Hydrological Summary
for the United Kingdom

July 2022

General
July was characterised by exceptional warmth and dryness, despite some unsettled spells, particularly in the north and west. It was the fourth hottest July for England (in a record from 1884) and exceptionally hot at times, particularly mid-month when a southerly airmass brought heatwave conditions, triggering a first Met Office red weather warning for extreme heat. Widespread record-breaking maximum temperatures followed, including a new maximum temperature record for the UK (40.3°C for Coningsby, Lincs, on the 19th). Widespread impacts were reported, with the hot temperatures and dry soils leading to wildfires, including fires that destroyed properties in London. Given the sustained hot, dry conditions, soil moisture and river flows receded sharply to exceptionally low levels across large areas of the country. Reservoir levels also declined, resulting in the lowest end-of-July stocks on record (from 1990) for England & Wales – many reservoirs saw stocks over 20% below average (e.g. 28% below at Elan Valley and Derwent Valley, 34% below at Colliford). The overall water resources situation in parts of south-east England was bolstered by a more favourable groundwater position, but groundwater resources also declined rapidly through the month. Given the continued deterioration in the water resources situation, in late July temporary use bans were announced (to commence in August) by several water companies in southern England. With hot, dry weather continuing in early August, water resource concerns continue to mount – the current Hydrological Outlook indicates a continuation of below normal river flows and groundwater levels over coming months, and exceptional late summer/early autumn rainfall will be needed to return to normal conditions.

Rainfall
July began cool and unsettled, with heavy, sometimes thundery showers a feature of the first week, especially in the north and west. An anticyclonic regime became established thereafter, with hot, dry and settled conditions extending across the UK, culminating in the extreme heatwave on the 18th/19th. Thundery showers followed (with 70mm recorded on the 23rd at Magilligan (Londonderry) bringing localised surface water flooding and disruption), along with more organised and persistent rainfall across central and northern regions, particularly approaching month-end. These incursions brought little respite to southern Britain, with large areas in the south-east receiving little appreciable rainfall throughout the month. July rainfall was 56% of average for the UK, but England saw only 35% of average – it was driest July since 1935. Only the far northwest of Scotland saw above average rainfall, while most of southern Britain registered less than 20% of average, and large areas of the south-east received less than 10%. The Anglian, Thames and Southern regions saw their driest July (in records from 1836) and the June-July rainfall was also exceptional: the fourth driest on record for Southern and the sixth driest for Anglian, although June-July for 2018 was drier. July extends exceptional deficiencies for the summer half-year so far (March-July rainfall for England was the sixth lowest on record, from 1836) and, while some autumn/winter months were wetter than average, broadly, notable deficiencies can be traced back to the autumn: it was the driest November-July period since 1976 across south-eastern regions.

River flows
In more responsive rivers in northern and western areas, there were modest flow increases at times in July following heavy rainfall early in the month and in the final week. Flood alerts were rare and high flows were largely unremarkable, although on the 23rd the Faughan in Northern Ireland registered its highest July flow on record (from 1977). In responsive rivers, much of the month was marked by sustained recession during the intervening settled period, and across central, southern and eastern areas, rivers generally receded through the month and in many cases approached July minima by month-end. Sustained low flows and contraction and fragmentation of the stream network caused ecological stress, with fish rescues reported in several regions. Diminishing flows also led to constraints on abstractions and measures to mitigate low flows were taken (e.g. flow augmentation of the Severn, voluntary irrigation restrictions in East Anglia). Correspondingly, July average river flows were notably or exceptionally low across large areas of England and south Wales. The Yscir registered its lowest July flow on record (in a record from 1972), and July flows ranked among the lowest two or three on record for many catchments in southern Britain – the Wye registered its third lowest in a long record from 1936. In groundwater-dominated rivers in southern and eastern England, flows were notably low but rarely exceptional (although the Coln registered its second lowest July flow in a record from 1960). It was the second lowest July outflow for the English Lowlands (after 1976) and the third lowest for England. Average flow accumulations since the spring were also notable or exceptional, especially in northern, western and central catchments.

Soil Moisture and Groundwater
The persistent hot and dry conditions, particularly in southern and central areas, led to rapid and sustained soil drying. Many COSMOS-UK sites that began July with normal soil moisture levels ended the month with dry or extremely dry soils for the time of year, with many sites registering lower soil moisture than the equivalent time in 2018, and the lowest on record in some localities (noting all COSMOS-UK records commence post-2013). Similarly, soil moisture deficits (SMDs) continued to increase steeply, and SMDs averaged across the Chalk aquifer approached historical maxima. Correspondingly, groundwater levels in the Chalk fell and while some boreholes were in the normal range (at Aylesby, Washpit Farm and Therfield Rectory), most were below normal to exceptionally low, notably in the South Downs, where Compton House recorded its second lowest monthly levels in a 126 year record, after 1976 (note this may have been affected by pumping). In the other limestones, levels receded and fell to below normal at New Red Lion and notably low at Ampney Crucis (Jurassic), but remained below normal Aycliffe and above normal at Brick House Farm (Magnesian). In the rapidly-responding Carboniferous Limestone, levels fell in South Wales, where Pant-y-Lladron set a record minimum (in a record from 1995) for the second month in succession; in the Peak District the level at Alstonfield rose slightly and recovered from below normal to average. In the Permo-Triassic sandstones levels fell but remained in the normal range, except at Bussels No 7a where they remained below normal and at Annan where they set a new monthly minimum (in a record from 1993). Levels also fell in the other sandstone aquifers: in the Upper Greensand at Lime Kiln Way they remained below normal, in the Fell Sandstone at Royalty Observatory were above normal and in the Devonian of eastern Scotland 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.

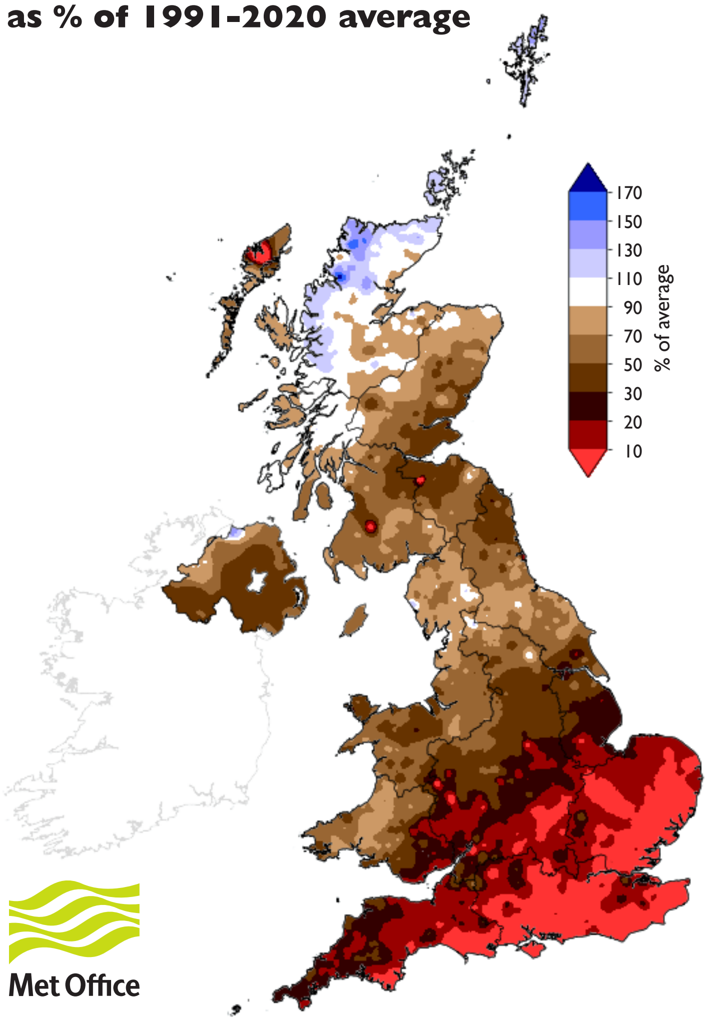
Region	Rainfall	Jul 2022	Jun22 – Jul22	RP	Apr22 – Jul22	RP	Nov21 – Jul22	RP	Aug21 – Jul22	RP
United Kingdom	mm	**46**	105		230		680		997	
	%	**56**	66	8-12	76	8-12	80	8-12	86	5-10
England	mm	**23**	68		144		444		681	
	%	**35**	52	10-20	59	40-60	70	20-30	79	10-15
Scotland	mm	**84**	158		362		1028		1452	
	%	**81**	80	2-5	96	2-5	89	2-5	92	2-5
Wales	mm	**52**	124		233		812		1225	
	%	**53**	65	5-10	64	20-30	75	10-15	84	5-10
Northern Ireland	mm	**46**	131		291		739		1063	
	%	**51**	76	2-5	91	2-5	86	2-5	92	2-5
England & Wales	mm	**27**	76		156		494		755	
	%	**38**	54	10-15	60	40-60	71	15-25	80	8-12
North West	mm	**69**	142		263		788		1177	
	%	**70**	77	2-5	79	5-10	85	2-5	92	2-5
Northumbria	mm	**43**	85		178		507		728	
	%	**58**	58	5-10	67	8-12	76	8-12	80	8-12
Severn-Trent	mm	**23**	67		139		435		640	
	%	**35**	51	8-12	56	30-50	74	10-20	80	5-10
Yorkshire	mm	**41**	78		159		500		718	
	%	**59**	55	5-10	63	15-25	78	5-10	83	5-10
Anglian	mm	**8**	43		94		298		456	
	%	**15**	39	25-40	47	50-80	66	30-50	73	15-25
Thames	mm	**6**	42		105		317		530	
	%	**12**	40	15-25	50	30-50	60	40-60	73	10-20
Southern	mm	**4**	37		105		333		575	
	%	**7**	35	40-60	50	30-50	55	50-80	70	15-25
Wessex	mm	**9**	59		135		396		656	
	%	**15**	49	8-12	56	20-30	59	40-60	73	15-25
South West	mm	**17**	83		173		612		967	
	%	**21**	52	5-10	56	20-35	65	20-35	77	8-12
Welsh	mm	**49**	120		226		770		1172	
	%	**51**	65	5-10	64	20-30	74	10-15	84	5-10
Highland	mm	**113**	190		472		1310		1748	
	%	**104**	91	2-5	111	5-10	95	2-5	94	2-5
North East	mm	**65**	100		254		638		947	
	%	**79**	62	5-10	84	2-5	83	5-10	89	2-5
Tay	mm	**63**	137		292		829		1232	
	%	**64**	74	2-5	83	2-5	80	5-10	89	2-5
Forth	mm	**51**	109		230		701		1073	
	%	**54**	61	5-10	71	5-10	77	5-10	87	2-5
Tweed	mm	**48**	86		192		623		963	
	%	**56**	52	10-20	65	10-20	78	5-10	89	2-5
Solway	mm	**72**	163		305		951		1455	
	%	**65**	78	2-5	78	2-5	82	2-5	93	2-5
Clyde	mm	**97**	212		439		1231		1747	
	%	**77**	91	2-5	99	2-5	88	2-5	92	2-5

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

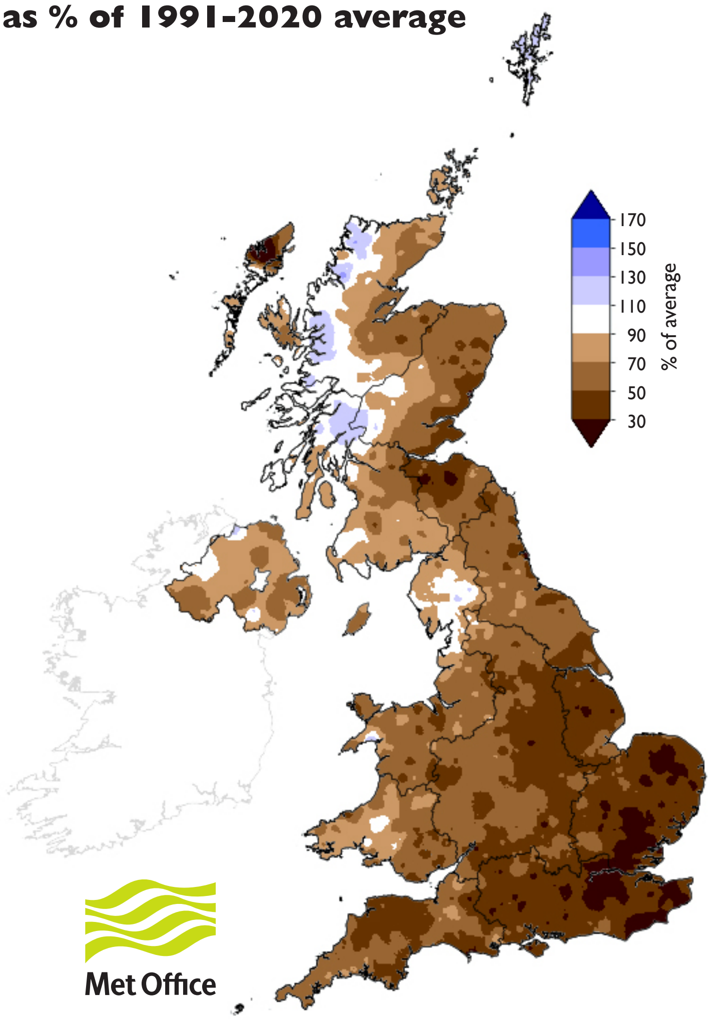
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability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

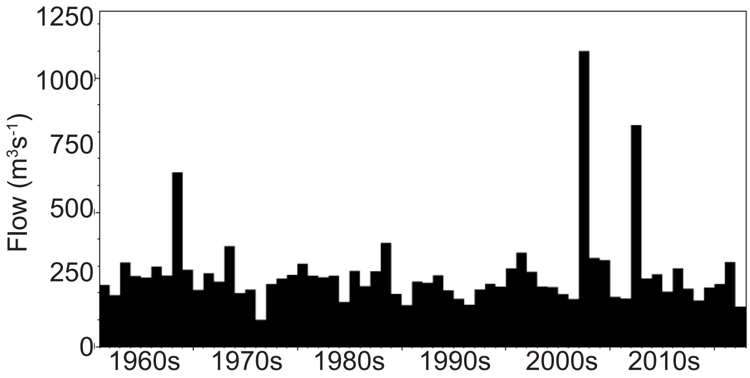
July 2022 rainfall as % of 1991-2020 average



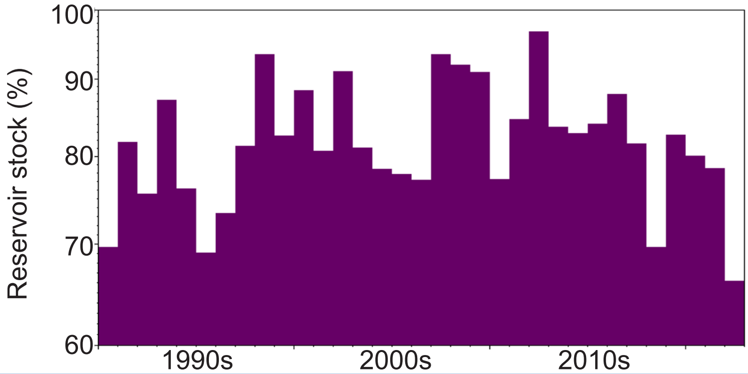
June 2022 - July 2022 rainfall as % of 1991-2020 average



July average outflows for England & Wales



End of July reservoir stocks for England & Wales



UK Hydrological Outlook

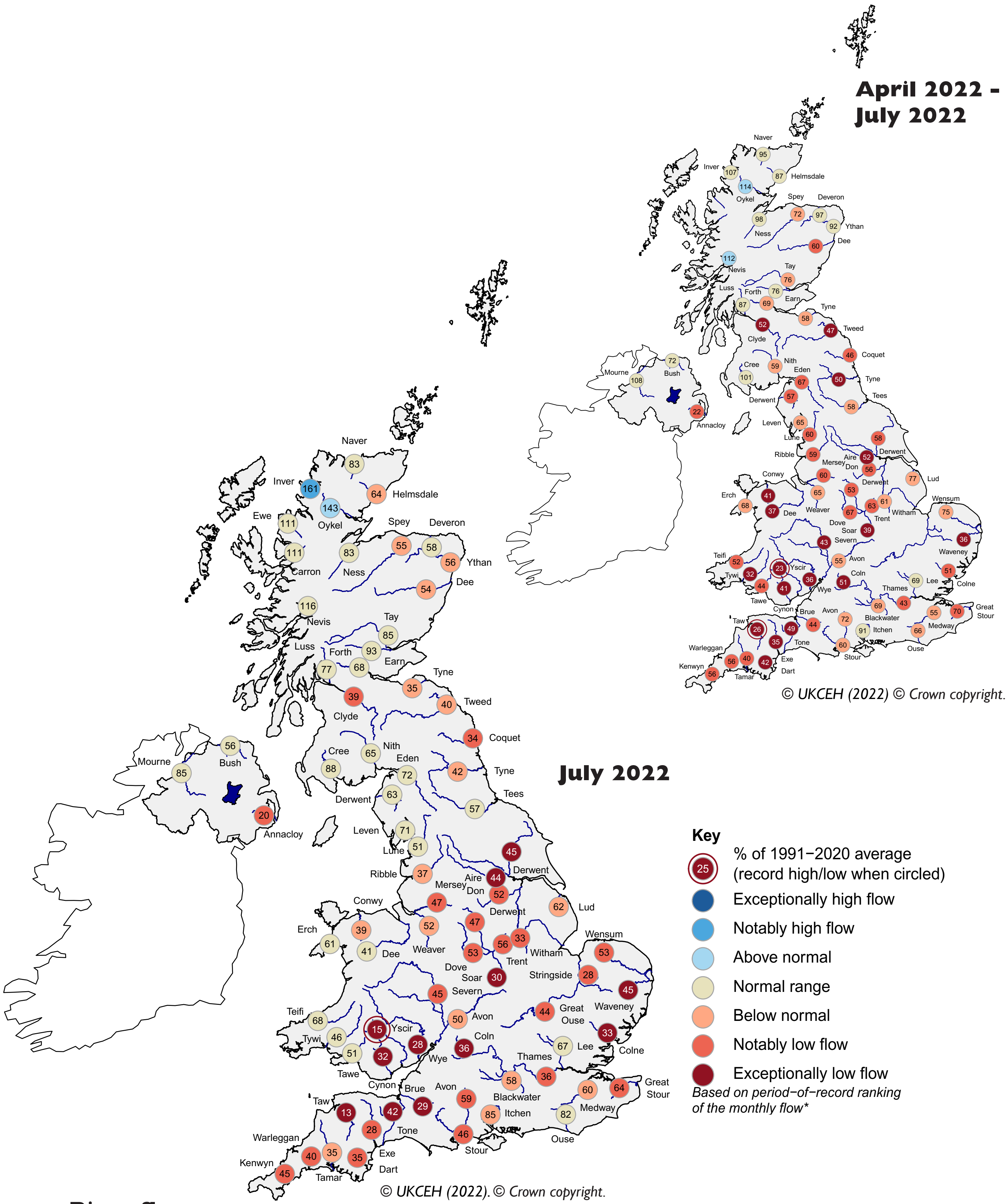
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from August 2022**
Issued: **08.08.2022**
using data to the end of July 2022

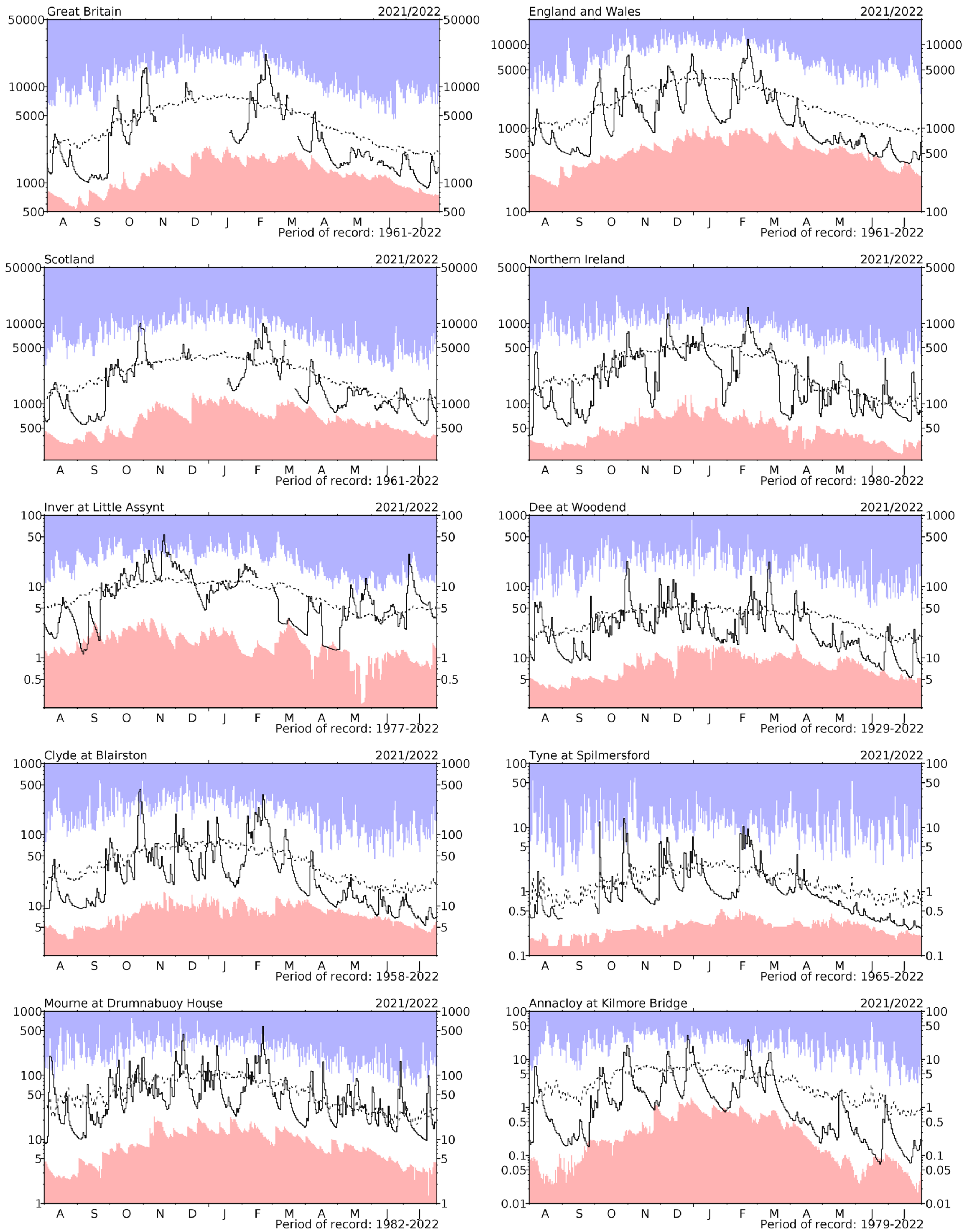
The outlook for August and for the August-October period is for river flows to be below normal, exceptionally so in central and southern England. In northern and western areas of the UK, flows are likely to be normal to below normal. Groundwater levels in August are likely to be normal in central and northern UK, below normal elsewhere, and notably or exceptionally so in southern England and south Wales. Over the three month period (August-October), levels will follow a similar pattern, however there is uncertainty regarding the timing of the onset of the recharge season in autumn.

River flow . . . River flow . . .



River flows

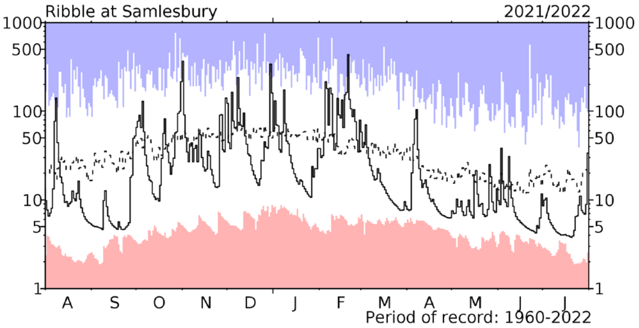
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

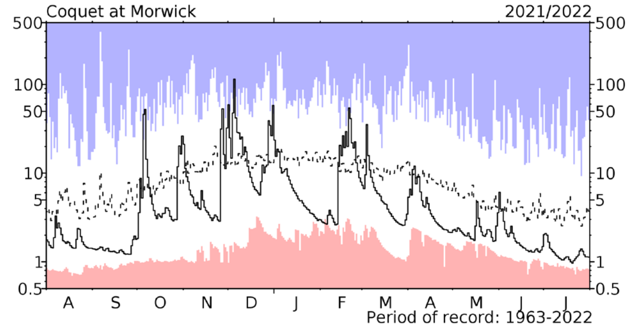


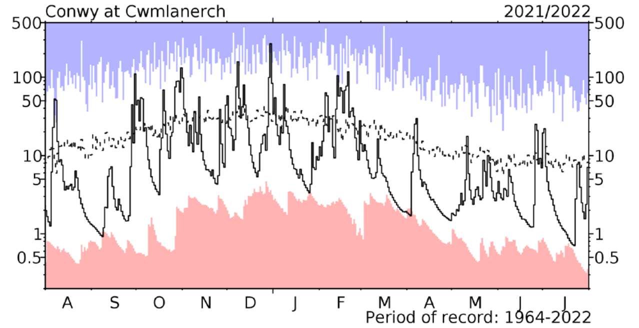
River flow hydrographs

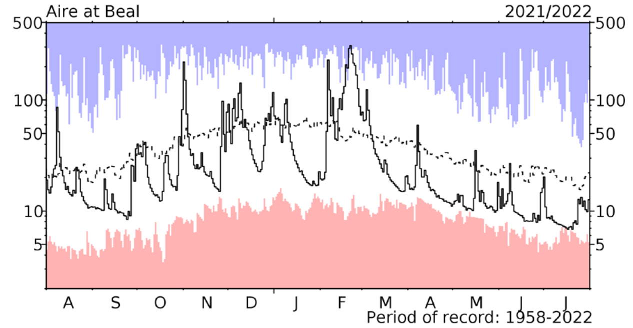
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to August 2021 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

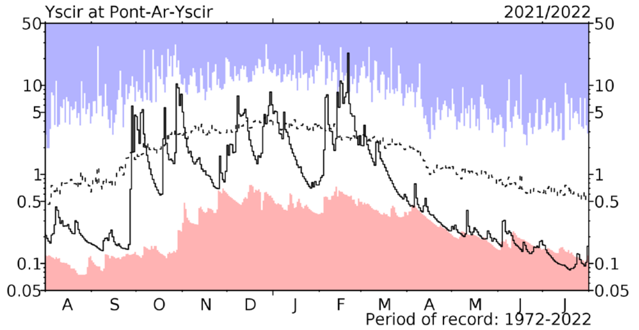
River flow . . . River flow . . .

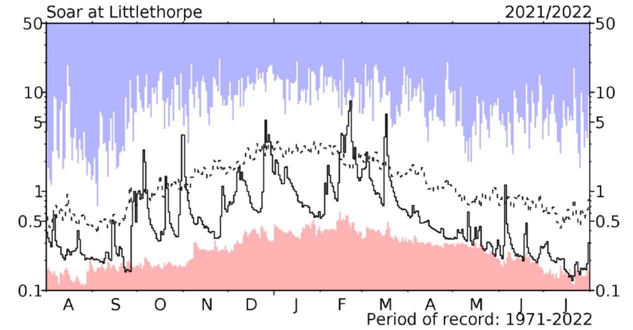


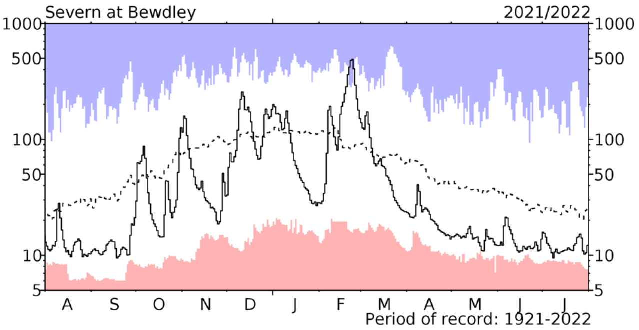


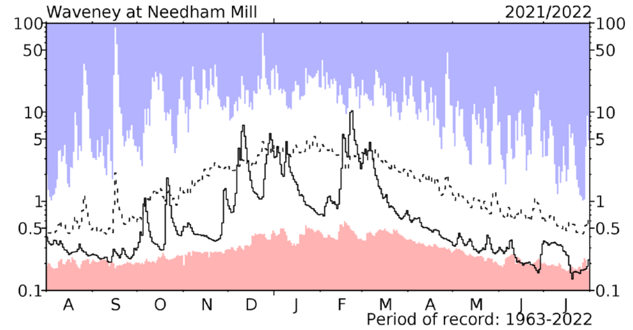


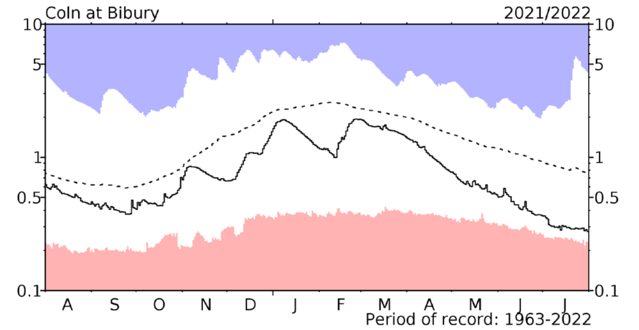


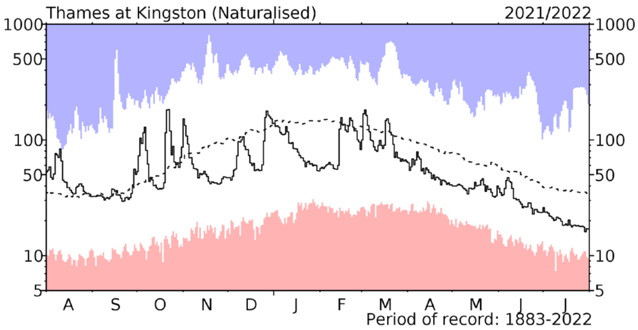


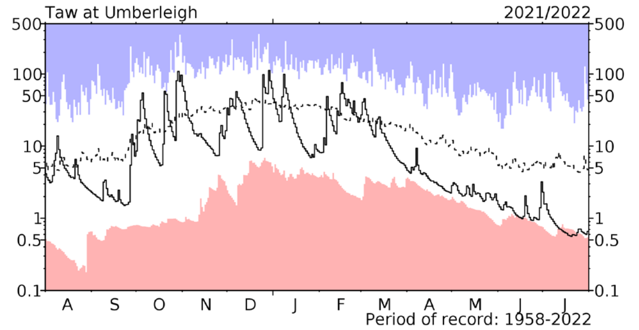


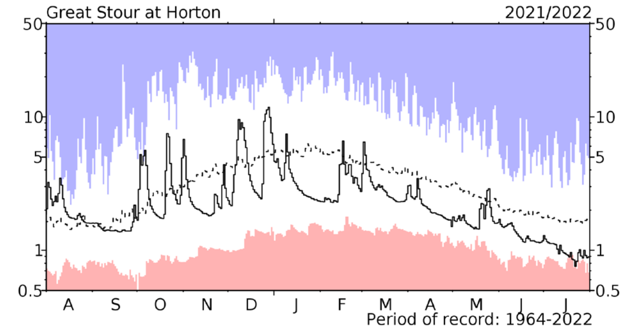


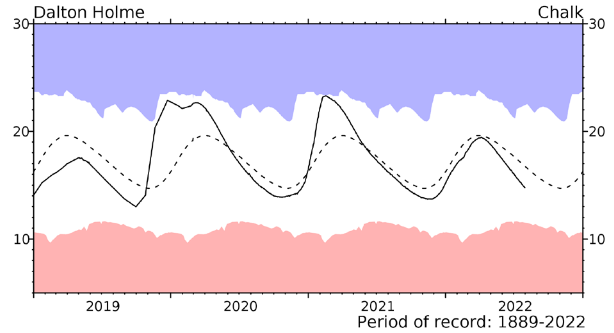


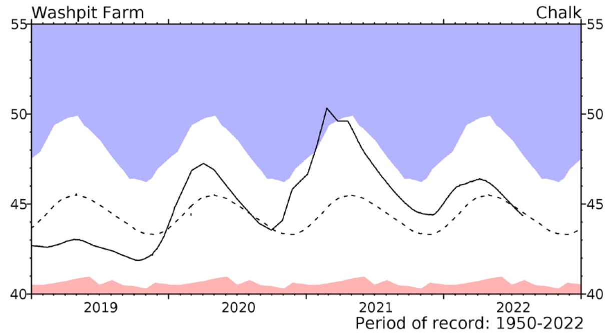


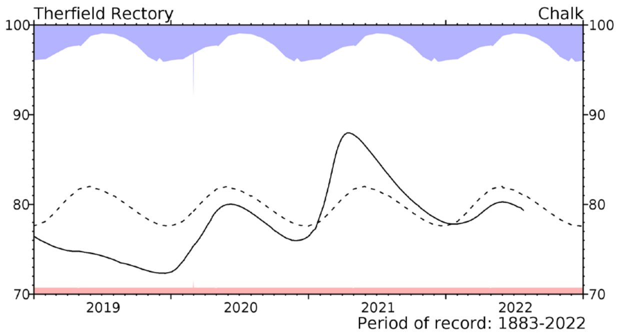


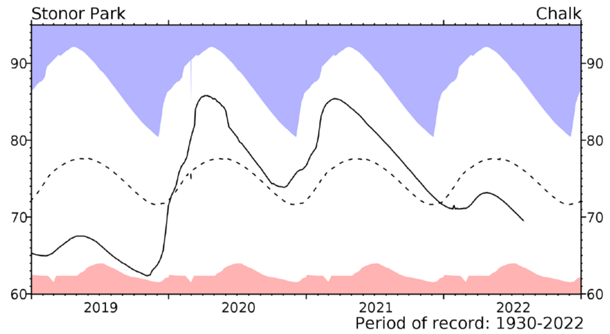


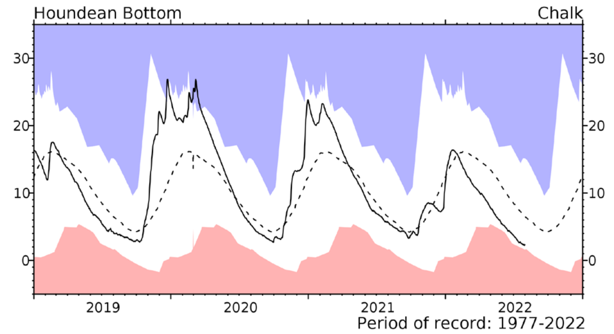


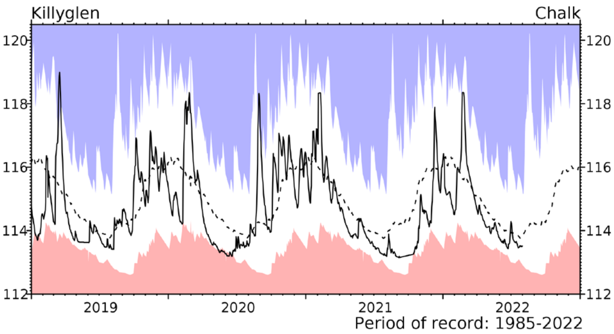


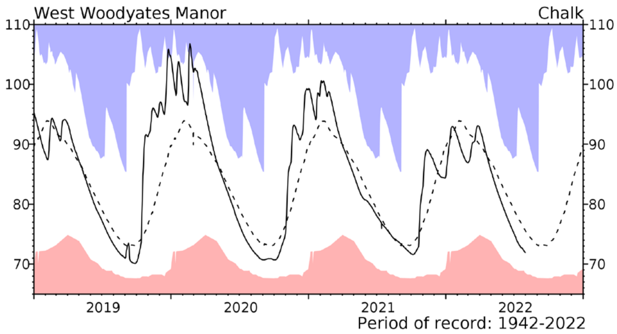


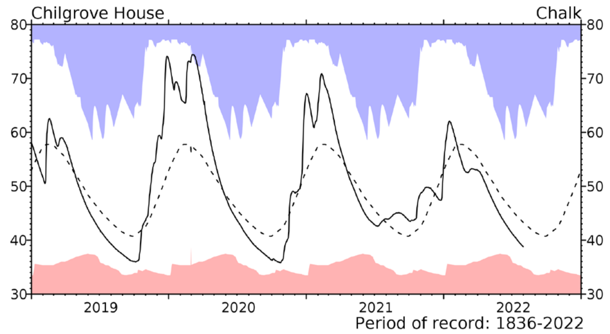


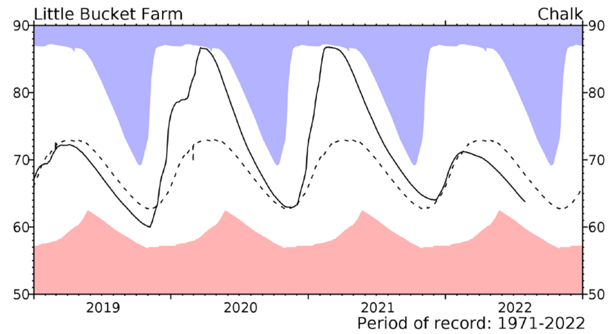


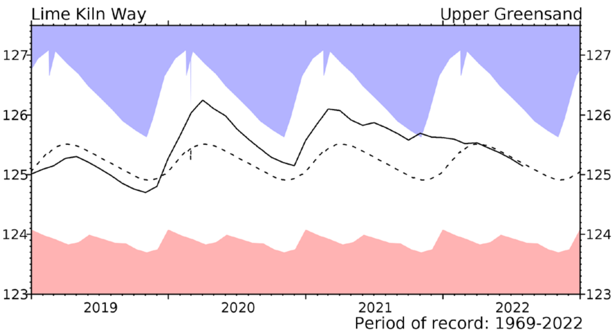






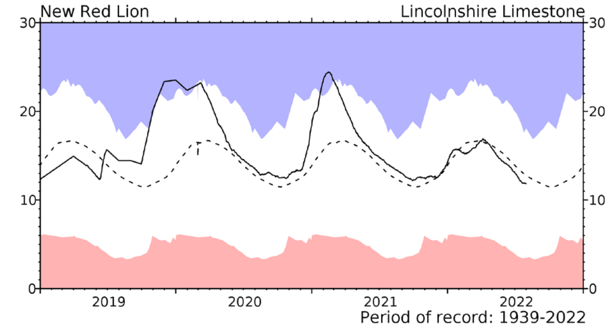


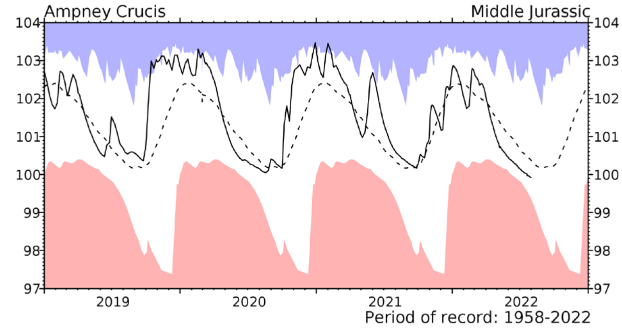


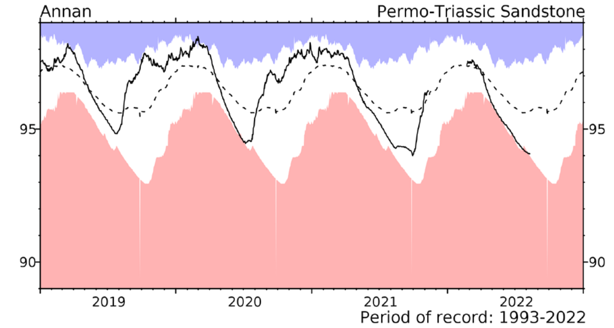


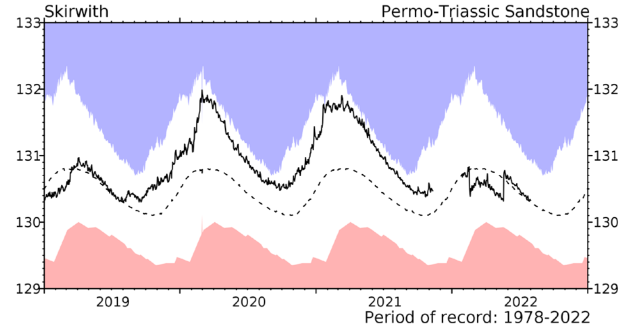
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

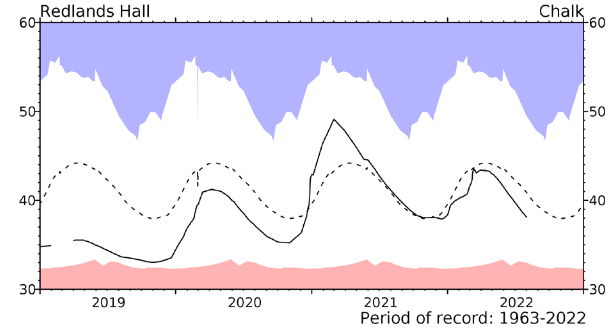
Groundwater... Groundwater

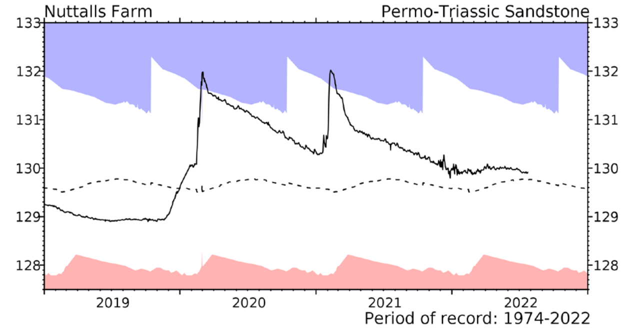


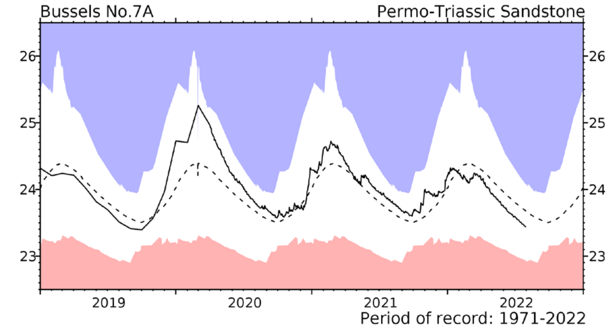


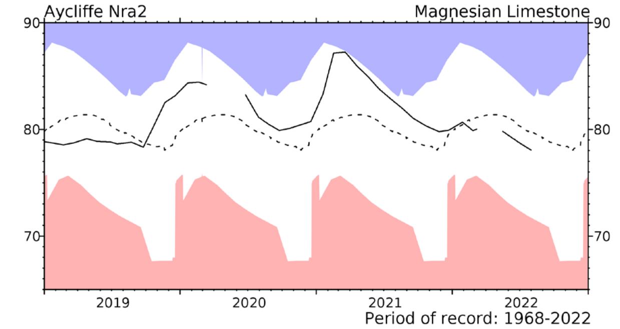


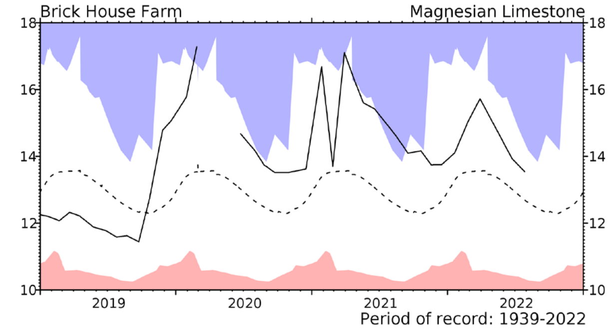


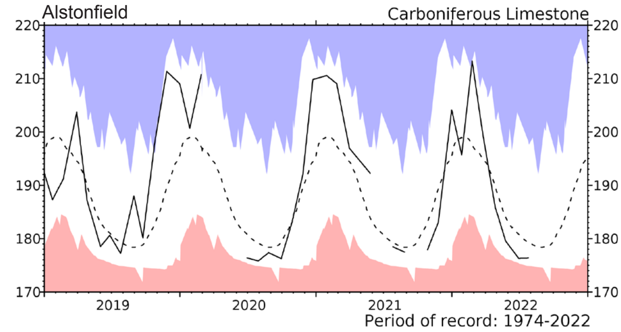


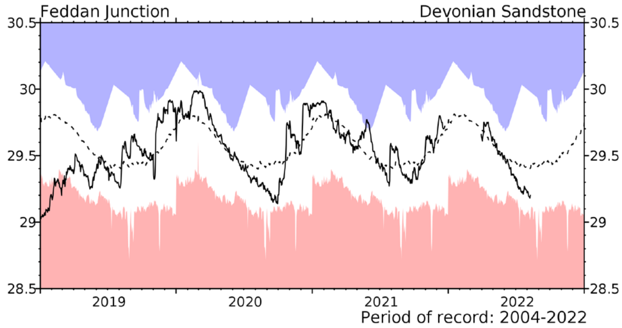


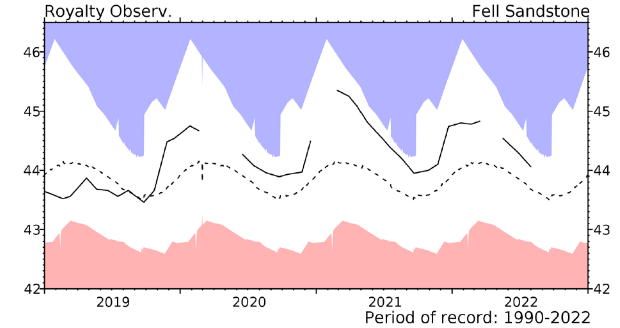










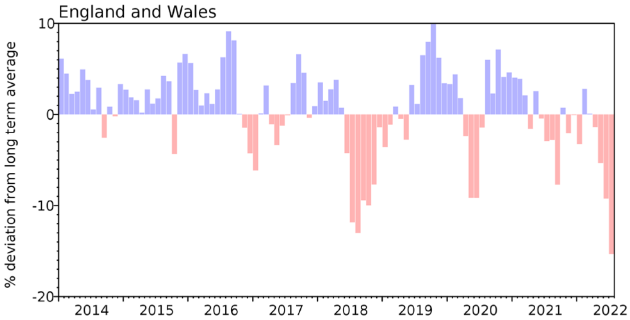


Groundwater levels - July 2022

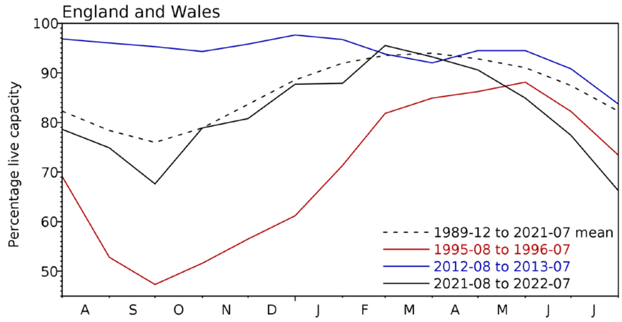
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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

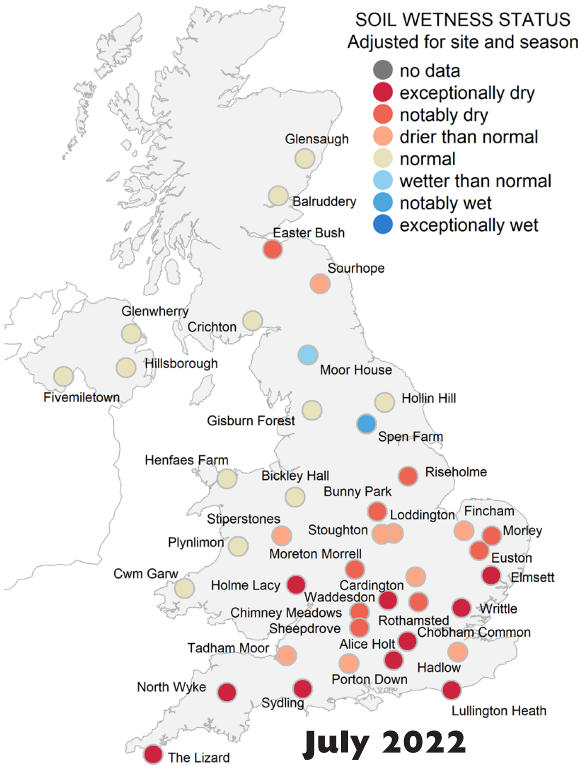
Area	Reservoir		Capacity (Ml)	2022 May	2022 Jun	2022 Jul	Jul Anom.	Min Jul	Year* of min	2021 Jul	Diff 22-21
North West	N Command Zone	•	124929	71	63	53	-10	23	1984	53	-1
	Vyrnwy		55146	82	73	57	-21	45	1984	79	-22
Northumbrian	Teesdale	•	87936	92	83	73	-1	45	1989	57	16
	Kielder		(199175)	91	88	82	-7	66	1989	85	-3
Severn-Trent	Clywedog		49936	96	85	66	-20	50	1976	87	-21
	Derwent Valley	•	46692	72	59	45	-28	43	1996	65	-21
Yorkshire	Washburn	•	23373	77	68	50	-24	50	2022	76	-26
	Bradford Supply	•	40942	74	61	47	-25	38	1995	69	-22
Anglian	Grafham		(55490)	96	91	78	-11	66	1997	96	-17
	Rutland		(116580)	94	90	83	-4	74	1995	93	-11
Thames	London	•	202828	96	91	75	-12	73	1990	89	-14
	Farmoor	•	13822	93	92	89	-8	84	1990	98	-9
Southern	Bewl		31000	80	72	64	-13	45	1990	82	-18
	Ardingly		4685	88	75	57	-28	57	2022	95	-39
Wessex	Clatworthy		5662	81	71	60	-13	43	1992	79	-19
	Bristol	•	(38666)	81	73	62	-13	53	1990	72	-10
South West	Colliford		28540	68	56	43	-34	43	2022	77	-33
	Roadford		34500	88	74	60	-17	46	1996	87	-27
	Wimbleball		21320	80	64	49	-29	49	2022	84	-35
	Stithians		4967	77	61	44	-27	39	1990	74	-31
Welsh	Celyn & Brenig	•	131155	83	75	65	-23	65	1989	84	-19
	Brianne		62140	76	68	64	-26	64	2022	78	-14
	Big Five	•	69762	77	67	54	-23	41	1989	66	-12
	Elan Valley	•	99106	75	65	53	-28	53	2022	73	-20
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	90	84	77	-6	51	1998	74	3
	East Lothian	•	9317	98	90	80	-10	72	1992	96	-16
Scotland(W)	Loch Katrine	•	110326	95	93	88	13	53	2000	58	30
	Daer		22494	79	77	71	-9	54	2021	54	17
	Loch Thom		10721	92	84	82	-2	55	2021	55	27
Northern	Total+	•	56800	84	79	77	0	54	1995	66	12
Ireland	Silent Valley	•	20634	82	76	73	0	42	2000	59	15

( ) 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

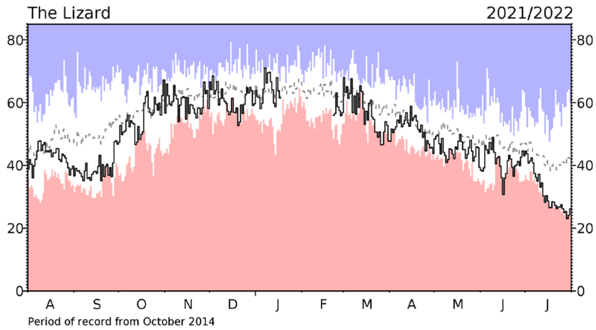


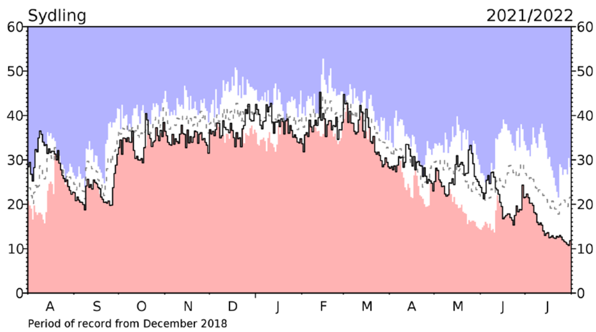
At the end of July, soils across the UK were dry for the time of year and were extremely dry in some areas in the south of England.

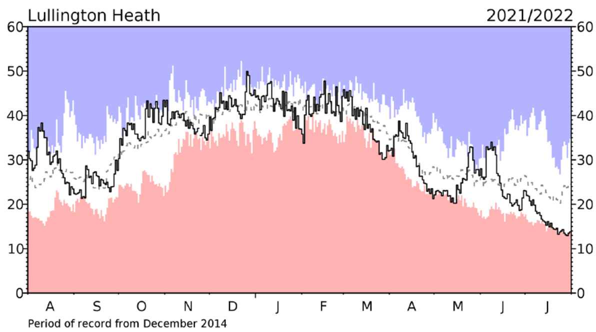
Much of the UK experienced significantly warm and dry conditions throughout July with record-breaking air temperatures in many regions and below-average rainfall. The highest air temperatures on the COSMOS-UK record were measured at 43 of 46 active sites in July, with the highest at Cardington of 39.5°C. The heatwave conditions, particularly in the south and midlands led to rapid and sustained soil drying. Many sites that began July with normal soil moisture levels ended the month with dry or extremely dry soils for the time of year (e.g. The Lizard, Sydling and Lullington). Other sites which either started the month with wetter soils and/or received substantial precipitation still ended the month below field capacity, as would be expected for the time of year.

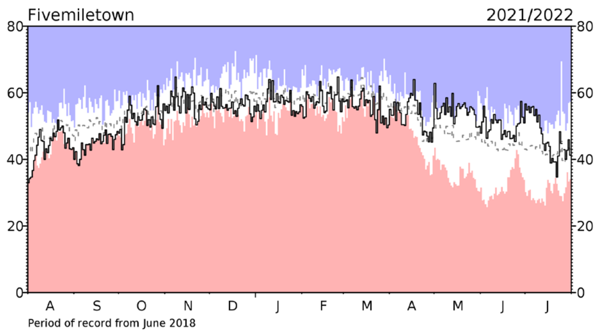
North-westerly parts of the UK received more rain than the south, however total precipitation was still much lower than normal. Sites that began July with extremely wet or wetter than normal soils in this region subsequently dried to normal levels for the time of year (e.g. Fivemiletown).

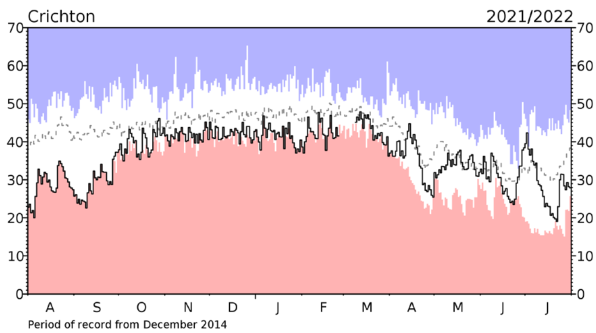
Northern parts of the UK received closer to average amounts of rainfall, which resulted in sites in these regions maintaining normal levels of soil moisture for the time of year (e.g. Crichton).











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

08/2022

UK-SCAPE
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UKRI Natural Environment Research Council