Hydrological Summary
for the United Kingdom

September 2020

General
September was a typical autumnal month with cool and unsettled conditions, although interrupted by a more settled and warm period mid-month. Consequently, rainfall was moderately below average at the national scale and less than half of the September average across a large swathe of eastern Scotland and central and southern England (and less than a third of average in isolated areas). Soil moisture deficits (SMDs) increased in most regions of the UK and soils were drier than average with the exception of some western areas where soils remained wetter than average. River flows were in the normal range across most of the UK with below average flows in parts of northern Scotland and the English Lowlands. Groundwater levels generally continued to recede during September, with index sites in the Chalk remaining in the normal range or below and levels generally in the normal range or above in other aquifers. Reservoir stocks declined at the majority of impoundments, but were moderately above average at the national scale, substantially so in some reservoirs in northern Britain and Northern Ireland. In contrast, stocks continued to fall substantially at Ardingly and levels were the lowest for September in a series from 1988. Whilst September was drier than average at the national scale and there were localised low reservoir stocks and groundwater levels, rainfall for the summer was above average and storm 'Alex' brought substantial rainfall totals at the start of October. The water resources situation therefore remains healthy for the winter half-year ahead, with the situation for 2021 in south-east England dependent on the timing of the onset of the groundwater recharge season.

Rainfall
Unsettled conditions prevailed at the start and end of September, bookending a more settled, dry and warm week mid-month. After a dry and sunny first day, a band of wet and windy weather crossed the UK on the 2nd, particularly affecting north-western areas – 65mm was recorded at Mickleden, Cumbria with impacts on roads and rail lines in south-west Scotland. Although the unsettled weather then persisted until mid-month there were few notable rainfall totals, with the exception of 88mm at Glen Nevis (Inverness-shire) on the 13th. Following a warm and dry spell, the unsettled weather returned in the last week. On the 25th, wet and windy weather particularly affected Norfolk (45mm at Houghton Hall), resulting in fallen trees and flooding that closed railway lines and major roads. For the UK as a whole September rainfall was 79% of average, with the Severn-Trent, Thames and Wessex regions all registering less than half the average. Wetter than average conditions were confined to western Scotland and most notably the far east of East Anglia, where a large area received more than 170% of the September average rainfall, much of which fell in the event on the 25th. For the summer half-year (April-September) rainfall was near average at the national scale (98% for the UK) however, this masked spatial contrasts. Rainfall was moderately above average in Northern Ireland and north-western Britain (120% of average for the Solway region) but was below average across much of the remainder of the UK – the Southern region was the driest with 70% of average rainfall for this period.

River flows
Flows at the start of September were generally near average, although new September daily flow minima were set on the Inver on the 1st-5th. Thereafter, flows in most catchments receded throughout the month with only modest interruptions following rainfall events, the spatial footprint of this pattern was reflected in the national outflow series. On the 13th, flows increased sharply in catchments draining the Scottish Highlands – a new September daily flow maxima was recorded on the Carron. Further flow responses were seen around the 25th in the south-east, most notably in catchments in East Anglia (e.g. on the Waveney). At month-end, flows rose sharply in some catchments in Wales and northern Britain following wet weather before the arrival of storm 'Alex' (named by Météo France) on the first day of October. For September as a whole, monthly mean flows were in the normal range across the vast majority of the UK. Flows were below normal and notably low in the north of Scotland (on the Naver, Ythan and Dee) and parts of the English Lowlands (on the groundwater-fed Coln). Exceptionally low flows on the Helmsdale were around a quarter of the September average and the second lowest in a series from 1975. For the summer half-year (April-September), flows were predominantly in the normal range or below with flows notably low and around half the average on the Deveron and Ythan. The exceptions to this pattern were above normal flows in some catchments in north-western Britain and notably high flows on the groundwater-fed Itchen.

Groundwater
SMDs increased marginally in September across most aquifer areas in response to the moderately below average rainfall. Groundwater levels fell at all index sites in the Chalk apart from West Woodyates Manor where levels stabilised. Levels remained in the normal range or below, exceptionally so at Compton House, and at Killyglen levels fell from a new record maximum at the end of August to within the normal range at the end of September. In the Jurassic and Magnesian limestones, levels fell but remained in the normal range or above (notably high at Brick House Farm) but rose to above normal at New Red Lion. Levels in the Carboniferous Limestone fell and in south Wales returned to within the normal range (from a new maximum at the end of August at Pant-y-Lladron). Levels fell in the Upper Greensand at Lime Kiln Way but remained above normal. In the Permo-Triassic sandstones, levels fell at all index sites (except at Newbridge where levels rose overall) and remained between normal and exceptionally high (at Weir Farm). In the Fell Sandstone at Royalty Observatory levels fell but remained above normal. In the Devonian sandstones, levels fell at both Easter Lathrisk and Feddan Junction, remaining in the normal range and below average, respectively.

UK Centre for Ecology & Hydrology
British Geological Survey

Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

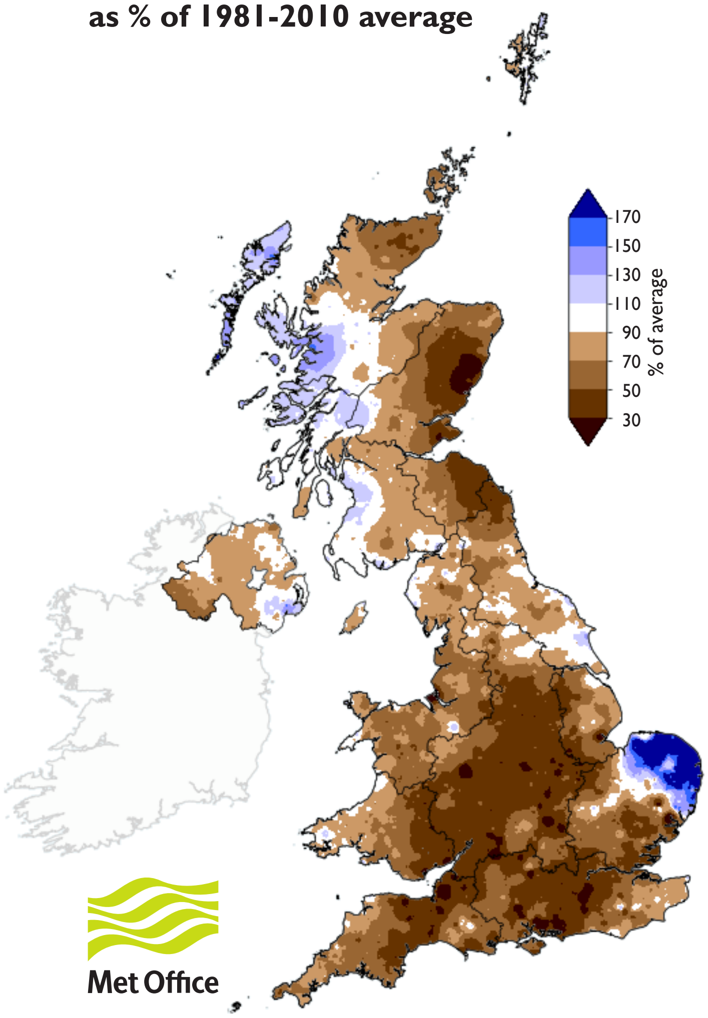
Region	Rainfall	Sep 2020	Jul20 – Sep20	RP	Apr20 – Sep20	RP	Jan20 – Sep20	RP	Oct19 – Sep20	RP
United	mm	**74**	290		457		866		1261	
Kingdom	%	**79**	113	2-5	98	2-5	113	10-20	112	15-25
England	mm	**45**	219		345		620		965	
	%	**65**	111	2-5	92	2-5	107	2-5	114	5-10
Scotland	mm	**122**	374		601		1209		1658	
	%	**93**	111	2-5	103	2-5	118	20-35	109	10-20
Wales	mm	**76**	367		559		1084		1635	
	%	**68**	120	2-5	100	2-5	116	5-10	115	10-15
Northern	mm	**78**	353		534		894		1232	
Ireland	%	**85**	130	5-10	108	2-5	113	8-12	108	5-10
England &	mm	**49**	240		375		684		1057	
Wales	%	**66**	112	2-5	94	2-5	109	2-5	114	8-12
North West	mm	**80**	398		582		1072		1451	
	%	**78**	137	5-10	113	2-5	130	40-60	118	20-30
Northumbria	mm	**50**	235		358		623		912	
	%	**70**	110	2-5	90	2-5	102	2-5	105	2-5
Severn-Trent	mm	**30**	203		323		580		913	
	%	**47**	107	2-5	88	2-5	106	2-5	117	8-12
Yorkshire	mm	**54**	254		387		674		1027	
	%	**80**	127	2-5	101	2-5	114	5-10	122	15-25
Anglian	mm	**46**	177		264		416		671	
	%	**86**	108	2-5	84	2-5	93	2-5	107	2-5
Thames	mm	**27**	172		281		499		804	
	%	**47**	103	2-5	87	2-5	101	2-5	112	2-5
Southern	mm	**36**	135		227		485		858	
	%	**57**	80	2-5	70	10-15	93	2-5	108	2-5
Wessex	mm	**33**	183		324		611		1005	
	%	**49**	96	2-5	89	2-5	104	2-5	114	5-10
South West	mm	**54**	253		450		890		1463	
	%	**60**	101	2-5	95	2-5	111	2-5	119	10-20
Welsh	mm	**73**	356		545		1044		1581	
	%	**67**	120	2-5	101	2-5	116	5-10	115	10-15
Highland	mm	**156**	337		632		1406		1893	
	%	**100**	88	2-5	96	2-5	116	10-20	105	5-10
North East	mm	**54**	256		415		671		1018	
	%	**62**	107	2-5	94	2-5	97	2-5	100	2-5
Tay	mm	**84**	347		531		1063		1490	
	%	**74**	119	2-5	102	2-5	116	10-15	111	8-12
Forth	mm	**80**	364		521		1021		1407	
	%	**76**	130	5-10	105	2-5	123	20-35	117	30-50
Tweed	mm	**52**	303		454		865		1183	
	%	**63**	124	2-5	103	2-5	123	10-20	115	10-20
Solway	mm	**111**	498		715		1294		1733	
	%	**91**	147	10-20	120	5-10	130	>100	117	30-50
Clyde	mm	**166**	533		786		1556		2116	
	%	**104**	128	5-10	112	5-10	127	50-80	116	30-50

% = percentage of 1981-2010 average *RP = Return period*

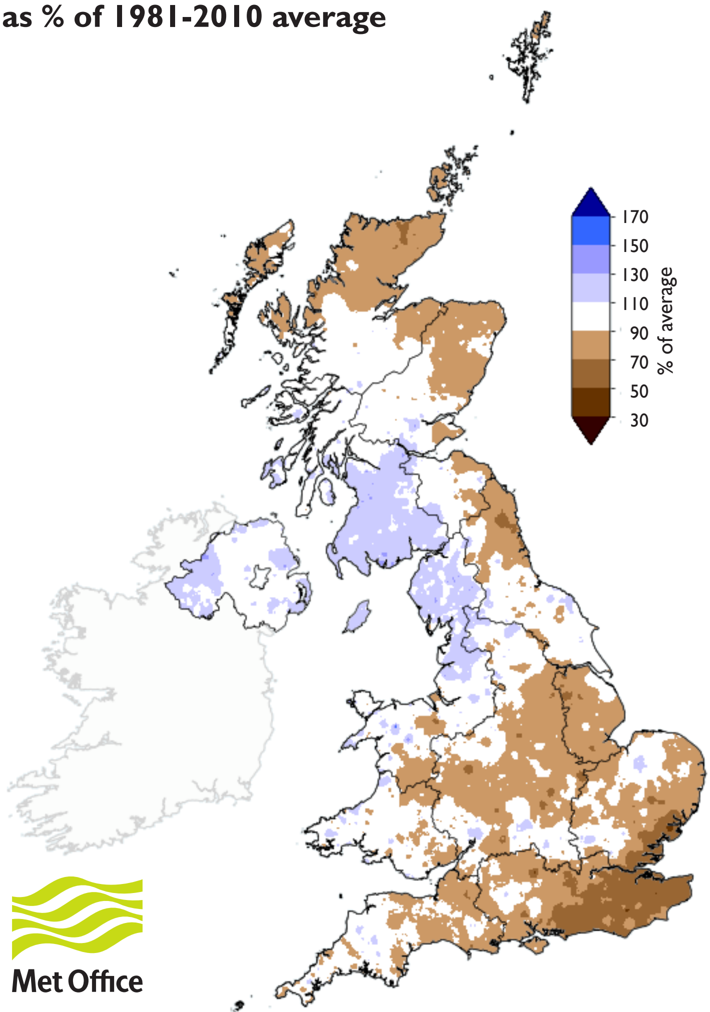
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1910; 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 2018 are provisional.

Rainfall . . . Rainfall . . .

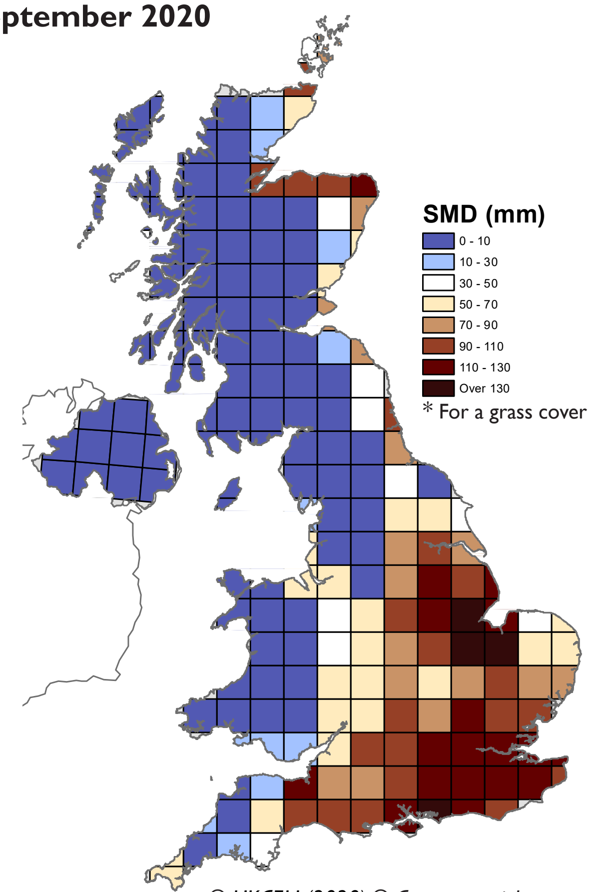
September 2020 rainfall
as % of 1981-2010 average



April 2020 - September 2020 rainfall
as % of 1981-2010 average



MORECS Soil Moisture Deficits*
September 2020



© UKCEH (2020) © Crown copyright.

Hydrological Outlook UK

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.

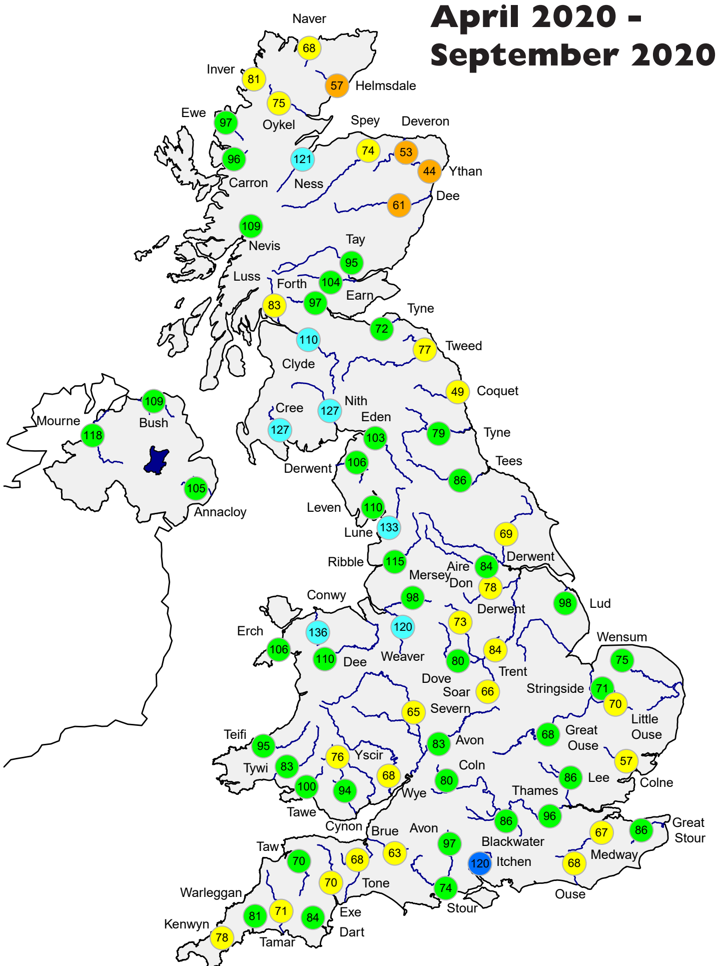
The complete version of the Hydrological Outlook UK can be found at: www.hydoutuk.net/latest-outlook/

Period: **from October 2020**
Issued: **08.10.2020**
using data to the end of September 2020

The outlook for October is for normal to above normal river flows and groundwater levels across most of the UK, but with below normal groundwater levels likely to persist in the far south of England. The three month outlook is for flows to be in the normal range, and for groundwater to follow a broadly similar pattern to October. Both the one and three month outlooks are sensitive to the exceptional rainfall received in early October that brings added complexity to a transitional time of year when uncertainty is already very high.

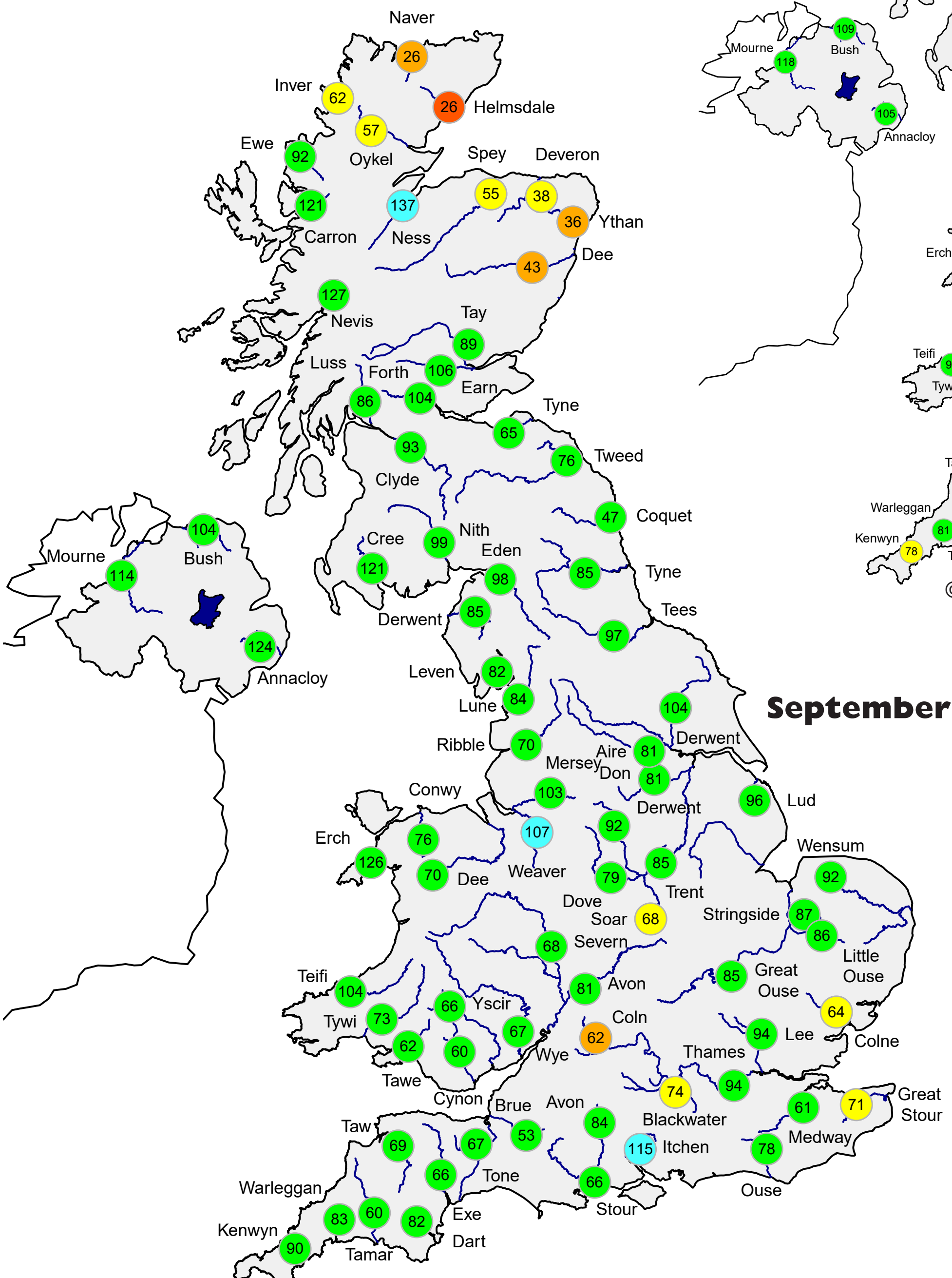
River flow . . . River flow . . .

April 2020 - September 2020



© UKCEH (2020) © Crown copyright.

September 2020



© UKCEH (2020). © Crown copyright.

Key

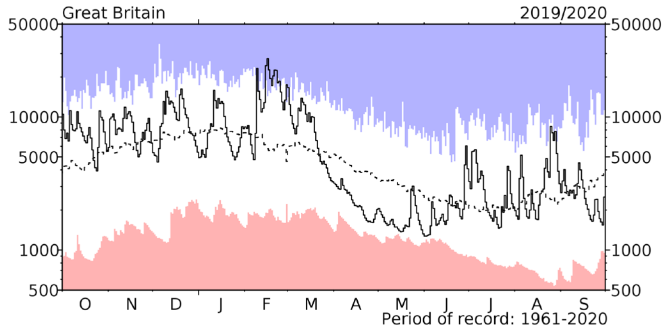
- 25 — % of long−term average (record high/low when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

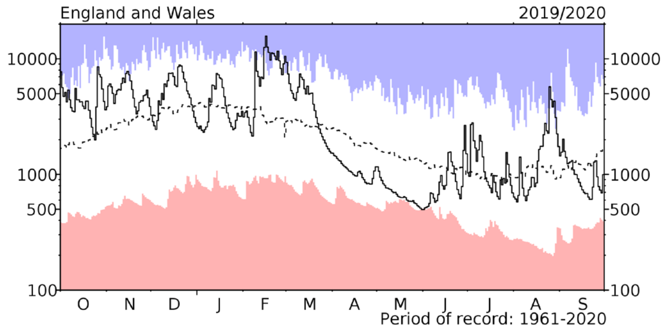
*Based on ranking of the monthly flow**

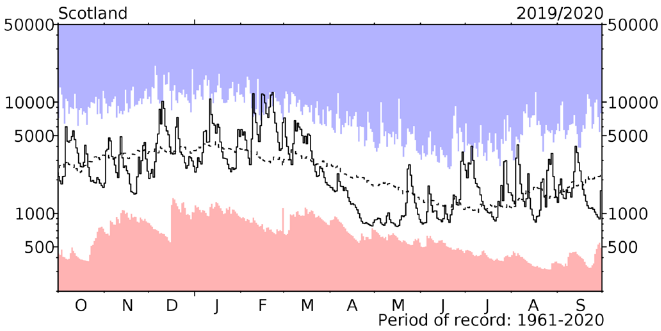
River flows

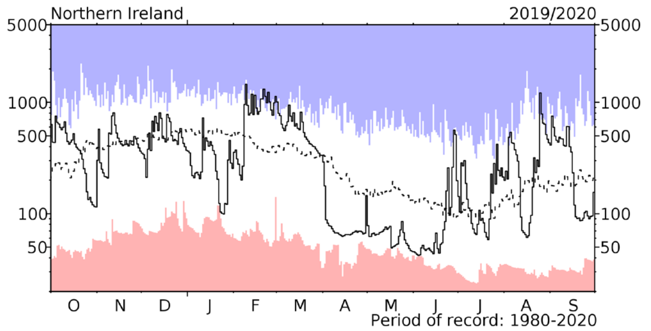
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the averaging period on which these percentages are based is 1981-2010. Percentages may be omitted where flows are under review.

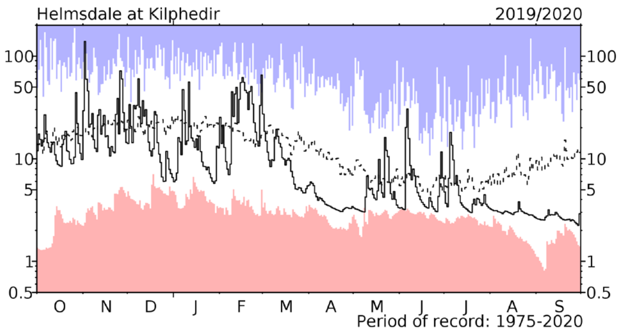
River flow . . . River flow . . .

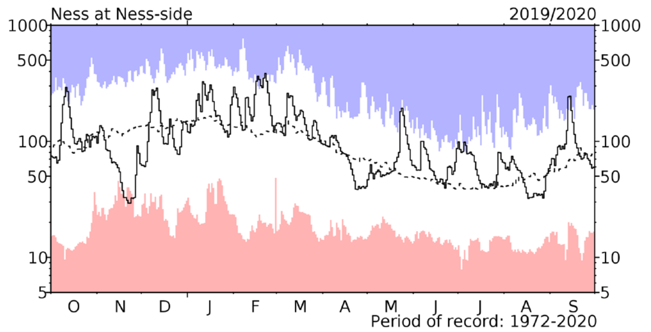


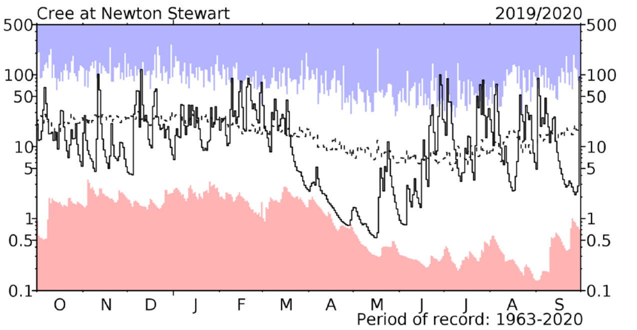


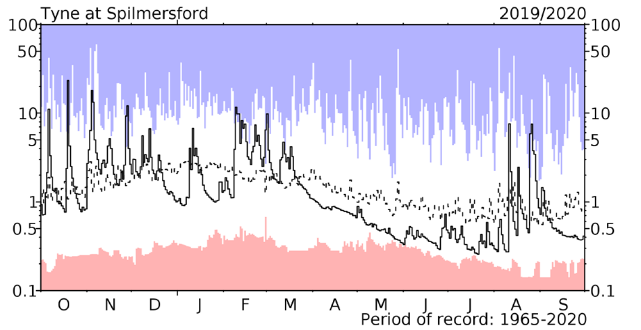


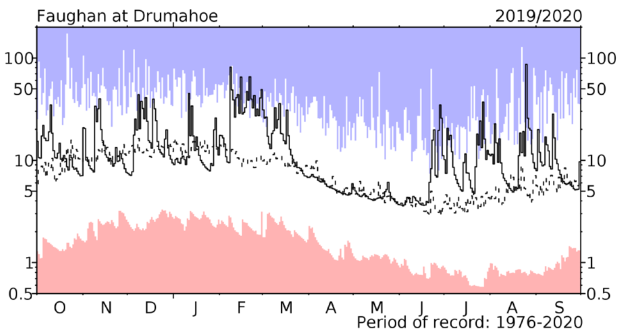


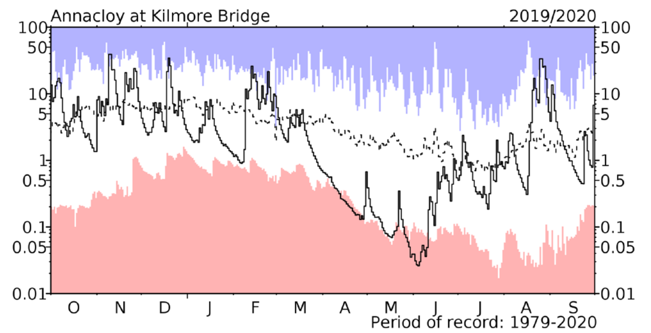








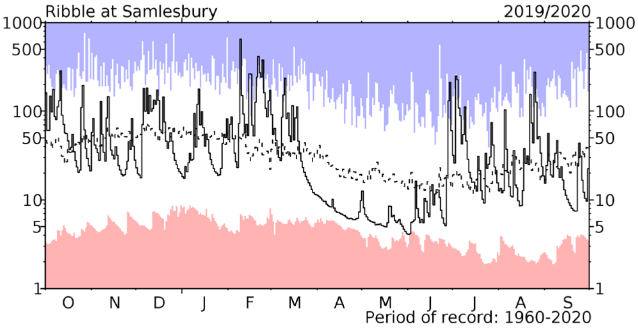


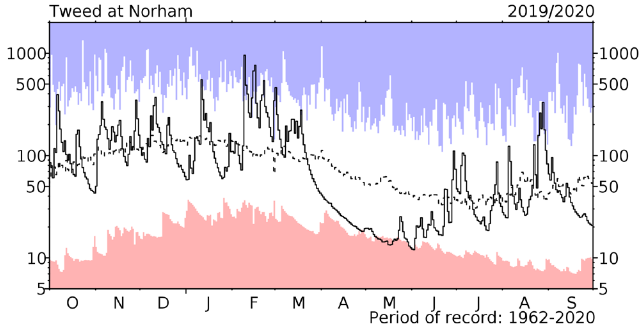


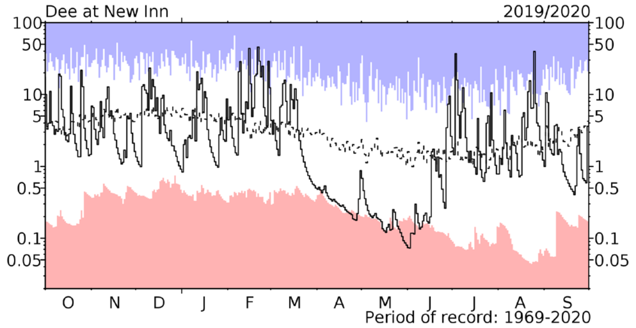
River flow hydrographs

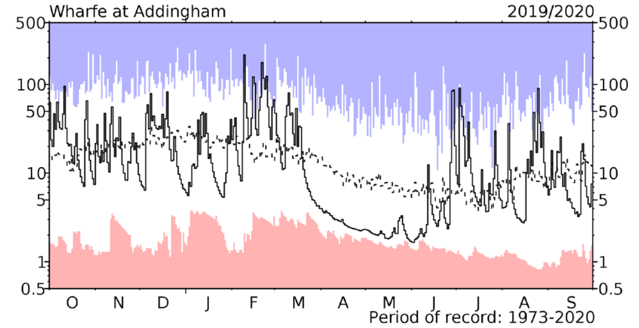
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to October 2019 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

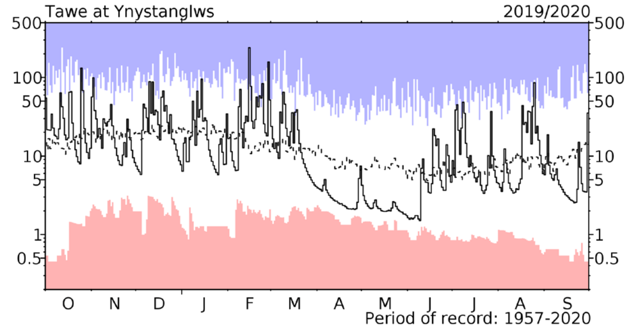
River flow . . . River flow . . .

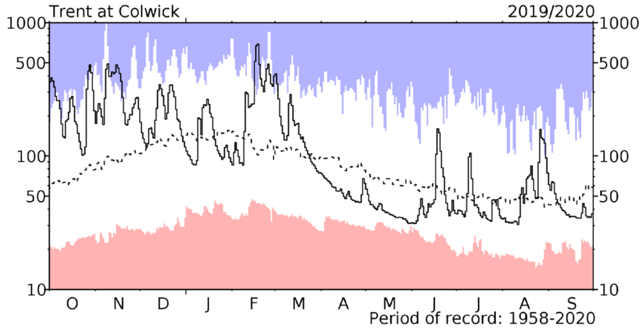


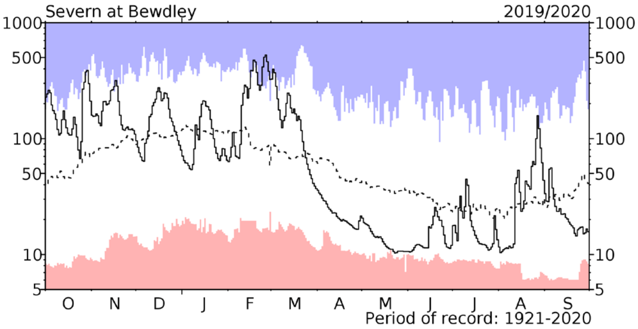


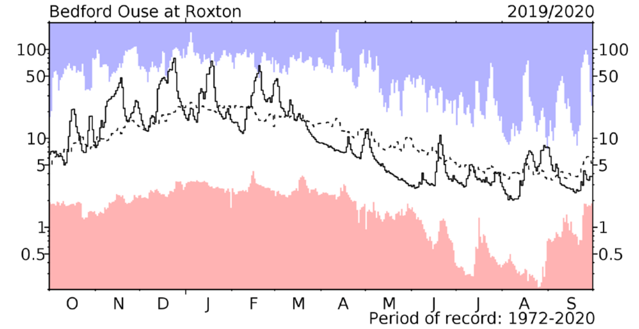


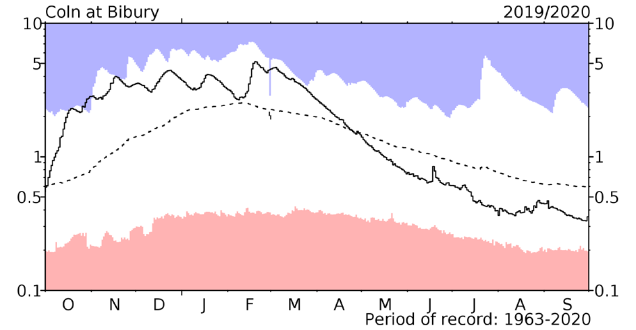


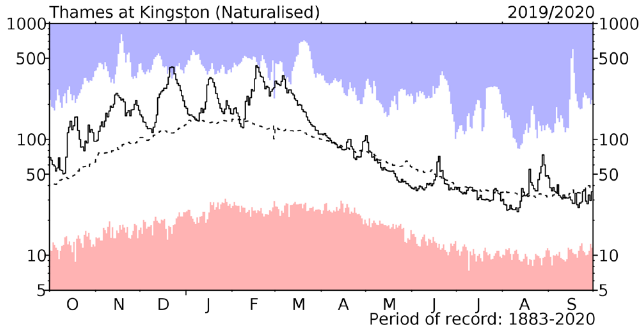


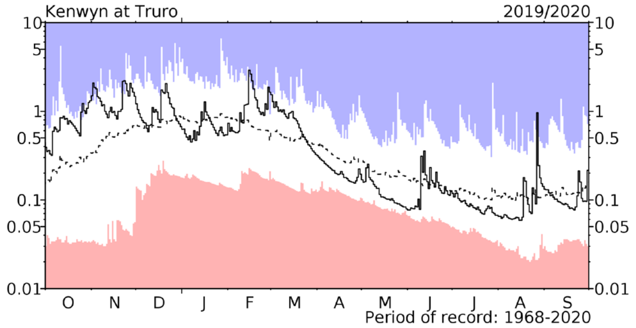


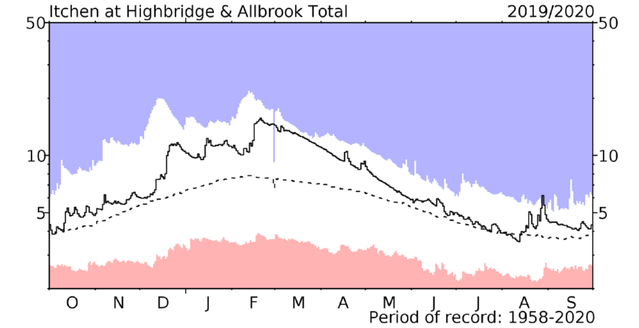




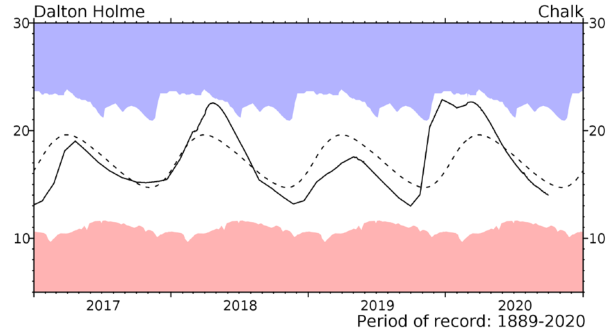


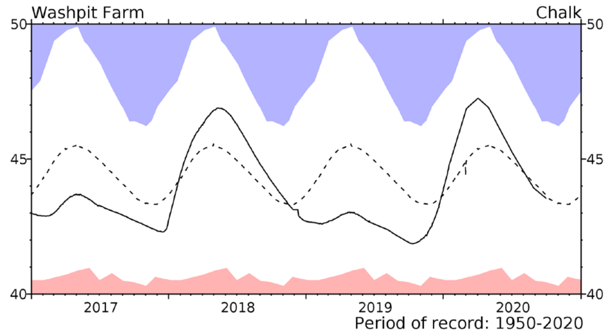


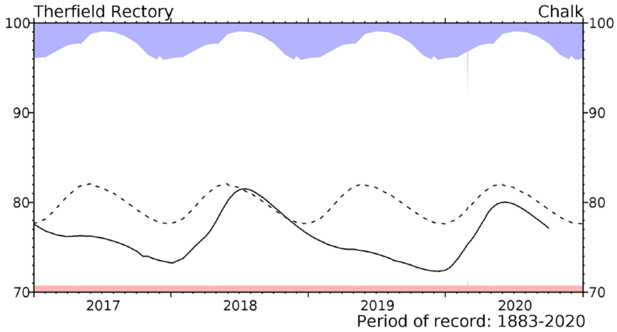


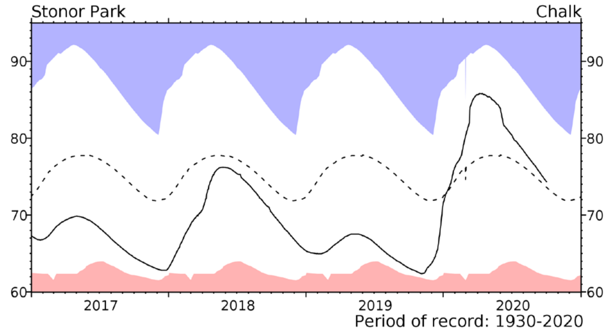


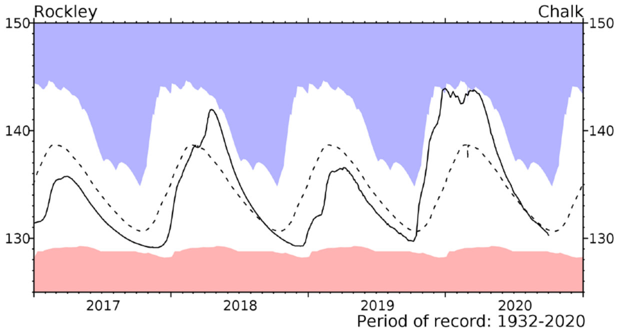
Groundwater . . . Groundwater

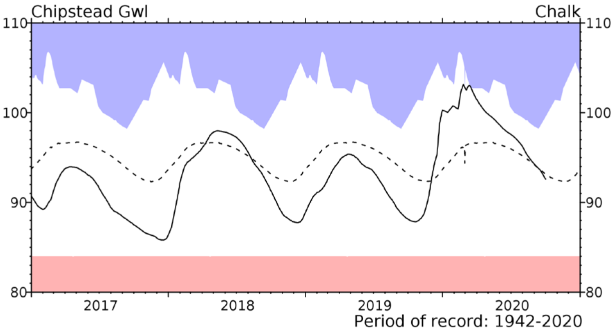


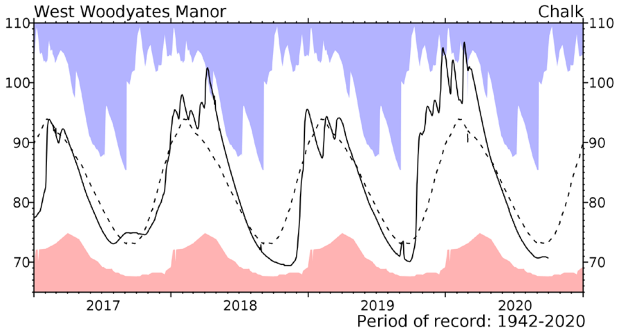


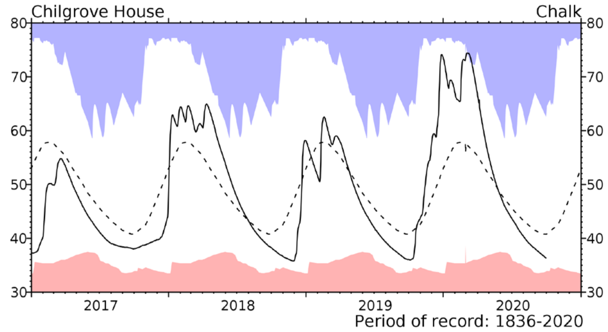


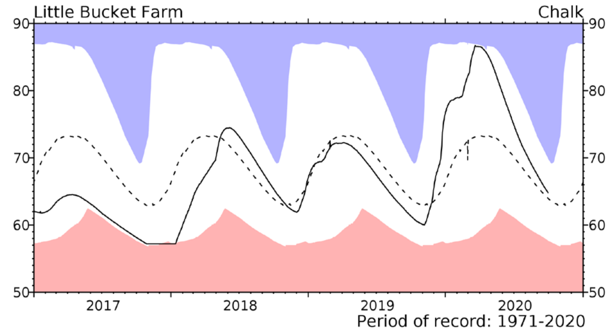


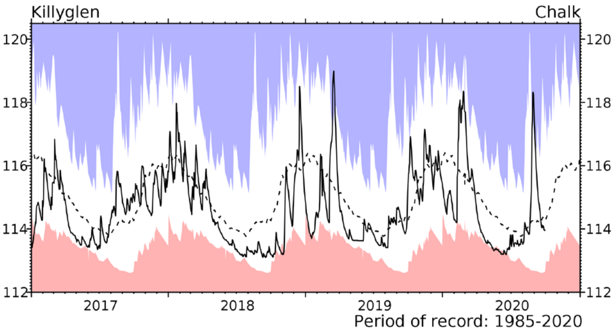




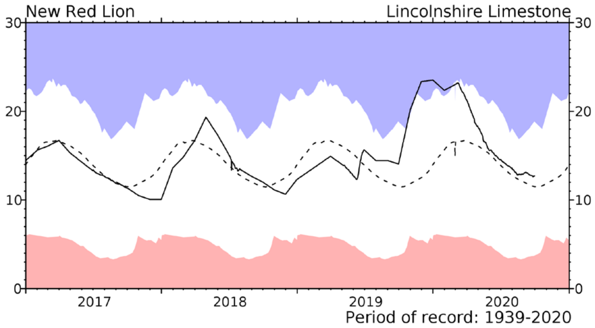


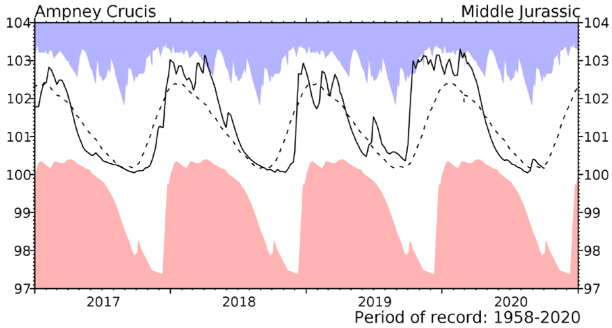


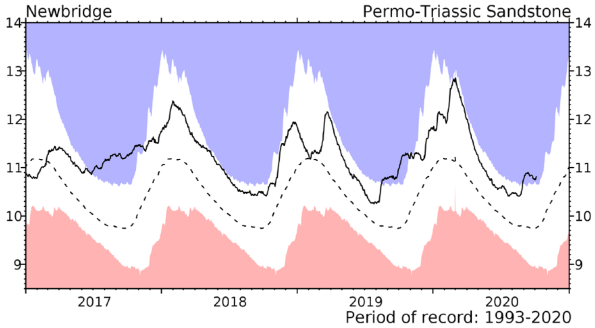


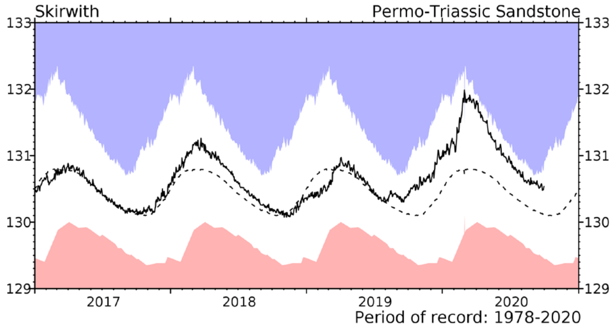


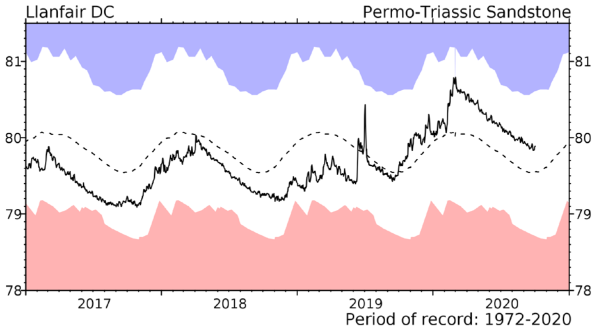
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is 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 displayed in a similar style to the river flow hydrographs. Note that most groundwater levels are not measured continuously and, for some index wells, the greater frequency of contemporary measurements may, in itself, contribute to an increased range of variation.

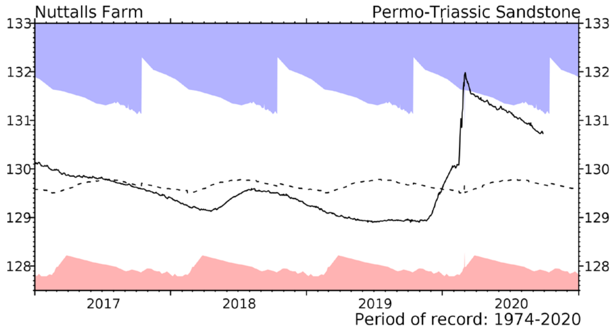

New Red Lion
Lincolnshire Limestone
2017 2018 2019 2020
Period of record: 1939-2020

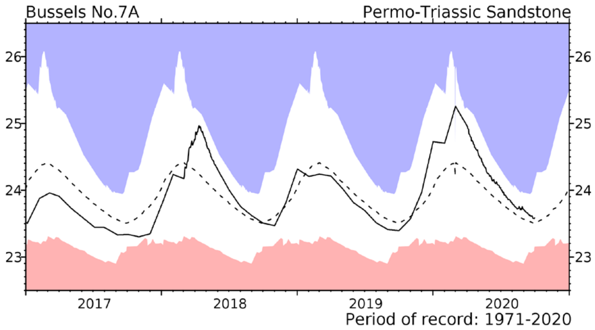

Ampney Crucis
Middle Jurassic
2017 2018 2019 2020
Period of record: 1958-2020

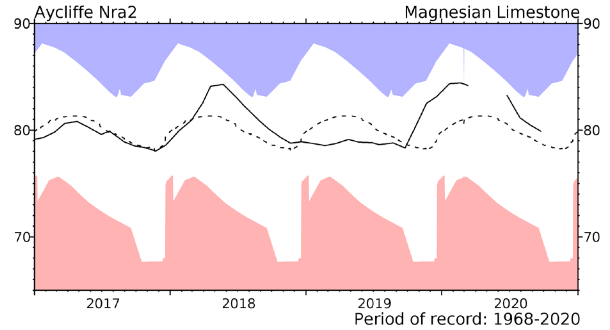

Newbridge
Permo-Triassic Sandstone
2017 2018 2019 2020
Period of record: 1993-2020

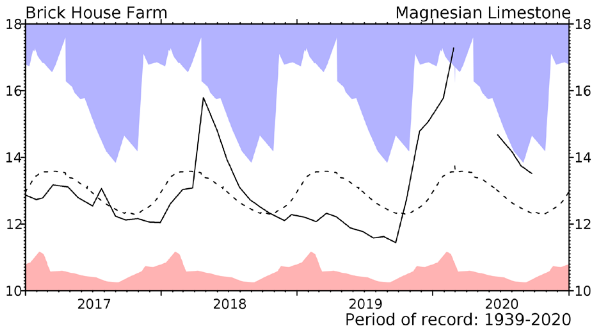

Skirwith
Permo-Triassic Sandstone
2017 2018 2019 2020
Period of record: 1978-2020

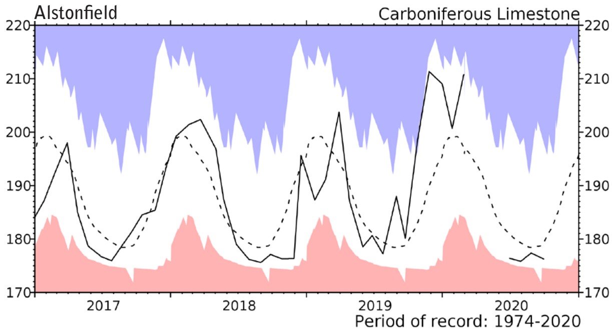

Llanfair DC
Permo-Triassic Sandstone
2017 2018 2019 2020
Period of record: 1972-2020

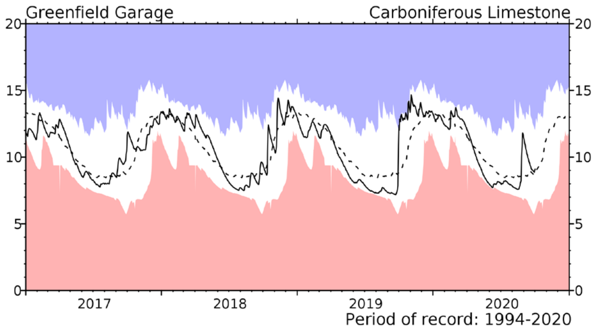

Nuttalls Farm
Permo-Triassic Sandstone
2017 2018 2019 2020
Period of record: 1974-2020

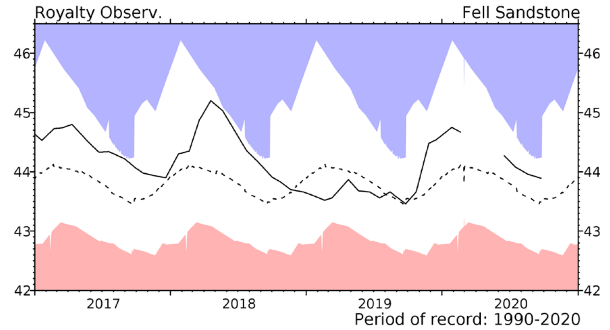

Bussels No.7A
Permo-Triassic Sandstone
2017 2018 2019 2020
Period of record: 1971-2020


Aycliffe Nra2
Magnesian Limestone
2017 2018 2019 2020
Period of record: 1968-2020

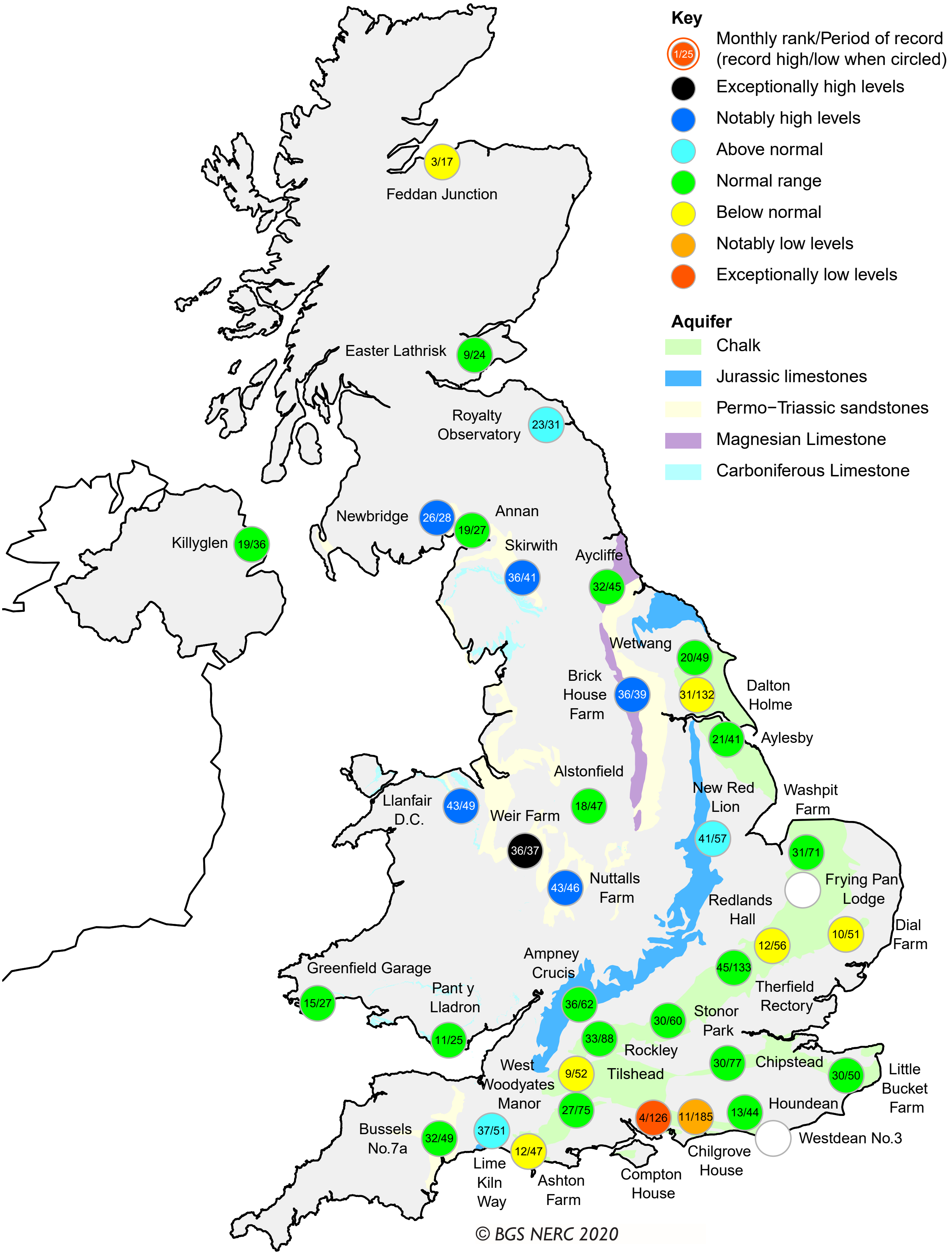

Brick House Farm
Magnesian Limestone
2017 2018 2019 2020
Period of record: 1939-2020


Alstonfield
Carboniferous Limestone
2017 2018 2019 2020
Period of record: 1974-2020


Greenfield Garage
Carboniferous Limestone
2017 2018 2019 2020
Period of record: 1994-2020


Royalty Observ.
Fell Sandstone
2017 2018 2019 2020
Period of record: 1990-2020

Groundwater...Groundwater



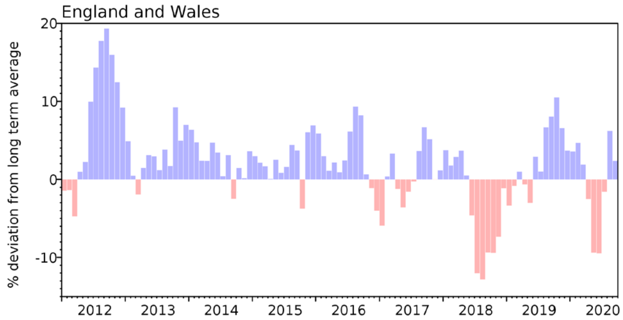
© BGS NERC 2020

Groundwater levels - September 2020

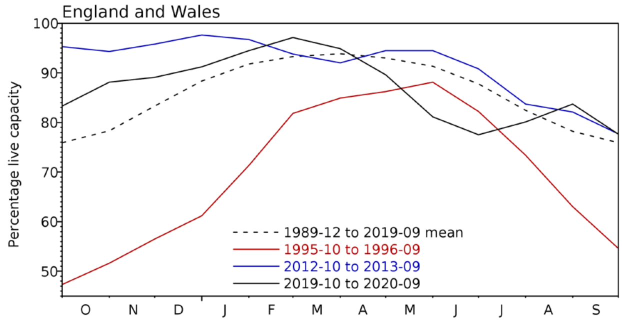
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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)	2020 Jul	2020 Aug	2020 Sep	Sep Anom.	Min Sep	Year* of min	2019 Sep	Diff 20-19
North West	N Command Zone	•	124929	67	81	74	14	13	1995	80	-6
	Vyrnwy		55146	81	100	93	22	26	1995	100	-7
Northumbrian	Teesdale	•	87936	62	70	65	-7	31	1995	98	-34
	Kielder		(199175)	90	91	80	-5	59	1989	85	-5
Severn-Trent	Clywedog		49936	93	94	87	14	24	1989	100	-13
	Derwent Valley	•	46692	73	84	78	14	24	1989	95	-17
Yorkshire	Washburn	•	23373	77	90	91	24	24	1995	95	-4
	Bradford Supply	•	40942	76	87	86	18	15	1995	91	-5
Anglian	Grafham		(55490)	92	90	90	6	46	1997	76	14
	Rutland		(116580)	93	91	88	8	61	1995	93	-6
Thames	London	•	202828	90	88	84	7	53	1997	65	19
	Farmoor	•	13822	98	94	97	6	54	2003	98	-2
Southern	Bewl		31000	75	69	60	-3	32	1990	65	-5
	Ardingly		4685	62	38	21	-44	21	2020	54	-33
Wessex	Clatworthy		5662	62	61	60	3	25	2003	59	1
	Bristol	•	(38666)	71	62	51	-12	31	1990	71	-19
South West	Colliford		28540	68	61	57	-11	38	2006	51	6
	Roadford		34500	66	65	61	-8	26	1995	48	13
	Wimbleball		21320	63	56	50	-15	30	1995	71	-21
	Stithians		4967	70	62	54	-3	22	1990	70	-16
Welsh	Celyn & Brenig	•	131155	79	87	86	4	39	1989	89	-3
	Brianne		62140	91	96	84	-4	48	1995	100	-16
	Big Five	•	69762	69	73	65	-6	19	1995	85	-20
	Elan Valley	•	99106	70	76	67	-9	33	1976	91	-24
Scotland(E)	Edinburgh/Mid-Lothian	•	97223	84	89	86	8	43	1998	87	-1
	East Lothian	•	9317	87	98	100	17	52	1989	100	0
Scotland(W)	Loch Katrine	•	110326	82	88	88	12	43	1995	95	-7
	Daer		22494	98	100	94	15	32	1995	97	-3
	Loch Thom		10721	76	69	59	-26	56	1995	100	-41
Northern Ireland	Total+	•	56800	77	91	90	15	29	1995	92	-2
	Silent Valley	•	20634	71	91	87	15	27	1995	90	-3

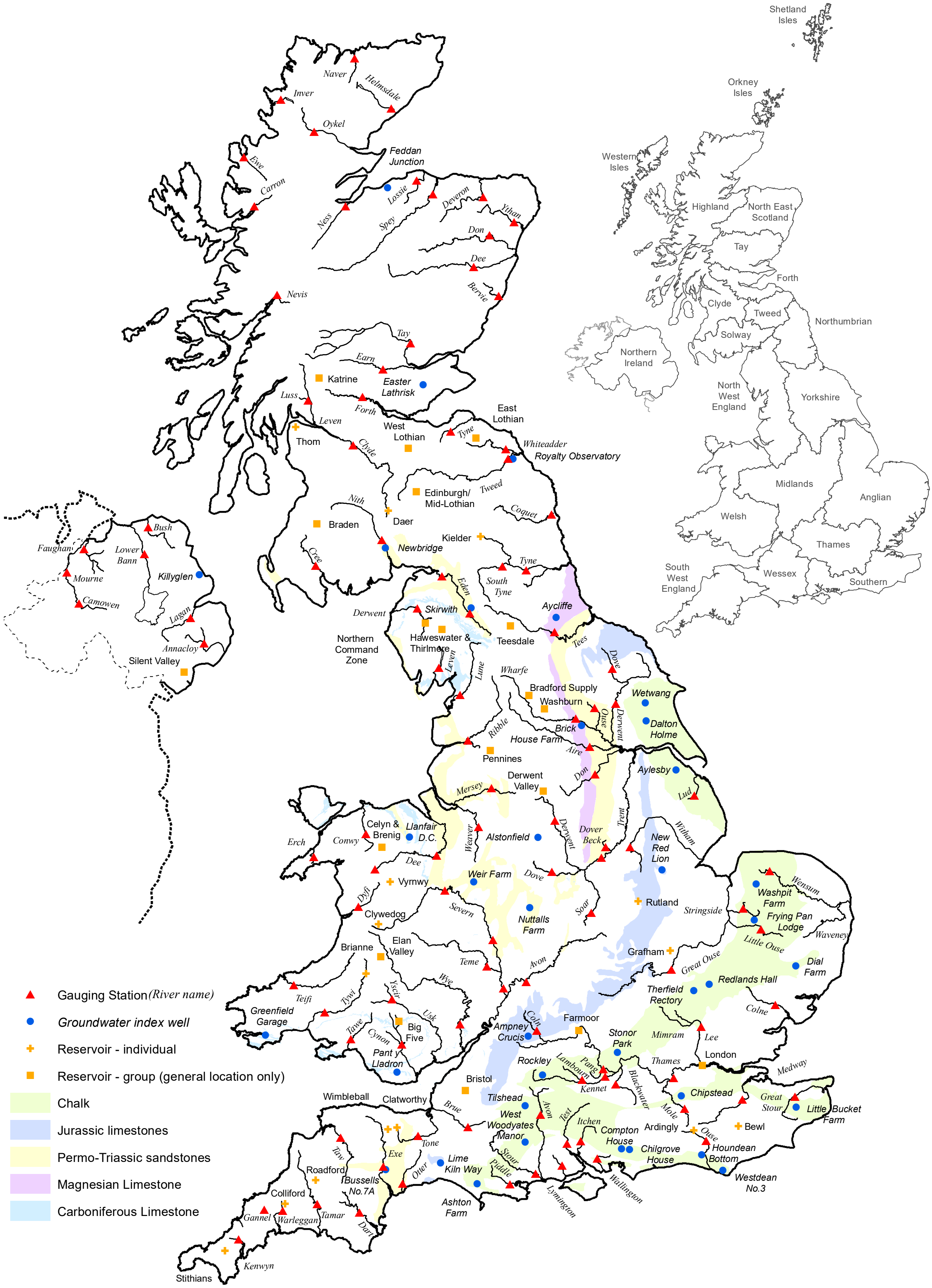
( ) figures in parentheses relate to gross storage • denotes reservoir groups *last occurrence

+ 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.

© UKCEH (2020).

Location map…Location map



© UKCEH, NERC BGS (2020). © Crown copyright.

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. 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 5km 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 1910 and form the official source of UK areal rainfall statistics which have been adopted by the NHMP. The gridding technique used is described in Perry MC and Hollis DM (2005) available at https://doi.org/10.1002/joc.1161

Long-term averages are based on the period 1981-2010 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: 0870 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.

All rights reserved. Unauthorised reproduction infringes crown copyright and may lead to prosecution or civil proceedings.

Text and maps in this document are © UKCEH (2020) unless otherwise stated and may not be reproduced without permission.