# Hydrological Summary

## *for the* United Kingdom

*April 2017*

### General

April was an exceptionally dry month dominated by high pressure with few notable rainfall events. Most of the UK recorded less than half the average rainfall, and some parts of southern England and eastern Scotland registered less than a fifth. For the UK overall, April was the equal ninth driest in a series from 1910, the culmination of a period of rainfall deficits that have accrued since summer 2016. The Southern region of England registered its driest July–April in a series from 1910. With minimal rainfall, soil moisture deficits (SMDs) increased rapidly. For the Forth region, end of April SMDs were the third highest in a series from 1961 and highest since 1980. Following prolonged river flow recessions throughout the month, daily flows in some catchments approached or eclipsed late April minima. River flows were substantially below average for most of the UK, with notably low flows in Northern Ireland, eastern Scotland and south-east England. April outflows from the English Lowlands were the fourth lowest in a series from 1961, only surpassed by the notable drought years of 1976, 1997 and 2011. Groundwater levels stabilised or followed their seasonal recessions at the majority of index sites and remained at or below normal everywhere except south-west Scotland and north-east England. Reservoir stocks fell in April, substantially so in some impoundments in northern England, and although most remained only moderately below average there were some notable shortfalls (e.g. 18% below normal at Bewl). Reservoir storage in the Northumbrian region and for Scotland overall was only marginally above previous April minima in series from 1988, though reservoir stocks remain relatively healthy overall. The prospects for the summer are likely to include above normal SMDs and low river flows causing agricultural stress and exerting pressure on the aquatic environment. Low flows are particularly likely in groundwater-influenced catchments of south-east England, some of which have already experienced a contraction of the stream network. Extensive water supply restrictions are unlikely this year; although localised water resource pressure cannot be ruled out, this is dependent on the amount of rainfall in future months for which there is no strong signal.

### Rainfall

Persistent anticyclonic conditions became established in the first week of April and were prevalent for most of the month. Notable rainfall totals were mostly limited to the far north-west of Scotland (e.g. 59mm at Achfary on the 11th), contributing to a month which registered more than 170% of the long-term average rainfall in this area. A brief northerly interlude towards month-end brought showers and snow to parts of Scotland (e.g. 12cm at Cromdale, Morayshire on the 25th). On the final night of the month, 45mm of rainfall was recorded at Dunkeswell (Devon) as a low pressure system traversed south-west England. Nevertheless, April rainfall totals for much of the UK were meagre; Edinburgh, London and the Home Counties received around 3mm, and at Wallingford 1.3mm was recorded over a 32-day period from late March to late April. Substantial areas of southern England, south Wales, the Pennines, and southern and eastern Scotland received less than a third of average rainfall; the Solway and Forth regions registered their driest April since the early 1980s, ranking amongst the top five driest in series from 1910. April was the latest in a series of notably dry months dating back to summer 2016. Accumulated rainfall totals over the November–April timeframe were the lowest since 1952/53 for Northern Ireland, and it has been the driest such period in eastern Scotland since the drought of 1975/76. Since July 2016, almost all of the UK registered less than 90% of average rainfall, with less than 70% across large parts of south-east England.

### River flows

Seasonally high flows were recorded on the 11th in the far north-west of Scotland; the Carron registered one of its highest April daily flows in a series from 1979. Otherwise, under anticyclonic conditions, river flows across the UK were in recession throughout the month. Daily flow minima were re-defined for the majority of the month on the Spey, Deveron and Don in north-east Scotland, and by month-end daily flow minima were approached in catchments in most regions of the UK. The widespread nature of dry weather and declining river flows is illustrated by the prolonged recessions in national outflows which were notably low by month-end, particularly so for Northern Ireland. Average river flows in April were below normal or lower for the majority of the UK, notably or exceptionally so in Northern Ireland, central and eastern Scotland and parts of northern and south-east England. River flows were around a third of average in the far south-east of England and a quarter of average for the Annacloy. With the exception of northern England, average river flows over the July 2016–April 2017 timeframe were predominantly below normal, notably so for Wales, central and southern Scotland, the far south-east of England and parts of the Midlands. Exceptionally low July-April average flows were registered in south-west England and the far north of Scotland (all of which were the second lowest in records which exceed 40 years), and new record minima were established for the Faughan and Annacloy.

### Groundwater

Following marked increases in April, end-of-month SMDs were above normal for almost all regions of the UK, substantially so in England and eastern Scotland. In the Chalk, groundwater levels stabilised or fell and remained below normal at the majority of sites. However, responses varied depending on location and depth to water as levels continued to rise at Dalton Holme and Frying Pan Lodge. Levels at Westdean No.3 and Killyglen were notably low, both located in areas where rainfall was well below average over the last three and six months, respectively. In the more rapidly responding Jurassic and Magnesian limestones, levels generally fell and were in the normal range or just below, but Aycliffe recorded a small rise. In the Permo-Triassic sandstones, groundwater levels fell at the index sites but remained in the same range as in March, mostly normal but below normal at Llanfair D.C. and Bussells No.7A and notably high at Newbridge. Levels in the Carboniferous Limestone fell and were below average at Alstonfield. Levels in the Fell Sandstone were stable at Royalty Observatory, but remained above normal.

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# Rainfall . . . Rainfall . . .

## Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

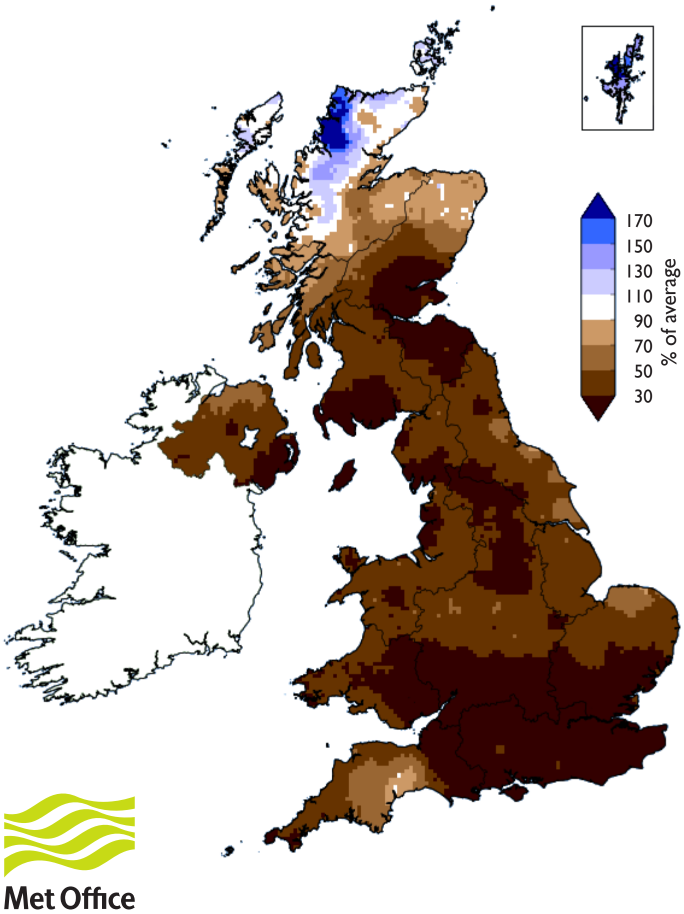
| Region | Rainfall | Apr 2017 | Feb17 – Apr17 | RP | Nov16 – Apr17 | RP | Jul16 – Apr17 | RP | May16 – Apr17 | RP |
|---|---|---|---|---|---|---|---|---|---|---|
| United | mm | **35** | 228 | | 494 | | 811 | | 977 | |
| Kingdom | % | **49** | 91 | 2-5 | 81 | 5-10 | 82 | 8-12 | 87 | 5-10 |
| England | mm | **19** | 151 | | 355 | | 567 | | 720 | |
| | % | **33** | 84 | 2-5 | 82 | 5-10 | 78 | 10-20 | 85 | 5-10 |
| Scotland | mm | **64** | 333 | | 698 | | 1172 | | 1346 | |
| | % | **74** | 95 | 2-5 | 82 | 2-5 | 87 | 2-5 | 89 | 2-5 |
| Wales | mm | **27** | 318 | | 632 | | 1016 | | 1244 | |
| | % | **32** | 103 | 2-5 | 81 | 5-10 | 81 | 5-10 | 88 | 2-5 |
| Northern | mm | **29** | 210 | | 422 | | 748 | | 906 | |
| Ireland | % | **38** | 83 | 2-5 | 71 | 20-30 | 76 | 20-35 | 80 | 20-35 |
| England & | mm | **20** | 174 | | 394 | | 629 | | 792 | |
| Wales | % | **33** | 88 | 2-5 | 81 | 5-10 | 79 | 10-15 | 86 | 5-10 |
| North West | mm | **25** | 264 | | 553 | | 948 | | 1125 | |
| | % | **35** | 102 | 2-5 | 86 | 2-5 | 88 | 2-5 | 92 | 2-5 |
| Northumbria | mm | **24** | 205 | | 413 | | 706 | | 817 | |
| | % | **39** | 107 | 2-5 | 92 | 2-5 | 94 | 2-5 | 94 | 2-5 |
| Severn-Trent | mm | **20** | 147 | | 334 | | 521 | | 685 | |
| | % | **34** | 88 | 2-5 | 86 | 2-5 | 79 | 8-12 | 88 | 2-5 |
| Yorkshire | mm | **21** | 160 | | 357 | | 596 | | 724 | |
| | % | **34** | 86 | 2-5 | 82 | 5-10 | 83 | 5-10 | 86 | 5-10 |
| Anglian | mm | **16** | 98 | | 237 | | 398 | | 549 | |
| | % | **36** | 76 | 2-5 | 80 | 5-10 | 76 | 8-12 | 88 | 2-5 |
| Thames | mm | **9** | 96 | | 284 | | 424 | | 584 | |
| | % | **18** | 63 | 5-10 | 78 | 5-10 | 70 | 15-25 | 81 | 5-10 |
| Southern | mm | **10** | 107 | | 316 | | 446 | | 600 | |
| | % | **19** | 64 | 5-10 | 74 | 5-10 | 64 | 50-80 | 75 | 10-20 |
| Wessex | mm | **14** | 138 | | 371 | | 557 | | 724 | |
| | % | **23** | 73 | 2-5 | 78 | 5-10 | 73 | 15-25 | 82 | 5-10 |
| South West | mm | **39** | 235 | | 518 | | 775 | | 930 | |
| | % | **50** | 87 | 2-5 | 75 | 5-10 | 72 | 20-35 | 76 | 15-25 |
| Welsh | mm | **26** | 302 | | 610 | | 977 | | 1198 | |
| | % | **31** | 102 | 2-5 | 81 | 5-10 | 81 | 5-10 | 88 | 2-5 |
| Highland | mm | **112** | 406 | | 870 | | 1420 | | 1610 | |
| | % | **111** | 93 | 2-5 | 83 | 2-5 | 87 | 2-5 | 89 | 2-5 |
| North East | mm | **51** | 201 | | 434 | | 770 | | 938 | |
| | % | **79** | 91 | 2-5 | 83 | 5-10 | 88 | 5-10 | 92 | 2-5 |
| Tay | mm | **30** | 268 | | 540 | | 923 | | 1099 | |
| | % | **40** | 88 | 2-5 | 73 | 8-12 | 78 | 10-15 | 82 | 8-12 |
| Forth | mm | **17** | 240 | | 476 | | 817 | | 968 | |
| | % | **25** | 90 | 2-5 | 74 | 5-10 | 77 | 8-12 | 80 | 5-10 |
| Tweed | mm | **19** | 247 | | 477 | | 808 | | 927 | |
| | % | **29** | 112 | 2-5 | 89 | 2-5 | 91 | 2-5 | 90 | 2-5 |
| Solway | mm | **26** | 342 | | 656 | | 1099 | | 1255 | |
| | % | **29** | 104 | 2-5 | 81 | 2-5 | 83 | 2-5 | 84 | 2-5 |
| Clyde | mm | **50** | 395 | | 833 | | 1406 | | 1603 | |
| | % | **50** | 95 | 2-5 | 82 | 2-5 | 86 | 2-5 | 88 | 2-5 |

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

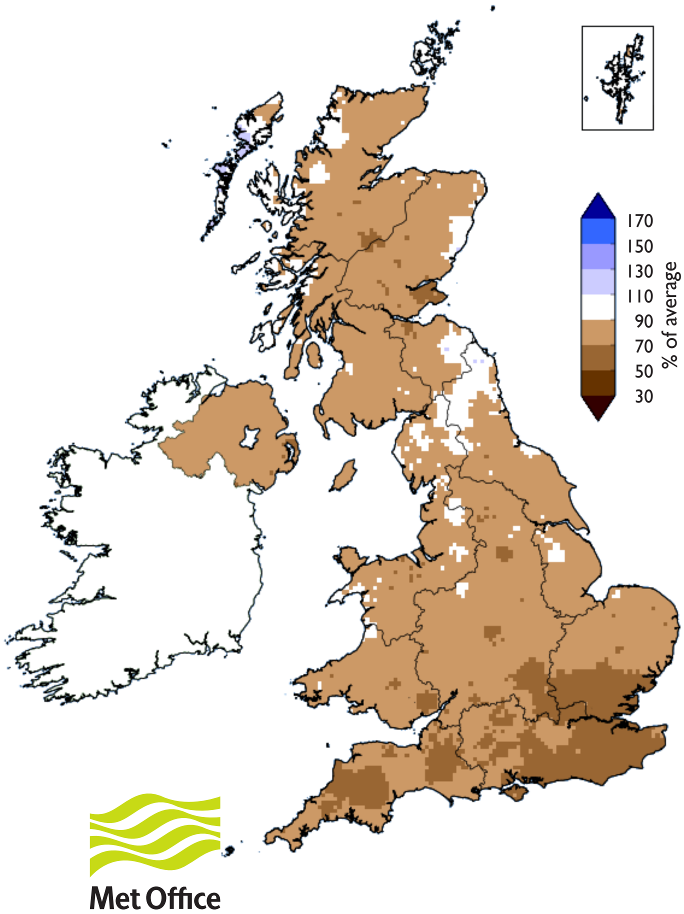
**Important note:** Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect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

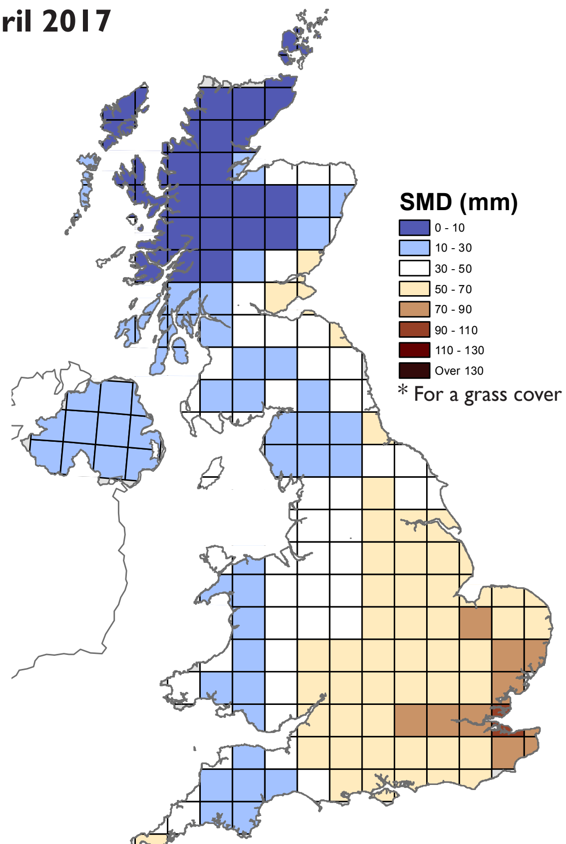
**April 2017 rainfall as % of 1981-2010 average**




**July 2016 - April 2017 rainfall as % of 1981-2010 average**




**MORECS Soil Moisture Deficits* April 2017**






## Hydrological Outlook UK

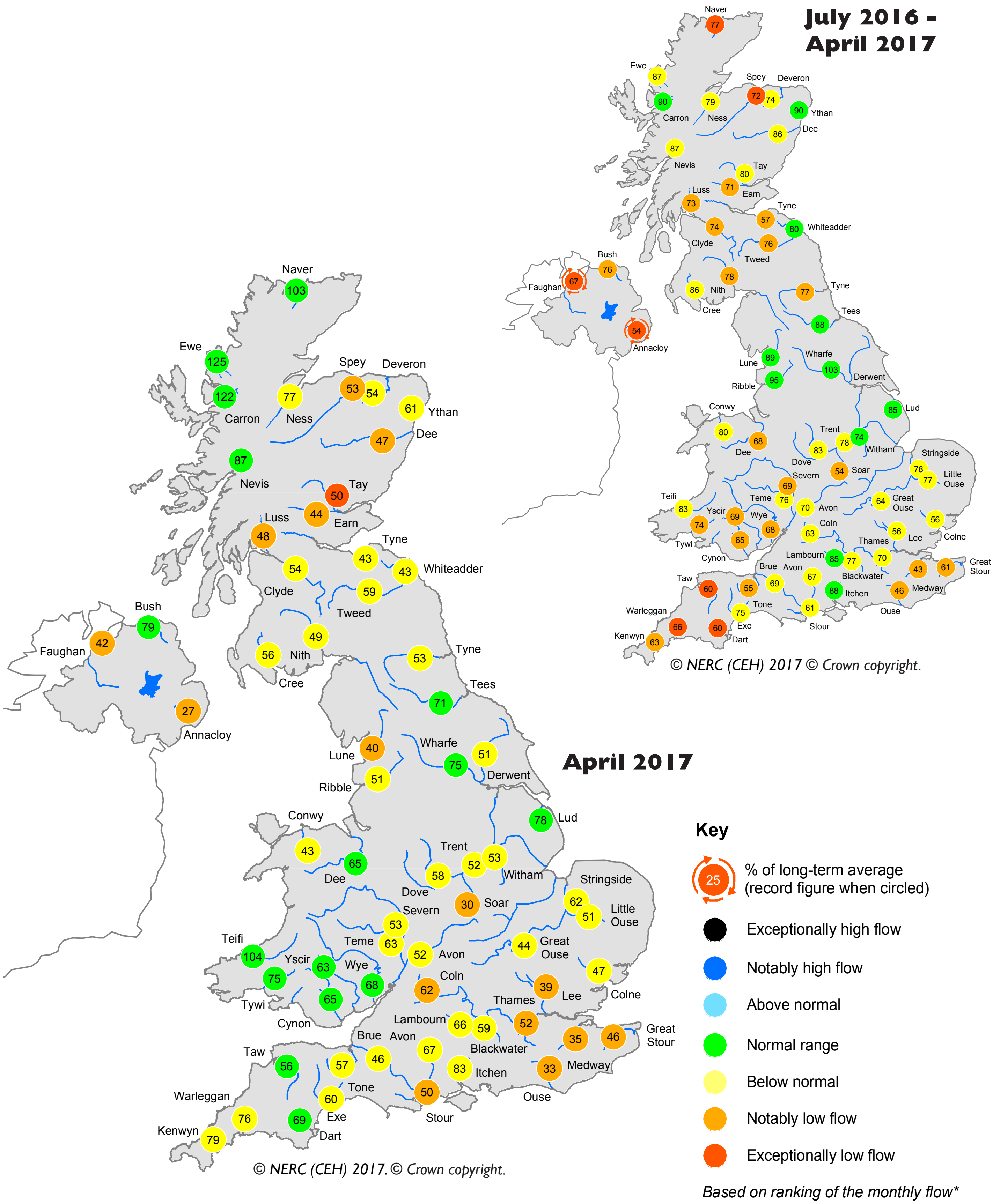
The Hydrological Outlook provides an insight into future hydrological conditions across the UK. Specifically it describes likely trajectories for river flows and groundwater levels on a monthly basis, with particular focus on the next three months.

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

**Period:** **from May 2017**
**Issued:** **09.05.2017**
**using data to the end of April 2017**

The outlook for May is for low river flows in south-east England, with flows elsewhere most likely to be below normal. Over the next three months, river flows are likely to be below normal or lower in south-east England and normal to below normal for the rest of the UK. The one- and three-month outlooks for groundwater levels are similar. Below normal or lower levels are likely in the Chalk of south-east England, particularly in the far south-east. Elsewhere, levels are likely to be normal to below normal, with the exception of above normal levels expected in southern Scotland.

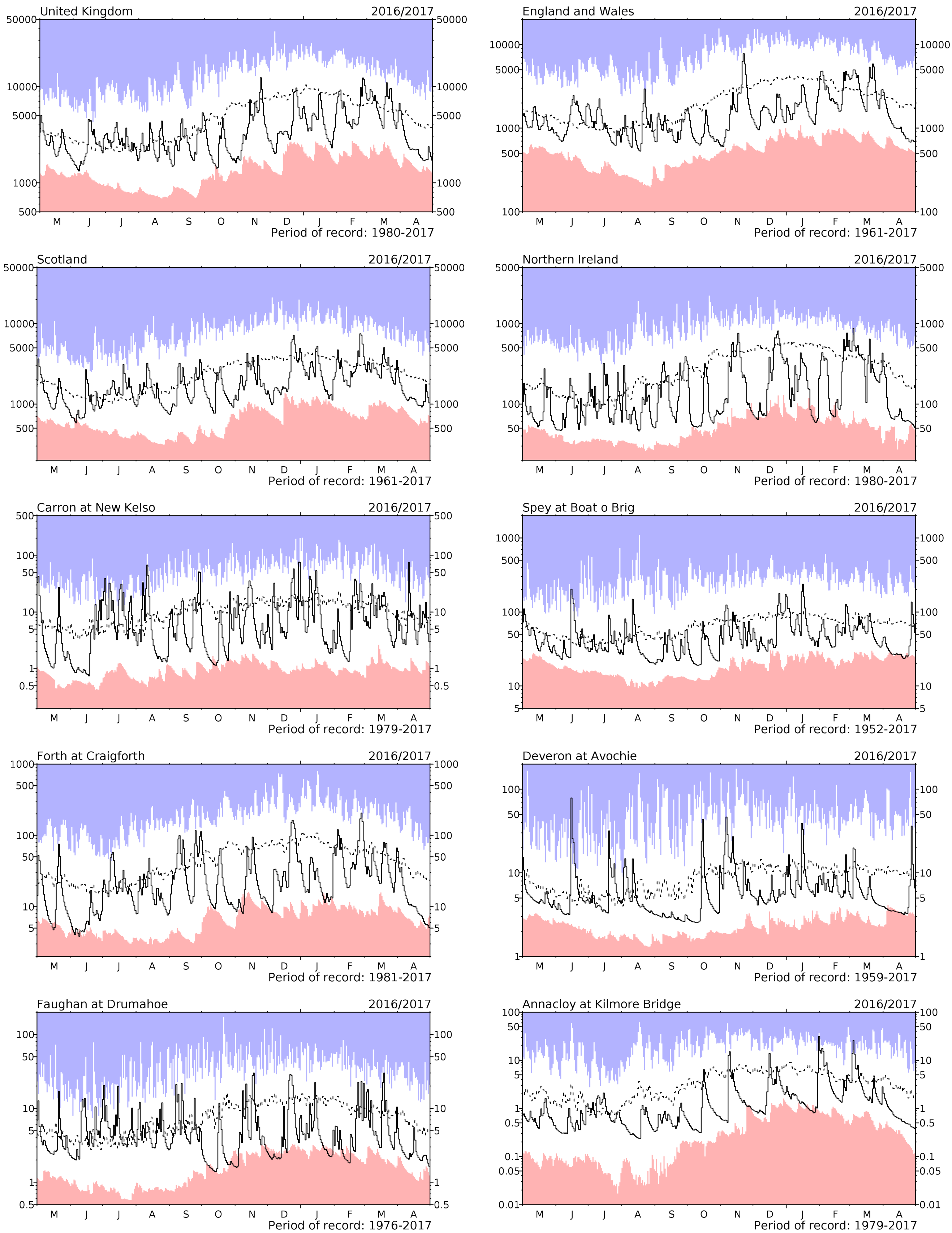
# River flow . . . River flow . . .




## 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.

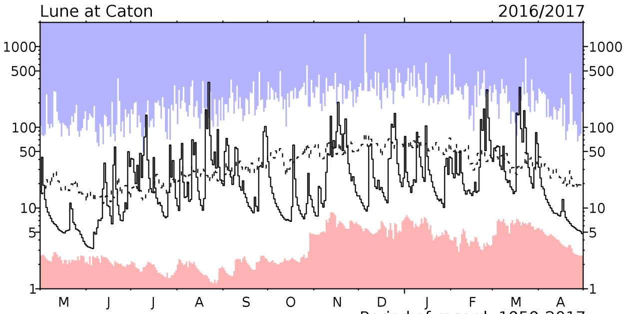
# River flow . . . River flow . . .




## River flow hydrographs

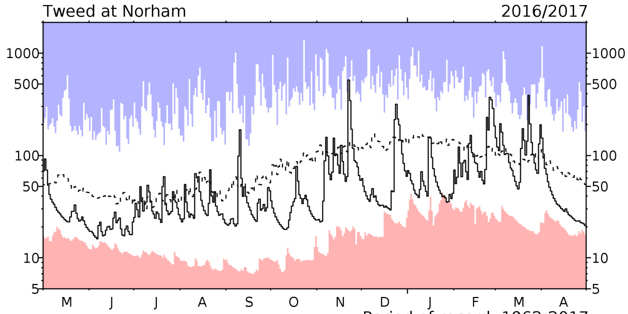
*The river flow hydrographs show the daily mean flows (measured in $m^3s^{-1}$) together with the maximum and minimum daily flows prior to May 2016 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

Lune at Caton 2016/2017



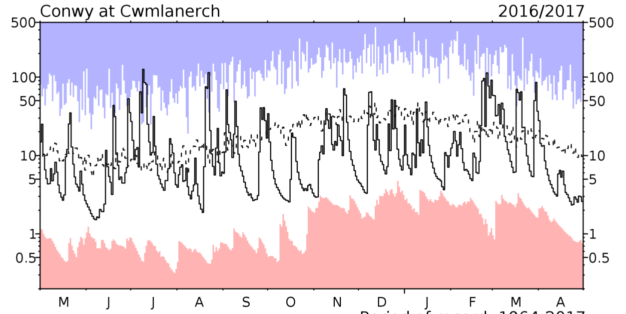

Period of record: 1959-2017

Tweed at Norham 2016/2017



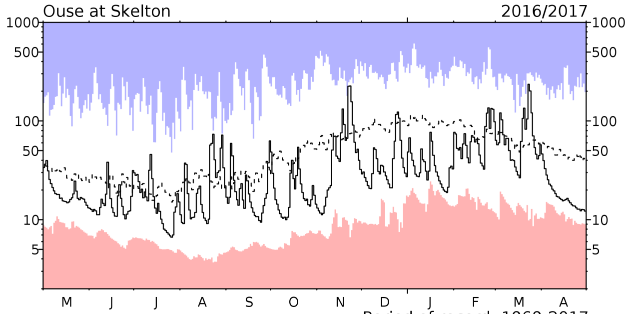

Period of record: 1962-2017

Conwy at Cwmlanerch 2016/2017



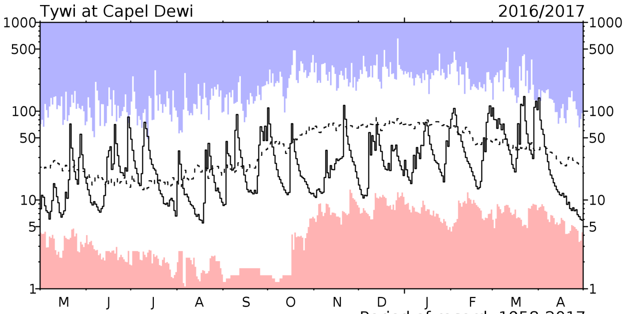

Period of record: 1964-2017

Ouse at Skelton 2016/2017



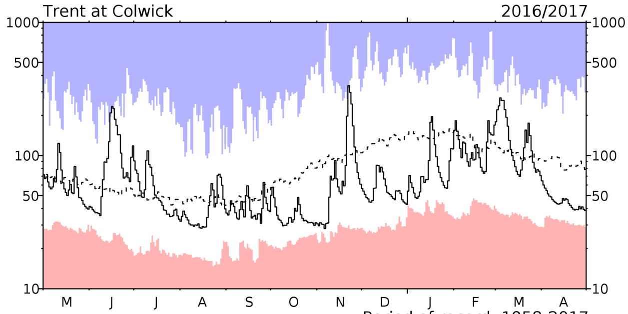

Period of record: 1969-2017

Tywi at Capel Dewi 2016/2017



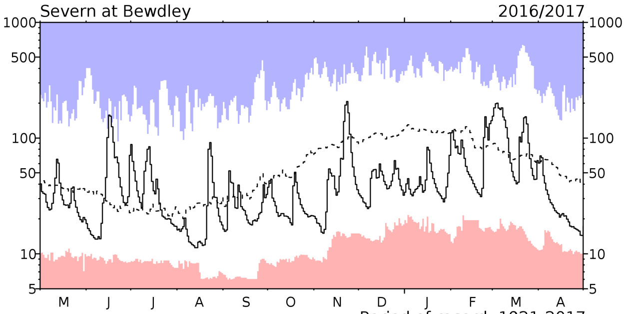

Period of record: 1958-2017

Trent at Colwick 2016/2017



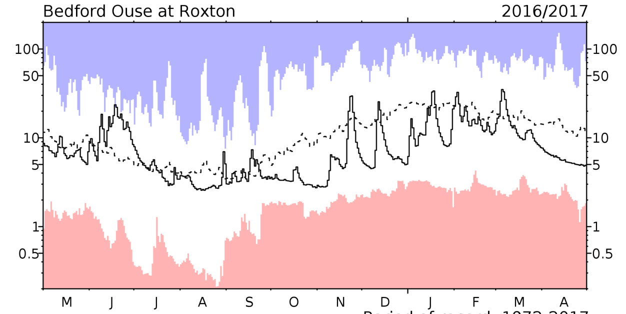

Period of record: 1958-2017

Severn at Bewdley 2016/2017



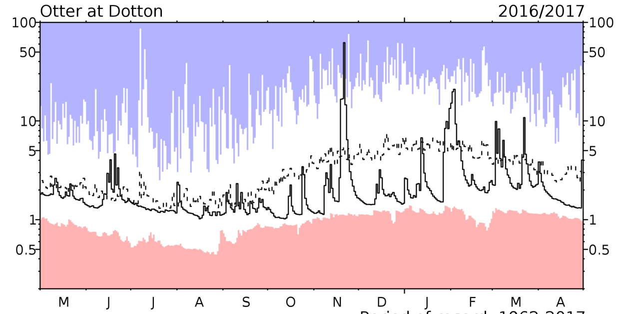

Period of record: 1921-2017

Bedford Ouse at Roxton 2016/2017



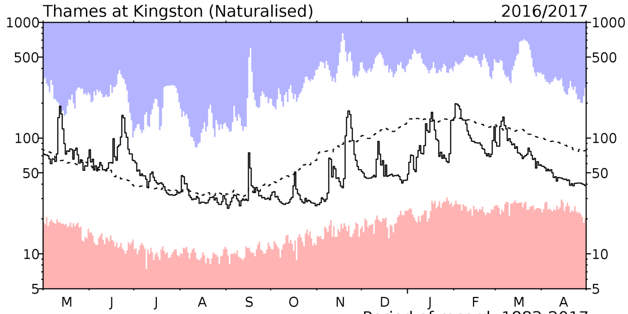

Period of record: 1972-2017

Otter at Dotton 2016/2017



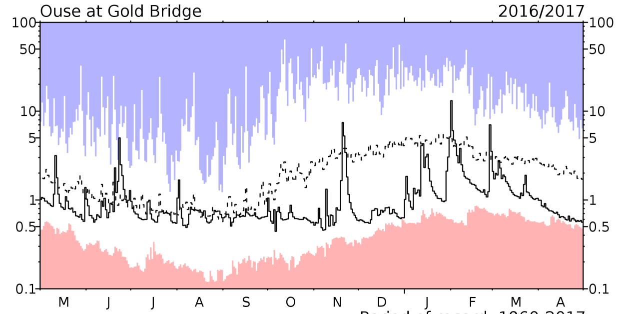

Period of record: 1962-2017

Thames at Kingston (Naturalised) 2016/2017



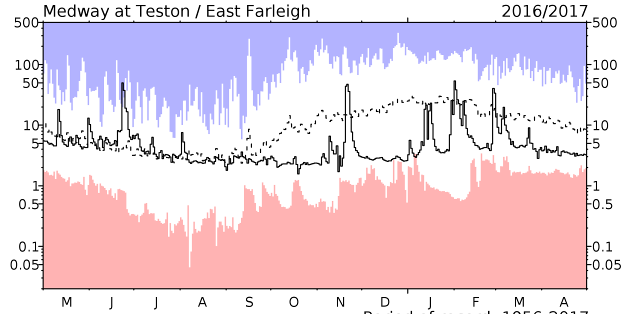

Period of record: 1883-2017

Ouse at Gold Bridge 2016/2017

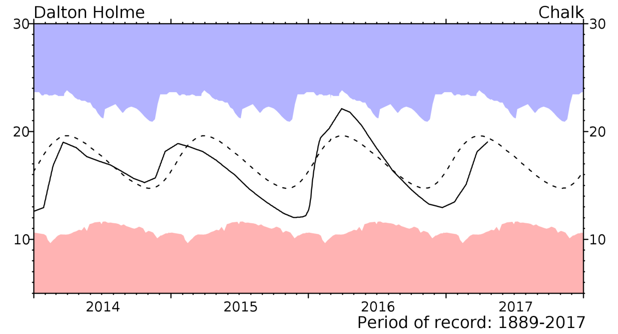


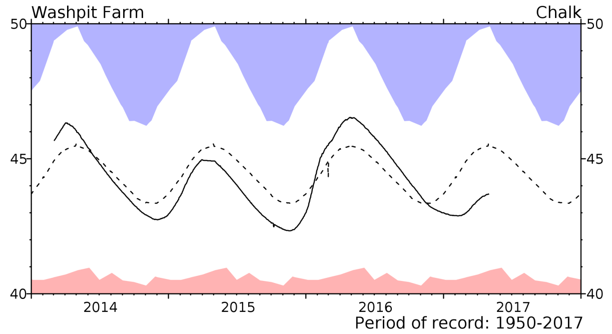

Period of record: 1960-2017

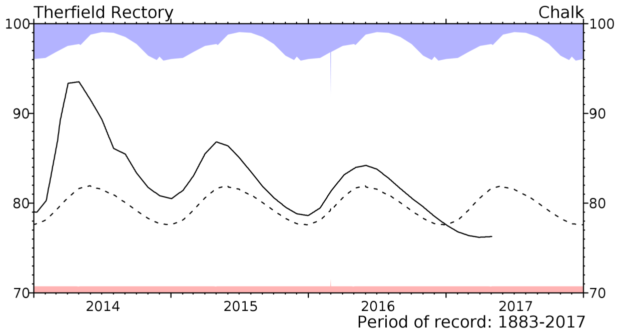
Medway at Teston / East Farleigh 2016/2017

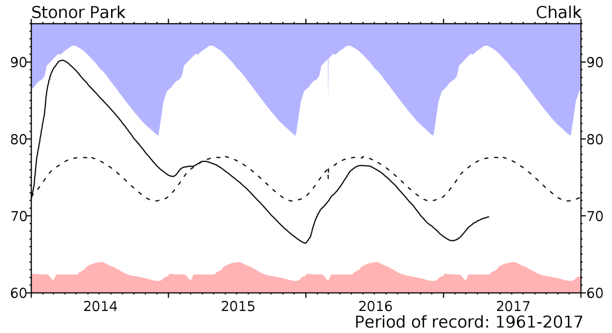


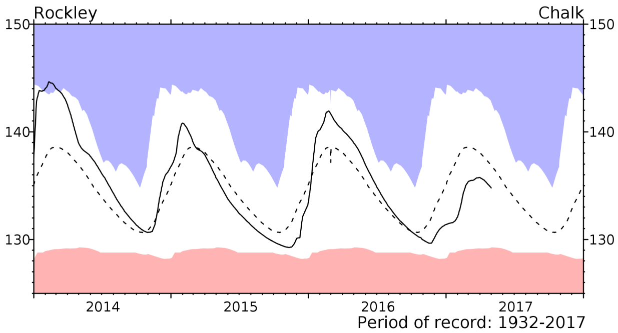

Period of record: 1956-2017

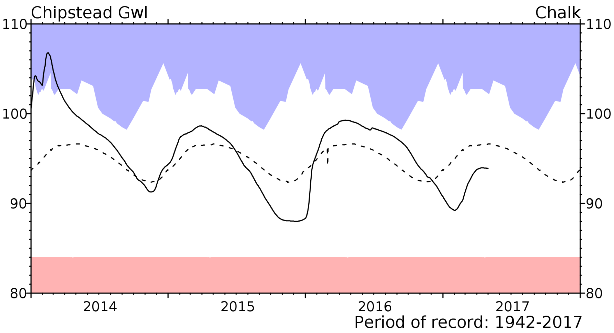


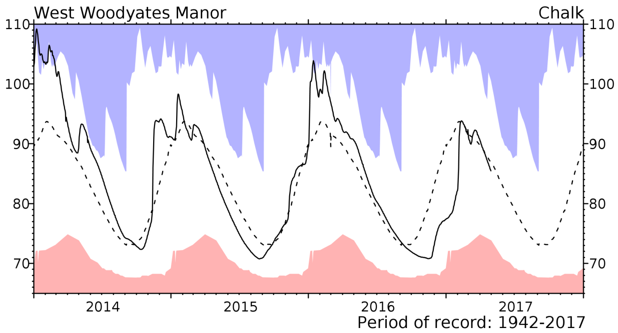



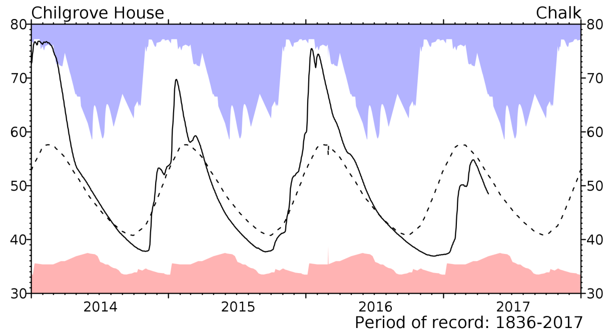



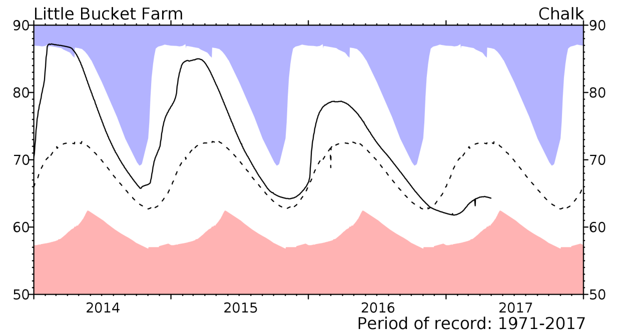



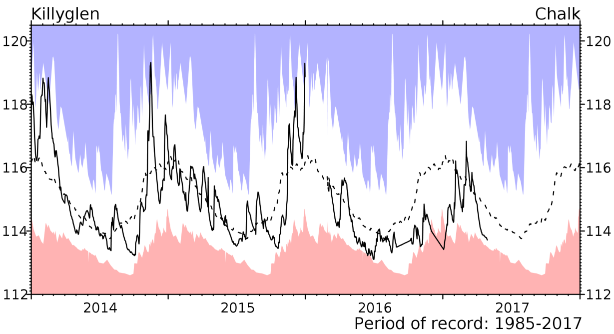



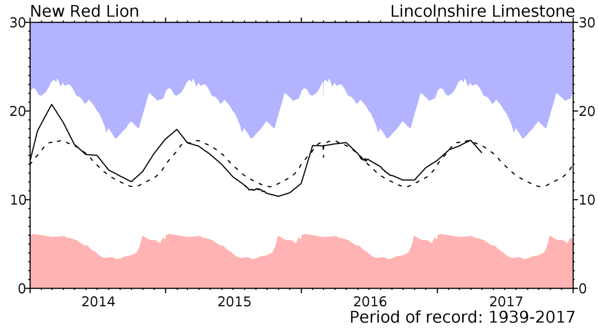



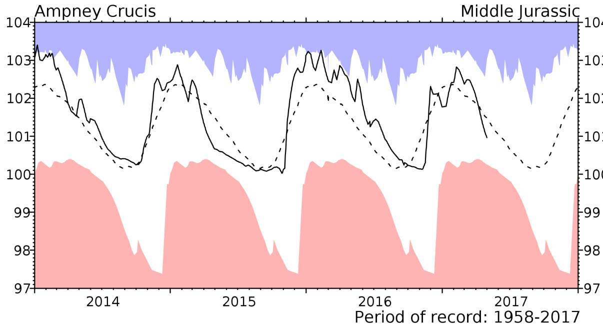



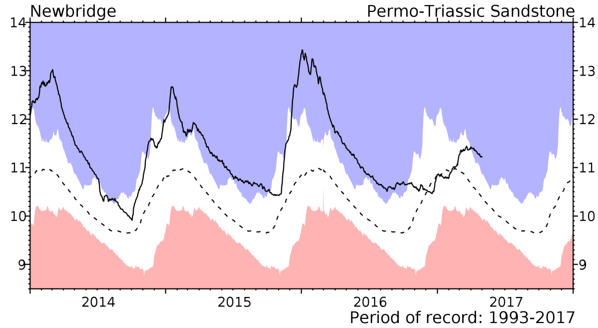



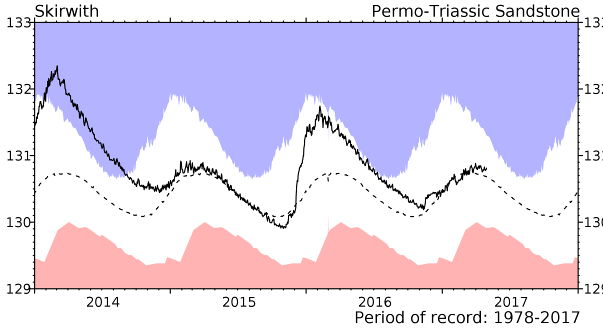

Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

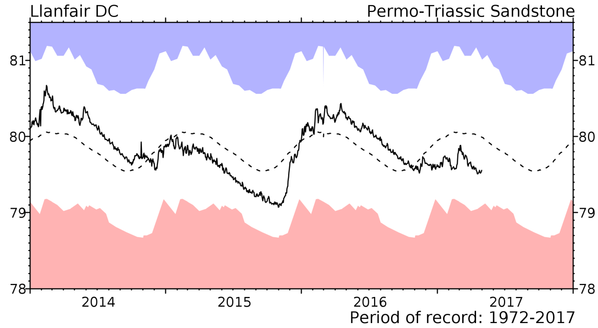
# Groundwater … Groundwater

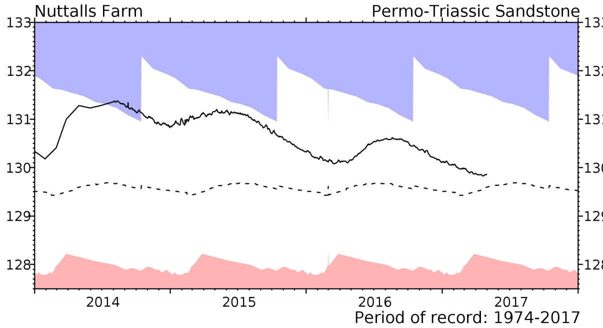


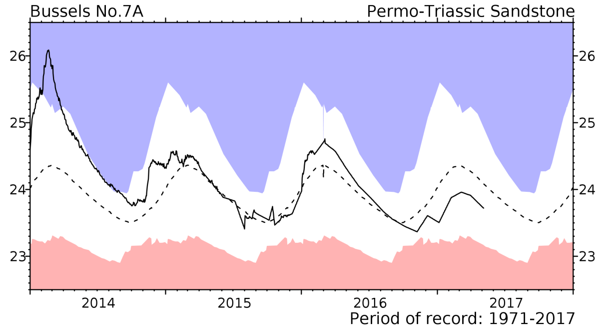



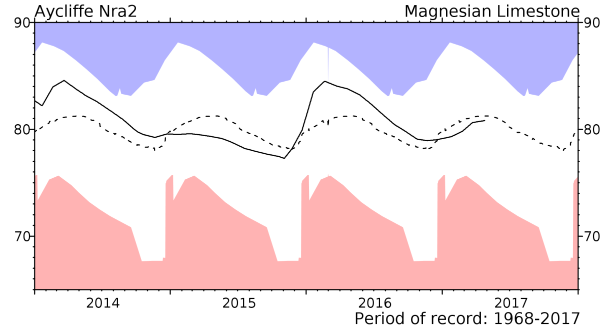



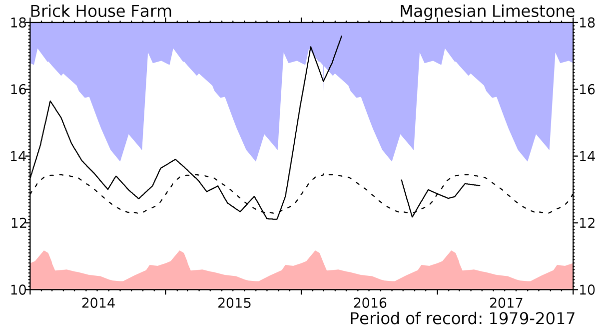



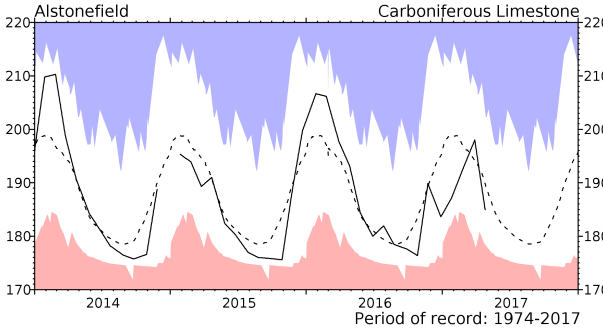



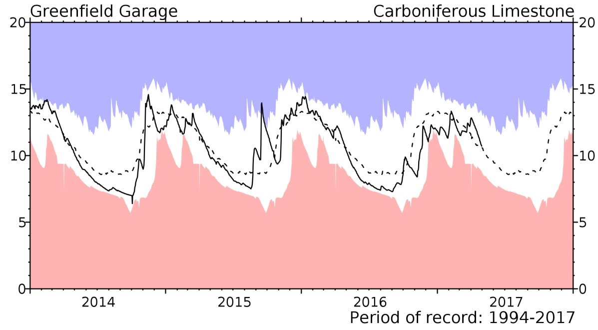



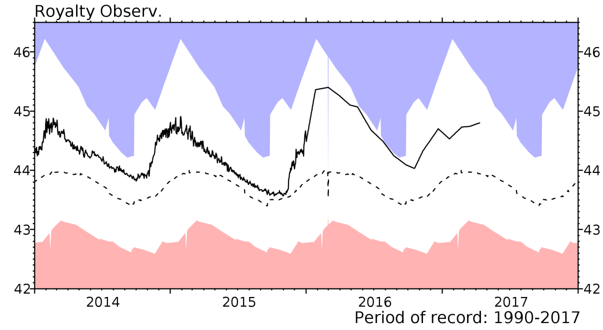



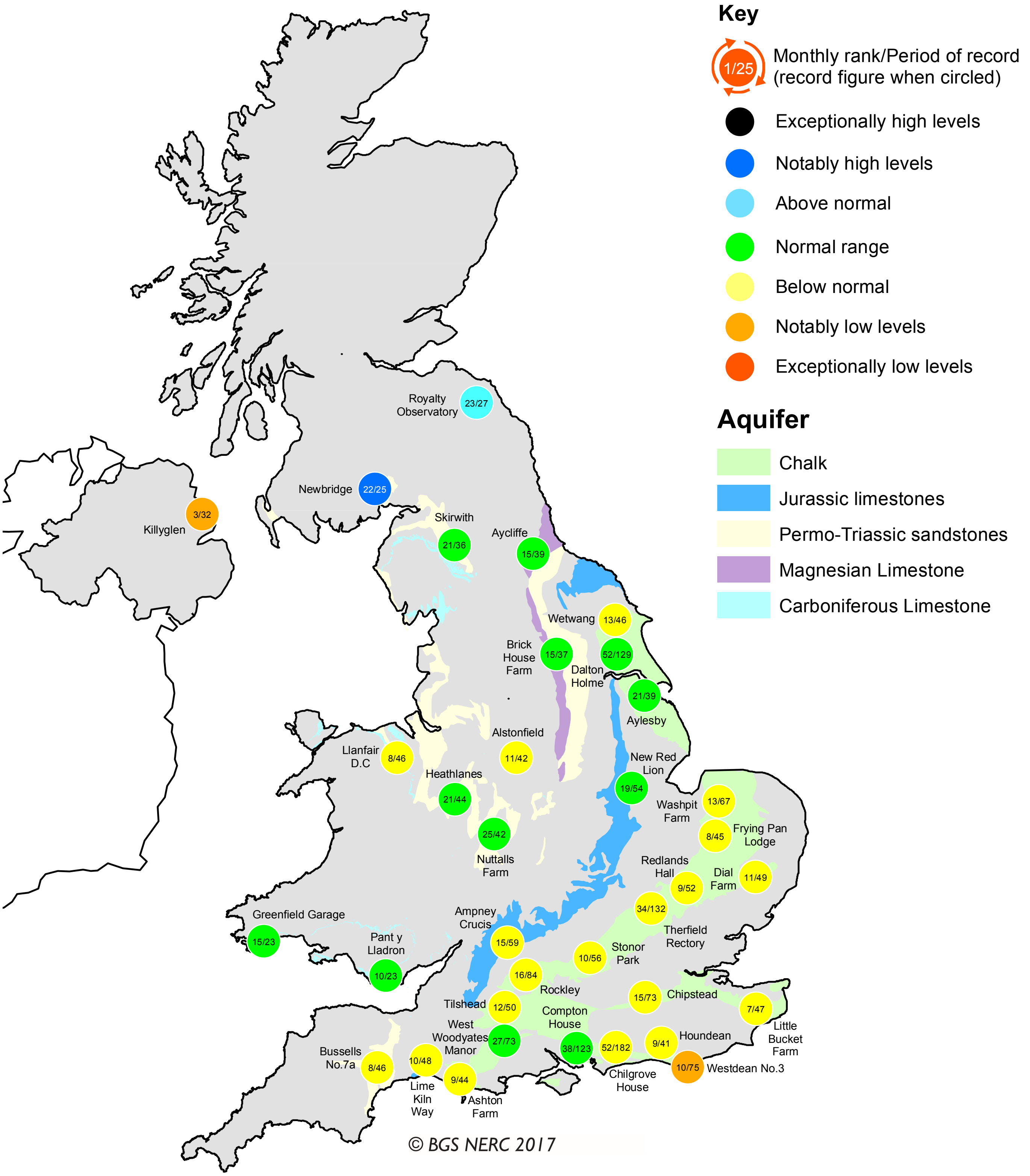



# Groundwater...Groundwater

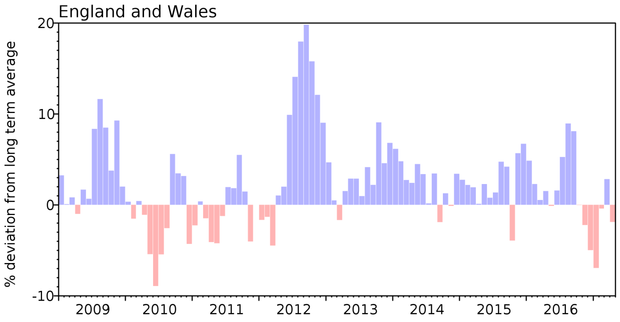



## Groundwater levels - April 2017

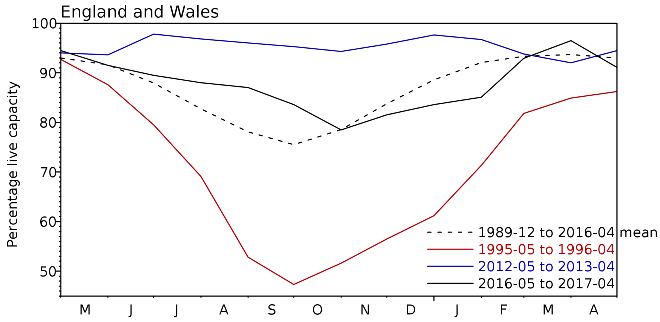
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

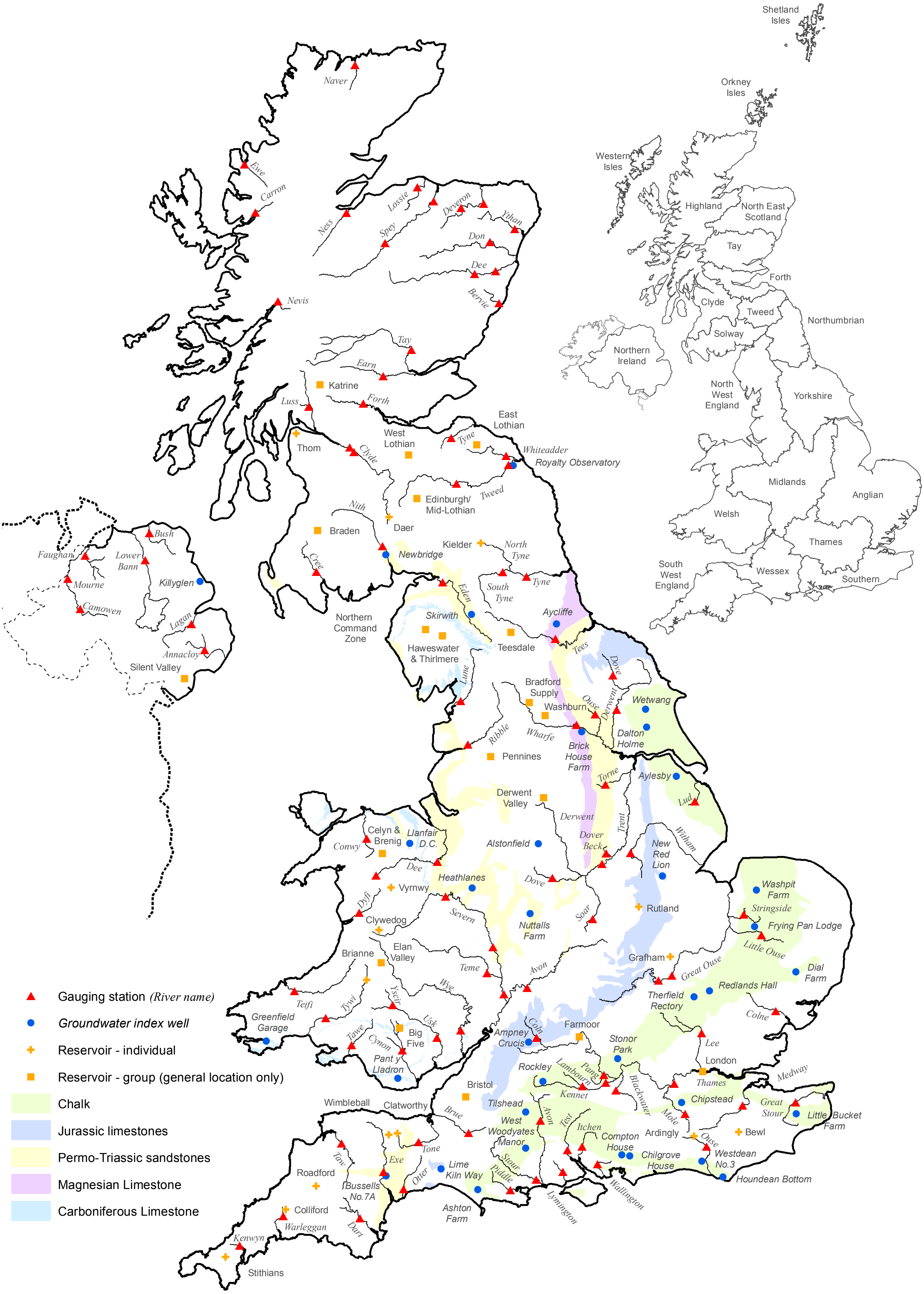
| Area | Reservoir | | Capacity (Ml) | 2017 Feb | 2017 Mar | 2017 Apr | Apr Anom. | Min Apr | Year* of min | 2016 Apr | Diff 17-16 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North West | N Command Zone | • | 124929 | 80 | 98 | 86 | -2 | 65 | 1984 | 85 | 0 |
| | Vyrnwy | | 55146 | 98 | 100 | 94 | 2 | 70 | 1996 | 98 | -4 |
| Northumbrian | Teesdale | • | 87936 | 100 | 98 | 78 | -13 | 74 | 2003 | 91 | -13 |
| | Kielder | | (199175) | 95 | 97 | 89 | -2 | 85 | 1990 | 89 | 0 |
| Severn-Trent | Clywedog | | 44922 | 100 | 99 | 100 | 3 | 85 | 1988 | 99 | 0 |
| | Derwent Valley | • | 39525 | 100 | 97 | 86 | -6 | 54 | 1996 | 99 | -13 |
| Yorkshire | Washburn | • | 22035 | 95 | 98 | 89 | -1 | 76 | 1996 | 91 | -2 |
| | Bradford Supply | • | 41407 | 86 | 95 | 84 | -7 | 60 | 1996 | 93 | -9 |
| Anglian | Grafham | | (55490) | 95 | 96 | 96 | 2 | 73 | 1997 | 95 | 2 |
| | Rutland | | (116580) | 95 | 97 | 97 | 5 | 72 | 1997 | 93 | 4 |
| Thames | London | • | 202828 | 94 | 95 | 96 | 1 | 86 | 1990 | 97 | -1 |
| | Farmoor | • | 13822 | 98 | 96 | 98 | 1 | 81 | 2000 | 98 | 0 |
| Southern | Bewl | | 28170 | 71 | 79 | 72 | -18 | 60 | 2012 | 96 | -24 |
| | Ardingly | | 4685 | 94 | 100 | 100 | 1 | 69 | 2012 | 100 | 0 |
| Wessex | Clatworthy | | 5364 | 90 | 100 | 91 | -2 | 81 | 1990 | 90 | 1 |
| | Bristol | • | (38666) | 84 | 94 | 93 | 0 | 83 | 2011 | 99 | -6 |
| South West | Colliford | | 28540 | 77 | 95 | 84 | -4 | 56 | 1997 | 99 | -15 |
| | Roadford | | 34500 | 69 | 76 | 74 | -11 | 41 | 1996 | 93 | -19 |
| | Wimbleball | | 21320 | 76 | 93 | 91 | -3 | 79 | 1992 | 98 | -6 |
| | Stithians | | 4967 | 95 | 99 | 94 | 3 | 65 | 1992 | 99 | -5 |
| Welsh | Celyn & Brenig | • | 131155 | 100 | 100 | 99 | 1 | 75 | 1996 | 100 | -2 |
| | Brianne | | 62140 | 100 | 100 | 96 | -1 | 86 | 1997 | 99 | -3 |
| | Big Five | • | 69762 | 92 | 94 | 90 | -3 | 85 | 2011 | 94 | -4 |
| | Elan Valley | • | 99106 | 100 | 100 | 94 | -2 | 83 | 2011 | 99 | -5 |
| Scotland(E) | Edinburgh/Mid-Lothian | • | 96518 | 90 | 92 | 87 | -6 | 62 | 1998 | 98 | -11 |
| | East Lothian | • | 9374 | 100 | 100 | 99 | 0 | 89 | 1992 | 100 | -1 |
| Scotland(W) | Loch Katrine | • | 110326 | 98 | 97 | 88 | -3 | 80 | 2010 | 88 | 0 |
| | Daer | | 22412 | 100 | 100 | 79 | -15 | 78 | 2013 | 89 | -10 |
| | Loch Thom | | 10798 | 100 | 97 | 87 | -8 | 83 | 2010 | 100 | -13 |
| Northern Ireland | Total+ | • | 56800 | 84 | 93 | 87 | -1 | 77 | 2007 | 93 | -6 |
| | Silent Valley | • | 20634 | 71 | 88 | 82 | -3 | 58 | 2000 | 94 | -12 |

( ) 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



05/2017

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