Hydrological Summary

for the United Kingdom

March 2017

General

March was a changeable month: there were dry, sunny spells and some spring warmth for most, but also wet, blustery periods and wintry interludes in places. For the UK as a whole, March was mild (the joint fifth warmest for the UK in a record from 1910) and rainfall was near-average. While some northern and western areas were significantly wetter than average, south-east England was dry, and also saw the warmest temperatures – it was the second warmest March in a record from 1910 for the Southern and Anglian regions. With significant rainfall since mid-February, river flows in many upland catchments were above normal and, correspondingly, the last two months have seen delayed but welcome replenishment in most northern and western reservoirs. Steep increases have returned stocks to near- or above-average for the first time since the autumn in many impoundments, and March stocks were near-average at the national scale. However, stocks remained >10% below average at Bewl and Roadford in southern England. In south-east England, the modest winter half-year recharge is evident in below-normal groundwater levels across much of the Chalk outcrop. With early April also seeing little rainfall in the English Lowlands, significant recovery is unlikely before evapotranspiration rates climb steeply in late spring. Low groundwater levels (and low flows in some groundwater-fed rivers) may be expected to persist in parts of south-east England and could lead to some localised pressures on water resources later in the year.

Rainfall

Early March saw a continuation of the unsettled weather of late February, with a westerly to southwesterly airflow bringing persistent rainfall to most areas of the UK. A generally mild but changeable complexion dominated until mid-month although there were quieter interludes and most rain-bearing systems made little impression on the far south-east of England. Around mid-month, the passage of frontal systems brought high winds and heavy rainfall, particularly to northern and western Britain (with 59mm at Alston Brighouse, Cumbria, on the 18th), while a wintry spell between the 20th and 22nd saw snow across northern Britain (with 14cm at Copley, County Durham on the 22nd), with some transport disruption in the Scottish Highlands. Anticyclonic conditions then brought a warm, dry spell for much of the UK before unsettled conditions returned to the west in the final days. March rainfall was moderately above average (107%) for the UK as a whole, although there were significant spatial variations. Above average rainfall was received in Wales, northern and western England and the Scottish borders (Wales, the North West and Northumbria regions all received >140% of average). In contrast, Scotland north of the central belt received below average rainfall and a large area of south-east England received <70% of average. While February and March saw near-average rainfall at the national scale, notable rainfall deficits for the winter half-year are evident across the country. Northern Ireland registered its fourth driest October-March on record, while it was the driest since 1991/1992 for the South West region of England (in records from 1910). Appreciable deficits extend back to summer 2016 in some regions, particularly in southern England; the July-March rainfall for the Southern Region was the lowest since 1991/1992 (also in a record from 1910).

River flows

In responsive index rivers, modest spates were common through much of the month, interspersed with brief recessions, reflecting the changeable weather. Rapid flow responses around mid-month in Wales, Northern Ireland and north-west England brought widespread flood alerts; on the 17th, the Ribble registered its second highest peak flow for March (in a record from 1969). Recessions became more widely established during the final week, although there were further spates at month end. In the English Lowlands, there were only muted responses to the wetter intervals, and flows continued to track below the seasonal average. Average flows for March as whole were above normal across Wales, northern England and the Scottish borders, with notably high flows in some cases; flows were >140% of the typical March average in many catchments and the Ribble registered 225% of the March average, the highest on record for that month. Elsewhere, flows were predominantly in the normal range, but below normal in some catchments in south-east England (notably so on the Great Stour) and two catchments in north-east Scotland. Despite the higher March flows, accumulated runoff for the winter half-year (October-March) was notably or exceptionally low across the north and west: the Luss, Annacloy and Faughan all registered the lowest runoff for this timeframe (in records of more than 38 years). Correspondingly, outflows for the winter half-year were the lowest on record for Northern Ireland (in a record from 1980) and the third lowest for Scotland (in a record from 1961). Appreciable winter half-year runoff deficiencies are apparent in some catchments in the English Lowlands (e.g. in the Medway and Sussex Ouse) although accumulated outflows were considerably lower in 2004/2005, 2005/2006 and 2011/2012.

Groundwater

Entering March, Soil Moisture Deficits (SMDs) were generally zero or negligible across the country, following the wet end to February. This situation persisted through March in northern and western areas, but SMDs climbed across central and eastern England, owing to the drier conditions and unseasonal warmth. By month-end, SMDs were moderately above average across the Chalk outcrop, and nearly twice the average for March in southern England. In the Chalk, groundwater levels remained largely below normal, and were notably low at Little Bucket Farm. Levels continued to rise at most sites, although responses varied according to location and aquifer characteristics. Levels declined at Therfield Rectory in the Chilterns, where they have yet to respond to the modest late-winter recharge, and at Ashton Farm, West Woodyates, Houndean (southern England) and Killyglen (Northern Ireland), where recharge has ceased. In the more rapidly responding Jurassic and Magnesian limestones, levels were in the normal range, and rose at most sites, although Ampney Crucis recorded a small fall. In the Permo-Triassic sandstones, groundwater levels rose in the north but fell in the Midlands and south. Most indicator sites were in the normal range, but Llanfair DC and Bussells No7A remained below normal and Newbridge was notably high. Levels in the Carboniferous Limestone rose and are now above average in south Wales. Levels in the Fell Sandstone stabilised at Royalty Observatory.

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British Geological Survey
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Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

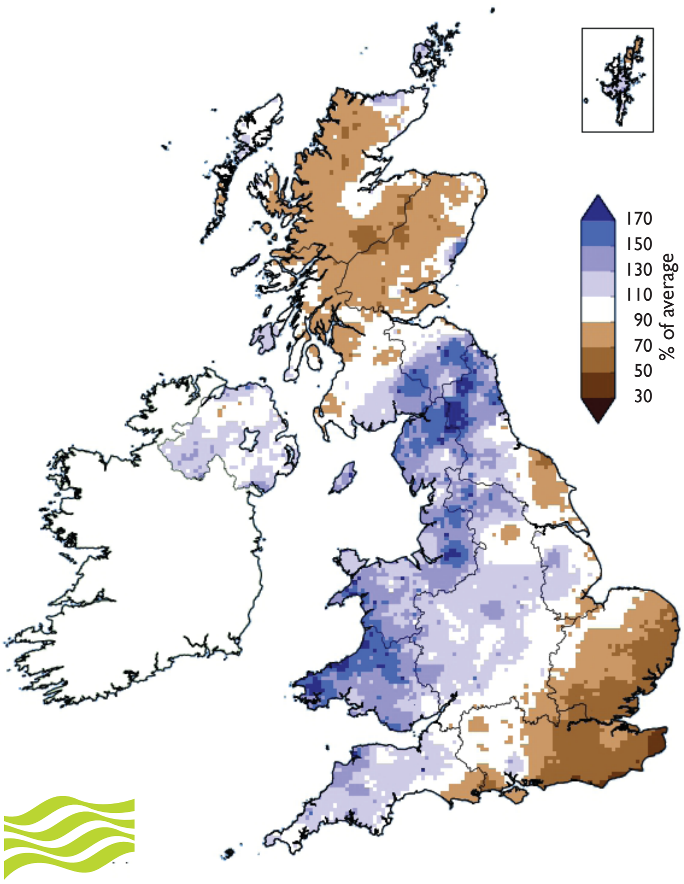
Region	Rainfall	Mar 2017	Jan17 – Mar17	RP	Oct16 – Mar17	RP	Jul16 – Mar17	RP	Apr16 – Mar17	RP
United	mm	**99**	269		508		776		1024	
Kingdom	%	**107**	90	2-5	77	8-12	85	5-10	91	2-5
England	mm	**70**	196		375		548		768	
	%	**112**	96	2-5	80	5-10	82	5-10	91	2-5
Scotland	mm	**128**	363		700		1108		1386	
	%	**94**	83	2-5	75	5-10	87	2-5	91	2-5
Wales	mm	**165**	384		652		989		1307	
	%	**144**	103	2-5	76	5-10	85	5-10	92	2-5
Northern	mm	**106**	235		443		719		958	
Ireland	%	**112**	80	2-5	69	25-40	79	15-25	84	10-15
England &	mm	**83**	222		414		609		842	
Wales	%	**119**	98	2-5	79	5-10	83	5-10	91	2-5
North West	mm	**140**	315		569		923		1199	
	%	**142**	101	2-5	80	5-10	92	2-5	98	2-5
Northumbria	mm	**97**	220		450		682		878	
	%	**148**	103	2-5	95	2-5	99	2-5	101	2-5
Severn-Trent	mm	**68**	187		343		501		735	
	%	**120**	104	2-5	83	2-5	83	5-10	94	2-5
Yorkshire	mm	**72**	185		382		575		782	
	%	**112**	90	2-5	83	2-5	87	2-5	93	2-5
Anglian	mm	**38**	127		261		382		592	
	%	**86**	93	2-5	83	2-5	80	5-10	95	2-5
Thames	mm	**42**	160		301		414		634	
	%	**83**	95	2-5	77	5-10	74	10-15	88	2-5
Southern	mm	**41**	183		338		435		641	
	%	**71**	93	2-5	72	5-10	68	20-35	80	5-10
Wessex	mm	**67**	211		399		543		761	
	%	**100**	95	2-5	77	5-10	77	10-15	86	5-10
South West	mm	**115**	291		530		737		944	
	%	**121**	88	2-5	70	10-20	73	15-25	77	15-25
Welsh	mm	**157**	368		630		951		1258	
	%	**144**	103	2-5	76	5-10	85	5-10	92	2-5
Highland	mm	**146**	408		823		1308		1608	
	%	**85**	74	2-5	72	5-10	85	2-5	89	2-5
North East	mm	**68**	216		470		719		987	
	%	**86**	85	2-5	82	5-10	89	2-5	97	2-5
Tay	mm	**99**	302		589		893		1162	
	%	**83**	77	2-5	72	8-12	81	5-10	87	2-5
Forth	mm	**97**	272		518		800		1038	
	%	**93**	81	2-5	73	5-10	81	5-10	86	2-5
Tweed	mm	**115**	275		516		789		994	
	%	**143**	104	2-5	89	2-5	96	2-5	97	2-5
Solway	mm	**155**	408		679		1073		1347	
	%	**123**	102	2-5	76	5-10	87	2-5	90	2-5
Clyde	mm	**157**	465		843		1357		1669	
	%	**95**	89	2-5	76	5-10	88	2-5	92	2-5

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

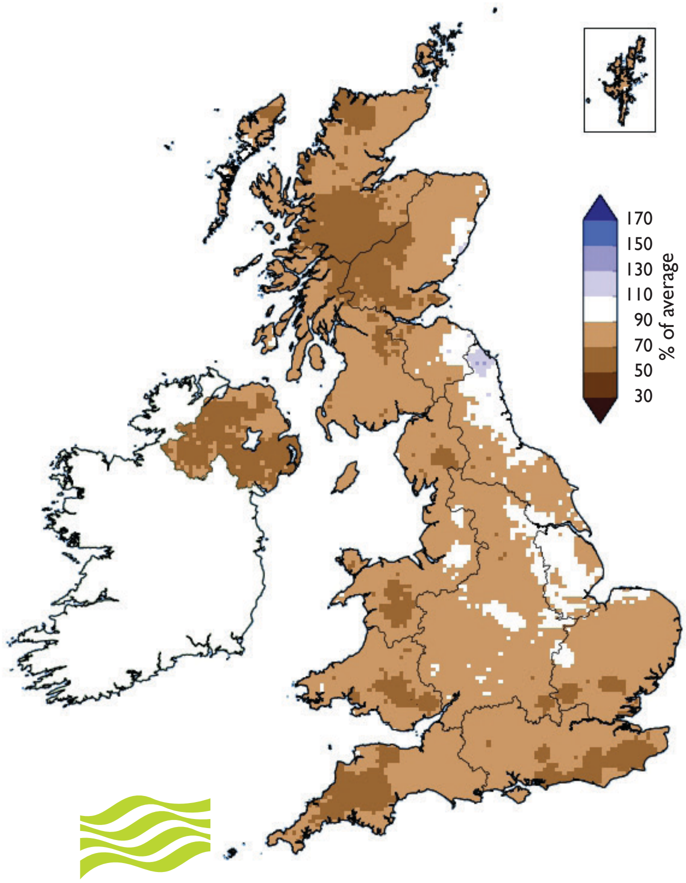
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic 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 February 2016 are provisional.

Rainfall . . . Rainfall . . .

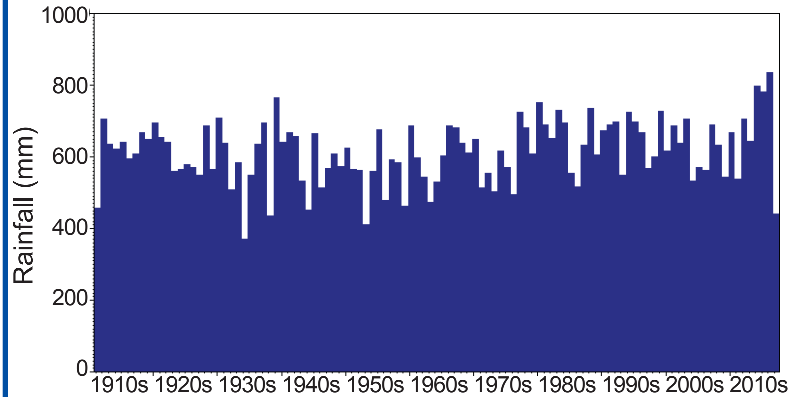
March 2017 rainfall as % of 1981-2010 average



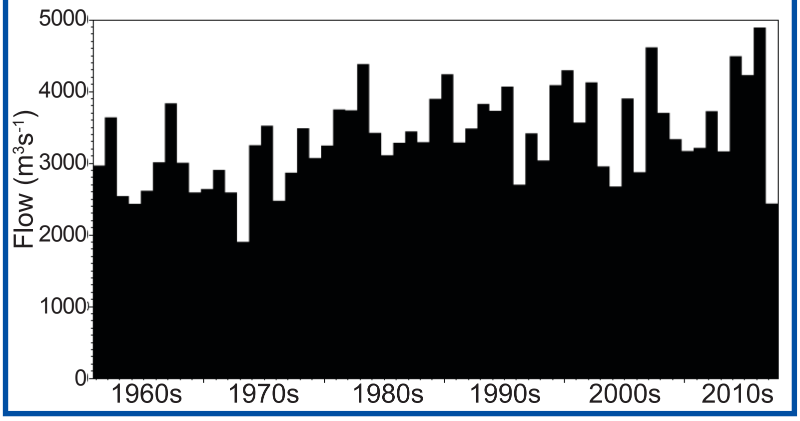
October 2016 - March 2017 rainfall as % of 1981-2010 average



October - March rainfall for Northern Ireland



October - March average outflows for Scotland



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.

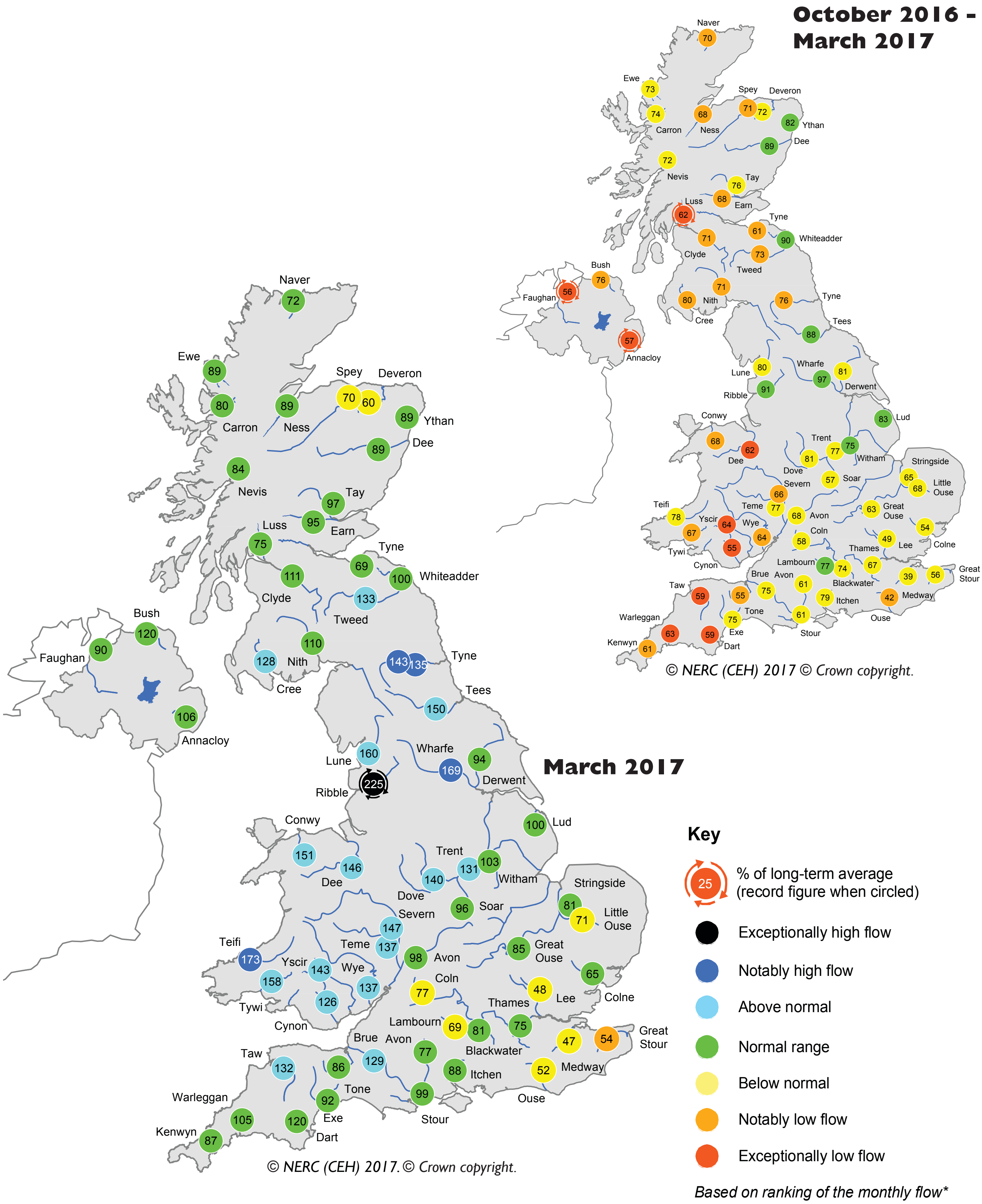
The complete version of the Hydrological Outlook UK can be found at: www.hydoutuk.net/latest-outlook/

Period: **from April 2017**
Issued: **11.04.2017**
using data to the end of March 2017

The outlook for April is for river flows and groundwater levels in the south east of England to be normal to below normal, while in the rest of the UK normal river flows and groundwater levels are most likely.

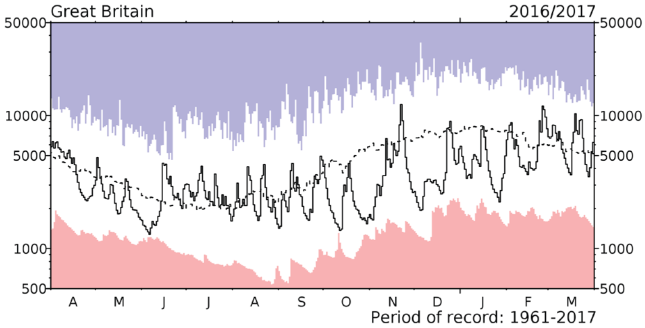
Over the next three months there is the possibility of very low groundwater levels occurring in parts of south-east England (i.e. the Chalk of Kent and Sussex, and possibly the Chilterns). Elsewhere in the UK over this time scale, normal river flows and groundwater levels are most probable.

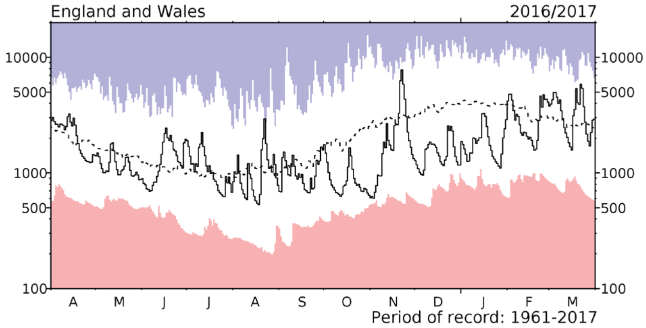
River flow . . . River flow . . .

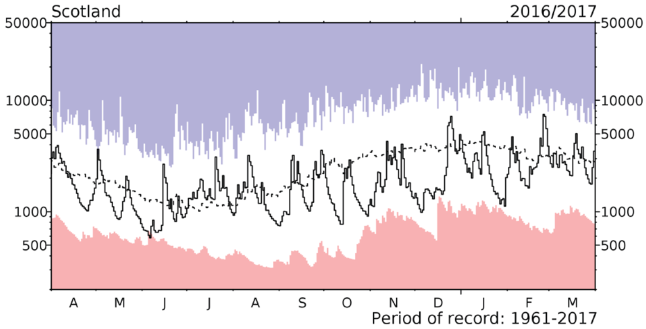


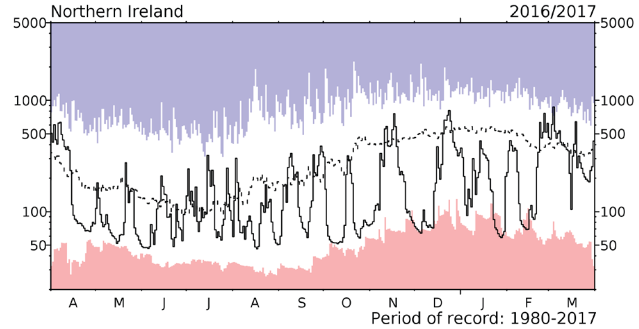
River flows

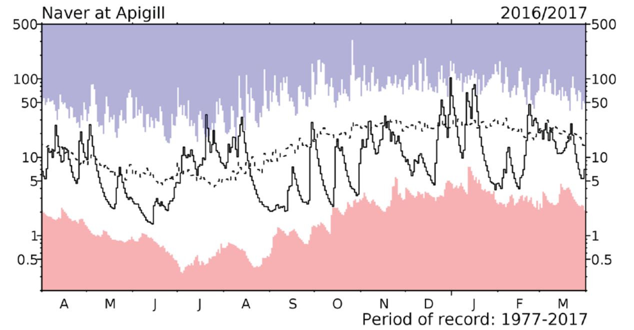
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

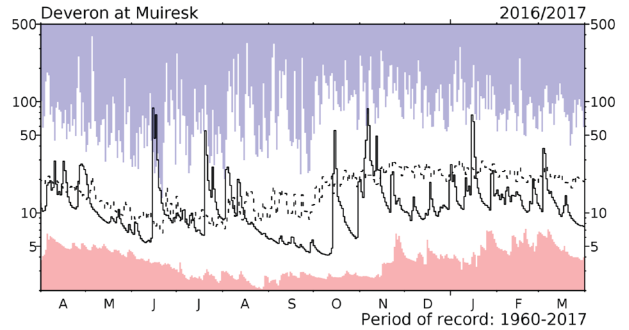


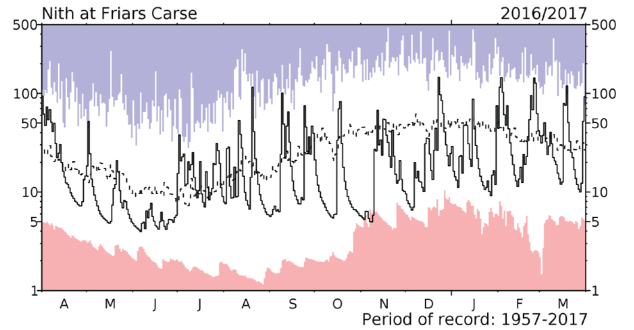


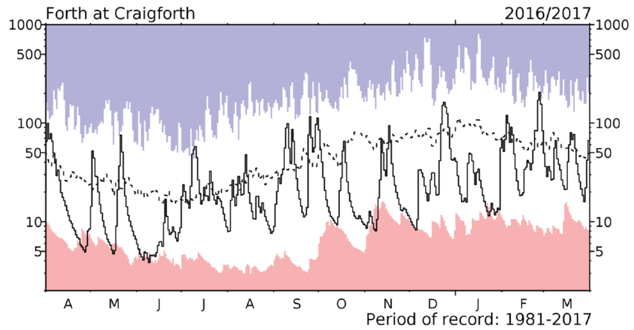


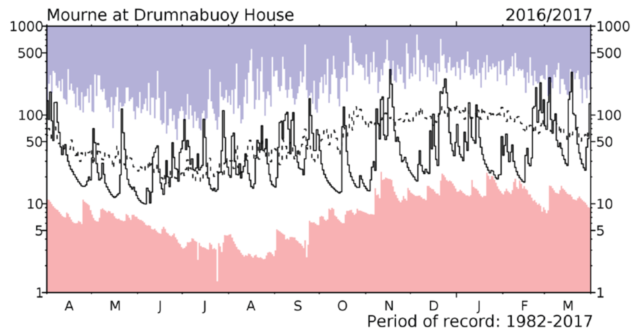


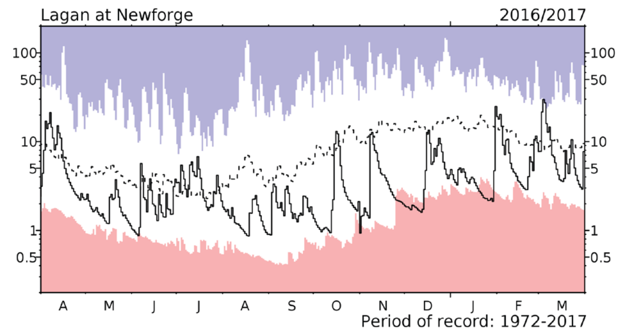








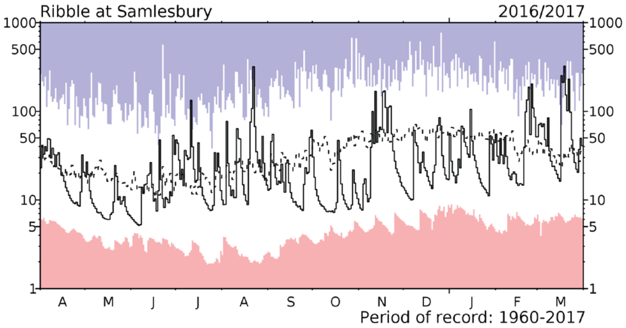


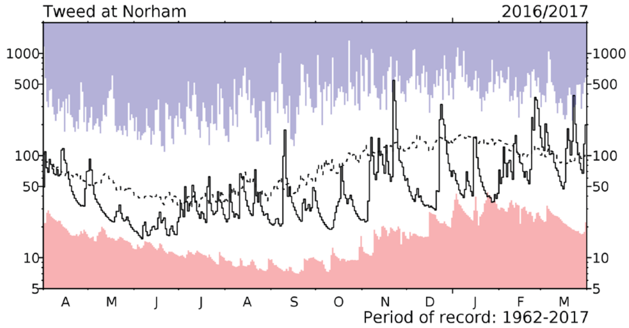


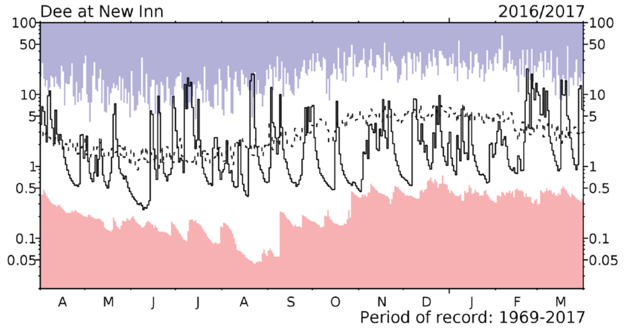
River flow hydrographs

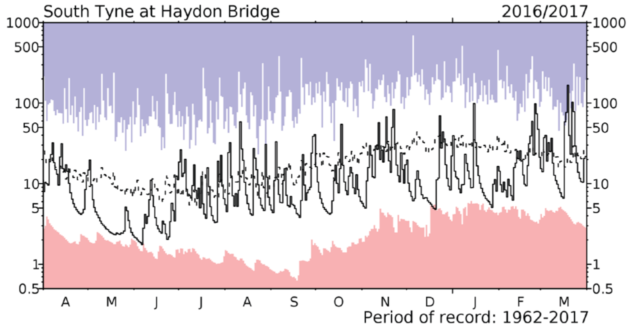
*The river flow hydrographs show the daily mean flows (measured in m^3s^{-1}) together with the maximum and minimum daily flows prior to April 2016 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

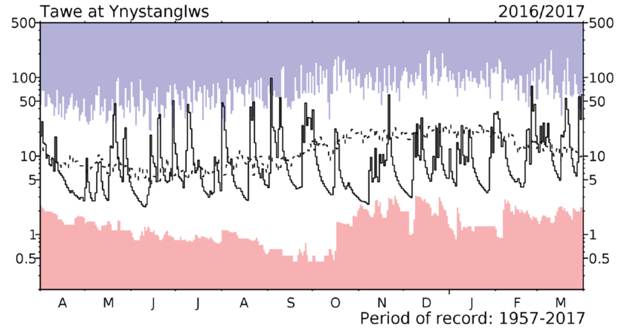
River flow . . . River flow . . .

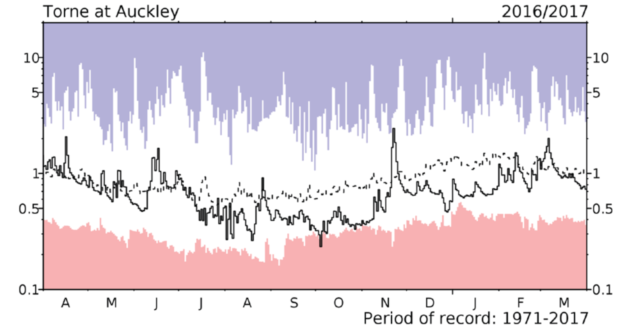


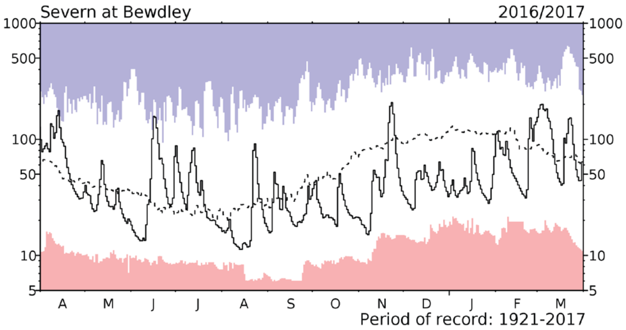


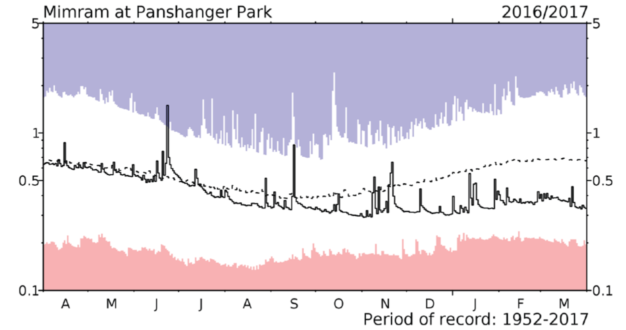


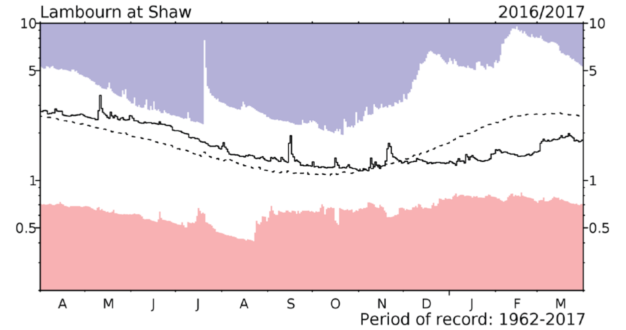


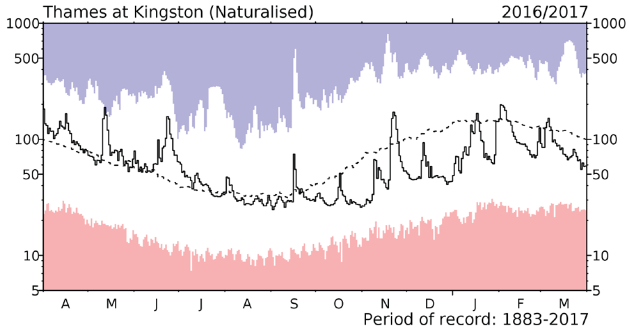


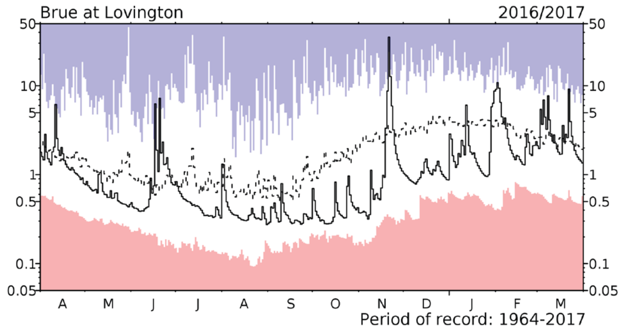


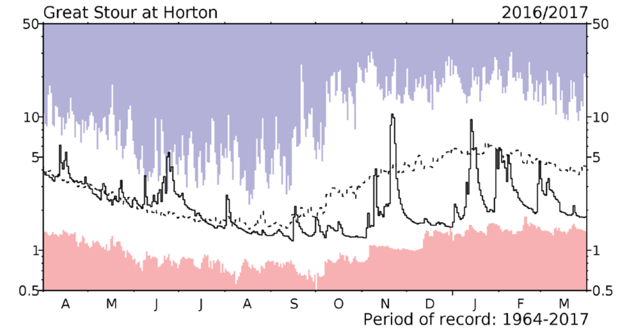




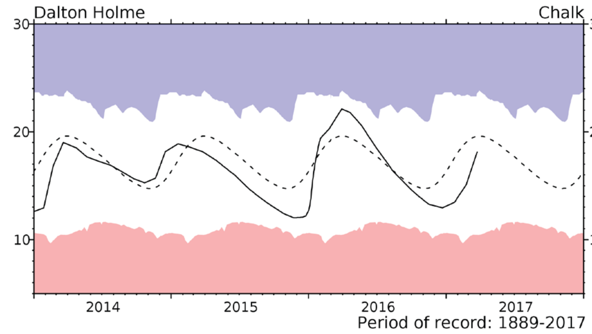


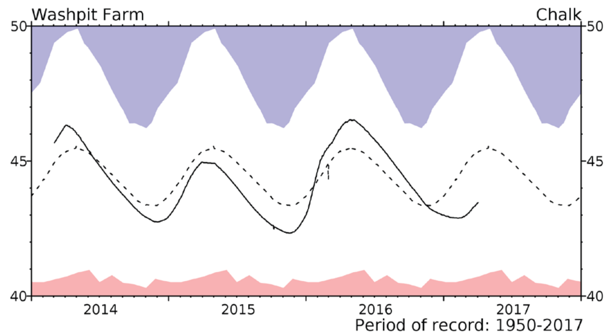


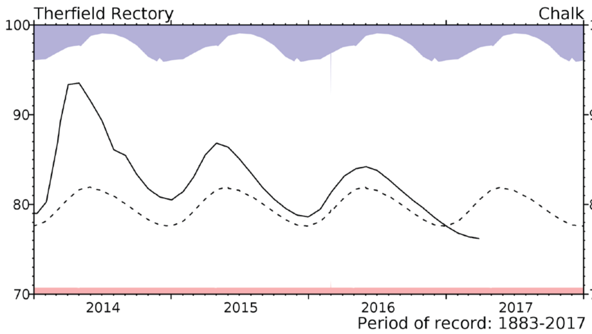


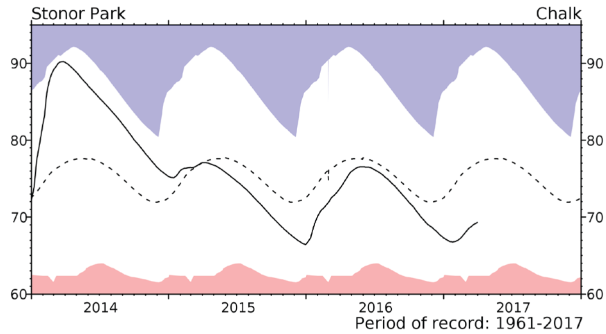


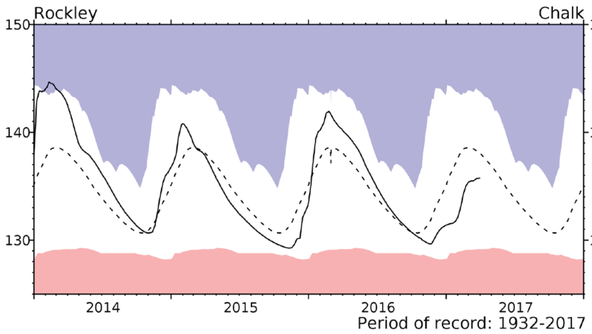
Groundwater . . . Groundwater

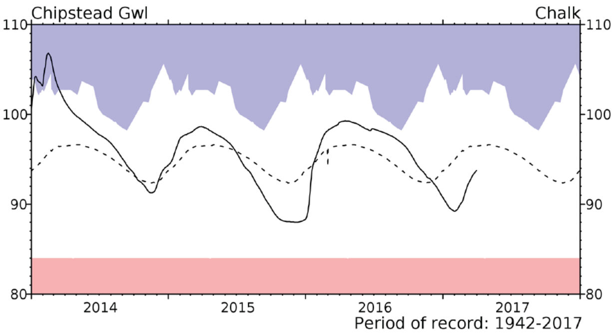


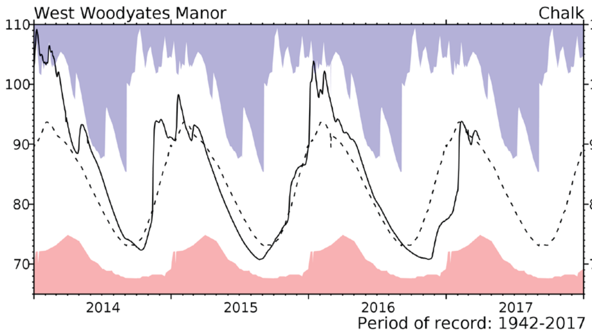


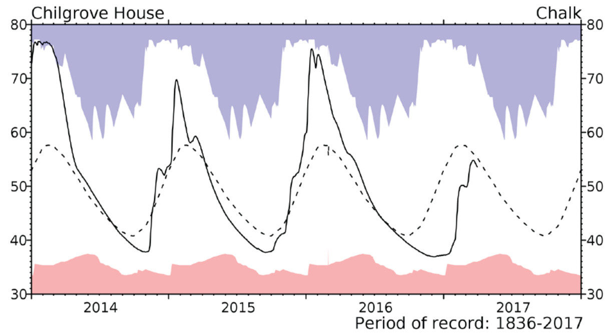


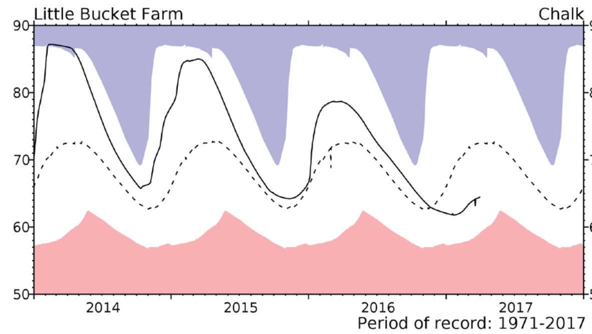


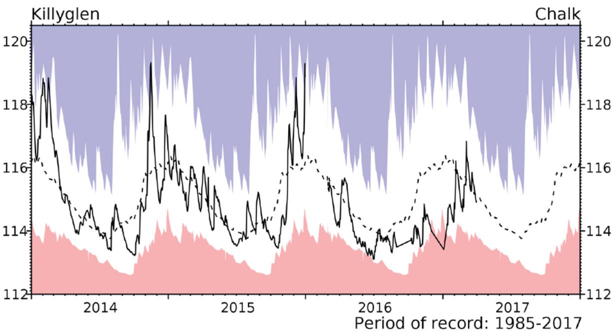






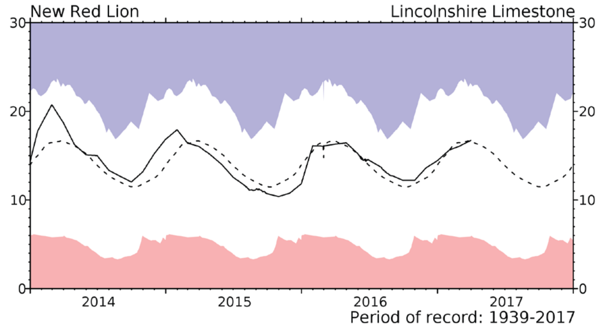


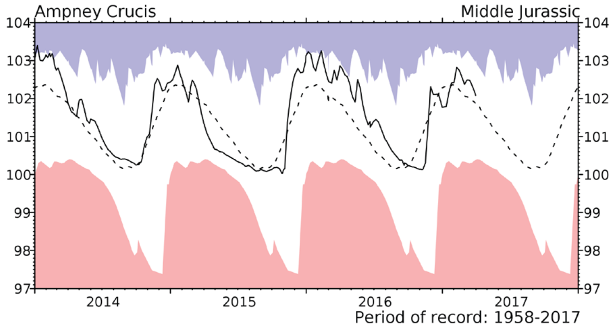


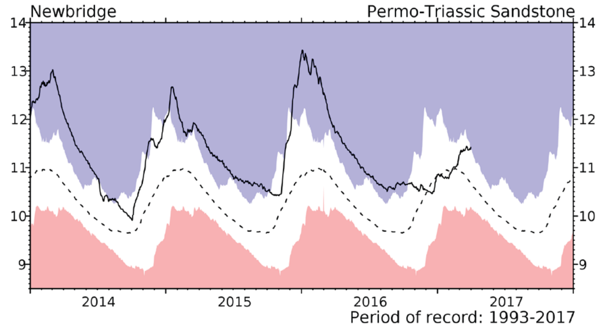


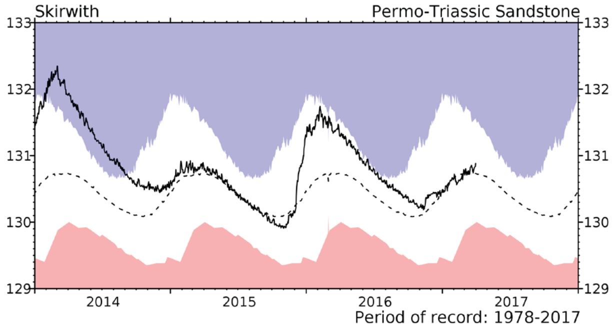
Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

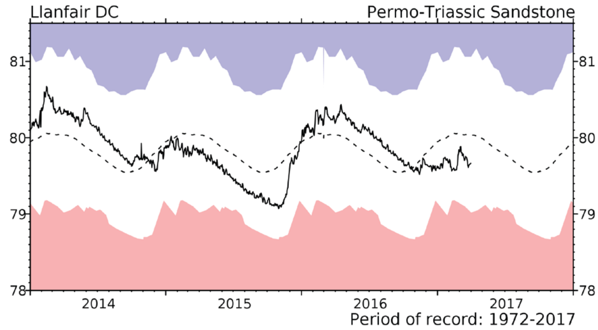
Groundwater... Groundwater

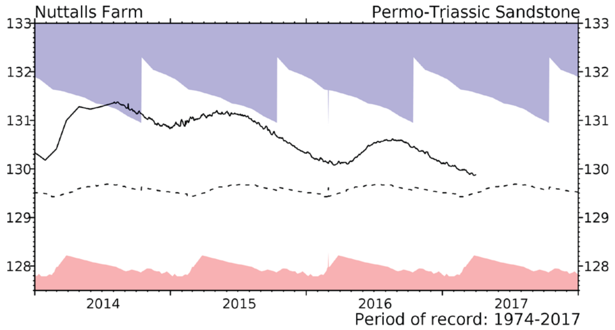


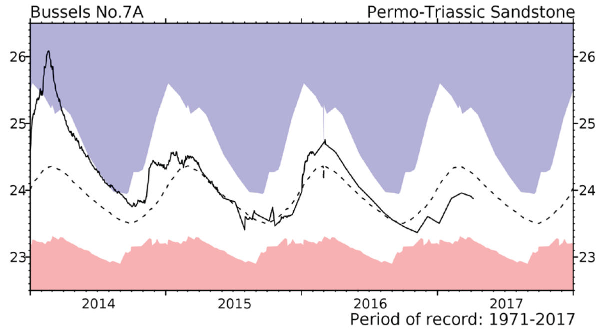


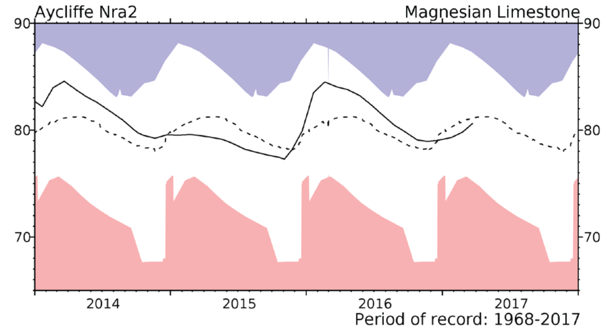


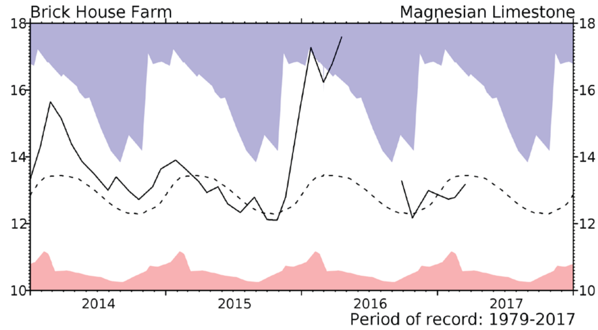


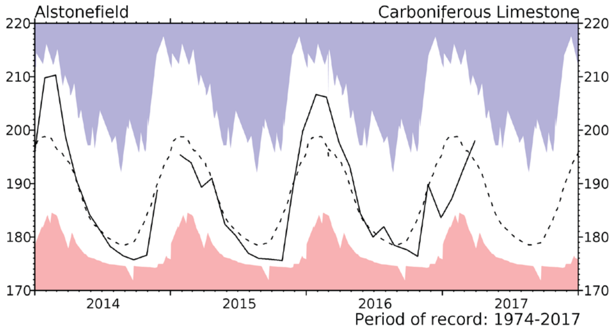


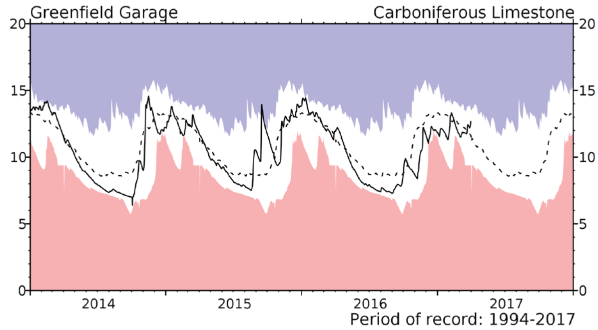


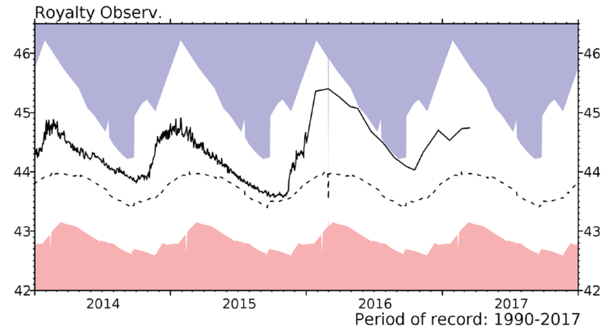




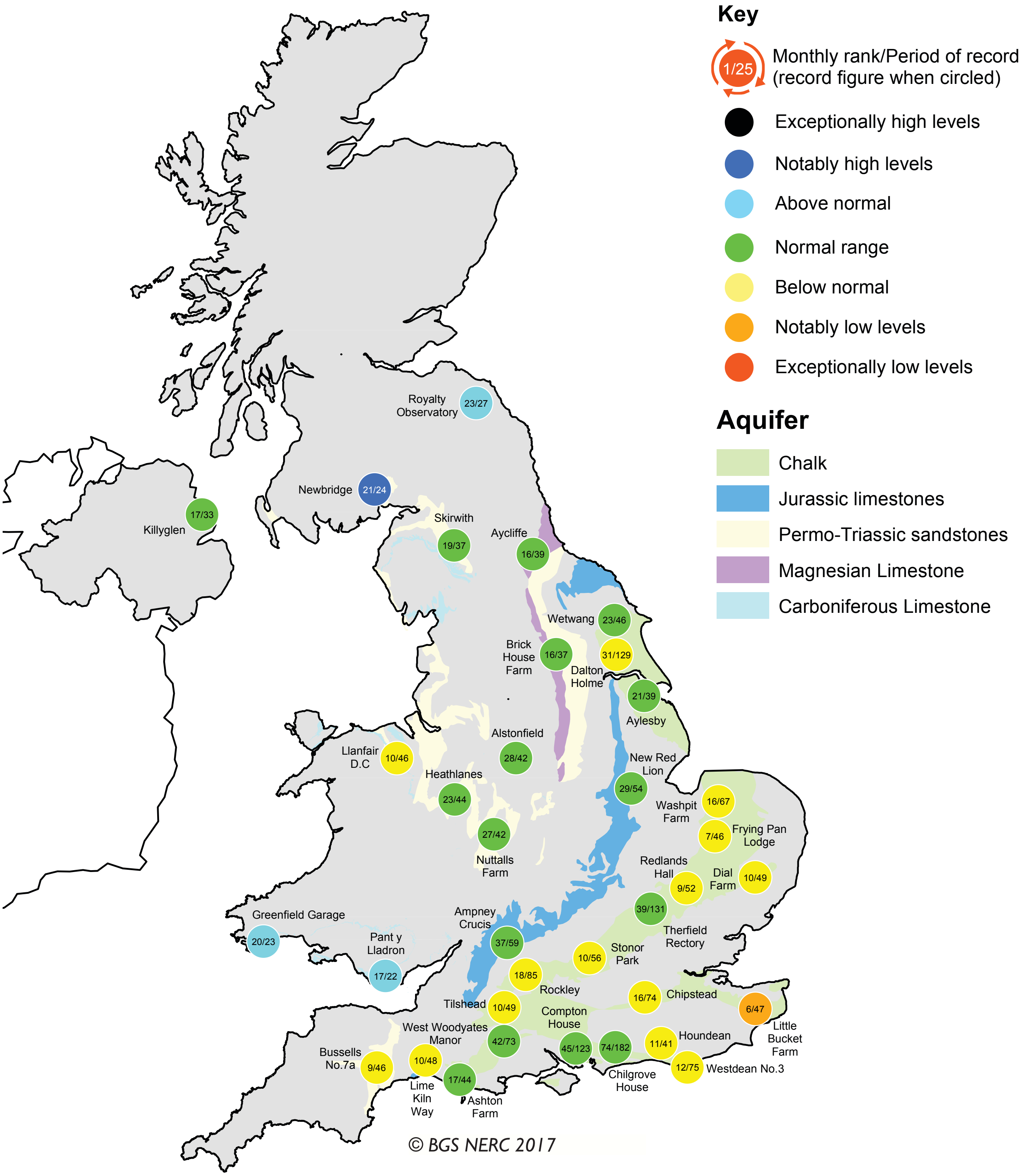








Groundwater...Groundwater

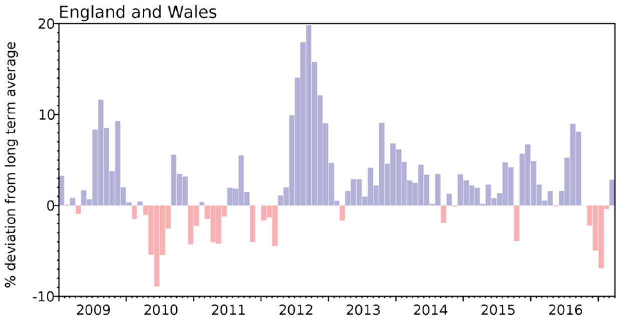


Groundwater levels - March 2017

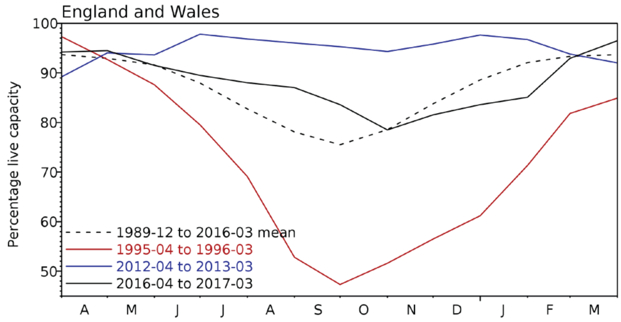
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

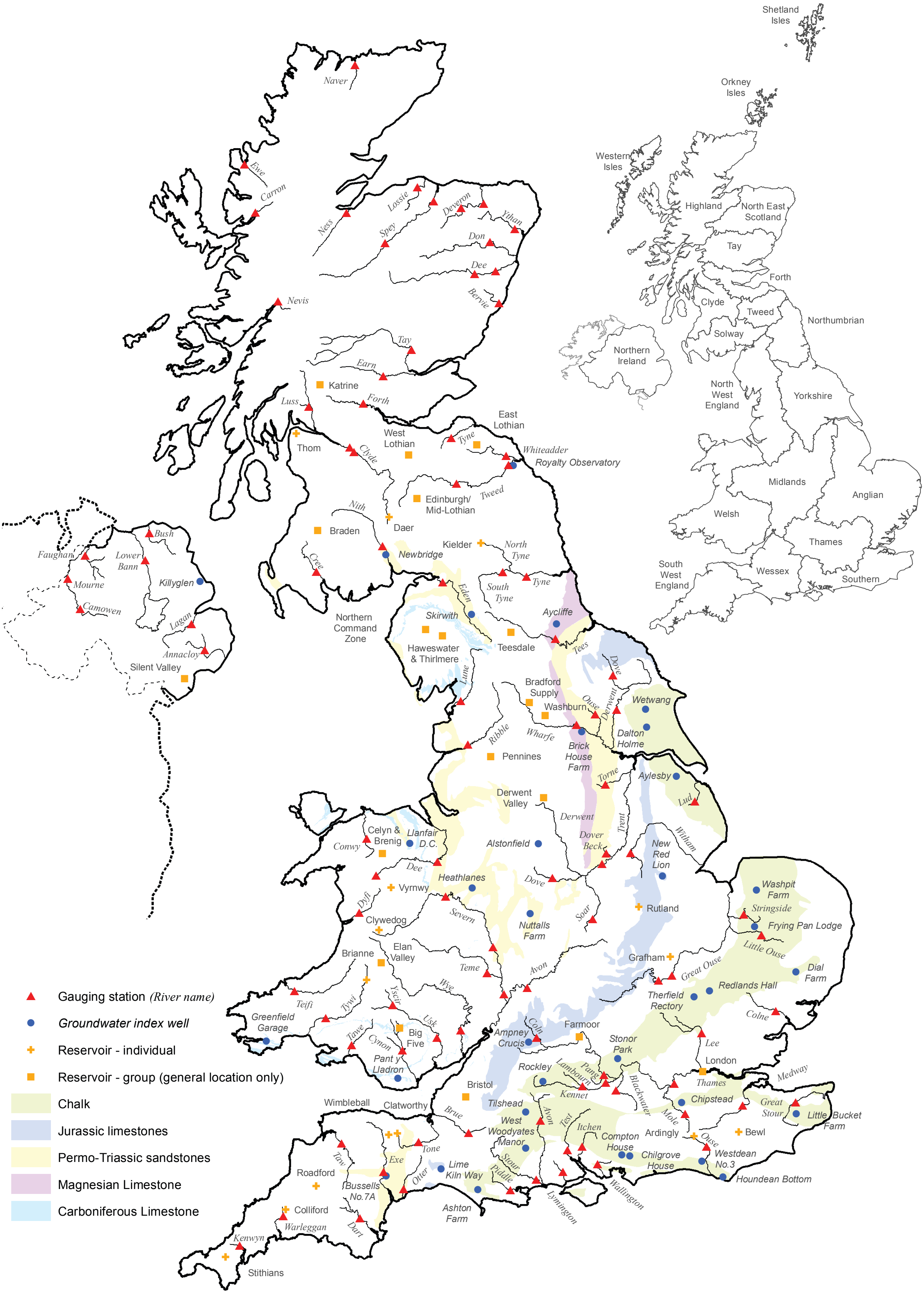
Area	Reservoir		Capacity (Ml)	2017 Jan	2017 Feb	2017 Mar	Mar Anom.	Min Mar	Year* of min	2016 Mar	Diff 17-16
North West	N Command Zone	•	124929	69	80	98	7	77	1993	90	9
	Vyrnwy		55146	84	98	100	5	64	1996	99	1
Northumbrian	Teesdale	•	87936	93	100	98	5	77	2003	86	12
	Kielder		(199175)	84	95	97	5	81	1993	86	11
Severn-Trent	Clywedog		44922	91	100	99	4	86	1996	98	1
	Derwent Valley	•	39525	92	100	97	1	54	1996	100	-3
Yorkshire	Washburn	•	22035	78	95	98	5	70	1996	95	3
	Bradford Supply	•	41407	78	86	95	1	59	1996	95	0
Anglian	Grafham		(55490)	87	95	96	4	77	1997	96	0
	Rutland		(116580)	87	95	97	6	73	2012	95	2
Thames	London	•	202828	92	94	95	1	88	1990	93	2
	Farmoor	•	13822	93	98	96	2	80	2013	82	14
Southern	Bewl		28170	59	71	79	-11	49	2012	100	-22
	Ardingly		4685	60	94	100	2	51	2012	95	5
Wessex	Clatworthy		5364	71	90	100	3	82	1992	100	0
	Bristol	•	(38666)	73	84	94	1	71	1992	99	-5
South West	Colliford		28540	70	77	95	7	58	1997	100	-5
	Roadford		34500	65	69	76	-10	37	1996	96	-21
	Wimbleball		21320	58	76	93	-3	78	1996	100	-7
	Stithians		4967	86	95	99	5	52	1992	100	-1
Welsh	Celyn & Brenig	•	131155	94	100	100	2	72	1996	100	0
	Brianne		62140	94	100	100	2	90	1993	98	2
	Big Five	•	69762	86	92	94	-2	78	1993	97	-3
	Elan Valley	•	99106	95	100	100	3	89	1993	99	1
Scotland(E)	Edinburgh/Mid-Lothian	•	96518	85	90	92	-3	71	1998	100	-8
	East Lothian	•	9374	100	100	100	1	95	2012	100	0
Scotland(W)	Loch Katrine	•	110326	89	98	97	5	74	2010	95	2
	Daer		22412	93	100	100	3	77	2013	94	6
	Loch Thom		10798	91	100	97	0	83	2010	100	-3
Northern Ireland	Total+	•	56800	74	84	93	2	83	2002	95	-3
	Silent Valley	•	20634	59	71	88	1	57	2000	94	-7

( ) 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.

Location map . . . Location map



NHMP

The National Hydrological Monitoring Programme (NHMP) was started in 1988 and is undertaken jointly by the Centre for Ecology & Hydrology (CEH) 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 CEH) and National Groundwater Level Archive (NGLA; maintained by BGS), including rainfall, river flows, borehole levels, and reservoir stocks.

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 Rivers Agency 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
http://www.metoffice.gov.uk/climate/uk/about/methods

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

04/2017

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