Hydrological Summary for the United Kingdom

November 2022

General

November was an unsettled and mild month, and for the UK as a whole, it was the third warmest November in a series from 1884. Following the exceptionally dry summer, November concluded a wet autumn with UK total rainfall a fifth above average. Correspondingly, river flows were generally above normal to exceptionally high, with between twice and four times the average in some catchments. Soils were wetter than average in all regions and soil moisture deficits (SMDs) were eliminated in some. Groundwater levels responded to the November rainfall in many areas, with some steep increases in the more responsive aquifers. Reservoir stocks increased at almost all impoundments, some substantially so (e.g. Ardingly increased by 47% relative to average). Despite this, many remained well below average, including Colliford which set a new November minimum of 25% of capacity (in a series from 1988). The very wet autumn has been transformative, and the recharge season has commenced in many areas – although it does so from well below average. This, coupled with the dry start to December and a winter outlook favouring normal to below normal flows and groundwater levels (e.g. in much of the south and east of England), means that water resource concerns remain in some areas. Winter rainfall will be important for securing supplies for the spring and summer.

Rainfall

November was characterised by a succession of low pressure systems, bringing wet and stormy weather to much of the UK, with only brief dry spells in between. The first week brought rain and thunderstorms to England and Wales (e.g. 65mm at Garnsllt Sewage Works, Dyfed), resulting in road and rail disruption across the country. A calmer period followed from the 5th-13th, although with some localised heavy rainfall in northern Scotland – e.g. 116mm on the 10th at Achnagart (Ross & Cromarty). Unsettled conditions then returned to much of the UK, with multiple weather warnings issued and some notable rainfall totals, e.g. 71mm on the 18th at Aboyne (Aberdeenshire), 68mm on the 21st at Trassey (Down), 95mm on the 26th at White Barrow (Devon). From the 27th to month-end conditions were more settled and wintry across the UK. For the UK as a whole November rainfall was 129% of average, with over 130% registered across much of England and southern Wales. Over one and half times the average was registered in a band from south Wales to East Anglia and along the south coast of England, where large parts received over 170% of average rainfall. It was the third wettest November for the Southern region with around twice the average, and the fifth wettest for the Tay region (162% of average), both in series from 1836. The Anglian, Thames, Wessex and South West regions all registered over 150% of the November average. In contrast, less than 90% of average rainfall was recorded in northern and south-western Scotland. For the autumn (Sep-Nov), rainfall was over 130% of average across much of the UK, with 149% of average in Southern region. Nevertheless, over the longer term, deficits are still evident across the UK: over the last 12 months, less than 90% of average rainfall was recorded across most of England and Wales and northern parts of Scotland.

River flows

River flows responded rapidly in many catchments in the first week (from a below-average position in the north) but thereafter recessions generally became established until mid-month when various heavy rainfall episodes triggered further flow responses. New daily flow maxima were set in many catchments between the 16th and 18th, with some rivers also registering their second highest November peak flows (e.g. the Coquet and Tawe in series from 1966 and 1957, respectively). Flows increased sharply again towards month-end in most responsive catchments, notably so in parts of southern England. Outflows from Great Britain remained above average for much of November, reflecting the numerous rainfall responses seen across the country. November mean flows were generally above average across the UK, with the majority registering as above normal to notably high. New November maxima were established on the Tawe and Dart (in 65- and 64-year records, respectively), with exceptionally high flows also recorded in southern England and eastern and southern Scotland. Flows on the Medway and Ouse were 320% and 413% of their November averages and ranked as the third and second highest Novembers in series from 1956 and 1960, respectively. Flows remained below average in Chalk catchments (e.g. 24% and 30% of average on the Stringside and Waveney, respectively) but they were in the normal range to below normal, in contrast with the notably to exceptionally low flows of recent months. The picture for autumn was similar to that for November, albeit with more catchments in the normal range or below, with flows in the Chalk catchments approaching or less than half the average for this period (e.g. Lud, Stringside, Coln). Over the last 12 months, flows were in the normal range or below across large parts of the country.

Groundwater

SMDs were eliminated in regions in the north-east of the UK and although soils were wetter than average at month-end, deficits remained elsewhere – most notably so around The Wash and Humber Estuary. Groundwater levels rose in about two-thirds of Chalk boreholes, where the recharge season has now commenced. Very steep responses to high rainfall were observed in the southern Chalk, with a rise in groundwater level of over 25m at Chilgrove House. Having recorded a record low for October, Chilgrove House had notably high levels at the end of November. Increases also occurred in the Chalk of Yorkshire; elsewhere levels mostly continued to fall. In the Jurassic limestones and Magnesian Limestone levels mostly rose and were in the normal range or above normal. Appreciable recharge occurred at Ampney Crucis which became notably high. Notable recharge also occurred in the Carboniferous Limestone, where levels at Pant y Lladron rose over 25m, from a record low for October to the normal range by the end of November. In the Permo Triassic sandstones, levels were mainly in the normal range and rose in over half of the boreholes. The level at Lime Kiln Way in the Upper Greensand was fairly stable and remained in the normal range. A record November low level was observed at Feddan Junction in the Devonian sandstones of Moray, and levels remained below normal, but rising, at Easter Lathrisk. Levels at Royalty Observatory (Fell Sandstone) were close to average, but indicated the onset of winter recovery.

National Hydrological Monitoring Programme

UK Centre for Ecology & Hydrology

BGS British Geological Survey

Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Percentages are from the 1991-2020 average.

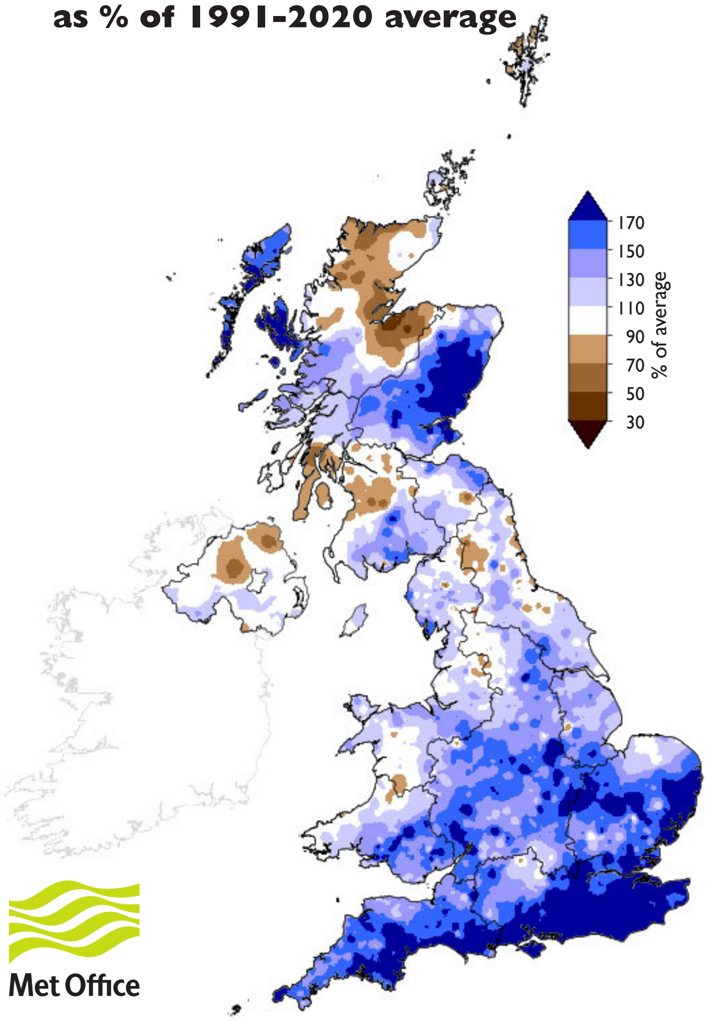
Region	Rainfall	Nov 2022	Sep22 – Nov22	RP	Jun22 – Nov22	RP	Mar22 – Nov22	RP	Dec21 – Nov22	RP
United Kingdom	mm	**160**	403		559		733		1055	
	%	**129**	119	5-10	95	2-5	90	2-5	91	2-5
England	mm	**134**	309		412		529		747	
	%	**145**	123	5-10	90	2-5	84	5-10	86	2-5
Scotland	mm	**200**	530		770		1035		1494	
	%	**121**	116	5-10	99	2-5	96	2-5	95	2-5
Wales	mm	**200**	489		653		814		1267	
	%	**123**	113	2-5	89	2-5	80	5-10	87	2-5
Northern Ireland	mm	**119**	433		608		818		1146	
	%	**97**	134	20-30	102	2-5	99	2-5	99	2-5
England & Wales	mm	**143**	333		445		568		818	
	%	**141**	121	5-10	90	2-5	83	5-10	86	2-5
North West	mm	**153**	428		631		794		1188	
	%	**114**	114	2-5	94	2-5	88	2-5	93	2-5
Northumbria	mm	**101**	296		415		552		768	
	%	**106**	116	2-5	86	2-5	83	5-10	84	5-10
Severn-Trent	mm	**109**	270		367		477		702	
	%	**139**	121	5-10	86	2-5	80	5-10	87	2-5
Yorkshire	mm	**106**	274		380		503		747	
	%	**119**	112	2-5	82	2-5	79	5-10	86	2-5
Anglian	mm	**95**	203		280		361		507	
	%	**153**	113	2-5	80	2-5	75	8-12	80	5-10
Thames	mm	**121**	278		353		455		612	
	%	**152**	130	5-10	93	2-5	85	2-5	84	5-10
Southern	mm	**197**	379		450		555		731	
	%	**201**	149	15-25	106	2-5	96	2-5	89	2-5
Wessex	mm	**169**	355		436		570		756	
	%	**161**	131	5-10	94	2-5	88	2-5	83	5-10
South West	mm	**240**	479		601		756		1074	
	%	**164**	129	8-12	96	2-5	88	2-5	85	2-5
Welsh	mm	**197**	479		638		796		1219	
	%	**126**	115	2-5	90	2-5	81	5-10	87	2-5
Highland	mm	**212**	544		825		1159		1729	
	%	**110**	102	2-5	94	2-5	93	2-5	93	2-5
North East	mm	**151**	388		545		755		997	
	%	**134**	122	5-10	96	2-5	97	2-5	94	2-5
Tay	mm	**240**	562		779		1016		1387	
	%	**162**	140	20-35	113	5-10	105	5-10	99	2-5
Forth	mm	**149**	435		625		792		1148	
	%	**120**	125	8-12	99	2-5	91	2-5	92	2-5
Tweed	mm	**132**	387		515		679		977	
	%	**118**	126	10-15	91	2-5	88	2-5	90	2-5
Solway	mm	**218**	607		851		1075		1534	
	%	**128**	132	15-25	107	2-5	98	2-5	97	2-5
Clyde	mm	**208**	637		938		1232		1808	
	%	**103**	115	5-10	101	2-5	95	2-5	95	2-5

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

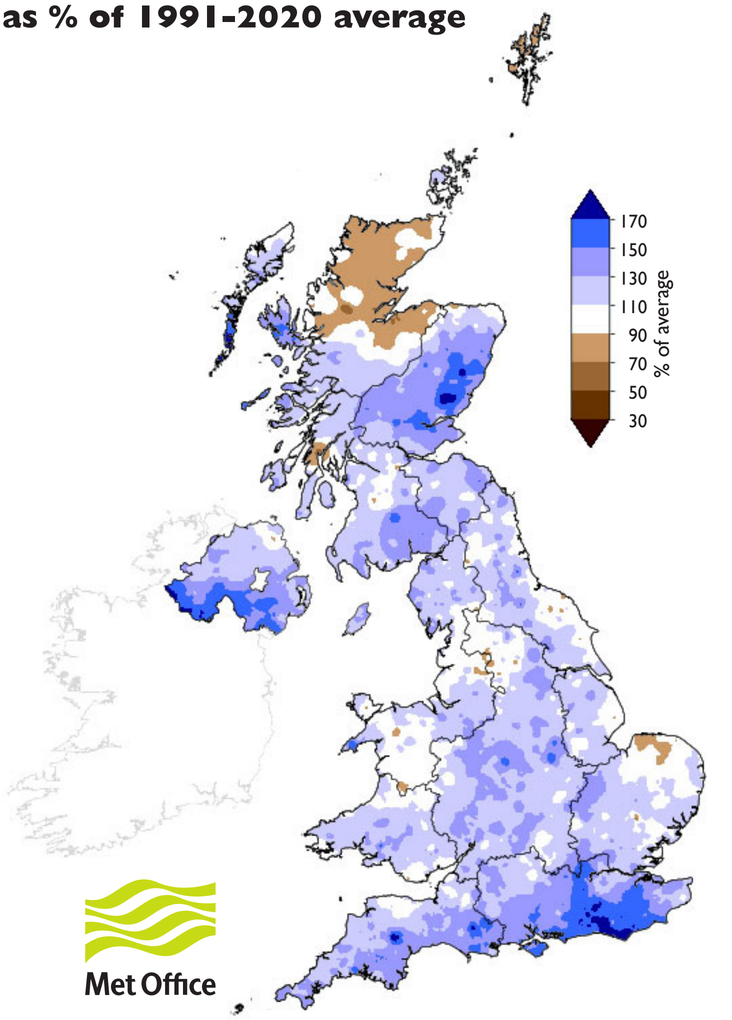
Important note: Figures in the above table may be quoted provided their source is acknowledged. Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability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

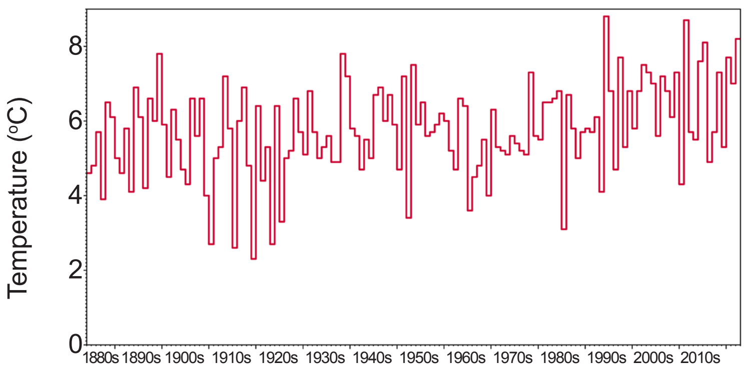
November 2022 rainfall as % of 1991-2020 average



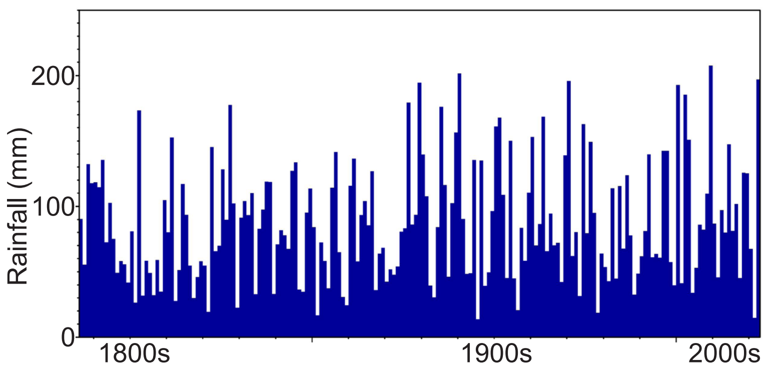
September 2022 - November 2022 rainfall as % of 1991-2020 average



November mean temperature for the UK



November rainfall for Southern region



UK Hydrological Outlook

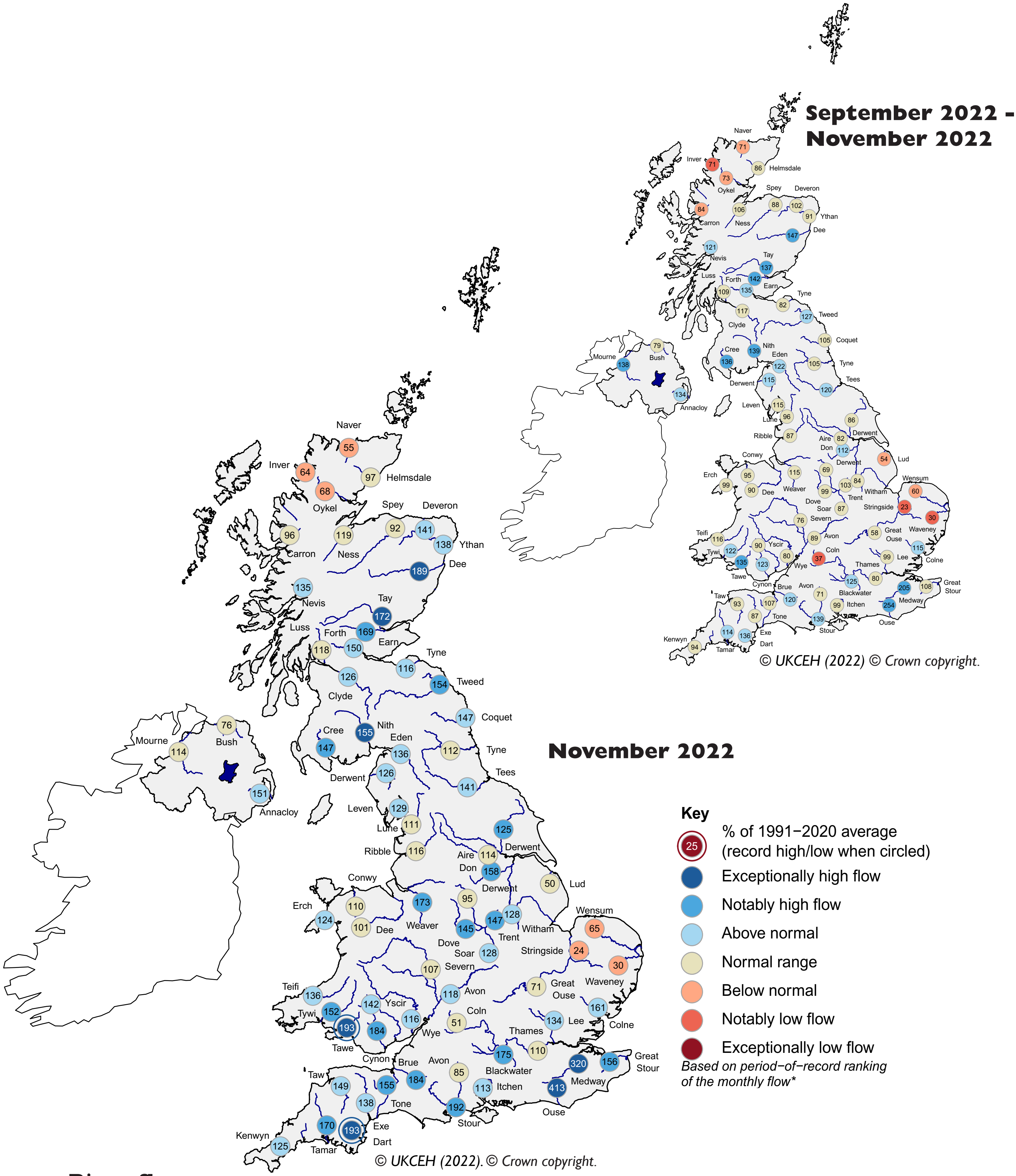
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

Period: **from November 2022**
Issued: **08.12.2022**
using data to the end of November 2022

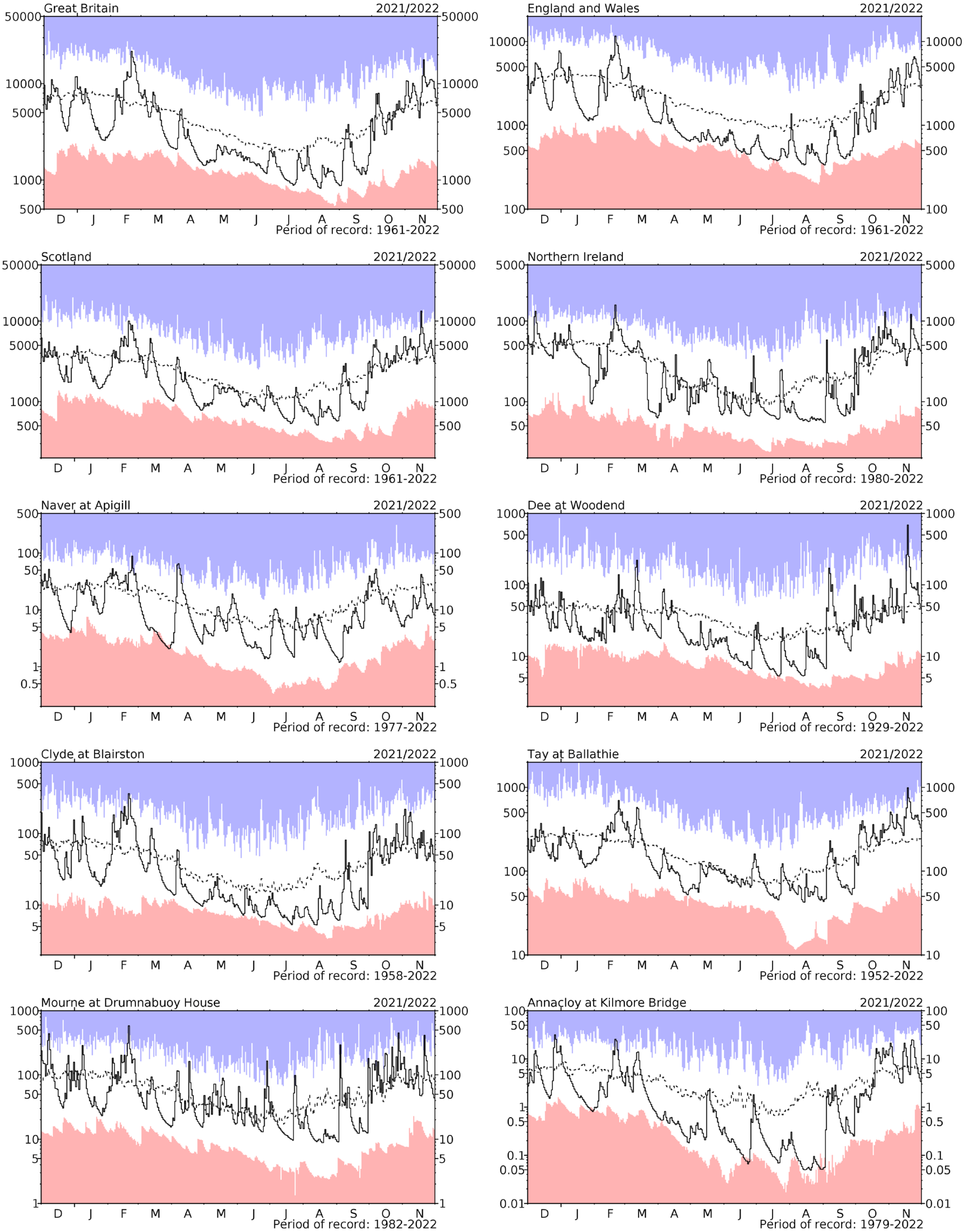
The outlook for December and for the December-February period is for normal to below normal river flows in most of the UK, except for the far southeast of England where normal to above normal flows are more likely. In East Anglia, below normal flows are likely to persist. Groundwater levels for the December-February period are likely to be normal to above normal in most of the UK, except in the northeast Chalk aquifer and north of London where normal to below normal levels are more likely.

River flow . . . River flow . . .



River flows

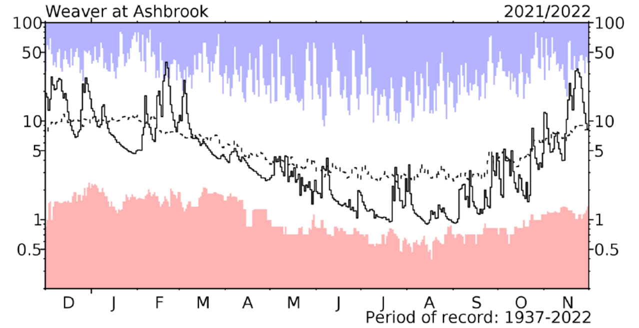
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

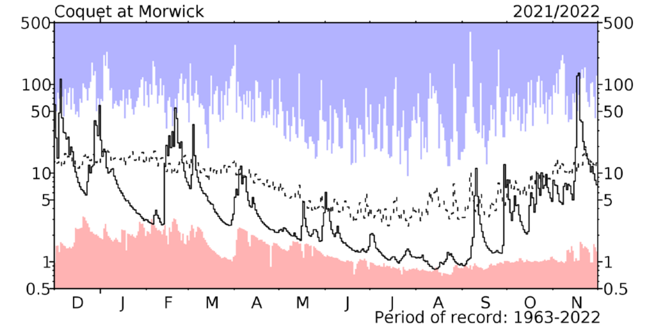


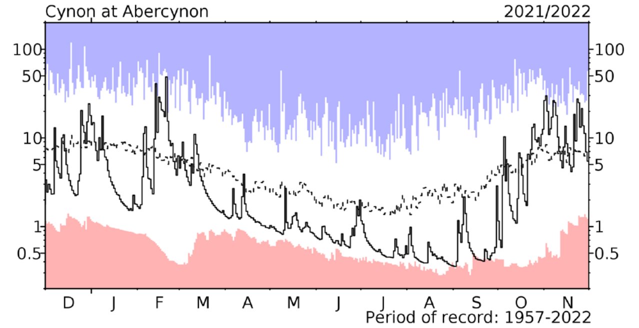
River flow hydrographs

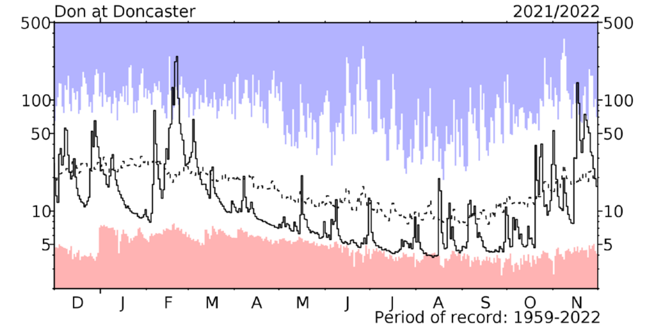
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to December 2021 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

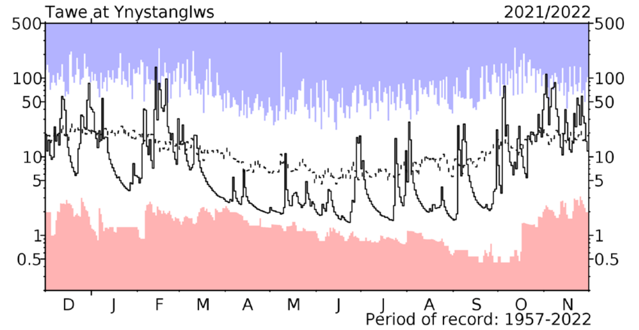
River flow . . . River flow . . .

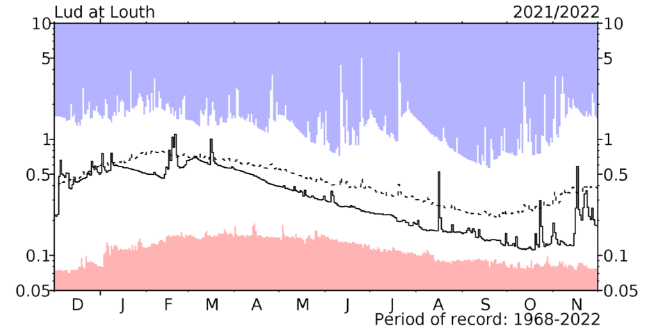


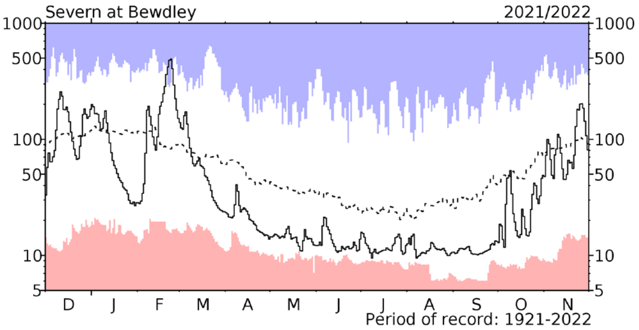


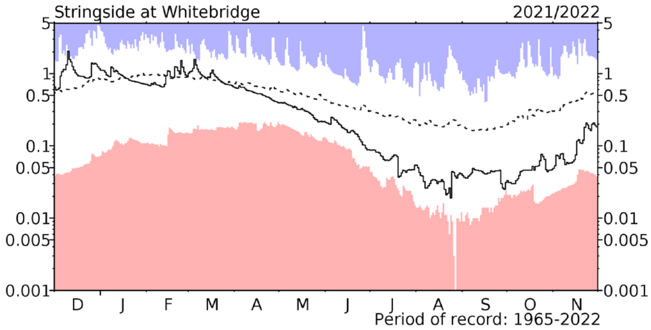


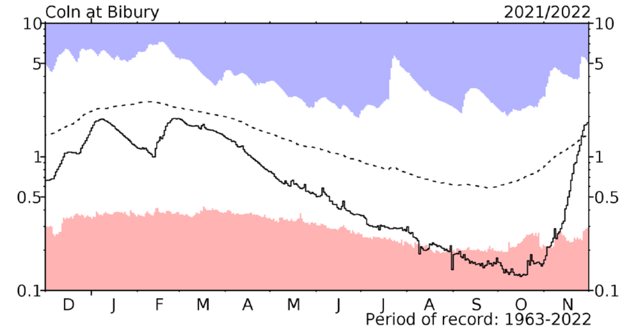


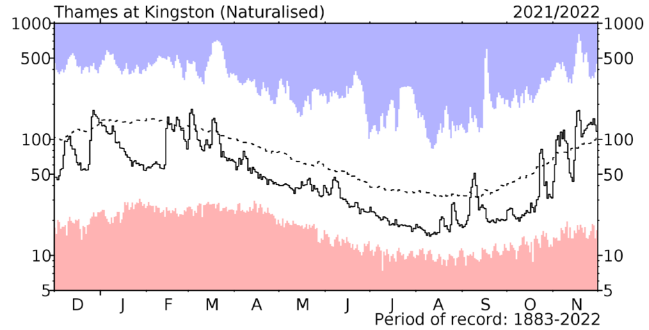


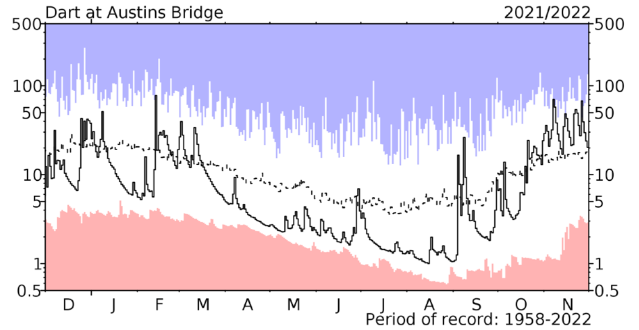


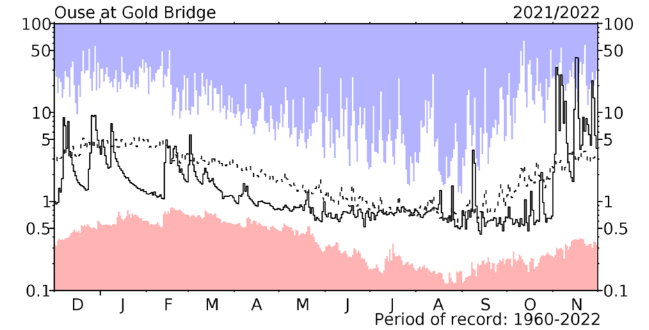




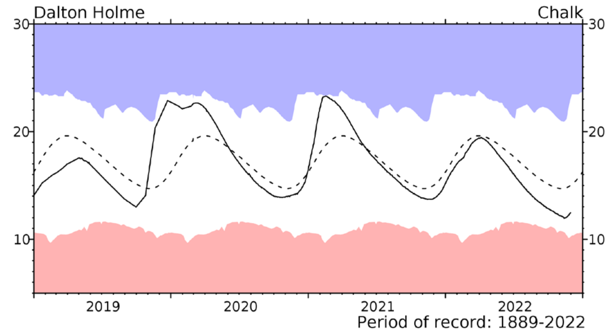


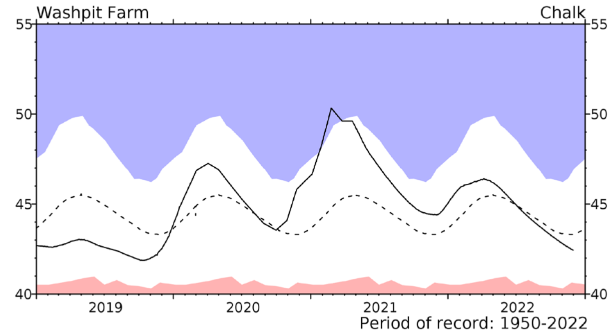


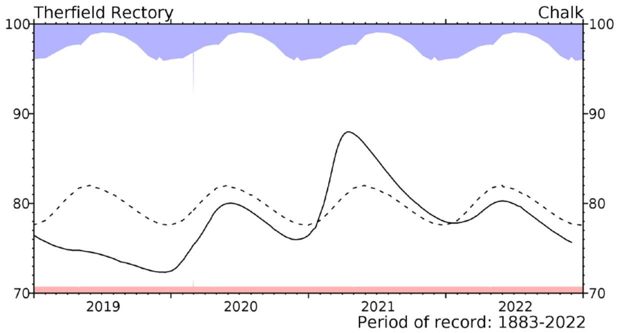


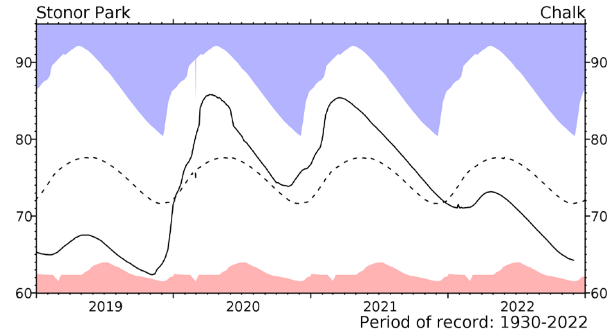


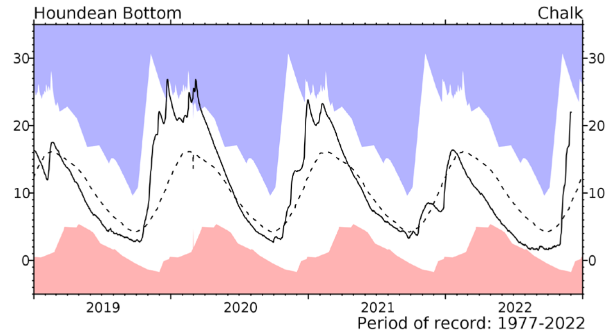
Groundwater . . . Groundwater

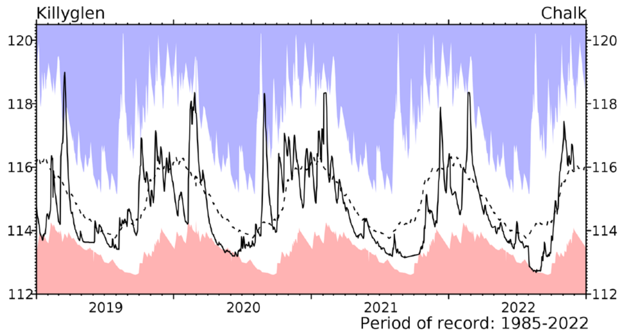


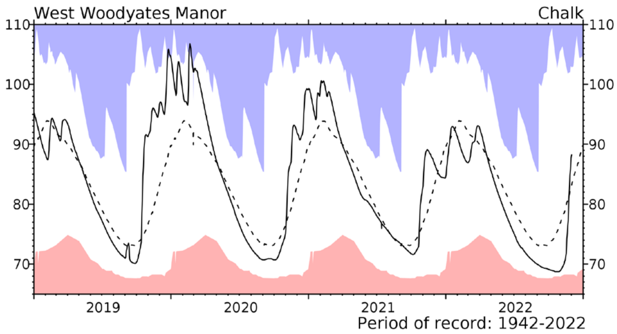


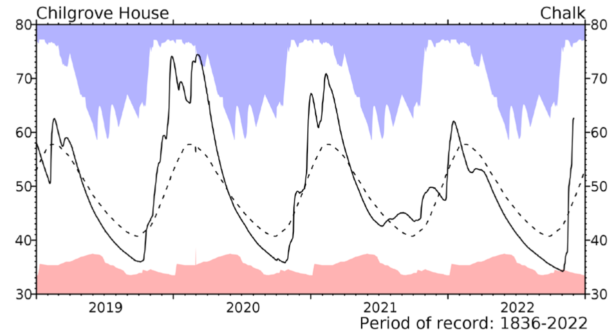


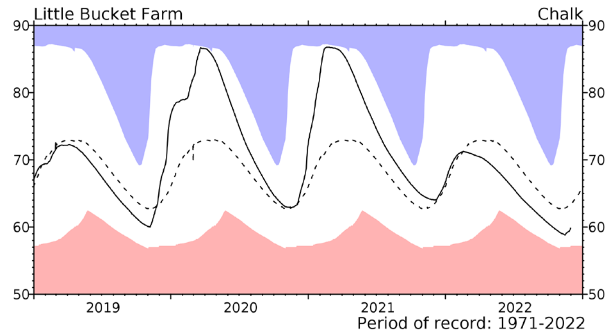


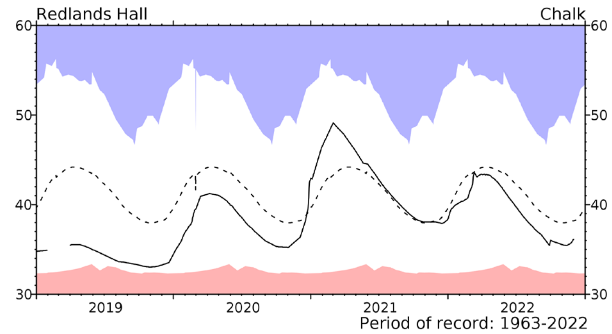






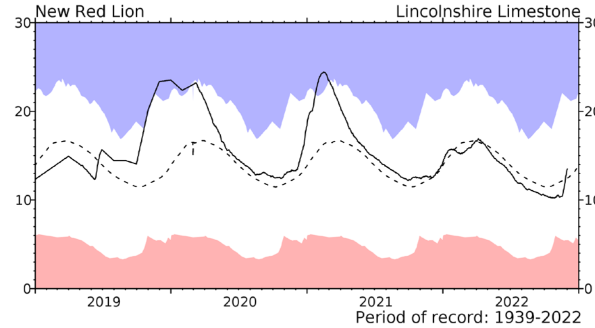


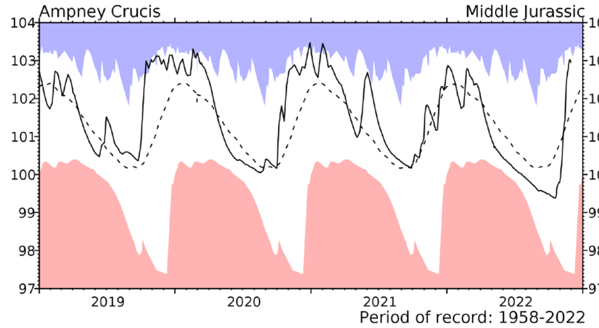


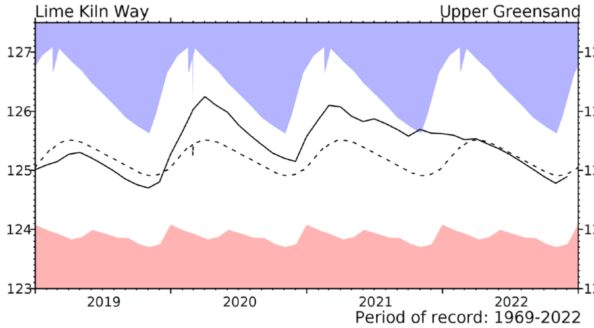


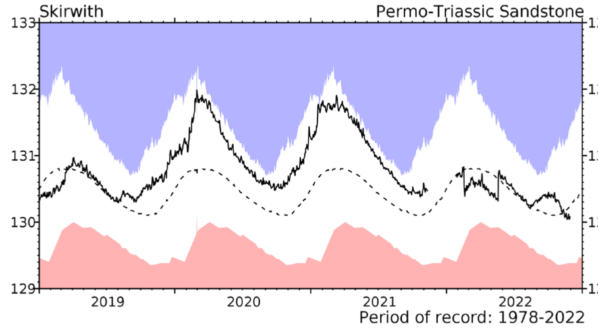
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

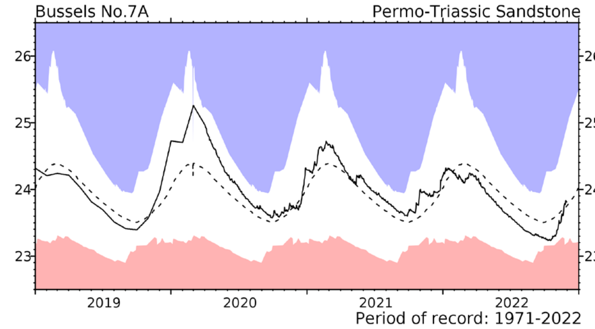
Groundwater ... Groundwater

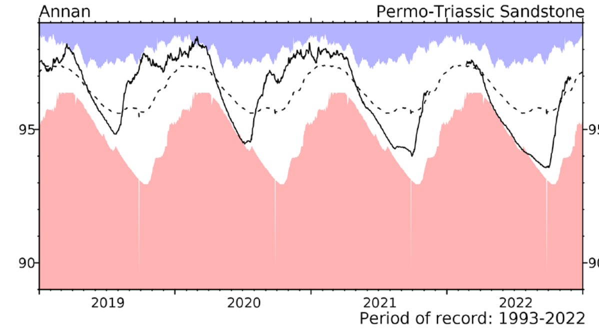


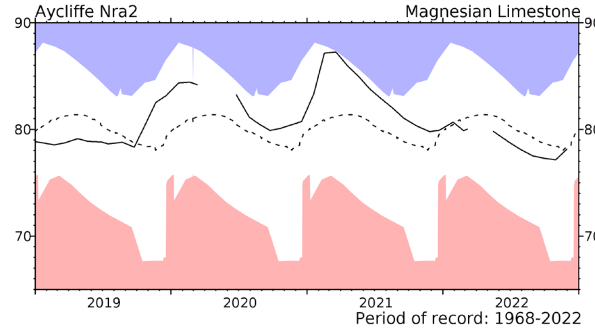


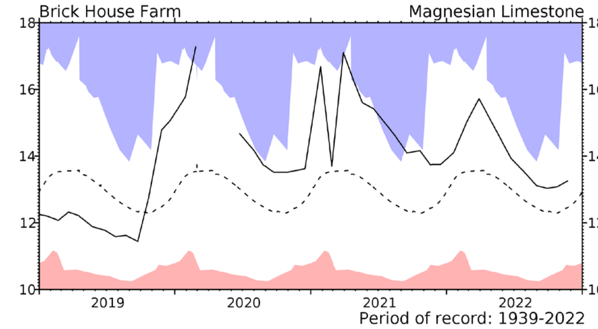


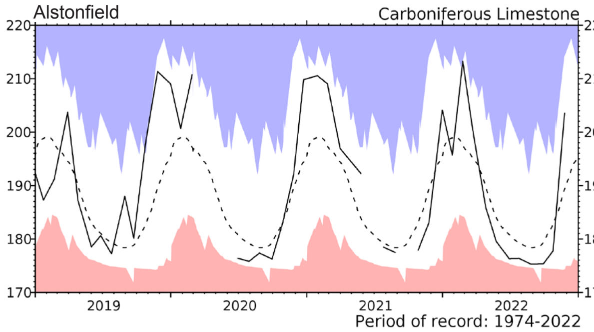


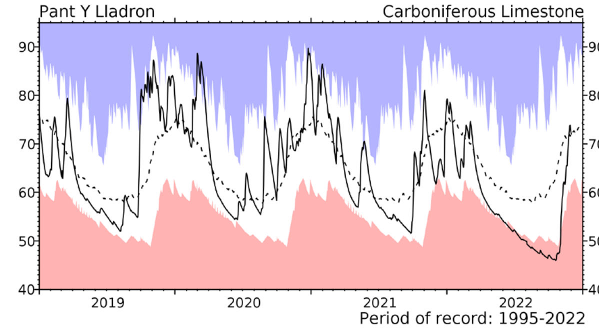


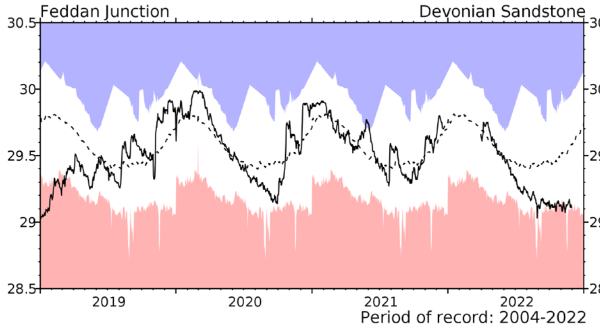


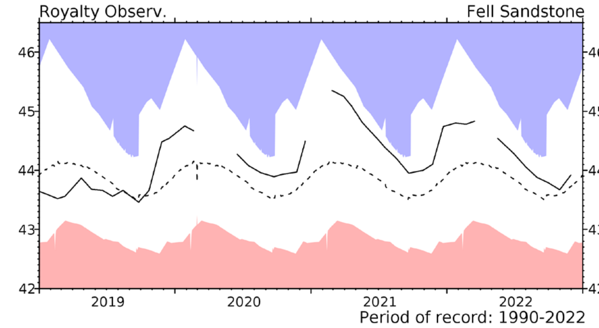




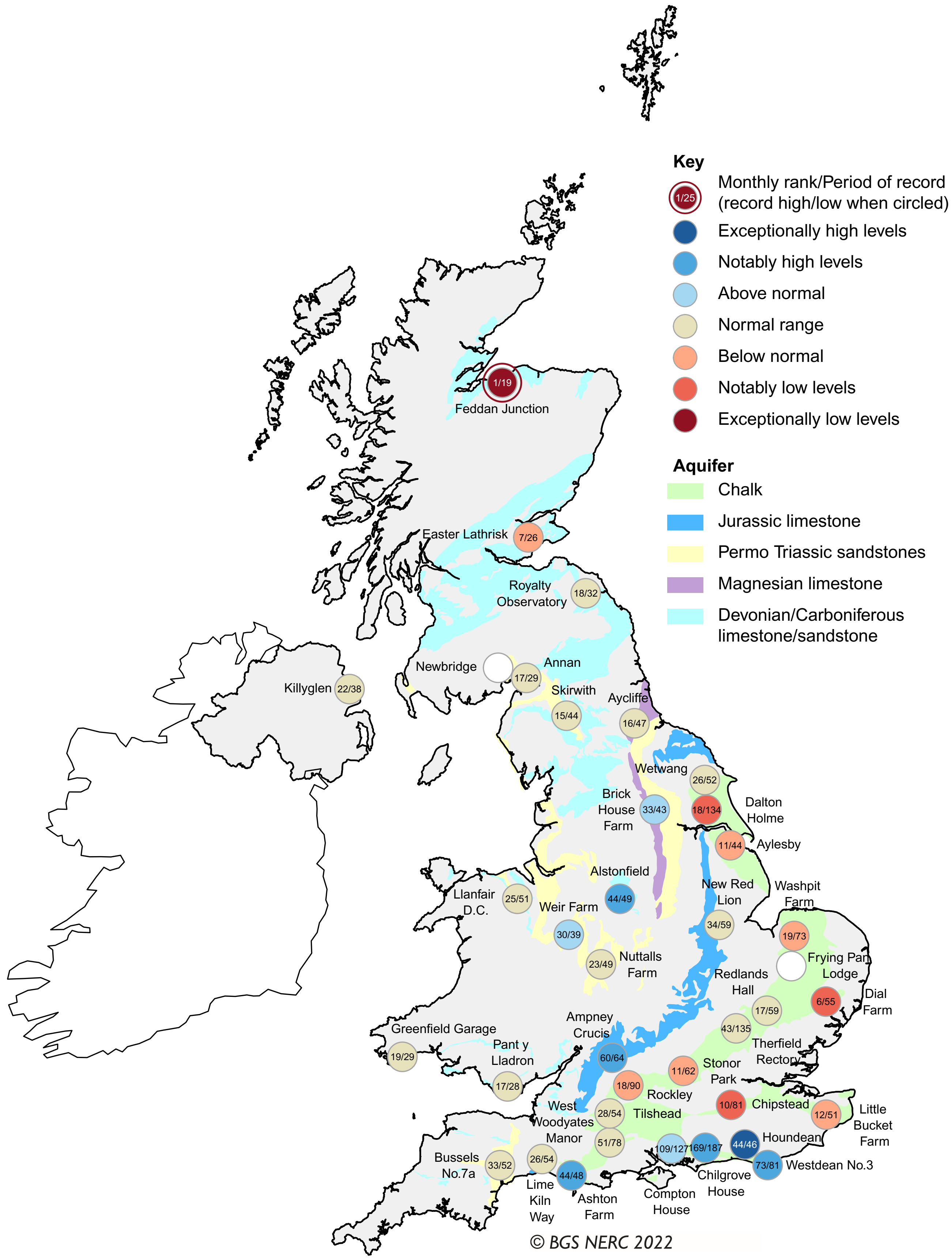








Groundwater . . . Groundwater

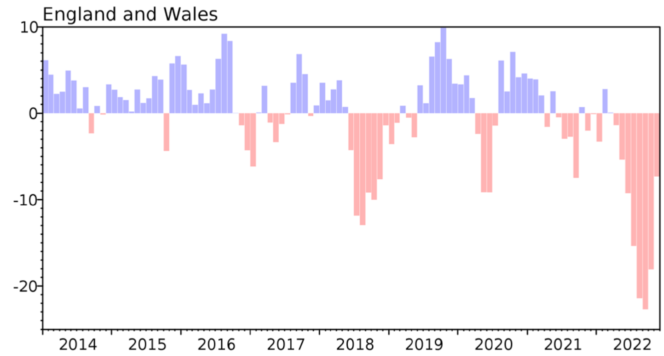


Groundwater levels - November 2022

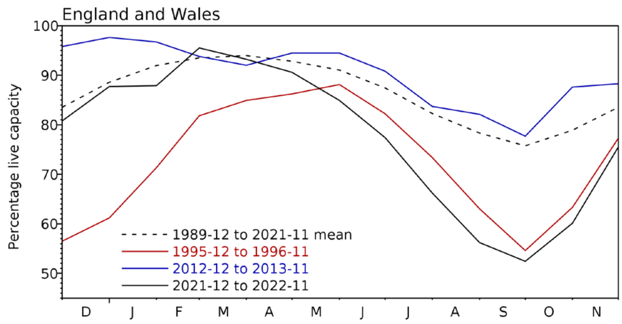
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

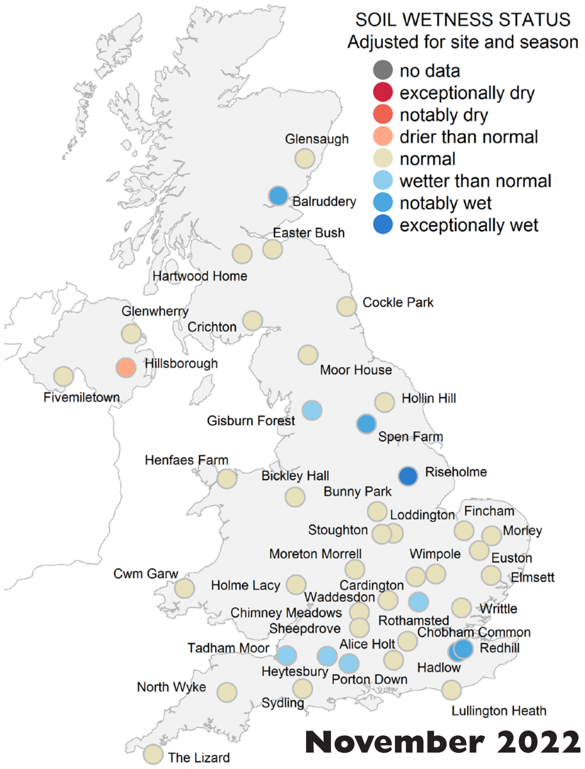
Area	Reservoir		Capacity (Ml)	2022 Sep	2022 Oct	2022 Nov	Nov Anom.	Min Nov	Year* of min	2021 Nov	Diff 22-21
North West	N Command Zone	•	124929	38	62	85	6	44	1993	76	9
	Vyrnwy		55146	37	55	83	0	33	1995	82	2
Northumbrian	Teesdale	•	87936	79	71	81	-3	39	1995	75	6
	Kielder		(199175)	88	86	91	5	55	2007	85	6
Severn-Trent	Clywedog		49936	40	54	74	-8	43	1995	88	-14
	Derwent Valley	•	46692	29	52	68	-10	9	1995	63	5
Yorkshire	Washburn	•	23373	28	42	82	5	16	1995	76	6
	Bradford Supply	•	40942	28	41	68	-14	20	1995	68	1
Anglian	Grafham		(55490)	58	57	64	-19	47	1997	94	-30
	Rutland		(116580)	70	69	77	-2	57	1995	76	2
Thames	London	•	202828	60	60	76	-5	52	1990	82	-6
	Farmoor	•	13822	63	70	84	-5	52	1990	93	-8
Southern	Bewl		31000	48	43	64	0	33	2017	72	-8
	Ardingly		4685	25	26	82	8	14	2011	100	-18
Wessex	Clatworthy		5662	30	24	71	-8	16	2003	85	-14
	Bristol	•	(38666)	46	44	70	1	27	1990	72	-2
South West	Colliford		28540	38	15	25	-48	25	2022	65	-40
	Roadford		34500	20	34	46	-29	19	1995	89	-43
	Wimbleball		21320	23	18	45	-28	34	1995	76	-30
	Stithians		4967	19	14	33	-34	29	2001	62	-29
Welsh	Celyn & Brenig	•	131155	46	58	65	-23	50	1995	85	-20
	Brianne		62140	49	83	98	2	72	1995	97	1
	Big Five	•	69762	32	52	73	-10	49	1990	80	-7
	Elan Valley	•	99106	31	51	71	-22	47	1995	81	-10
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	71	86	93	7	45	2003	88	5
	East Lothian	•	9317	67	72	100	10	38	2003	100	0
Scotland(W)	Loch Katrine	•	110326	75	96	98	6	65	2007	92	6
	Daer		22494	70	94	90	-7	73	2003	100	-10
	Loch Thom		10721	69	97	81	-13	72	2003	83	-2
Northern	Total+	•	56800	69	84	94	8	59	2003	74	20
Ireland	Silent Valley	•	20634	64	83	100	18	43	2001	65	36

( ) 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.

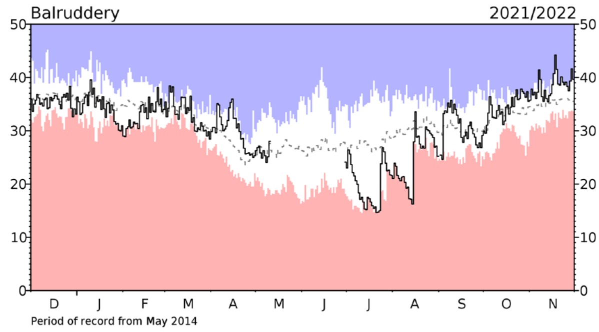
Soil Moisture . . . Soil Moisture

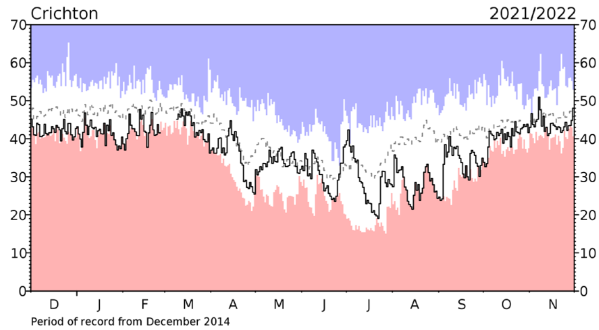


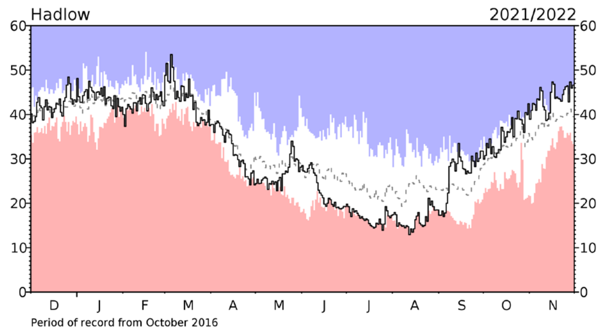
Increased precipitation throughout November has resulted in all COSMOS-UK stations wetting up to above or close to field capacity.

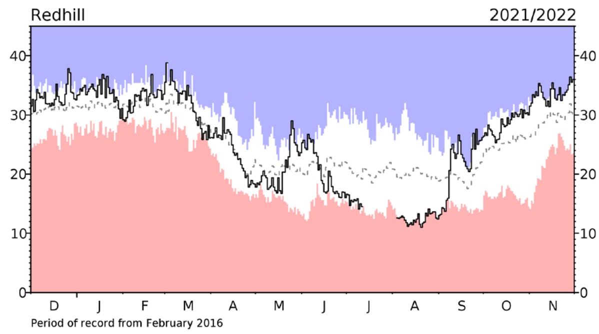
Most of the COSMOS-UK sites had soil moisture within or above the normal range over November. Balruddery, in eastern Scotland, has been within the saturated range after heavy rain. In contrast, Crichton, in western Scotland, was drier than usual for much of the month. In England, Spen Farm and Redhill were both very wet. Hadlow shows continued recovery from being unusually dry over the summer to wetter than usual during the autumn. Sites located in the west, such as The Lizard, have shown slower recovery in soil moisture than the more eastern sites.

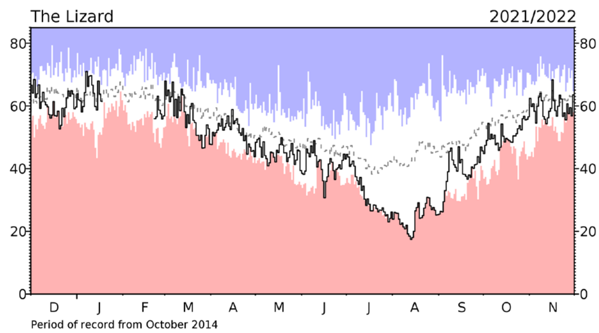
Generally, soil moisture conditions are recovering from the dry summer after prolonged rainfall in many regions in November, particularly in south-east England.











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