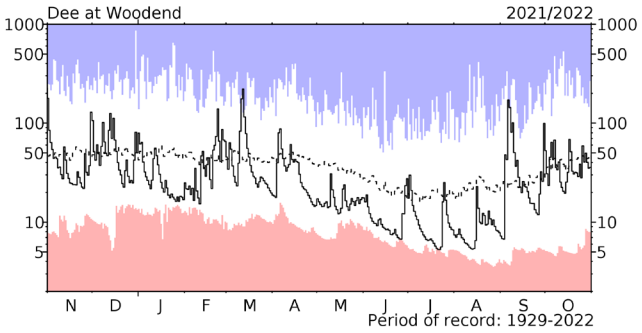


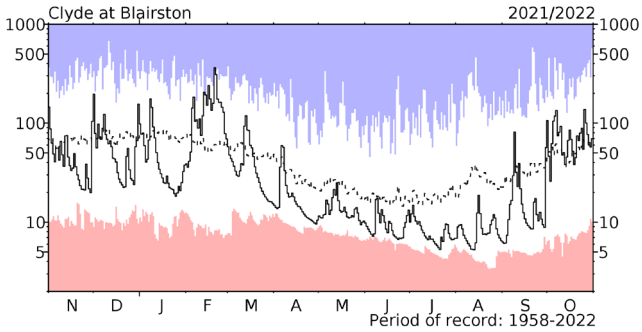


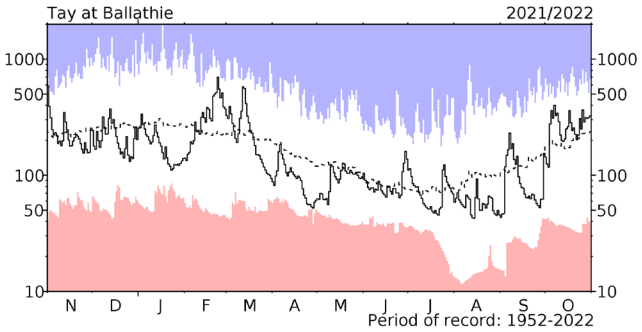


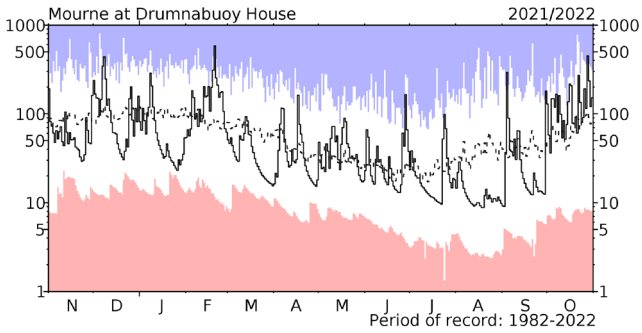


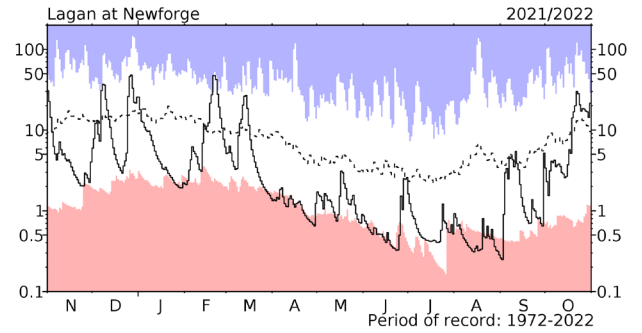








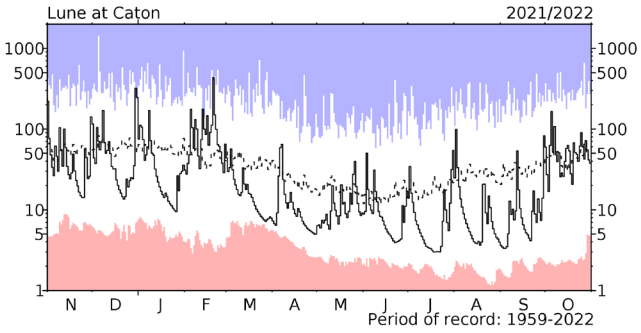


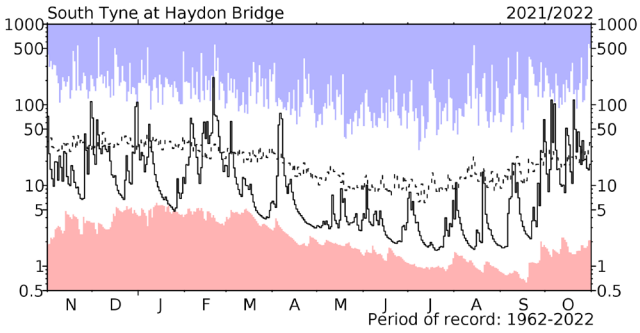


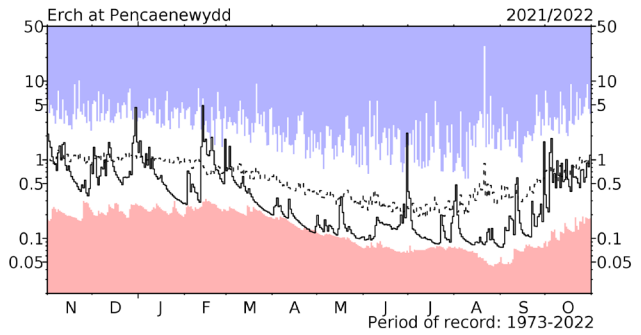
River flow hydrographs

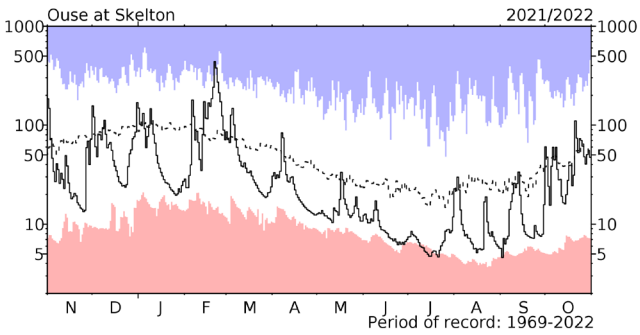
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to November 2021 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

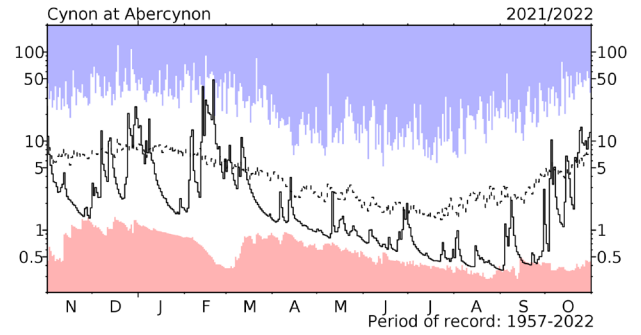
River flow . . . River flow . . .

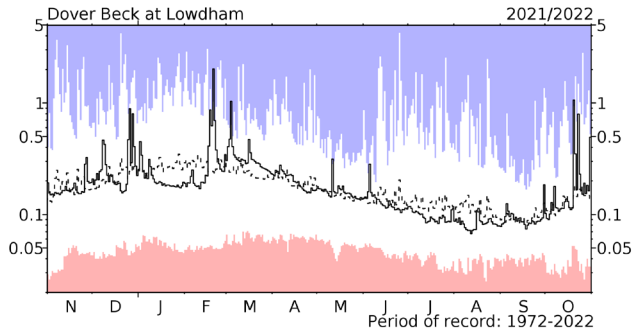


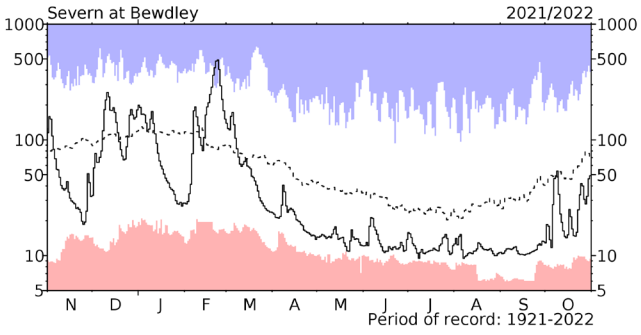


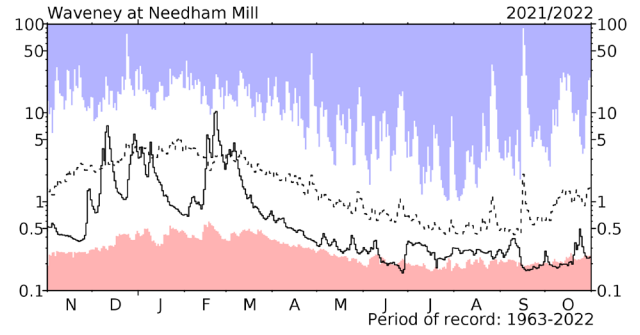


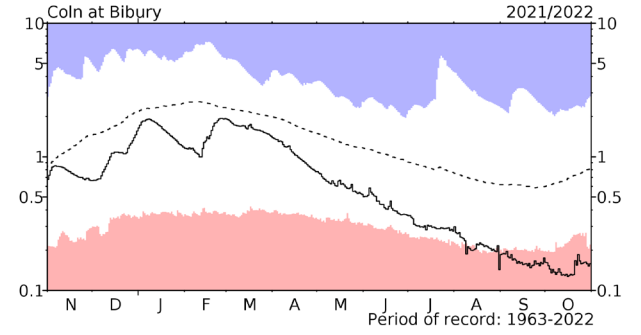


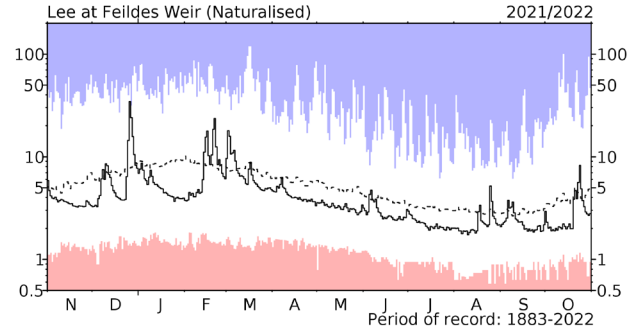


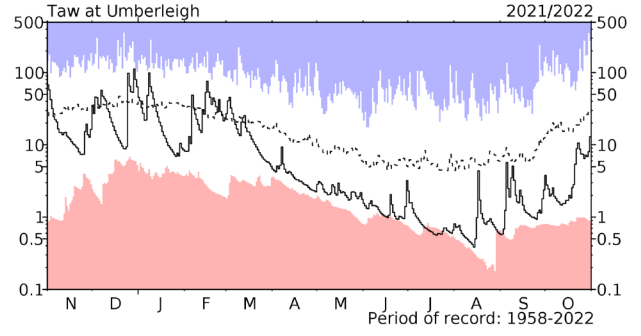


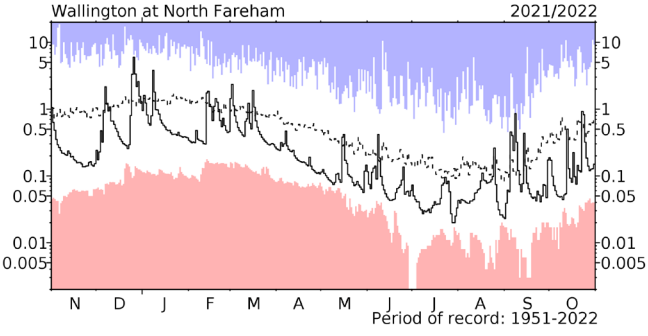




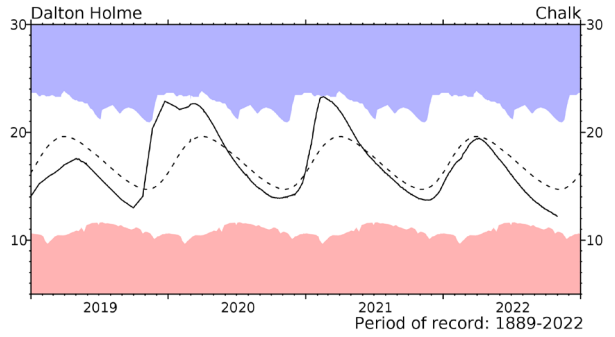


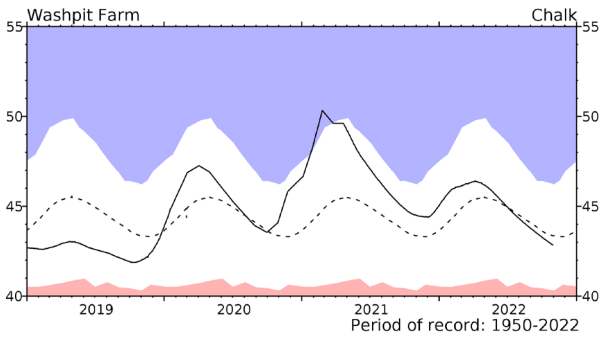


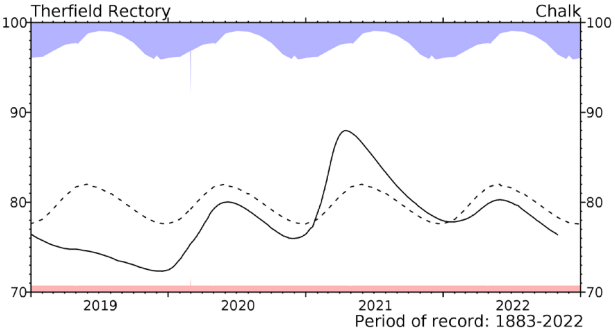


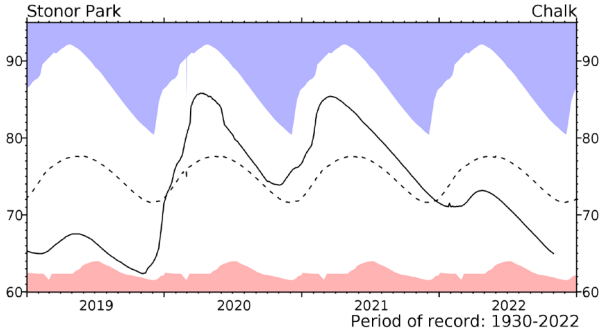


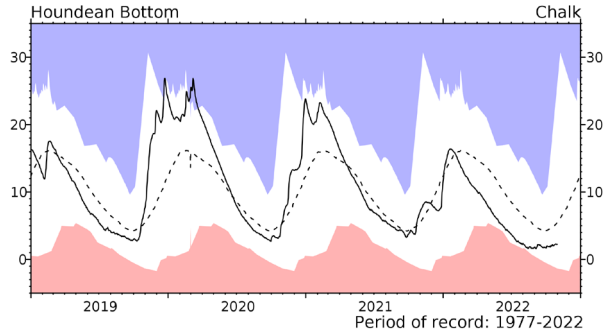
Groundwater…Groundwater

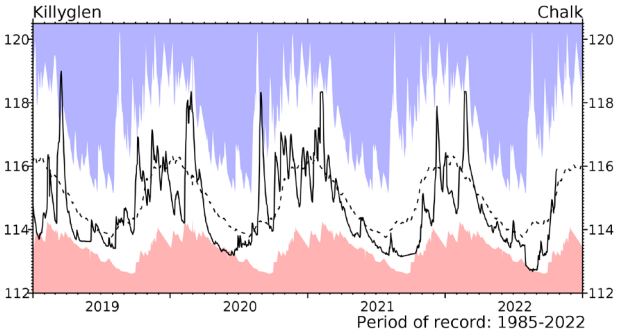


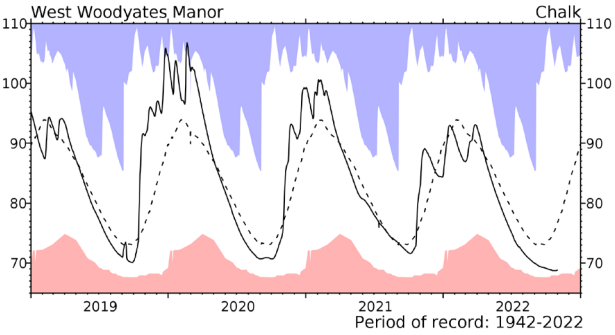


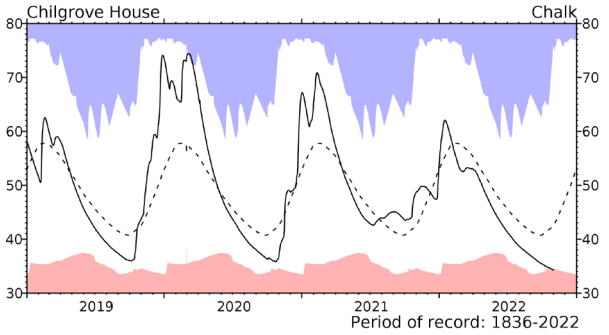


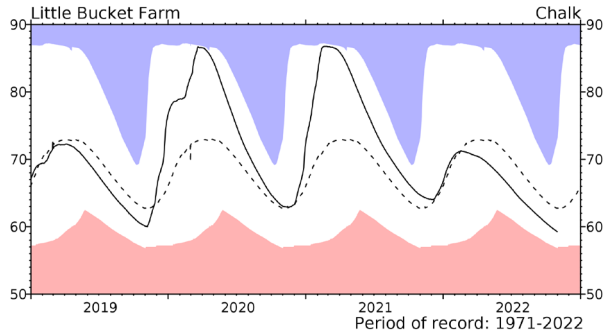


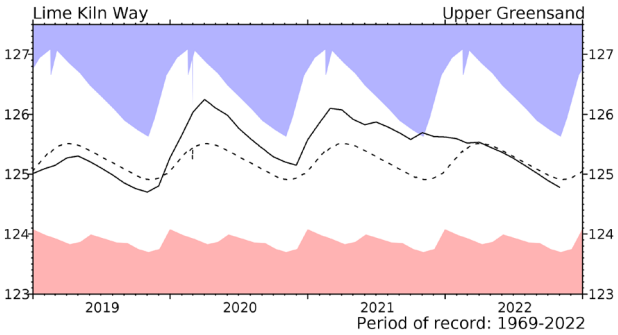






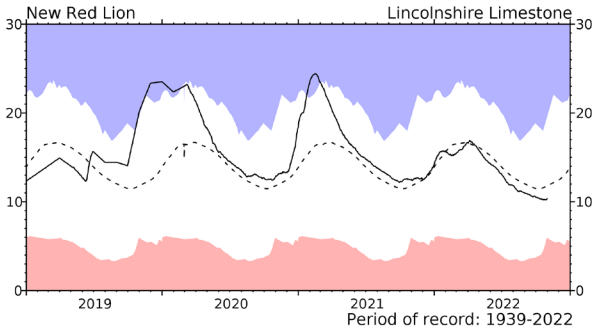


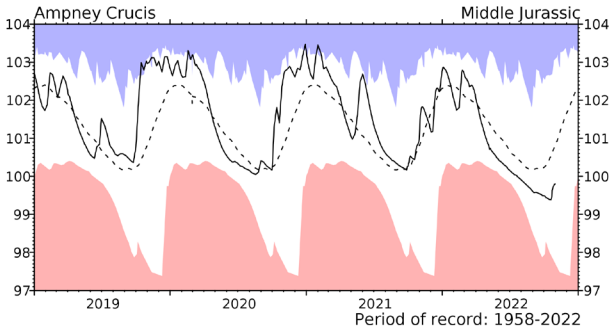


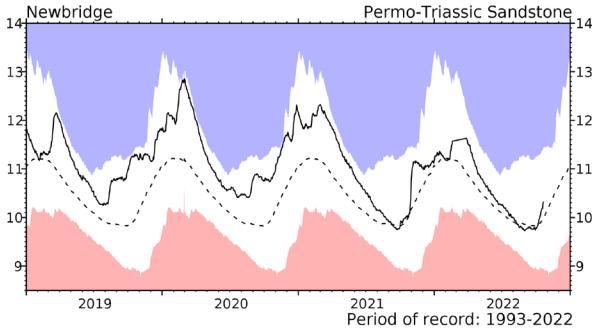


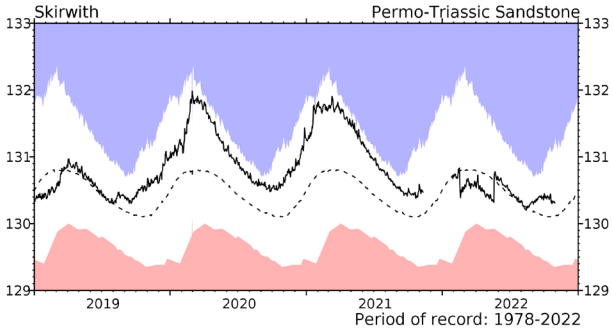
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is 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 2018. 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.

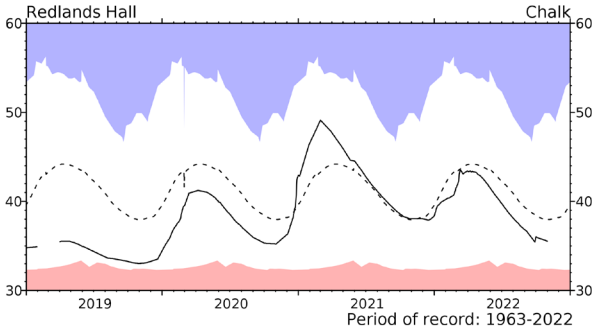
Groundwater… Groundwater

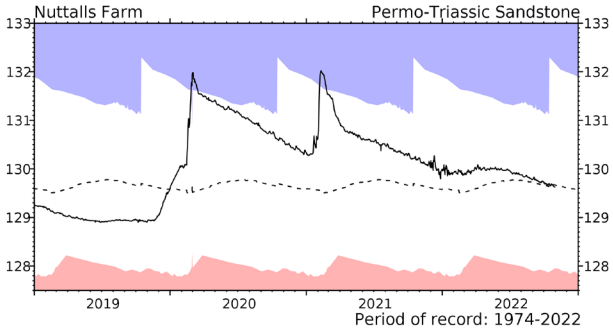


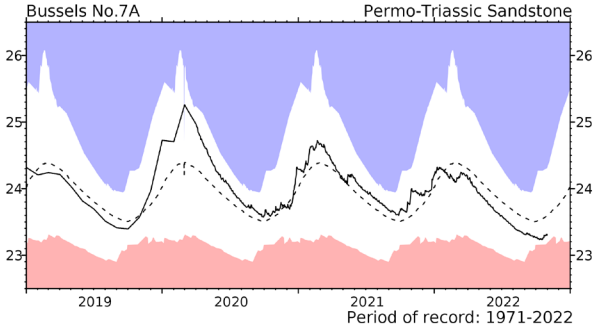


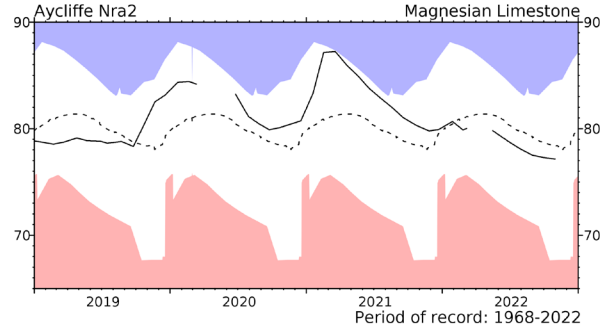


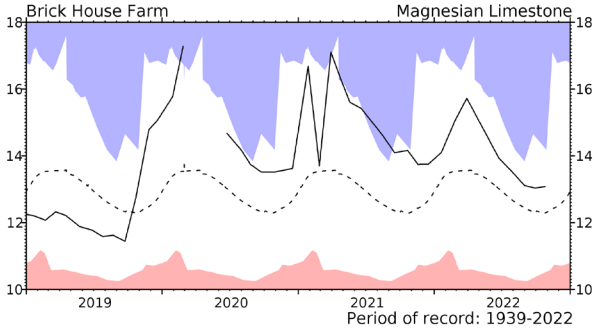


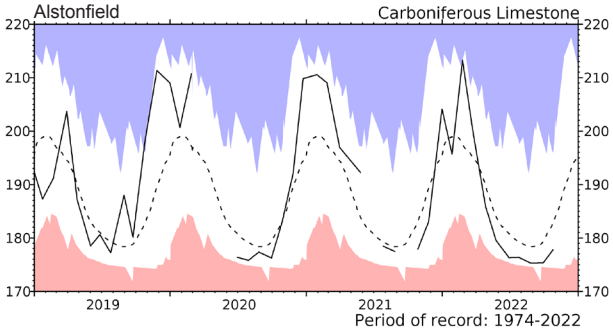


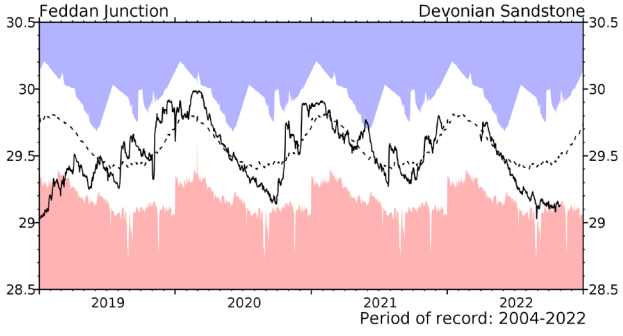


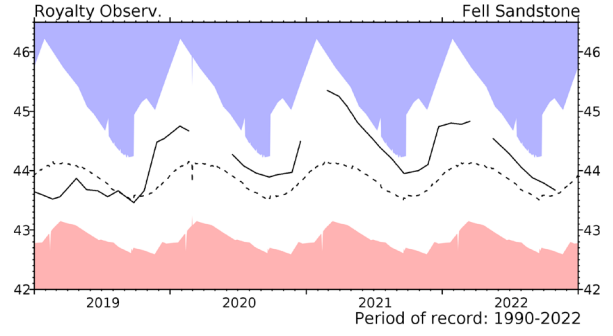










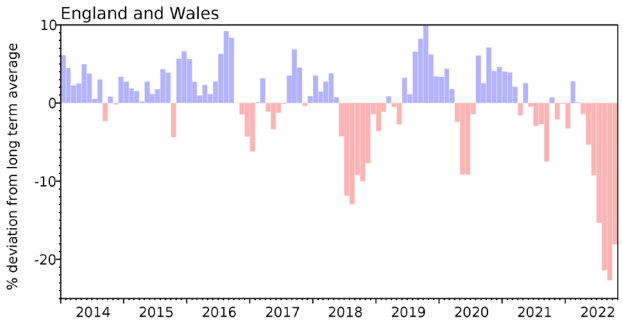


Groundwater levels - October 2022

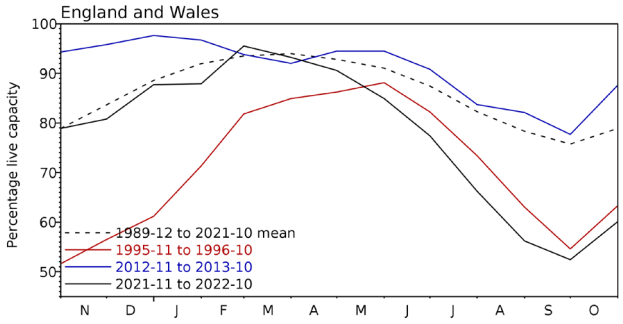
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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 Aug	2022 Sep	2022 Oct	Oct Anom.	Min Oct	Year* of min	2021 Oct	Diff 22-21
North West	N Command Zone	•	124929	45	38	62	-7	33	2003	72	-10
	Vyrnwy		55146	46	37	55	-22	25	1995	91	-35
Northumbrian	Teesdale	•	87936	66	79	71	-6	33	1995	69	3
	Kielder		(199175)	79	88	86	0	63	1989	81	5
Severn-Trent	Clywedog		49936	52	40	54	-23	38	1995	88	-34
	Derwent Valley	•	46692	36	29	52	-18	15	1995	51	1
Yorkshire	Washburn	•	23373	37	28	42	-28	15	1995	73	-31
	Bradford Supply	•	40942	35	28	41	-32	16	1995	66	-25
Anglian	Grafham		(55490)	66	58	57	-27	44	1997	94	-37
	Rutland		(116580)	76	70	69	-10	59	1995	80	-11
Thames	London	•	202828	62	60	60	-17	46	1996	82	-22
	Farmoor	•	13822	72	63	70	-19	43	2003	90	-20
Southern	Bewl		31000	57	48	43	-17	33	1990	74	-31
	Ardingly		4685	31	25	26	-39	15	2003	96	-69
Wessex	Clatworthy		5662	45	30	24	-39	14	2003	78	-54
	Bristol	•	(38666)	53	46	44	-20	24	1990	67	-24
South West	Colliford		28540	31	38	15	-54	15	2022	64	-48
	Roadford		34500	47	20	34	-36	18	1995	87	-53
	Wimbleball		21320	37	23	18	-48	18	2022	74	-56
	Stithians		4967	27	19	14	-45	14	2022	56	-42
Welsh	Celyn & Brenig	•	131155	55	46	58	-26	48	1989	80	-22
	Brianne		62140	52	49	83	-11	57	1995	100	-17
	Big Five	•	69762	40	32	52	-25	38	2003	78	-26
	Elan Valley	•	99106	39	31	51	-34	37	1995	80	-29
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	71	71	86	5	48	2003	85	1
	East Lothian	•	9317	67	67	72	-14	38	2003	100	-28
Scotland(W)	Loch Katrine	•	110326	79	75	96	9	40	2003	71	25
	Daer		22494	62	70	94	3	42	2003	100	-6
	Loch Thom		10721	75	69	97	8	63	2020	75	22
Northern Ireland	Total+	•	56800	65	69	84	2	39	1995	75	9
	Silent Valley	•	20634	60	64	83	6	34	1995	68	16

( ) figures in parentheses relate to gross storage

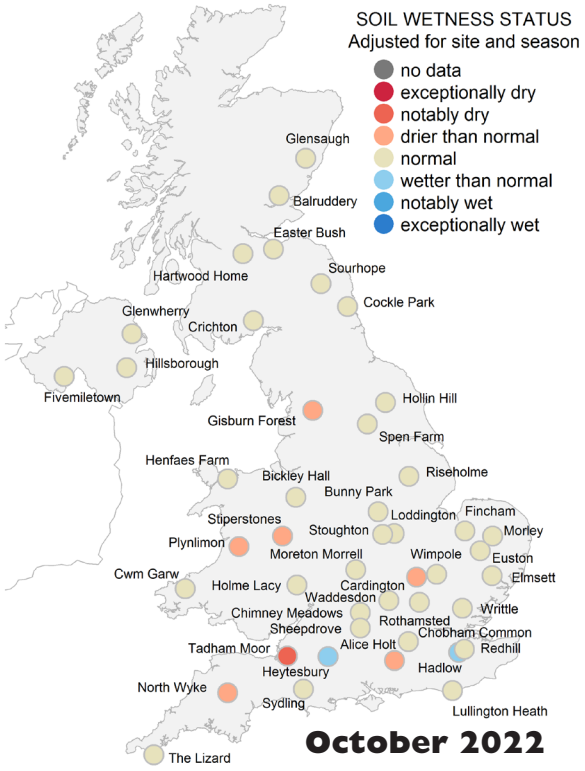
• denotes reservoir groups

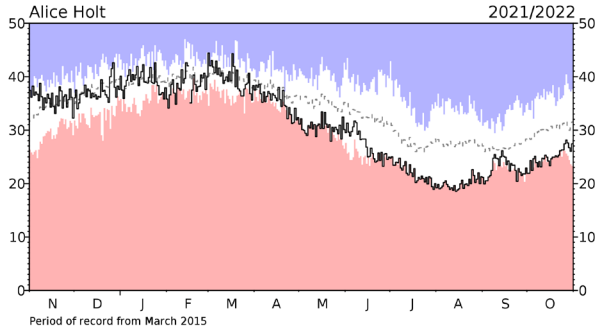
*last occurrence

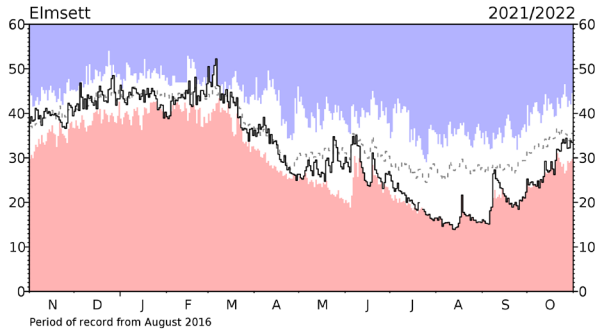
+ excludes Lough Neagh

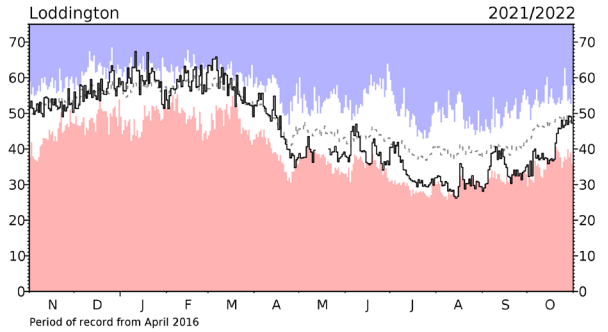
Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed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

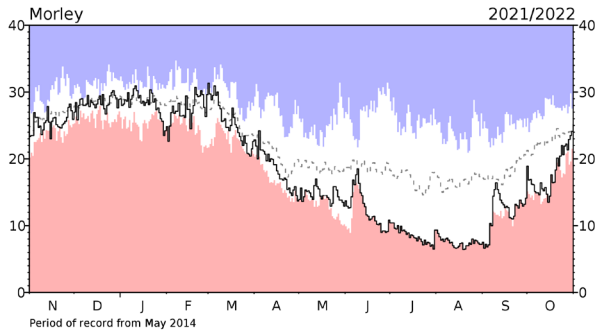
Soil Moisture . . . Soil Moisture

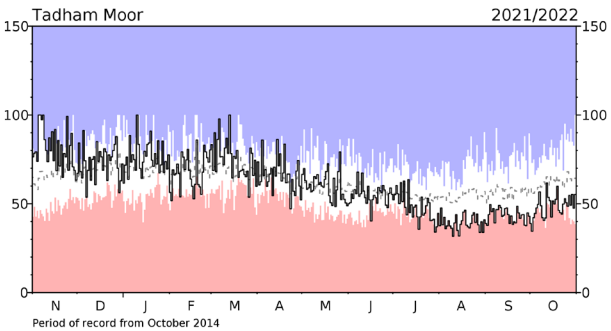












Increased precipitation throughout September and October has resulted in COSMOS-UK stations wetting up to near-normal conditions with a few exceptions.

More than 80% of the COSMOS-UK sites reported normal soil moisture, though some sites still exhibited drier conditions, mainly in the southeast and some central regions. On average, air temperatures were cooler than those in September, but conditions were generally mild. Morley, Elmsett and Loddington were dry at the beginning of October but gradually recovered towards average conditions by the end of the month.

Soil moisture at Tadham Moor increased significantly over the month after a very dry summer, but as the seasonal soil moisture expectation is also increasing, it remains exceptionally dry for the time of the year. Alice Holt and Waddesdon started to recover slowly after the dry summer, but remain drier than normal.

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

Some of the features displayed on the maps contained in this report are based on the following data with permission of the controller of HMSO.

i. Ordnance Survey data. © Crown copyright and/or database right 2005. Licence no. 100017897.
ii. Land and Property Services data. © Crown copyright and database right, S&LA 145.
iii. Met Office rainfall data. © Crown copyright.