# Hydrological Summary

## *for the* United Kingdom

*June 2018*

### General

June was a hot and dry month; for England and Wales, it was the only June in series from 1910 to rank among both the three hottest and three driest Junes. Under the influence of persistent high pressure, it was the hottest June on record for both Wales and Northern Ireland (in series from 1910), and the fourth driest June in a series from 1766 in the CRU England & Wales Precipitation series. Correspondingly, late June soil moisture deficits (SMDs) were the highest on record for the UK (in a series from 1961) and the highest for any month since August 1995. The arid soils and persistent heatwave in late June caused moorland fires (e.g. the Pennines outside Manchester), contracting stream networks (requiring fish rescues on the Teme) and agricultural stress. The infrastructural challenges of supplying water during periods of high demand caused localised water supply shortages (e.g. bottled water provided in Derbyshire, Staffordshire and Shropshire), and the implementation of a hosepipe ban in Northern Ireland. Mean river flows for June were below normal or lower across most of the north and west, notably in north-east Scotland, north-west and south-west England, and south Wales. Daily flows in some of these areas and Northern Ireland began to eclipse daily minima towards month-end. Groundwater levels fell but generally remained in the normal range or above due to the delayed end to the recharge season. Many reservoirs in the north and west fell by 10-15%, and by more than 20% at Clatworthy. Overall stocks in Northern Ireland and Wales fell by 12%, and were more than 10% below average in Wales and parts of northern England. The continuation of blocking high pressure and little appreciable rainfall during the first half of July across the UK is likely to have exacerbated agricultural and environmental stress. Increased water demand associated with high temperatures will continue to put pressure on water supply infrastructure, particularly in northern and western areas which are more vulnerable to short-term rainfall deficiencies. Though forecasts are uncertain, the timing and magnitude of rainfall over the next six weeks will be influential on the prospects for UK water resources into late summer and autumn.

### Rainfall

Anticyclonic conditions dominated in June, delivering summery weather and meagre rainfall. On the 1st/2nd, heavy rainfall (e.g. 34mm at Fylingdales, North Yorkshire) caused surface water flooding of transport networks and properties in parts of England and Scotland. For much of England and Wales, however, this was the last appreciable rainfall in June. Further north, conditions were more unsettled mid-month, including thunderstorms and hail causing surface water flooding in Northern Ireland and Scotland on the 9th. On the 14th, storm 'Hector' traversed the same areas, an unusually intense system for the summer, bringing high winds (the strongest in June in Northern Ireland since 1962, causing power cuts for 26,000 properties) and heavy rainfall (e.g. 45mm at Achnagart, Ross & Cromarty). Thereafter, blocking high pressure became entrenched bringing fine, dry weather to all areas. For June overall, the UK registered half of average rainfall, but less than a third of average south of a line between the Mersey and Humber. It was the driest June on record for Southern Region (in a series from 1910) as many rain gauges here recorded less than 1mm of rainfall in June (less than 5% of average). Over the April-June period, most of the UK received around 80% of average rainfall. It was particularly dry in North East Scotland, the sixth driest April-June in a series from 1910 and driest since the 1984 drought. Substantial parts of the Scottish Highlands registered less than 70% of average over January-June, and for North East Scotland it was the driest start to the year since 1973.

### River flows

Following moderately high flows resulting from late May rainfall, recessions became established across much of the UK in early June. In the second week, catchments draining northern Scotland (e.g. the Carron, Spey and Forth) and Northern Ireland (e.g. the Lower Bann and Lagan) were already redefining daily flow minima. Recessions were briefly interrupted mid-month in the north-west though peak flows relating to 'Hector' were generally not notable. Following protracted steep recessions through the final third of the month, daily flows became exceptionally low across the north and west of the UK. By month-end, they were amongst the lowest June daily flows on record for some catchments in eastern Scotland, north-east England and south Wales, and the lowest on record for June for the Welsh Dee, Lower Bann and Lagan. Flows on the Tywi were the lowest on record for any month (in a series from 1958). Outflows from Great Britain reflected nationwide recessions, approaching daily minima towards month-end. The outflow from Northern Ireland on 30th June was the second lowest daily outflow in the entire record (in a series from 1980). For June overall, river flows were substantially below average across much of the north and west. Exceptionally low flows were recorded on the Spey and Yscir, and the Tywi registered its lowest June mean flow on record (in a series from 1958). Further south and east, flows were predominantly in the normal range reflecting the lagged response to spring rainfall. River flows for May-June were below normal in northern Scotland, northern and south-west England, and eastern Northern Ireland, exceptionally so for the Naver, Spey, Deveron and Ribble. January-June river flows for northern Scotland were around three quarters of average.

### Groundwater

Between late April and late June, SMDs for the UK increased by two and a half times the average April-June rate, the second largest increase over any two-month period in a series from 1961. Against this backdrop, groundwater levels at the Chalk boreholes fell in June, though faster than their normal seasonal recession. Groundwater levels were in the normal range or above, apart from Dial Farm where they were below normal and in the more rapidly responding Chalk at Killyglen where they were exceptionally low. In the more quickly responding limestone aquifers levels fell and were normal (Jurassic) or above normal to notably high (Magnesian). Levels in the Upper Greensand at Lime Kiln Way fell and remained in the normal range. In the Permo-Triassic sandstones, levels fell (except at Nuttalls Farm where they rose and at Heathlanes where they were stable) and were generally in the normal range, but were notably high in south-west Scotland and above average in south-west England. Levels in the rapidly responding Carboniferous Limestone receded during June and were normal or below. In the Fell Sandstone at Royalty Observatory, levels fell and were notably high.

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# Rainfall . . . Rainfall . . .

Met Office

## Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

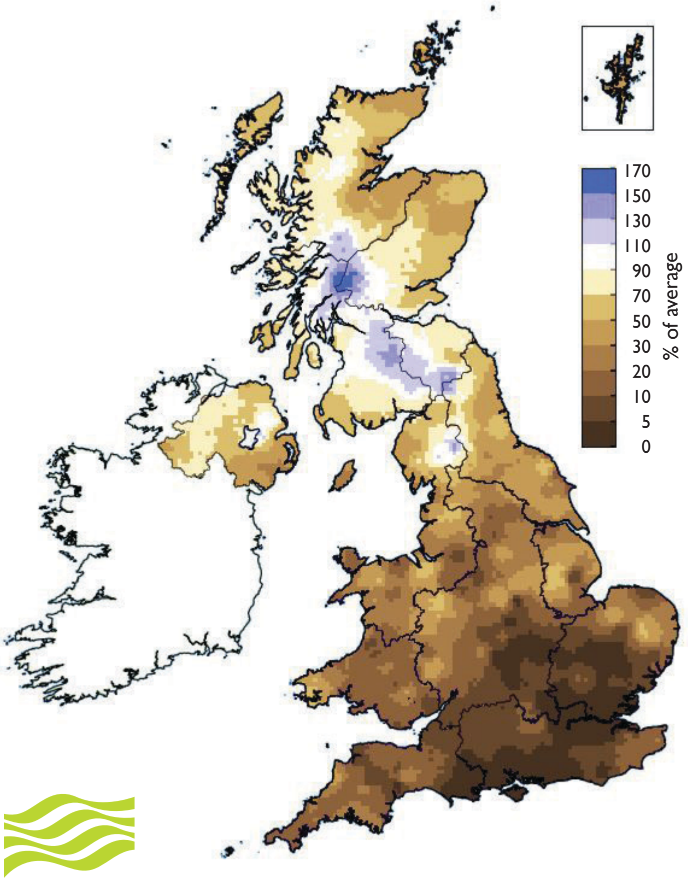
| Region | Rainfall | June 2018 | RP | Apr18 – Jun18 | RP | Jan18 – Jun18 | RP | Jul17 – Jun18 | RP |
|---|---|---|---|---|---|---|---|---|---|
| United | mm | **35** | | 170 | | 472 | | 1127 | |
| Kingdom | % | **50** | 10-15 | 81 | 5-10 | 93 | 2-5 | 100 | 2-5 |
| England | mm | **15** | | 143 | | 380 | | 855 | |
| | % | **25** | 20-35 | 81 | 2-5 | 100 | 2-5 | 101 | 2-5 |
| Scotland | mm | **71** | | 204 | | 577 | | 1469 | |
| | % | **86** | 2-5 | 82 | 5-10 | 84 | 2-5 | 97 | 2-5 |
| Wales | mm | **19** | | 204 | | 624 | | 1455 | |
| | % | **23** | 20-30 | 81 | 2-5 | 100 | 2-5 | 103 | 2-5 |
| Northern | mm | **49** | | 188 | | 519 | | 1247 | |
| Ireland | % | **65** | 2-5 | 84 | 2-5 | 100 | 2-5 | 110 | 5-10 |
| England & | mm | **16** | | 151 | | 413 | | 938 | |
| Wales | % | **24** | 20-35 | 81 | 2-5 | 100 | 2-5 | 102 | 2-5 |
| North West | mm | **39** | | 170 | | 461 | | 1293 | |
| | % | **49** | 5-10 | 76 | 5-10 | 86 | 2-5 | 106 | 2-5 |
| Northumbria | mm | **41** | | 145 | | 393 | | 845 | |
| | % | **62** | 2-5 | 79 | 2-5 | 99 | 2-5 | 97 | 2-5 |
| Severn-Trent | mm | **13** | | 156 | | 378 | | 796 | |
| | % | **21** | 20-30 | 88 | 2-5 | 106 | 2-5 | 102 | 2-5 |
| Yorkshire | mm | **21** | | 143 | | 391 | | 852 | |
| | % | **30** | 10-15 | 78 | 2-5 | 101 | 2-5 | 101 | 2-5 |
| Anglian | mm | **9** | | 123 | | 288 | | 628 | |
| | % | **16** | 30-50 | 82 | 2-5 | 101 | 2-5 | 101 | 2-5 |
| Thames | mm | **3** | | 135 | | 331 | | 718 | |
| | % | **6** | 50-80 | 85 | 2-5 | 101 | 2-5 | 100 | 2-5 |
| Southern | mm | **3** | | 144 | | 374 | | 802 | |
| | % | **6** | 50-80 | 92 | 2-5 | 106 | 2-5 | 100 | 2-5 |
| Wessex | mm | **4** | | 133 | | 397 | | 876 | |
| | % | **7** | 40-60 | 76 | 2-5 | 100 | 2-5 | 99 | 2-5 |
| South West | mm | **12** | | 149 | | 553 | | 1245 | |
| | % | **17** | 20-35 | 67 | 5-10 | 100 | 2-5 | 102 | 2-5 |
| Welsh | mm | **19** | | 199 | | 605 | | 1398 | |
| | % | **23** | 20-30 | 81 | 2-5 | 100 | 2-5 | 102 | 2-5 |
| Highland | mm | **74** | | 210 | | 604 | | 1721 | |
| | % | **82** | 2-5 | 75 | 5-10 | 73 | 2-5 | 95 | 2-5 |
| North East | mm | **41** | | 130 | | 348 | | 929 | |
| | % | **58** | 5-10 | 64 | 10-20 | 77 | 10-15 | 92 | 2-5 |
| Tay | mm | **69** | | 185 | | 524 | | 1134 | |
| | % | **91** | 2-5 | 81 | 2-5 | 84 | 2-5 | 85 | 5-10 |
| Forth | mm | **77** | | 192 | | 518 | | 1089 | |
| | % | **100** | 2-5 | 89 | 2-5 | 94 | 2-5 | 91 | 2-5 |
| Tweed | mm | **73** | | 203 | | 507 | | 1017 | |
| | % | **104** | 2-5 | 102 | 2-5 | 109 | 5-10 | 99 | 2-5 |
| Solway | mm | **72** | | 231 | | 642 | | 1546 | |
| | % | **85** | 2-5 | 90 | 2-5 | 98 | 2-5 | 104 | 5-10 |
| Clyde | mm | **99** | | 263 | | 752 | | 1852 | |
| | % | **102** | 2-5 | 92 | 2-5 | 93 | 2-5 | 102 | 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 January 2018 are provisional.

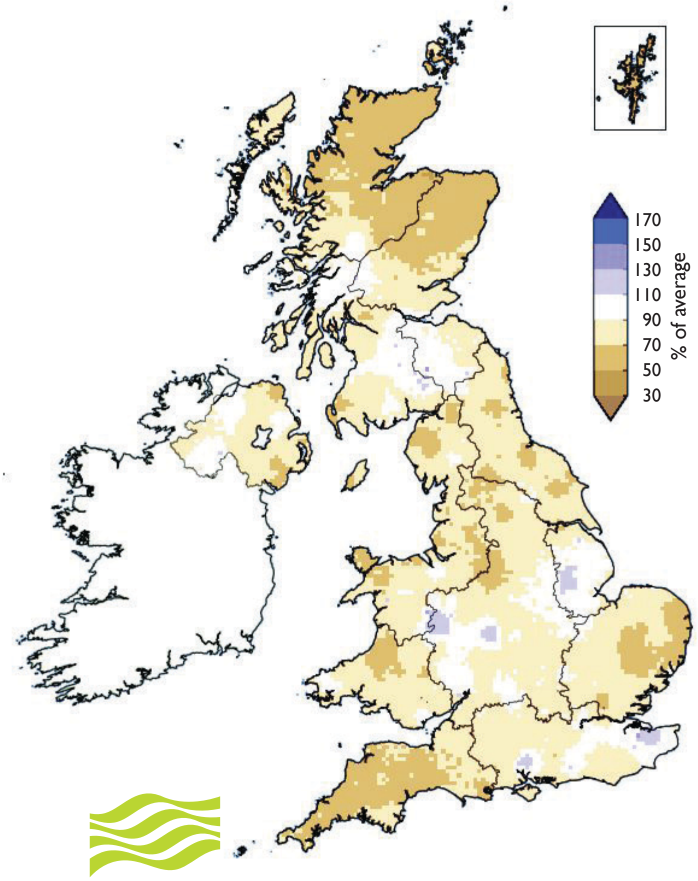
# Rainfall . . . Rainfall . . .

**June 2018 rainfall as % of 1981-2010 average**



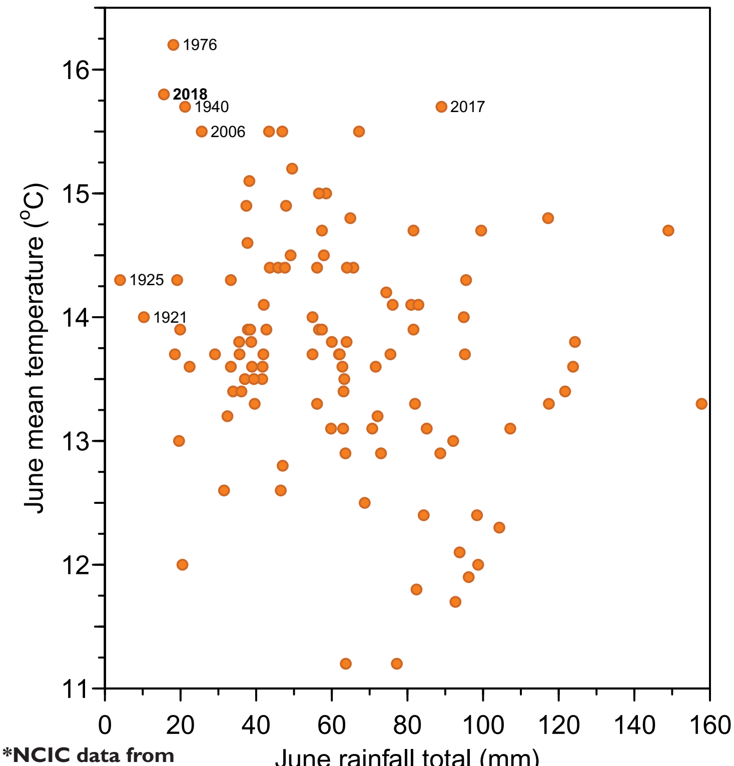

Met Office

**April 2018 - June 2018 rainfall as % of 1981-2010 average**




Met Office

## June rainfall totals (mm) and mean temperature (°C) for England and Wales*




*NCIC data from 1910-2018

## Hydrological Outlook UK

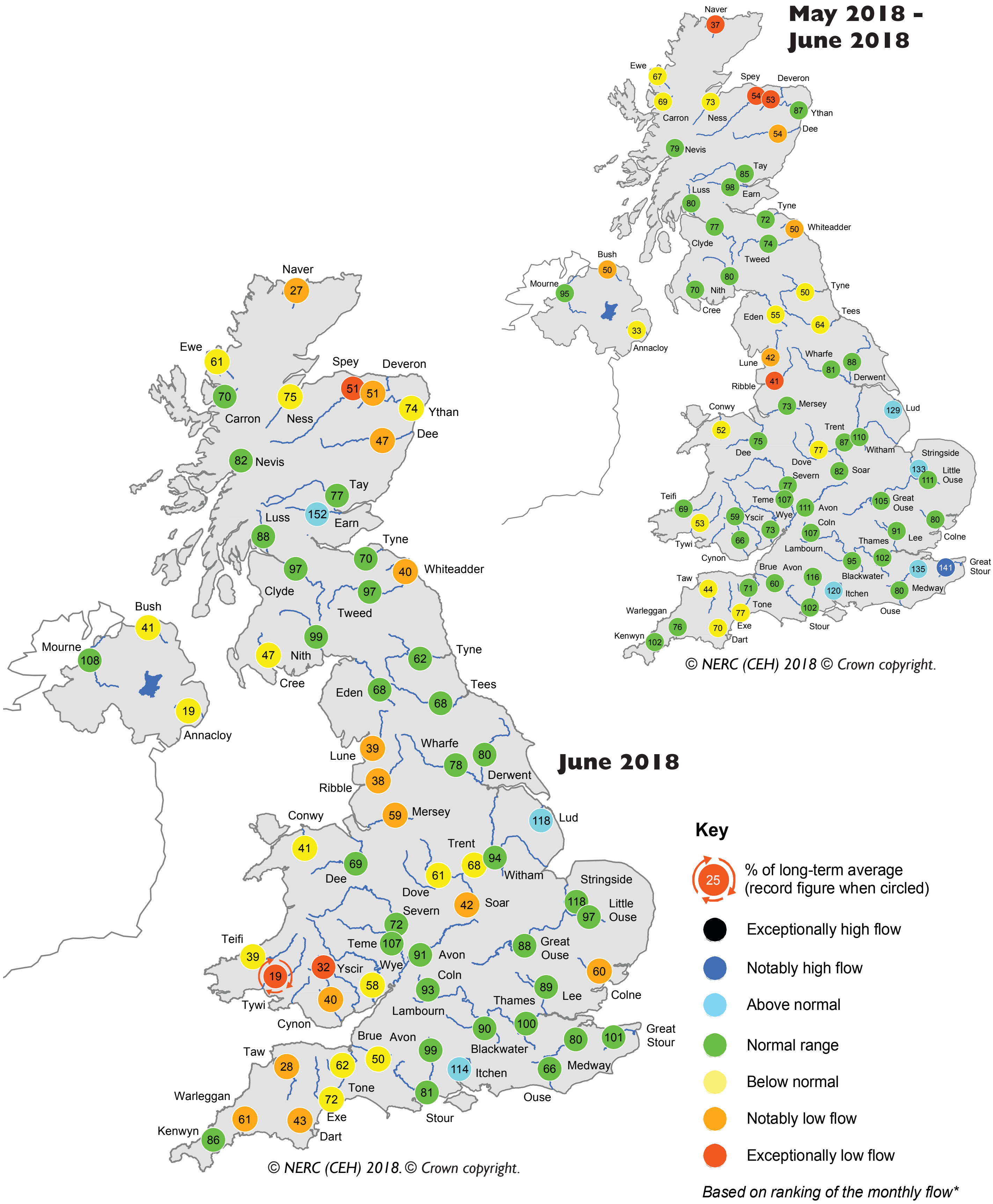
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

**Period:** **from July 2018**
**Issued:** **09.07.2018**
**using data to the end of June 2018**

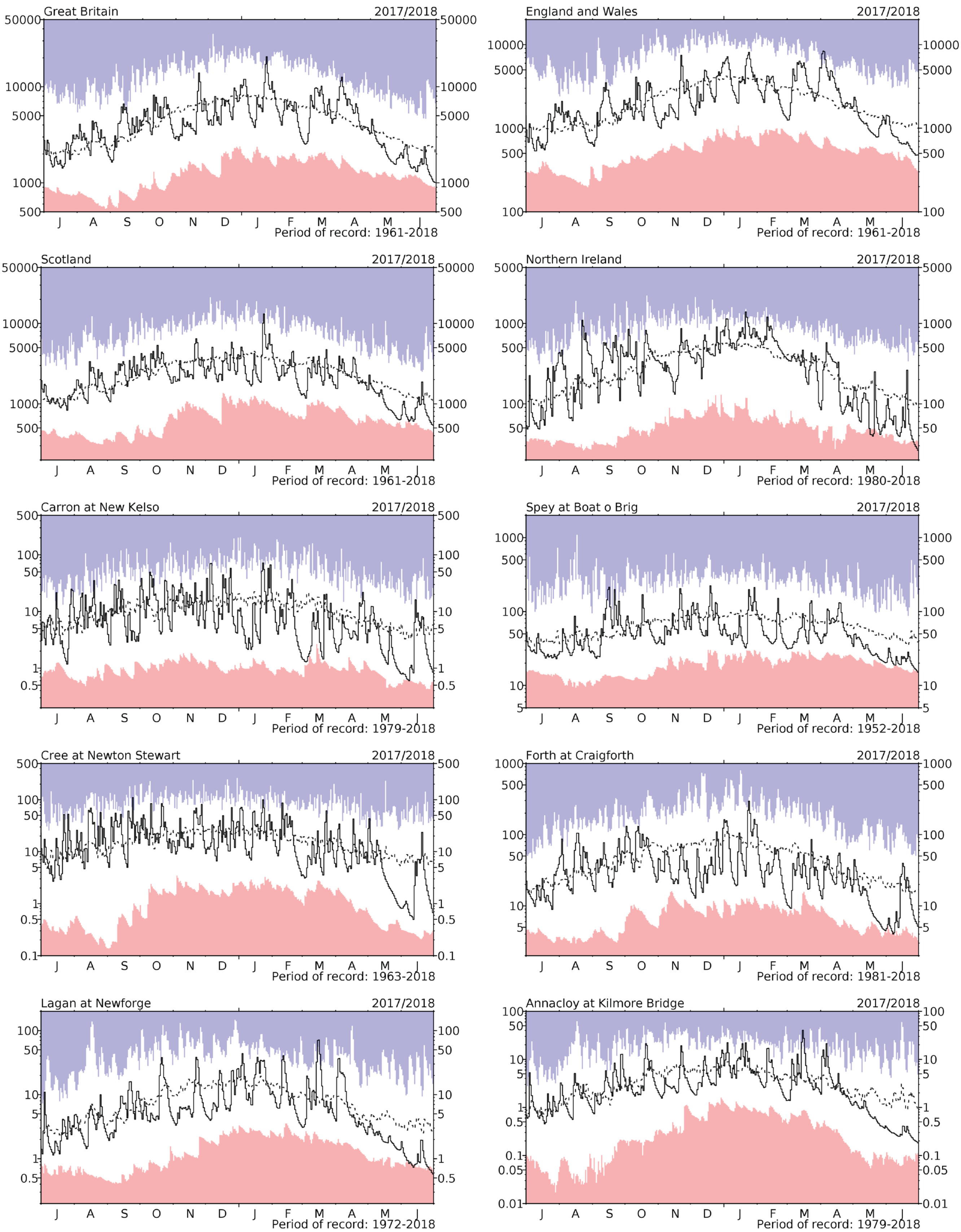
The outlook for the recent hot and dry weather to continue indicates that in northern and western parts of the UK river flows are likely to be below normal during July and for the next three months. In some places, river flows may be exceptionally low. However, as a consequence of a wet spring, river flows in the south-east, central and eastern parts of England are likely to remain normal in July, although it should be noted that, as the hot and dry weather continues, river flows may fall to below normal over the next three months. Generally, groundwater levels across the UK are likely to be normal to above normal during July and for the next three months.

# River flow . . . River flow . . .




## River flows

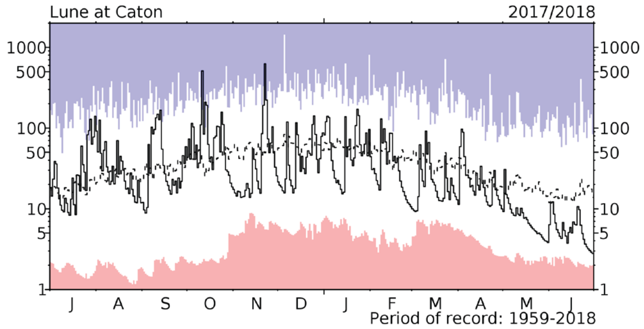
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

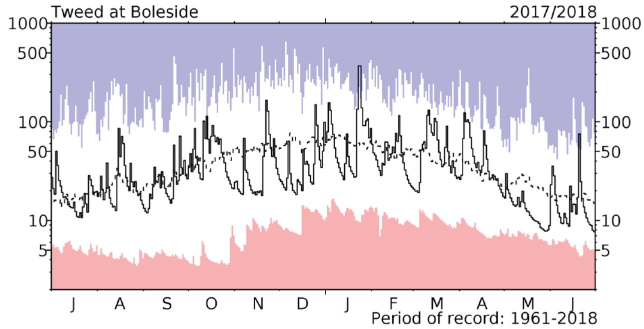


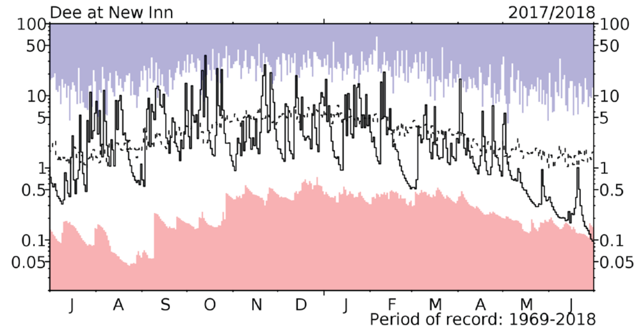

## River flow hydrographs

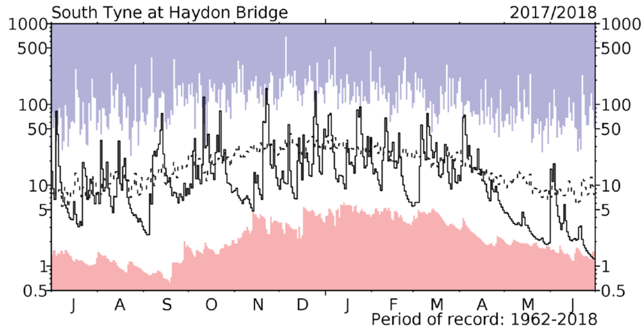
*The river flow hydrographs show the daily mean flows (measured in $m^3s^{-1}$) together with the maximum and minimum daily flows prior to July 2017 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

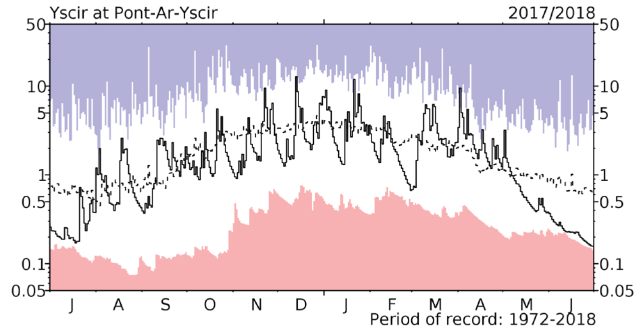
# River flow . . . River flow . . .

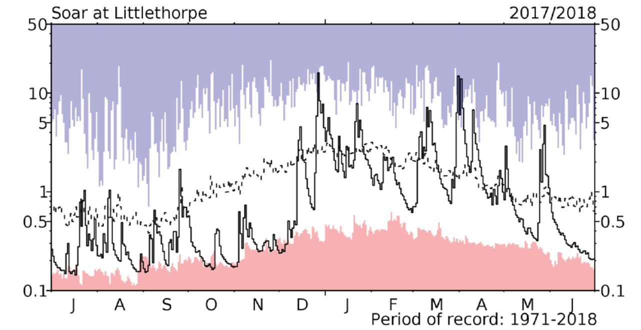


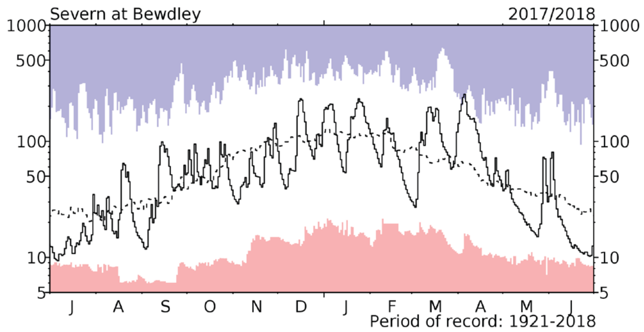



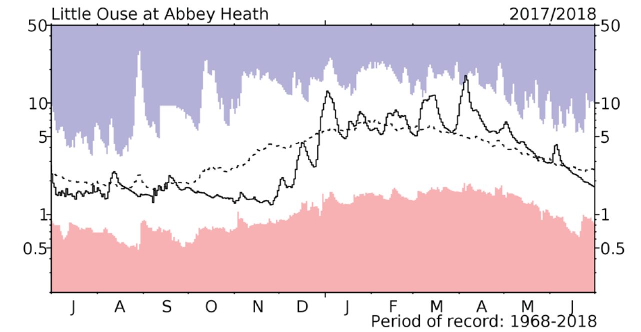



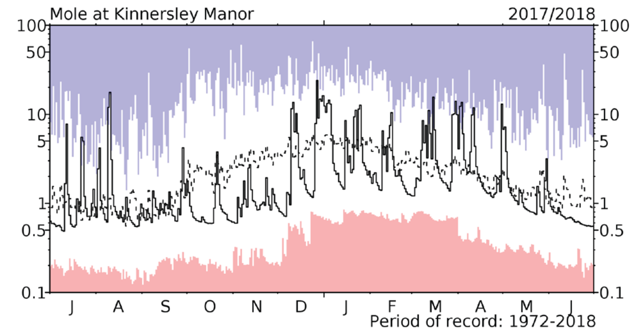



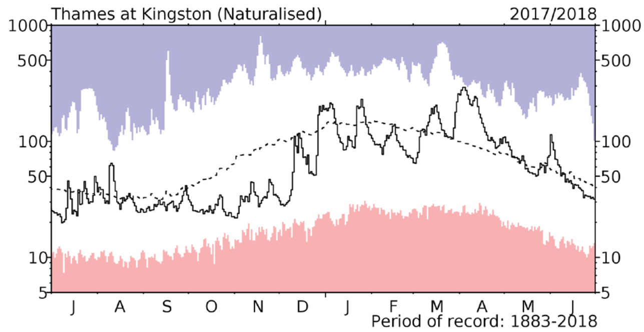



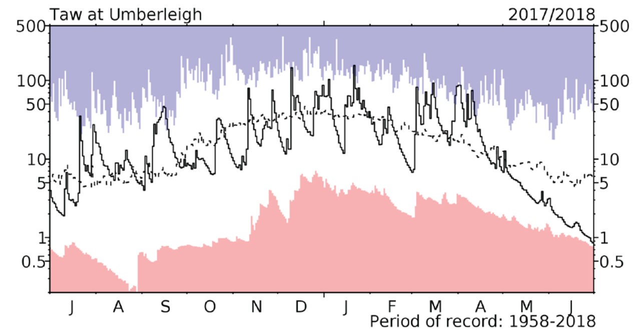



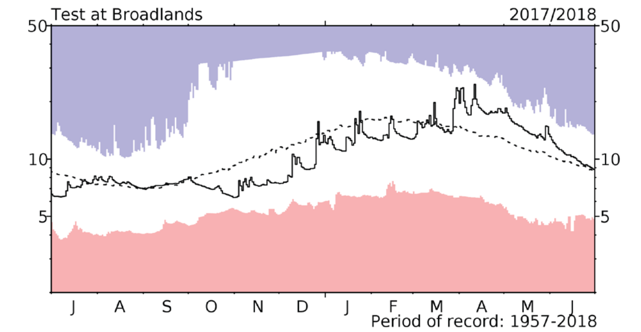



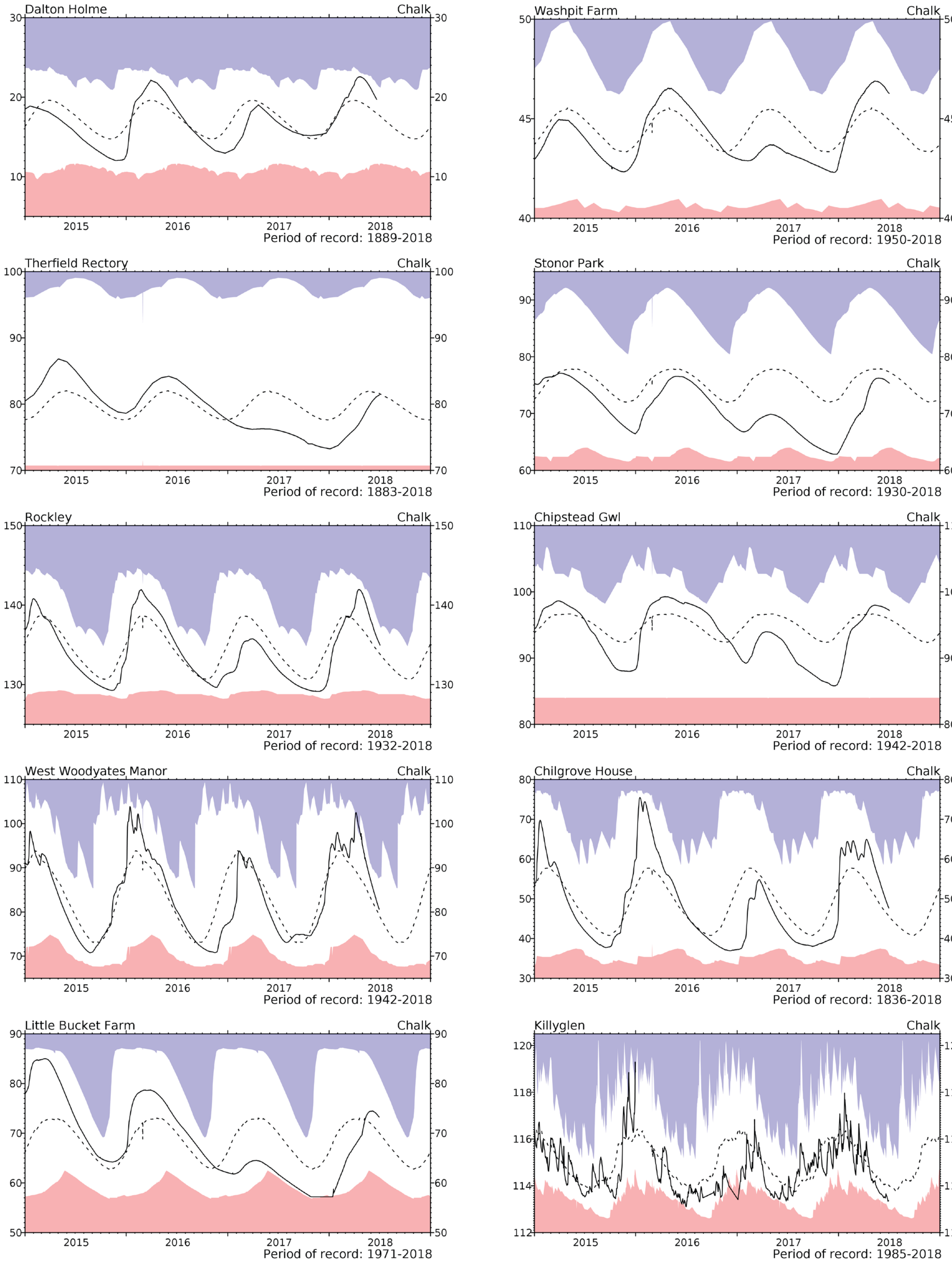



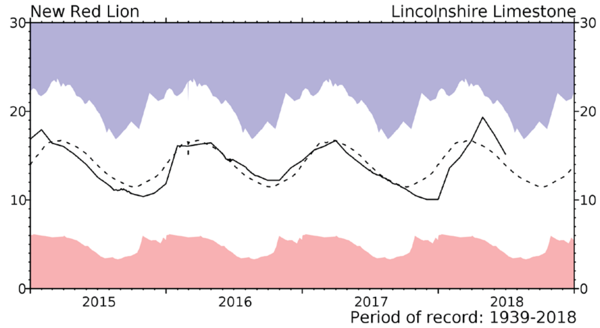



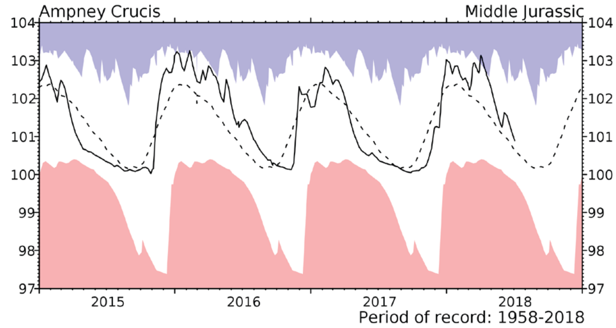



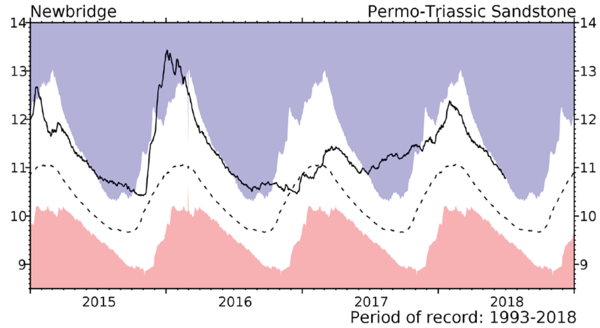
# Groundwater . . . Groundwater

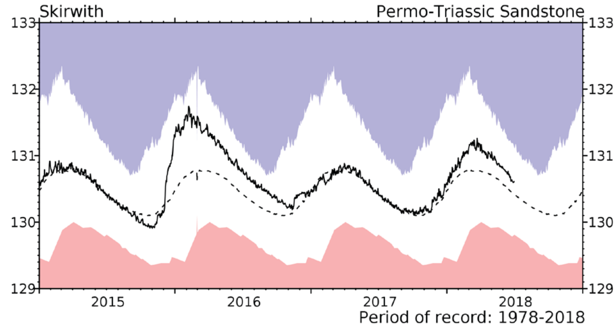


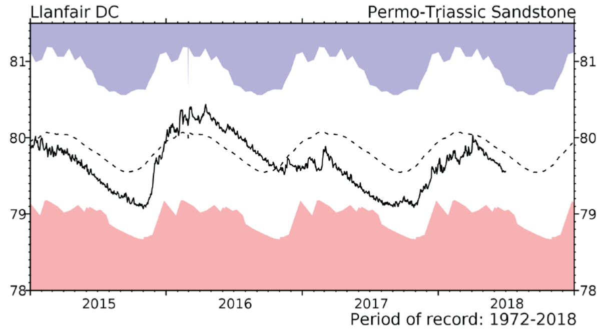

Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

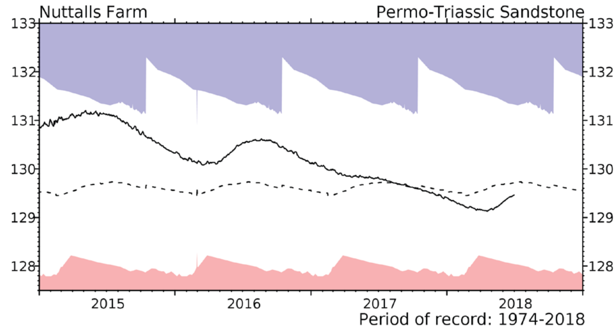

New Red Lion
Lincolnshire Limestone
2015
2016
2017
2018
Period of record: 1939-2018

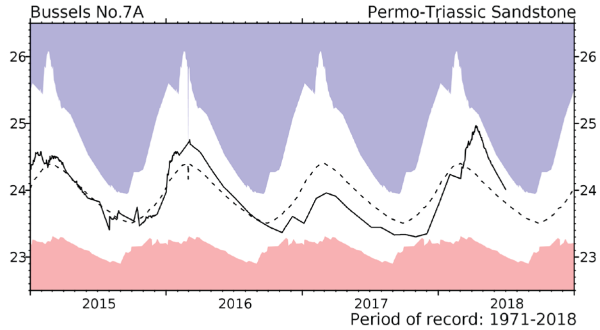

Ampney Crucis
Middle Jurassic
2015
2016
2017
2018
Period of record: 1958-2018

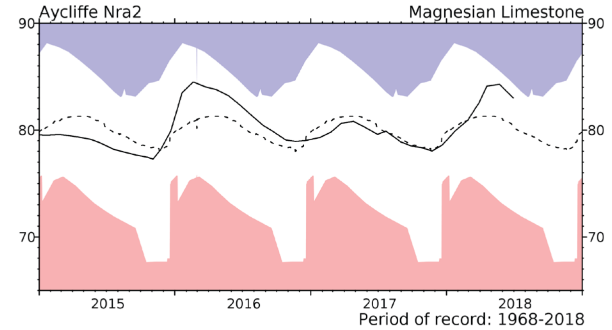

Newbridge
Permo-Triassic Sandstone
2015
2016
2017
2018
Period of record: 1993-2018

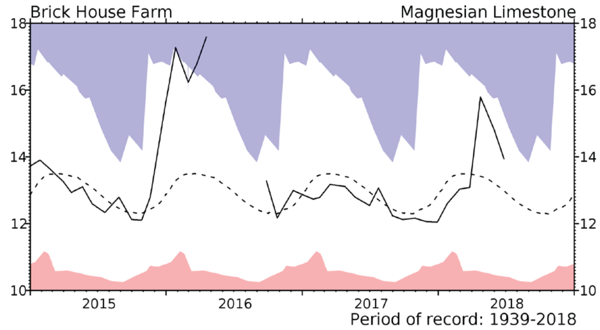

Skirwith
Permo-Triassic Sandstone
2015
2016
2017
2018
Period of record: 1978-2018

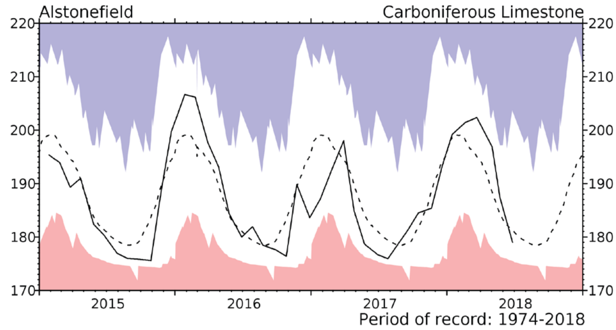

Llanfair DC
Permo-Triassic Sandstone
2015
2016
2017
2018
Period of record: 1972-2018

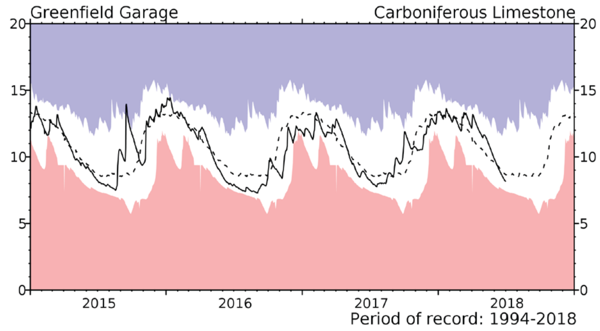

Nuttalls Farm
Permo-Triassic Sandstone
2015
2016
2017
2018
Period of record: 1974-2018

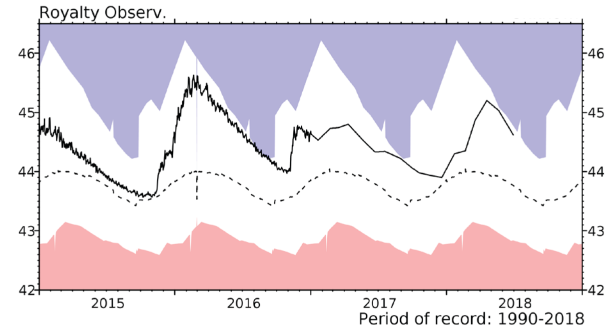

Bussels No.7A
Permo-Triassic Sandstone
2015
2016
2017
2018
Period of record: 1971-2018

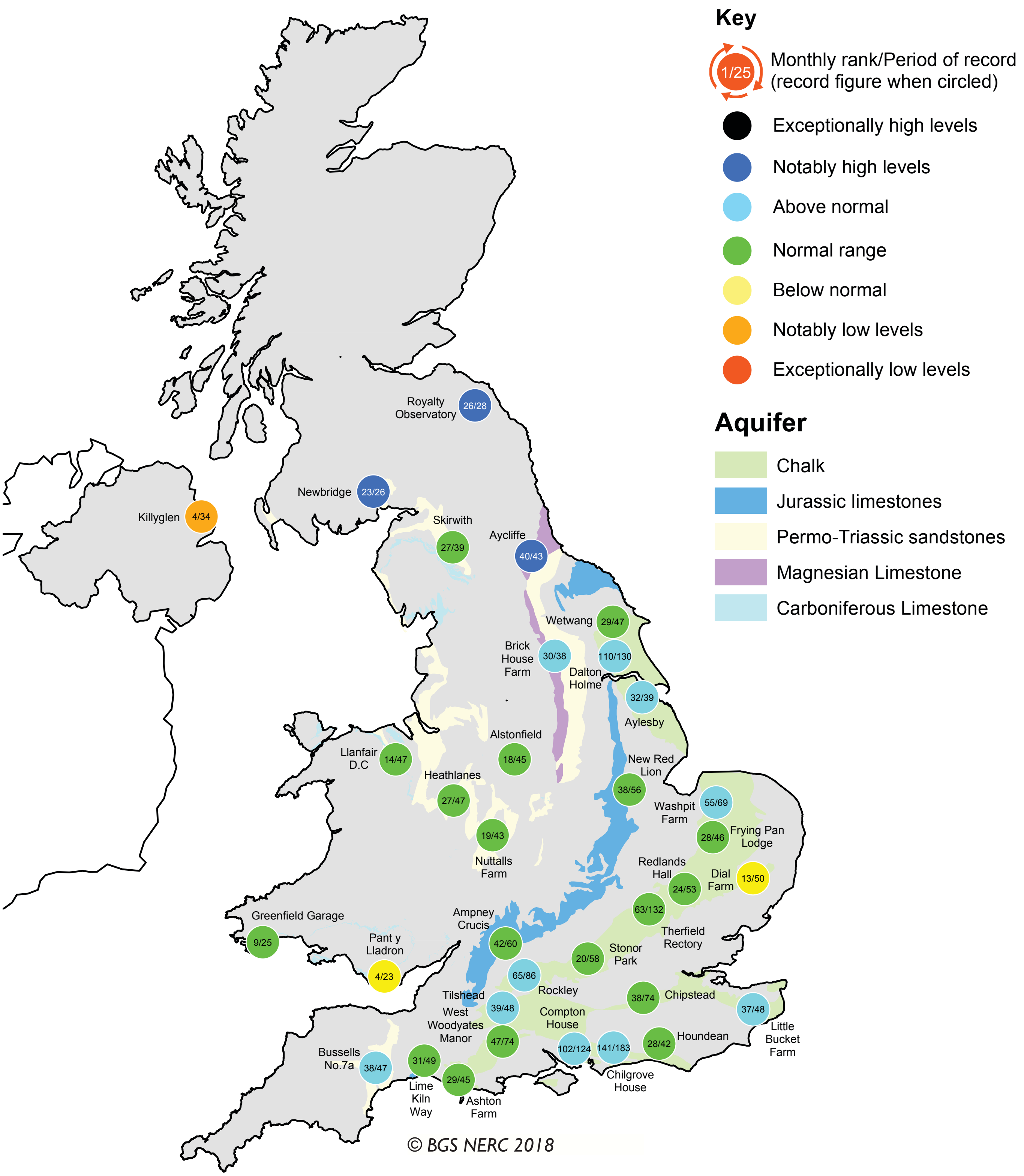

Aycliffe Nra2
Magnesian Limestone
2015
2016
2017
2018
Period of record: 1968-2018


Brick House Farm
Magnesian Limestone
2015
2016
2017
2018
Period of record: 1939-2018


Alstonefield
Carboniferous Limestone
2015
2016
2017
2018
Period of record: 1974-2018


Greenfield Garage
Carboniferous Limestone
2015
2016
2017
2018
Period of record: 1994-2018


Royalty Observ.
2015
2016
2017
2018
Period of record: 1990-2018

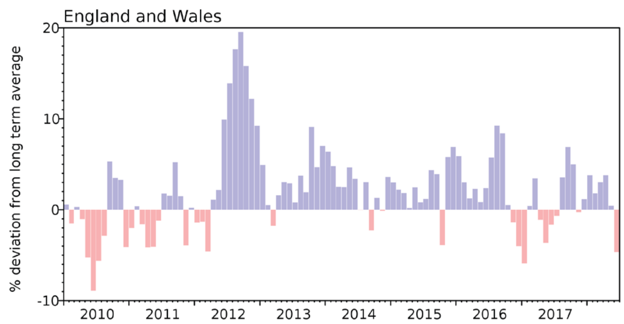



## Groundwater levels - June 2018

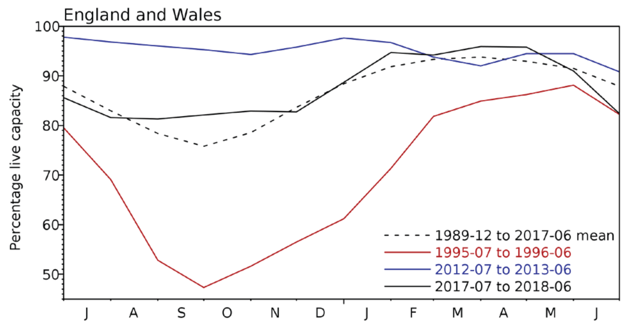
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

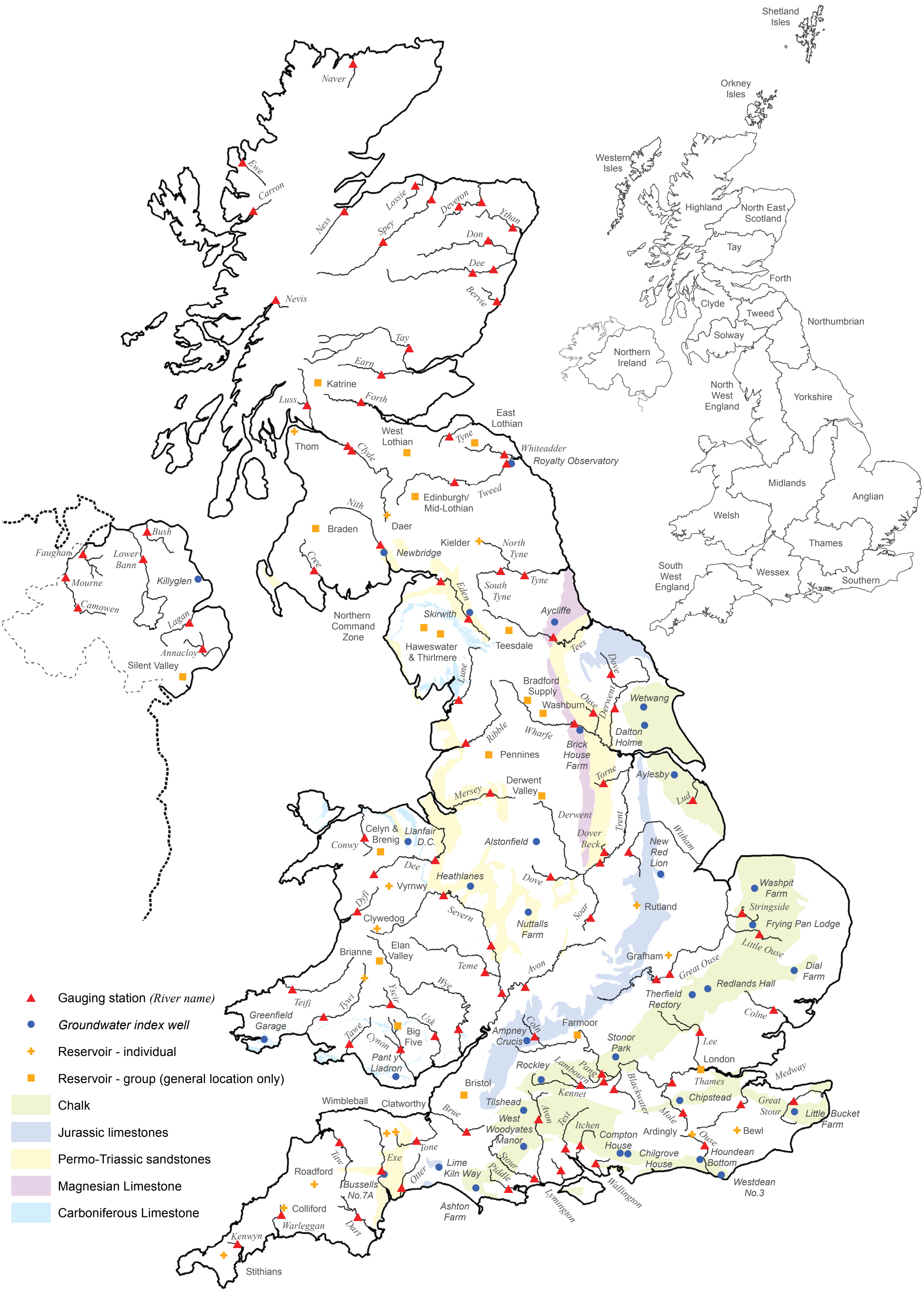
| Area | Reservoir | | Capacity (Ml) | 2018 Apr | 2018 May | 2018 Jun | Jun Anom. | Min Jun | Year* of min | 2017 Jun | Diff 18-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North West | N Command Zone | • | 124929 | 86 | 69 | 57 | -15 | 38 | 1984 | 78 | -21 |
| | Vyrnwy | | 55146 | 100 | 93 | 82 | -1 | 58 | 1984 | 95 | -13 |
| Northumbrian | Teesdale | • | 87936 | 92 | 82 | 71 | -9 | 58 | 1989 | 76 | -4 |
| | Kielder | | (199175) | 93 | 91 | 87 | -3 | 71 | 1989 | 92 | -5 |
| Severn-Trent | Clywedog | | 49936 | 100 | 100 | 93 | 0 | 32 | 1976 | 96 | -3 |
| | Derwent Valley | • | 46692 | 98 | 86 | 69 | -12 | 53 | 1996 | 76 | -7 |
| Yorkshire | Washburn | • | 23373 | 95 | 85 | 71 | -10 | 63 | 1995 | 80 | -9 |
| | Bradford Supply | • | 40942 | 96 | 84 | 67 | -13 | 54 | 1995 | 74 | -7 |
| Anglian | Grafham | | (55490) | 94 | 92 | 90 | -3 | 70 | 1997 | 94 | -4 |
| | Rutland | | (116580) | 97 | 96 | 94 | 5 | 75 | 1997 | 93 | 1 |
| Thames | London | • | 202828 | 98 | 97 | 94 | 2 | 85 | 1990 | 89 | 5 |
| | Farmoor | • | 13822 | 92 | 98 | 95 | -3 | 94 | 1995 | 94 | 1 |
| Southern | Bewl | | 31000 | 99 | 98 | 93 | 10 | 52 | 1990 | 62 | 31 |
| | Ardingly | | 4685 | 100 | 100 | 91 | -4 | 82 | 2005 | 91 | 0 |
| Wessex | Clatworthy | | 5364 | 100 | 93 | 72 | -10 | 61 | 1995 | 75 | -3 |
| | Bristol | • | (38666) | 97 | 93 | 85 | 2 | 64 | 1990 | 81 | 4 |
| South West | Colliford | | 28540 | 99 | 98 | 88 | 5 | 51 | 1997 | 77 | 10 |
| | Roadford | | 34500 | 96 | 92 | 83 | 2 | 49 | 1996 | 70 | 14 |
| | Wimbleball | | 21320 | 100 | 98 | 86 | 0 | 63 | 2011 | 74 | 12 |
| | Stithians | | 4967 | 100 | 96 | 82 | 2 | 53 | 1990 | 83 | -2 |
| Welsh | Celyn & Brenig | • | 131155 | 100 | 96 | 86 | -8 | 77 | 1996 | 88 | -2 |
| | Brianne | | 62140 | 97 | 94 | 83 | -10 | 76 | 1995 | 98 | -15 |
| | Big Five | • | 69762 | 95 | 88 | 72 | -13 | 61 | 1989 | 85 | -13 |
| | Elan Valley | • | 99106 | 99 | 93 | 77 | -11 | 68 | 1976 | 79 | -2 |
| Scotland(E) | Edinburgh/Mid-Lothian | • | 96518 | 98 | 93 | 90 | 3 | 54 | 1998 | 85 | 5 |
| | East Lothian | • | 9374 | 100 | 99 | 94 | -1 | 81 | 1992 | 100 | -6 |
| Scotland(W) | Loch Katrine | • | 110326 | 96 | 88 | 80 | 0 | 55 | 2010 | 84 | -4 |
| | Daer | | 22412 | 92 | 79 | 78 | -6 | 62 | 1994 | 80 | -2 |
| | Loch Thom | | 10798 | 100 | 95 | 90 | 3 | 69 | 2000 | 74 | 16 |
| Northern Ireland | Total+ | • | 56800 | 95 | 88 | 75 | -7 | 61 | 2008 | 83 | -8 |
| | Silent Valley | • | 20634 | 95 | 86 | 72 | -7 | 54 | 1995 | 81 | -8 |

( ) 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 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
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.



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



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