# Hydrological Summary for the United Kingdom

October 2017

## General

October was a mixed month, with a pronounced north-west/south-east contrast. Westerly and south-westerly winds, including ex-hurricane Ophelia and storm 'Brian', brought strong winds and bands of rainfall to the north and west. In contrast, the south and east was dry, with less than a third of average rainfall recorded in some parts. Given the warm, dry conditions in the south-east, soil moisture deficits (SMDs) climbed and remained above average in regions of south-eastern England. River flows were generally in the normal range or above, with flows in north Wales and northern England approaching twice the October average. In contrast, river flows in south-east England were normal to exceptionally low, with a number of catchments recording less than half the October average. A similar spatial pattern is reflected in the October groundwater status: levels in index boreholes in southern England generally fell and were below normal to notably low. Reservoir stocks were generally near to above average for October, except the London group where stocks were almost 20% below the October average, and Bewl (East Sussex) where stocks were almost 25% below average and approached the October minima. While summer was damp, the influence of the dry winter/spring of 2016/2017 is still apparent in groundwater levels and in some rivers. The long-term water resources outlook is dependent on recharge over the winter half-year, which will commence from a below-normal baseline in the south and east. The dry start to autumn has delayed the onset of replenishment, implying that above average rainfall will be needed over the late autumn to winter to return conditions to normal.

## Rainfall

Westerlies in the first week of the month were followed by a succession of frontal systems bringing rain to the north and west. Notable rainfall totals included: 90mm at Alltdearg House (Skye) on the 9th and 77mm at Capel Curig (north Wales) on the 13th. Provisional data suggest that over 200mm fell in 24 hours in Cumbria on the 11th, which caused disruption to road and rail travel and a number of schools to close. Conditions then became milder across the north and west to month-end with south-westerlies bringing showers and blustery conditions. Ex-hurricane Ophelia hit western and northern regions on the 16th followed by the second named storm, 'Brian', on the 21st. Both brought strong winds and heavy rain (e.g. 48mm was recorded at Capel Curig on the 21st) and caused surface water flooding, transport disruption and power outages in western parts of the British Isles. At the national scale rainfall was 81% of the October average, however, there were significant spatial contrasts. In north-west England and parts of western Scotland, localised areas received over 130% of average, whereas much of south-east England received less than 50% and with large patches of less than 30%. It was the driest October since 1995 for Anglian region, and the driest since 1978 for Thames region, both in series from 1910. At the national scale, the start of autumn has been average (with 101% of UK average rainfall), but the regional picture is more mixed. Patches of northern England registered over 150% of average whilst coastal areas of Essex and Kent received less than 50% of average.

## River flows

With the exception of more slowly responding catchments in the south-east, the majority of catchments began the month with above average flows, and October was characterised by a number of spates as frontal systems passed over the north and west. A new October peak flow was recorded on the Lune on the 11th (in a series from 1968) and new daily flow maxima were set at several catchments in northern England and north Wales between the 10th and 14th. In the drier south and east, flows generally continued their seasonal recession with few interruptions; a number of catchments recorded below average flows for the whole month. Although many stations registered mean monthly flows in the normal range for October, the majority of catchments were below average by month-end. October monthly mean flows were normal to above normal in the north and west with notably high flows on the Lune, Wharfe, Ribble and Conwy, where flows approached twice the October monthly mean. However, normal to exceptionally low flows were recorded in the south-east of England, and the Soar, Colne and Medway recorded a third (or less) of the October average. October mean flows were the second lowest on record for the Soar (after 2016) and the Great Stour (after 1996) and were the third lowest on the Coln behind 1976 and 2011 (all in records of over 45 years). Over the last two months, average flows were normal to notably high in the north and west; flows on the Conwy were almost twice the average and were the third highest for this period in a record from 1964. In the south and east, average flows were normal to notably low with exceptionally low flows recorded on the Coln, the second lowest September-October flows (behind 1976) in a series from 1963. Despite the wetter summer, long-term river flow deficiencies in southern and eastern England can be traced back to the winter of 2016/2017.

## Groundwater

As a result of below average rainfall across the principal aquifers and above average temperatures, SMDs increased throughout the English Lowlands and remained above average. Groundwater levels generally continued to fall in the Chalk. The majority of sites in East Anglia and southern England remained low to notably low, with many falling further below the normal range. The lowest October levels since 1996 were recorded at Little Bucket Farm (in a series since 1971). A small increase was recorded at Wetwang and levels were stable at Houndean and Westdean No.3. Sizeable increases were recorded at Ashton Farm and Chilgrove House, rising to above normal and normal, respectively. Levels in the more rapidly responding Jurassic and Magnesian limestones remained within the normal range, although small rises were recorded at Ampney Crucis and Brick House Farm. In the Permo-Triassic sandstones, groundwater levels were generally stable and were in the normal range or below (notably so at Bussels No.7a). However, they rose at Newbridge recording a new high level for the fifth consecutive month. Levels in the Carboniferous Limestone at Pant y Lladron and Alstonfield rose overall during October and were in the normal range, whilst at Greenfield Garage they fell from notably high to normal. Levels fell at Royalty Observatory in the Fell Sandstone, but remained higher than average for the time of year.

Centre for Ecology & Hydrology
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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.

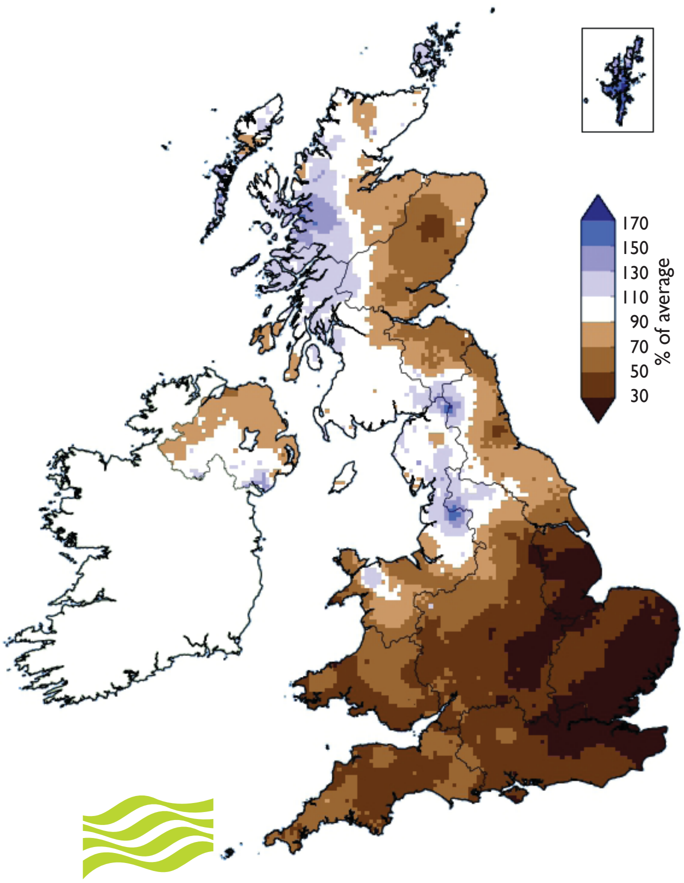
| Region | Rainfall | Oct 2017 | Sep17 – Oct17 | | Aug17 – Oct17 | | May17 – Oct17 | | Nov16 – Oct17 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *RP* | | *RP* | | *RP* | | *RP* |
| United | mm | **100** | 219 | | 324 | | 602 | | 1088 | |
| Kingdom | % | **81** | 101 | 2-5 | 106 | 2-5 | 116 | 5-10 | 97 | 2-5 |
| England | mm | **54** | 148 | | 223 | | 462 | | 811 | |
| | % | **59** | 93 | 2-5 | 98 | 2-5 | 113 | 2-5 | 96 | 2-5 |
| Scotland | mm | **175** | 314 | | 459 | | 786 | | 1474 | |
| | % | **103** | 104 | 2-5 | 111 | 2-5 | 118 | 8-21 | 97 | 2-5 |
| Wales | mm | **104** | 285 | | 408 | | 744 | | 1356 | |
| | % | **63** | 103 | 2-5 | 107 | 2-5 | 117 | 5-10 | 95 | 2-5 |
| Northern | mm | **107** | 253 | | 377 | | 672 | | 1096 | |
| Ireland | % | **89** | 119 | 2-5 | 122 | 5-10 | 125 | 10-20 | 97 | 2-5 |
| England & | mm | **61** | 167 | | 249 | | 500 | | 886 | |
| Wales | % | **60** | 95 | 2-5 | 100 | 2-5 | 114 | 2-5 | 96 | 2-5 |
| North West | mm | **149** | 314 | | 427 | | 760 | | 1302 | |
| | % | **109** | 131 | 5-10 | 125 | 2-5 | 131 | 10-15 | 106 | 2-5 |
| Northumbria | mm | **76** | 177 | | 239 | | 506 | | 908 | |
| | % | **89** | 113 | 2-5 | 103 | 2-5 | 120 | 2-5 | 104 | 2-5 |
| Severn-Trent | mm | **42** | 135 | | 206 | | 408 | | 736 | |
| | % | **52** | 93 | 2-5 | 98 | 2-5 | 105 | 2-5 | 94 | 2-5 |
| Yorkshire | mm | **69** | 171 | | 255 | | 511 | | 865 | |
| | % | **85** | 114 | 2-5 | 115 | 2-5 | 127 | 5-10 | 103 | 2-5 |
| Anglian | mm | **18** | 83 | | 144 | | 352 | | 585 | |
| | % | **28** | 71 | 2-5 | 82 | 2-5 | 107 | 2-5 | 94 | 2-5 |
| Thames | mm | **25** | 94 | | 164 | | 376 | | 656 | |
| | % | **32** | 69 | 2-5 | 85 | 2-5 | 107 | 2-5 | 92 | 2-5 |
| Southern | mm | **31** | 101 | | 177 | | 404 | | 716 | |
| | % | **32** | 63 | 2-5 | 82 | 2-5 | 110 | 2-5 | 90 | 2-5 |
| Wessex | mm | **51** | 134 | | 197 | | 434 | | 801 | |
| | % | **51** | 80 | 2-5 | 85 | 2-5 | 107 | 2-5 | 91 | 2-5 |
| South West | mm | **70** | 215 | | 309 | | 579 | | 1093 | |
| | % | **50** | 94 | 2-5 | 99 | 2-5 | 108 | 2-5 | 89 | 2-5 |
| Welsh | mm | **97** | 267 | | 383 | | 709 | | 1299 | |
| | % | **61** | 100 | 2-5 | 104 | 2-5 | 115 | 2-5 | 95 | 2-5 |
| Highland | mm | **228** | 373 | | 539 | | 858 | | 1715 | |
| | % | **115** | 105 | 2-5 | 113 | 2-5 | 113 | 5-10 | 95 | 2-5 |
| North East | mm | **87** | 202 | | 298 | | 555 | | 986 | |
| | % | **74** | 98 | 2-5 | 104 | 2-5 | 112 | 2-5 | 97 | 2-5 |
| Tay | mm | **123** | 237 | | 353 | | 657 | | 1175 | |
| | % | **81** | 89 | 2-5 | 98 | 2-5 | 110 | 2-5 | 88 | 2-5 |
| Forth | mm | **111** | 206 | | 323 | | 658 | | 1122 | |
| | % | **83** | 86 | 2-5 | 98 | 2-5 | 117 | 5-10 | 93 | 2-5 |
| Tweed | mm | **92** | 188 | | 289 | | 588 | | 1064 | |
| | % | **83** | 97 | 2-5 | 105 | 2-5 | 120 | 5-10 | 104 | 2-5 |
| Solway | mm | **176** | 346 | | 493 | | 915 | | 1552 | |
| | % | **102** | 118 | 2-5 | 120 | 5-10 | 135 | 25-40 | 105 | 5-10 |
| Clyde | mm | **221** | 395 | | 573 | | 979 | | 1808 | |
| | % | **108** | 108 | 2-5 | 113 | 2-5 | 121 | 10-20 | 99 | 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 2017 are provisional.

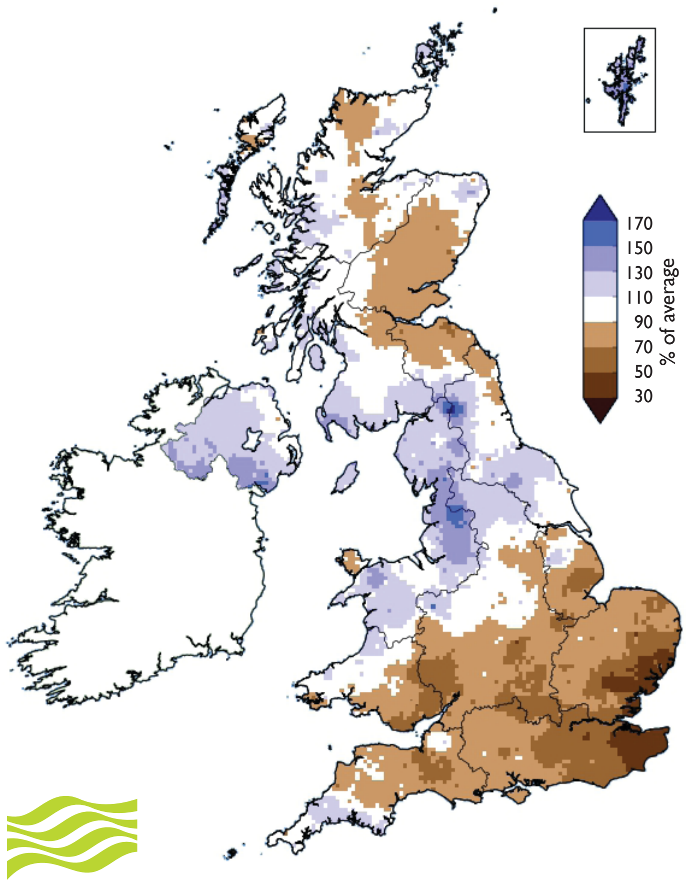
# Rainfall . . . Rainfall . . .

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



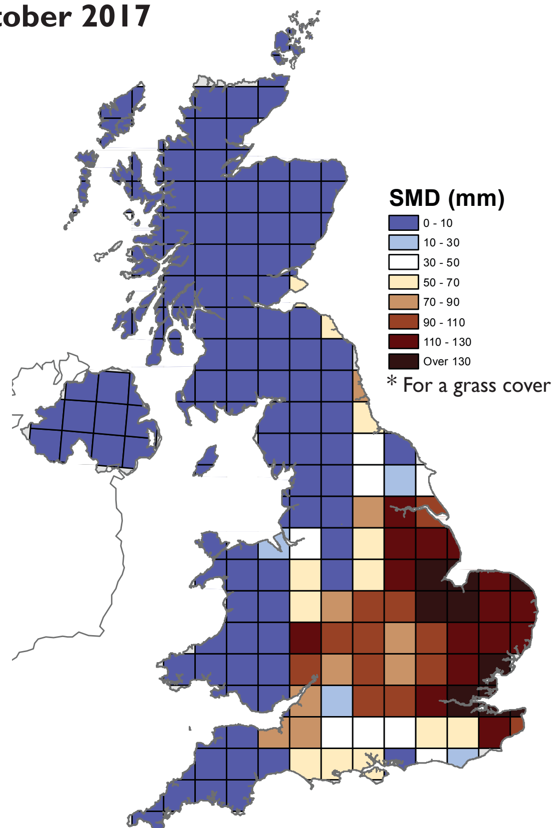

Met Office

**September 2017 - October 2017 rainfall as % of 1981-2010 average**




Met Office

**MORECS Soil Moisture Deficits* October 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.

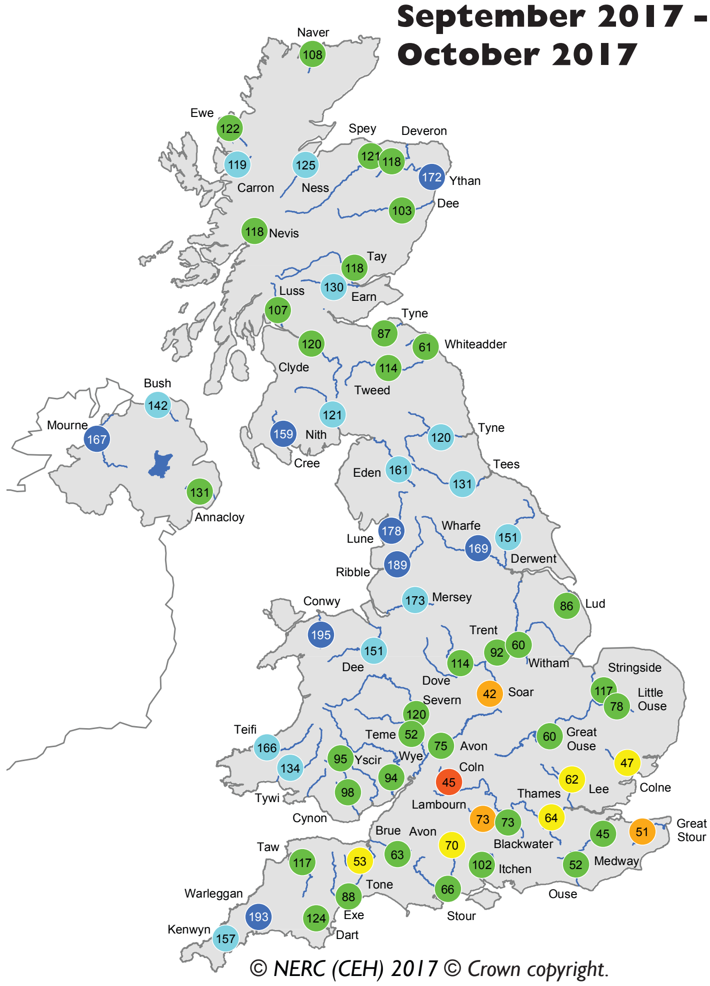
The complete version of the Hydrological Outlook UK can be found at: [www.hydoutuk.net/latest-outlook/](www.hydoutuk.net/latest-outlook/)

**Period:** **from November2017**
**Issued:** **09.11.2017**
**using data to the end of October 2017**

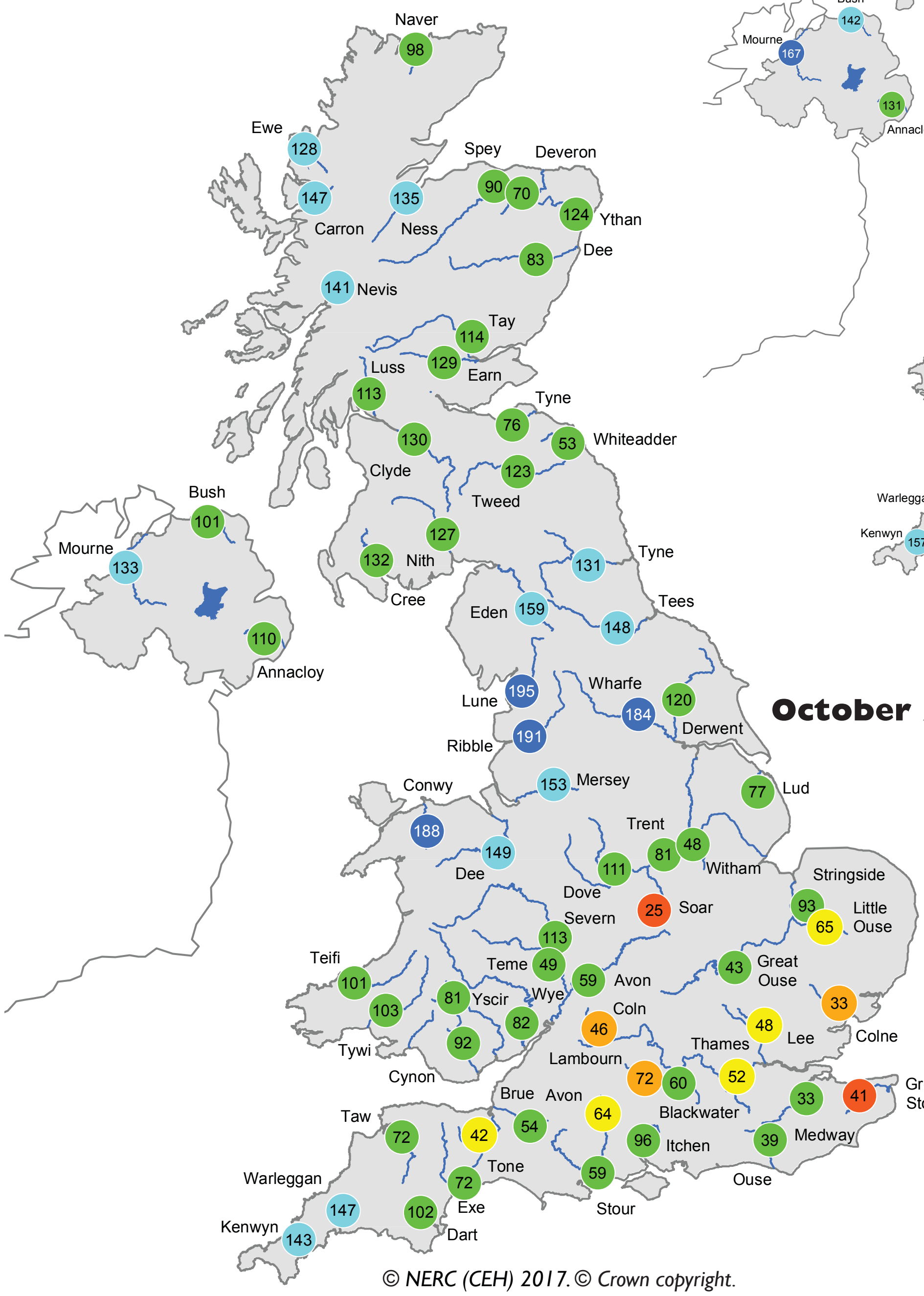
The outlook for November is for river flows to be within the normal range across the UK, except in the south-east where flows are likely to be below normal for November and the next three months. Groundwater levels in the Chalk aquifer of the south-east are likely to be below normal for the next three months, whilst groundwater levels elsewhere across the UK are likely to be normal to above normal.

# River flow . . . River flow . . .

## September 2017 - October 2017




## October 2017




**Key**

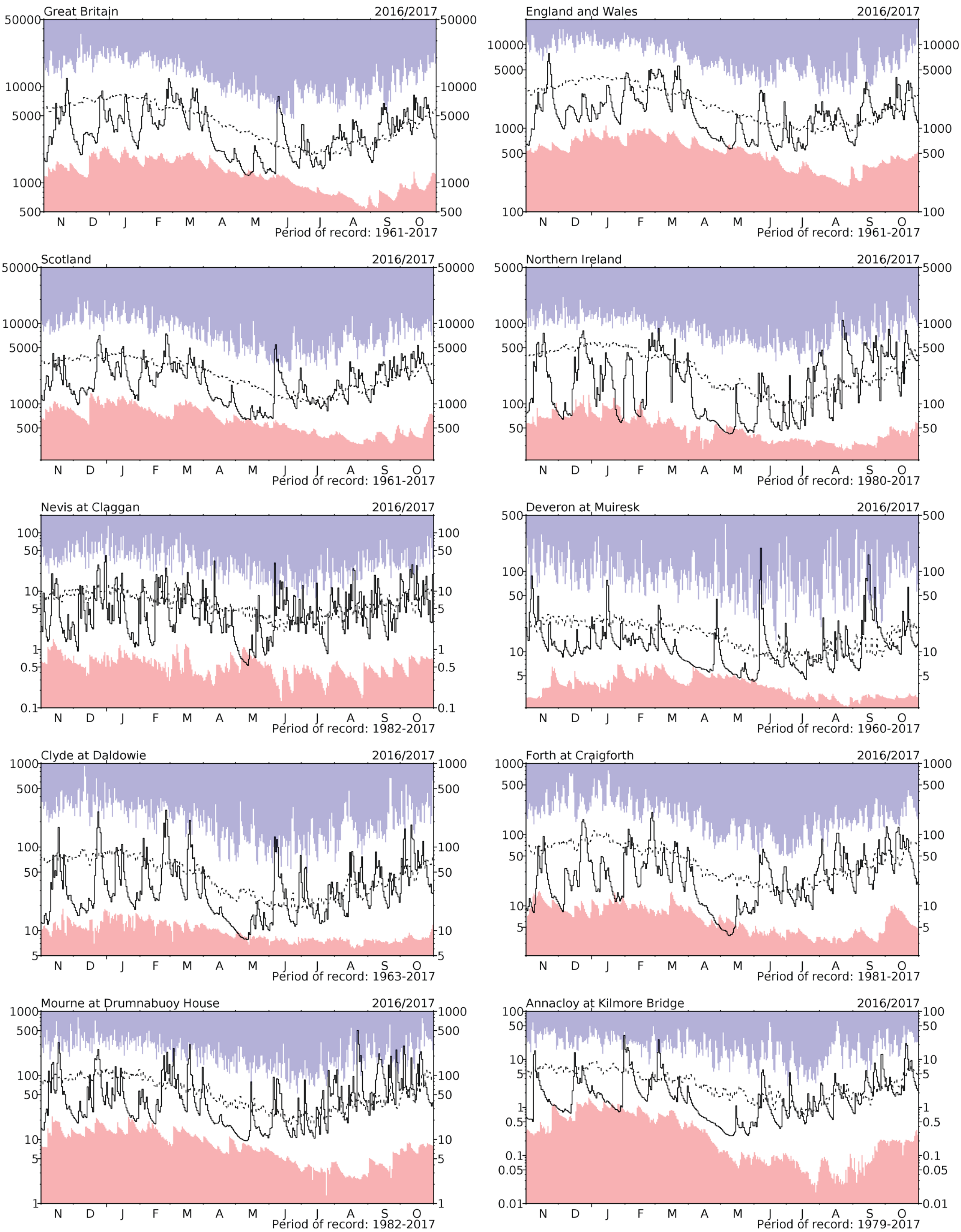
- 25 — % of long-term average (record figure when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

*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.

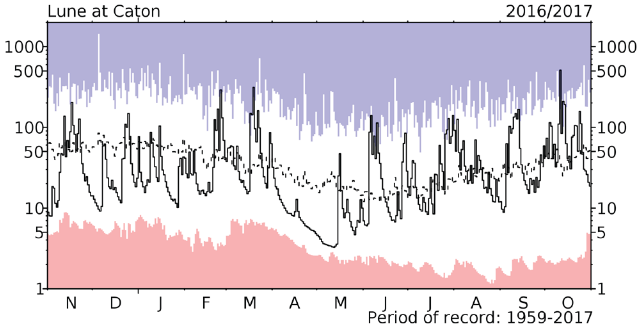
# River flow . . . River flow . . .

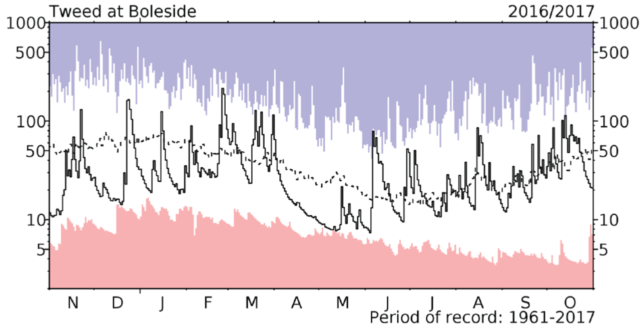


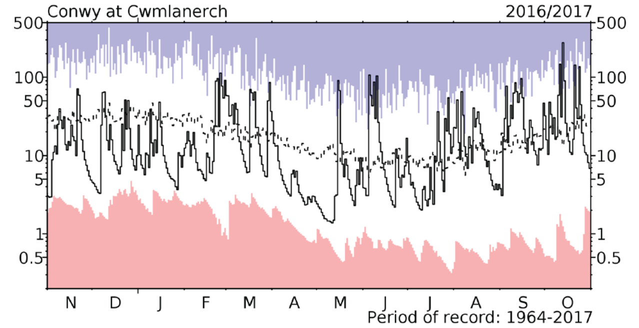

## River flow hydrographs

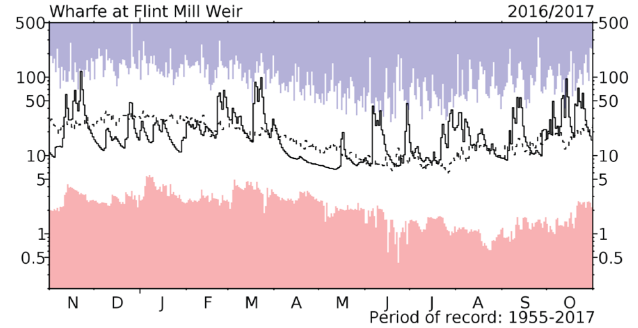
*The river flow hydrographs show the daily mean flows (measured in $m^3s^{-1}$) together with the maximum and minimum daily flows prior to November 2016 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

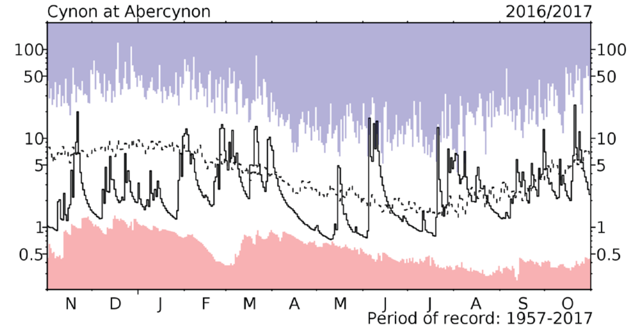
# *River flow . . . River flow . . .*

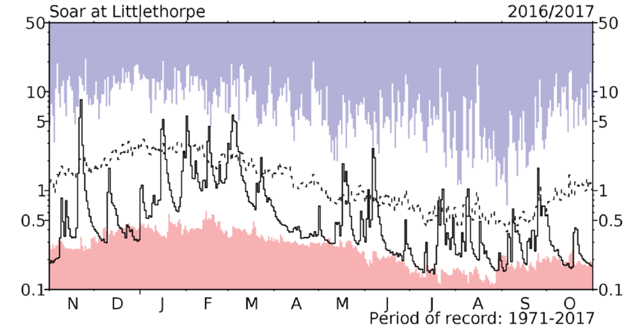


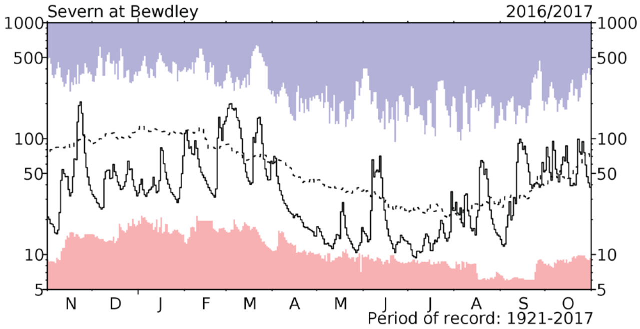



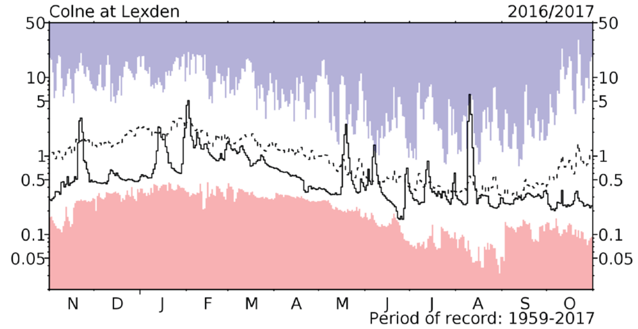



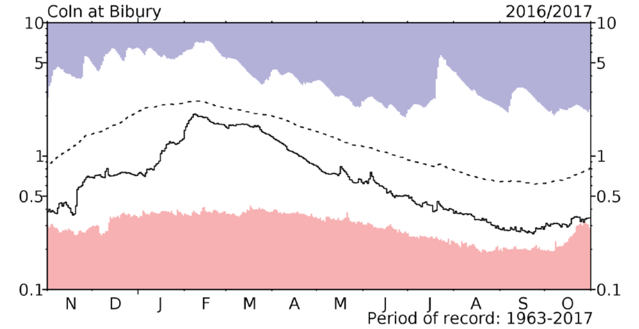



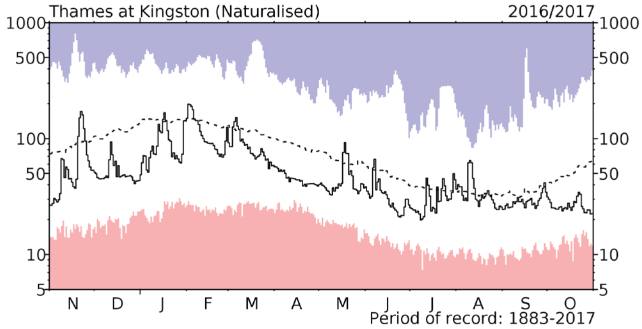



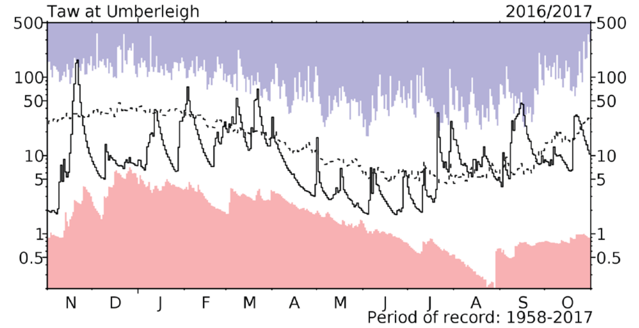



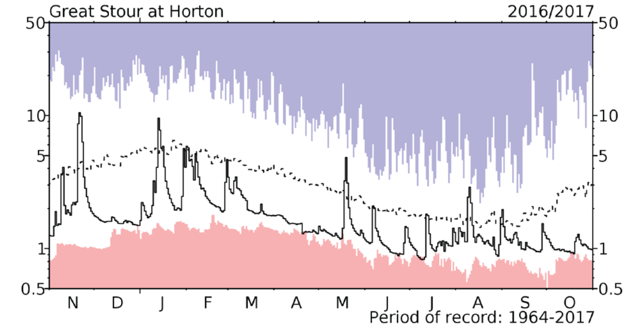



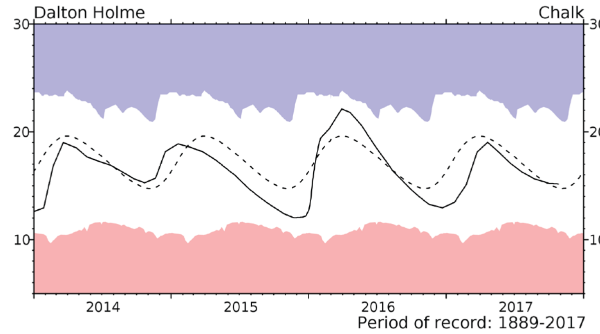



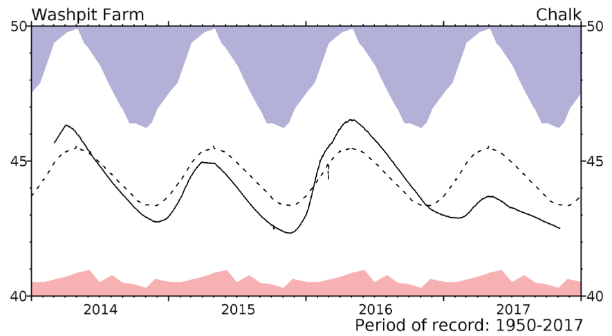



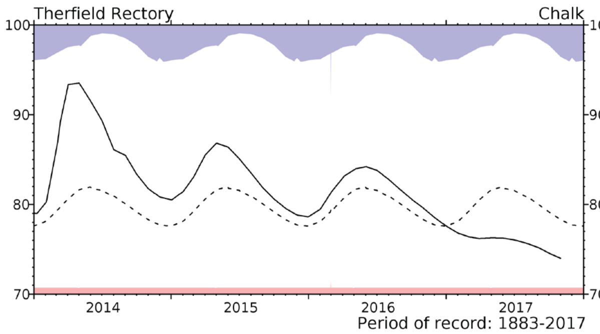



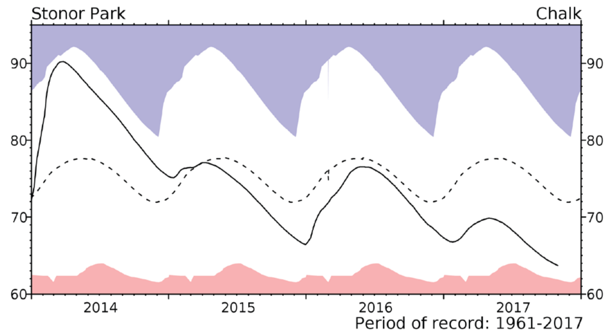



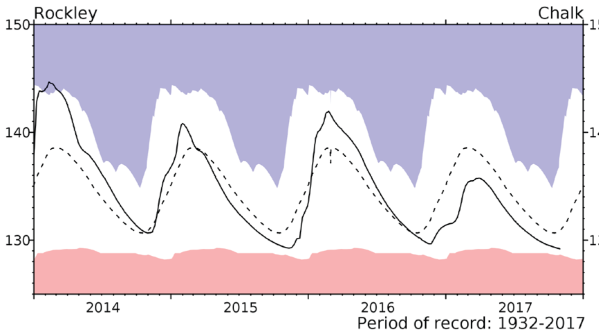
# Groundwater . . . Groundwater

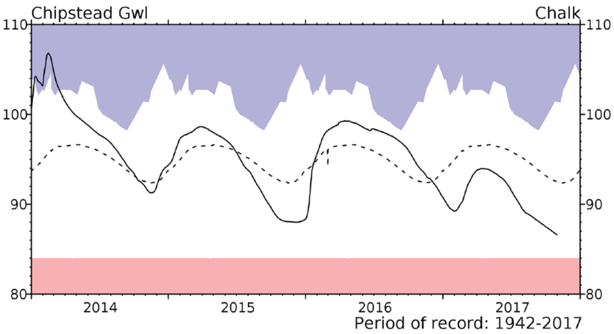


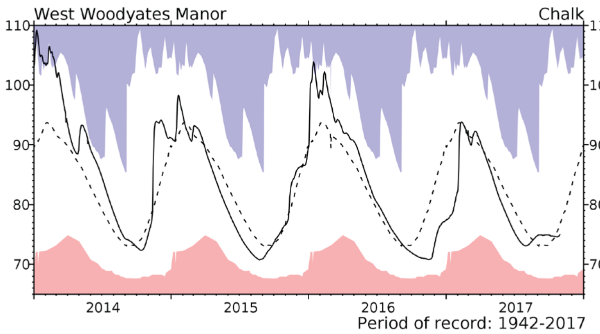



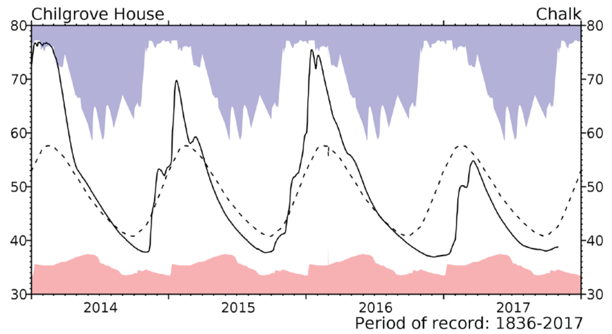



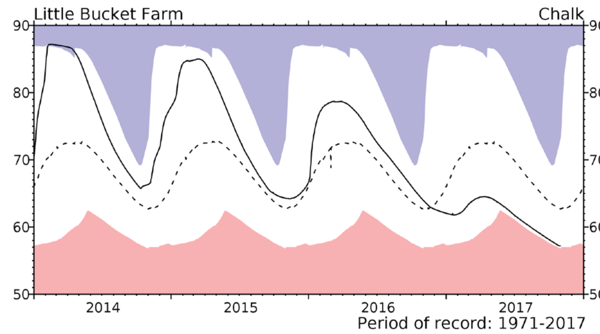



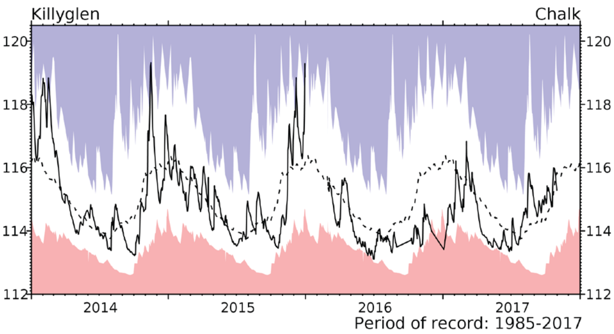



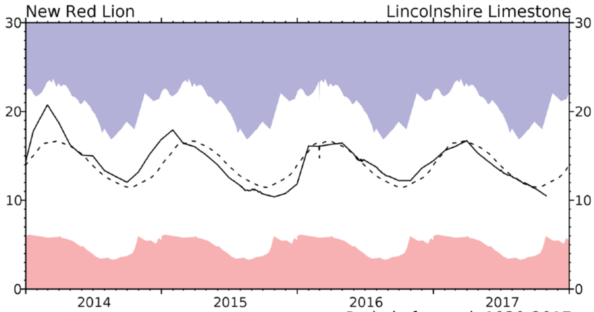



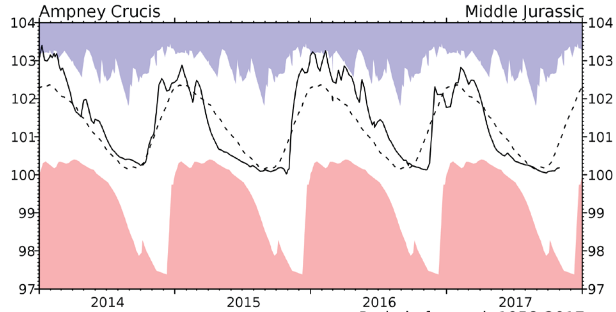




Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

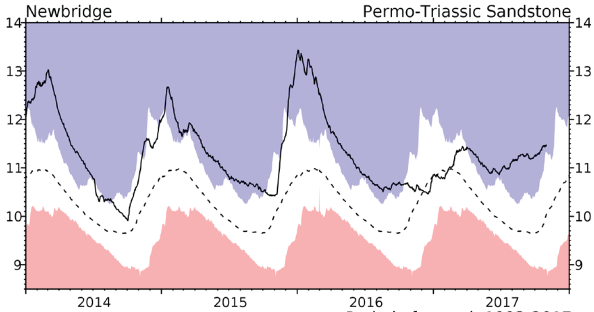
# Groundwater ... Groundwater



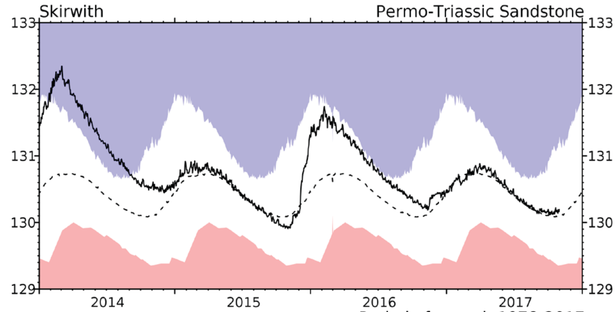
Period of record: 1939-2017



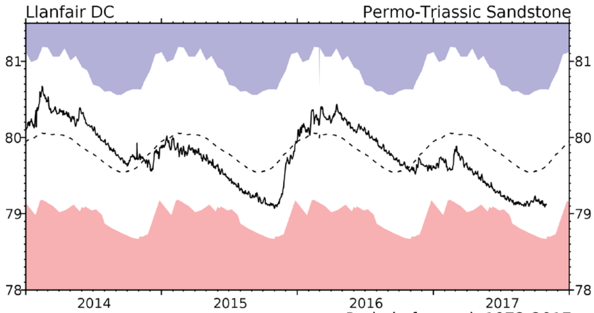
Period of record: 1958-2017



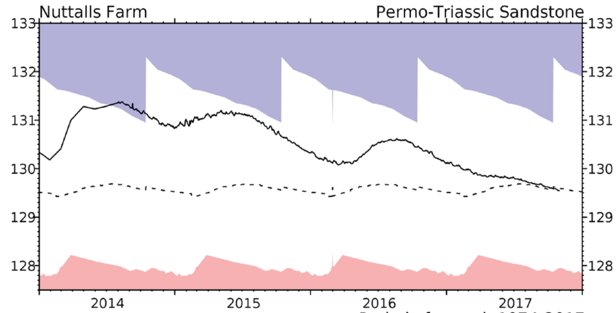
Period of record: 1993-2017



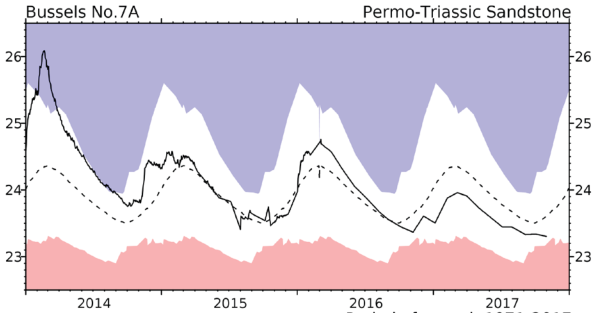
Period of record: 1978-2017



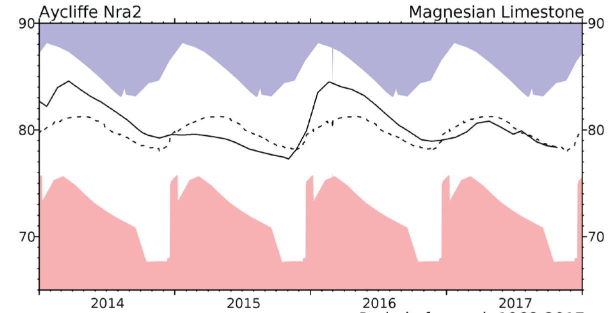
Period of record: 1972-2017



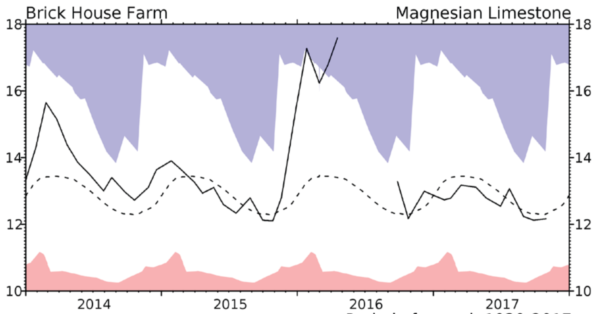
Period of record: 1974-2017



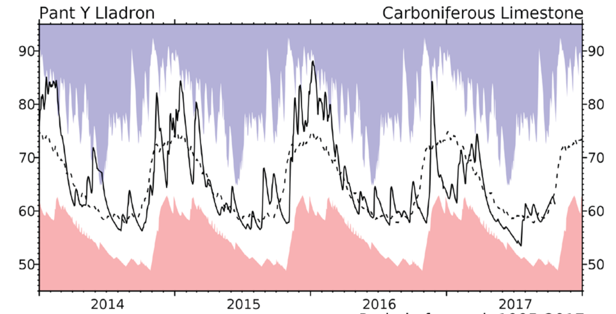
Period of record: 1971-2017



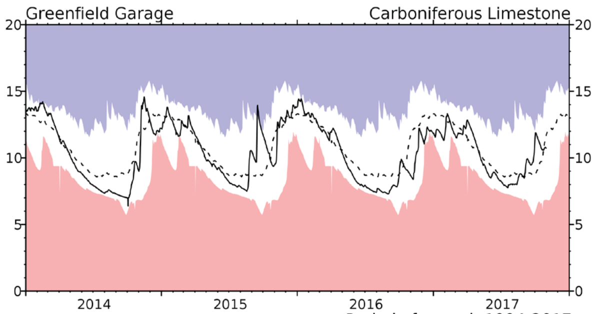
Period of record: 1968-2017



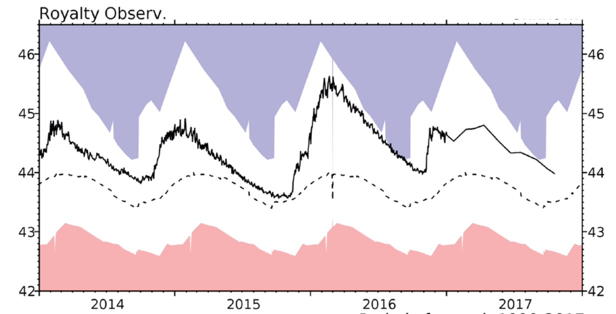
Period of record: 1939-2017



Period of record: 1995-2017

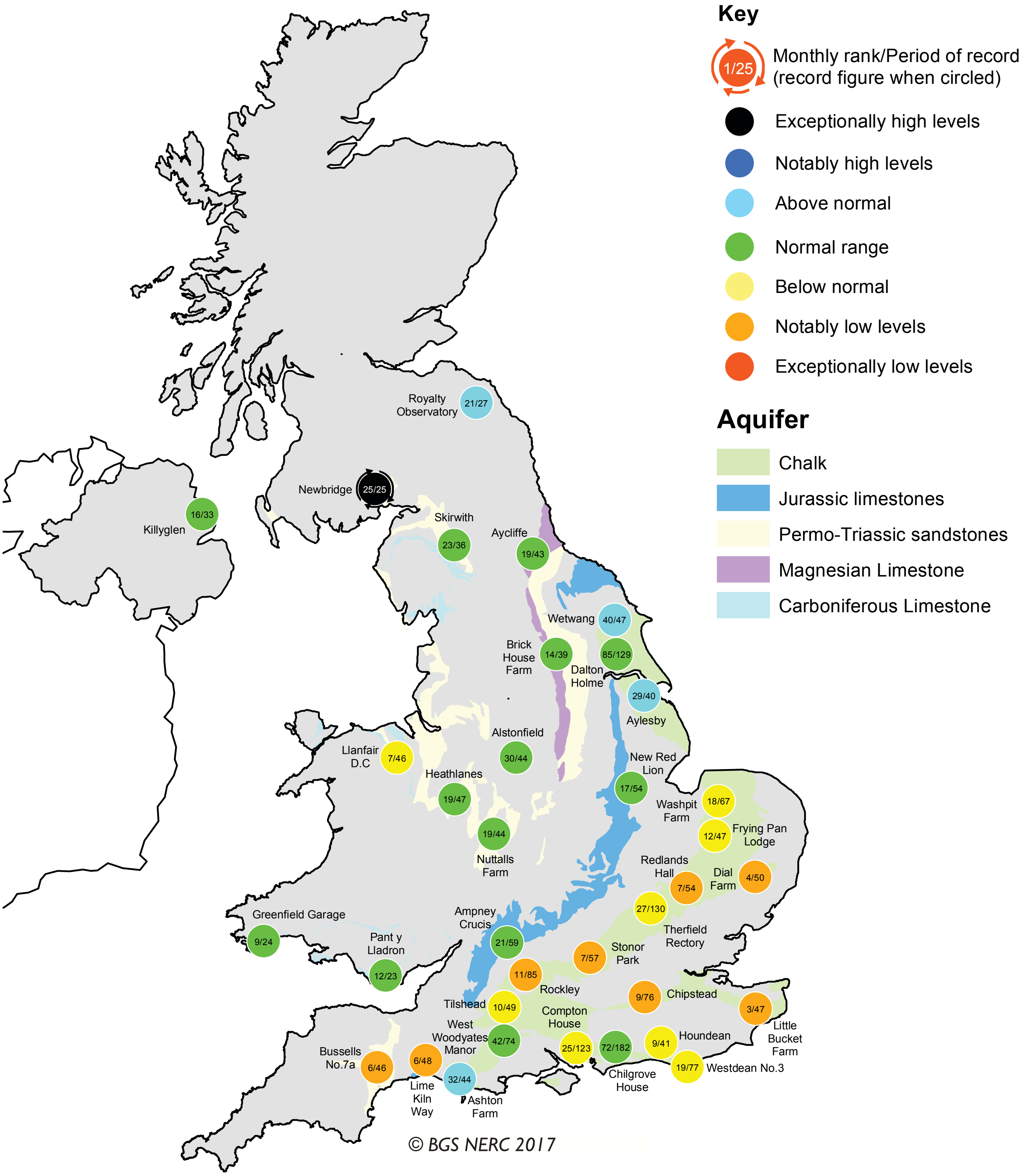


Period of record: 1994-2017



Period of record: 1990-2017

# Groundwater...Groundwater

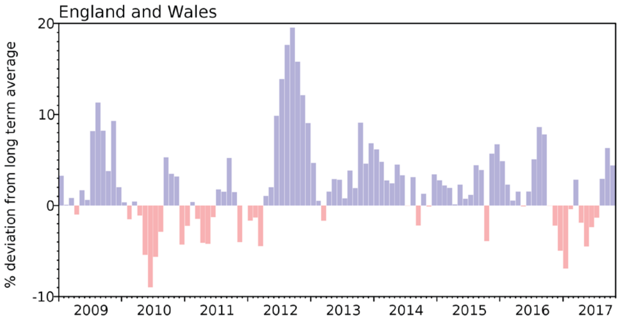



## Groundwater levels - October 2017

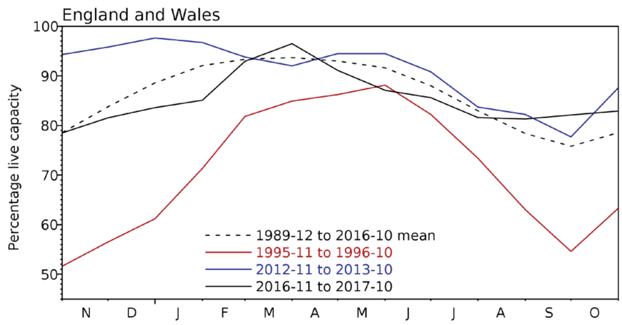
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

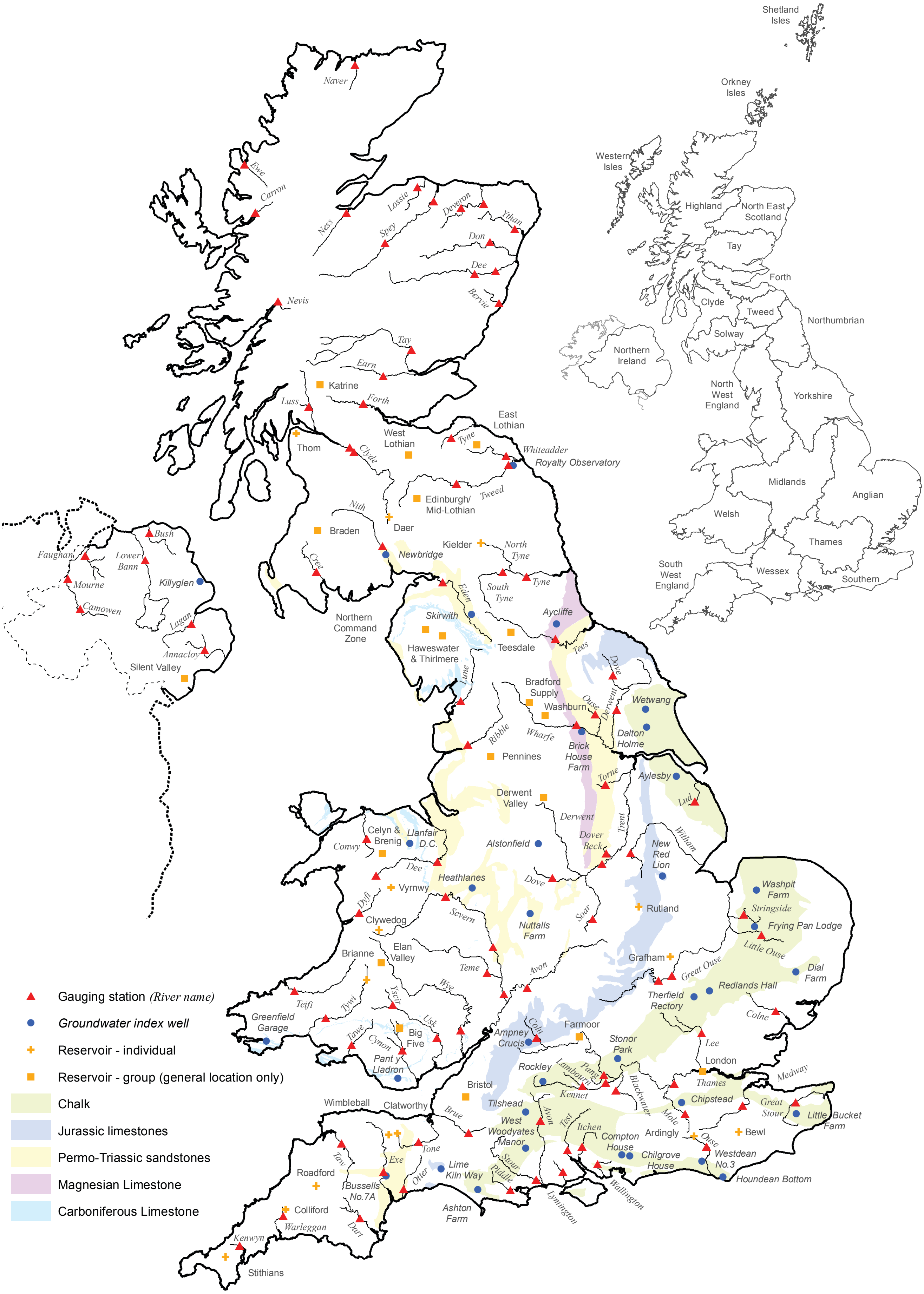
| Area | Reservoir | | Capacity (Ml) | 2017 Aug | 2017 Sep | 2017 Oct | Oct Anom. | Min Oct | Year* of min | 2016 Oct | Diff 17-16 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North West | N Command Zone | • | 124929 | 72 | 77 | 88 | 20 | 33 | 2003 | 68 | 20 |
| | Vyrnwy | | 55146 | 97 | 97 | 98 | 23 | 25 | 1995 | 79 | 18 |
| Northumbrian | Teesdale | • | 87936 | 85 | 98 | 98 | 22 | 33 | 1995 | 80 | 18 |
| | Kielder | | (199175) | 87 | 82 | 87 | 0 | 63 | 1989 | 88 | -1 |
| Severn-Trent | Clywedog | | 44922 | 93 | 92 | 85 | 9 | 38 | 1995 | 83 | 2 |
| | Derwent Valley | • | 39525 | 61 | 68 | 80 | 11 | 15 | 1995 | 74 | 6 |
| Yorkshire | Washburn | • | 22035 | 77 | 79 | 87 | 18 | 15 | 1995 | 58 | 29 |
| | Bradford Supply | • | 41407 | 73 | 80 | 91 | 18 | 16 | 1995 | 66 | 25 |
| Anglian | Grafham | | (55490) | 96 | 94 | 94 | 10 | 44 | 1997 | 88 | 5 |
| | Rutland | | (116580) | 91 | 90 | 85 | 7 | 59 | 1995 | 87 | -2 |
| Thames | London | • | 202828 | 80 | 71 | 60 | -18 | 46 | 1996 | 76 | -17 |
| | Farmoor | • | 13822 | 91 | 93 | 95 | 7 | 43 | 2003 | 90 | 5 |
| Southern | Bewl | | 28170 | 50 | 43 | 36 | -24 | 33 | 1990 | 61 | -24 |
| | Ardingly | | 4685 | 84 | 81 | 81 | 15 | 15 | 2003 | 47 | 34 |
| Wessex | Clatworthy | | 5364 | 68 | 69 | 68 | 6 | 14 | 2003 | 29 | 39 |
| | Bristol | • | (38666) | 64 | 61 | 61 | -1 | 24 | 1990 | 55 | 6 |
| South West | Colliford | | 28540 | 76 | 81 | 98 | 28 | 38 | 2006 | 65 | 33 |
| | Roadford | | 34500 | 68 | 71 | 74 | 3 | 18 | 1995 | 65 | 9 |
| | Wimbleball | | 21320 | 59 | 76 | 53 | -13 | 26 | 1995 | 43 | 10 |
| | Stithians | | 4967 | 73 | 75 | 81 | 24 | 18 | 1990 | 62 | 19 |
| Welsh | Celyn & Brenig | • | 131155 | 89 | 93 | 91 | 7 | 48 | 1989 | 90 | 2 |
| | Brianne | | 62140 | 99 | 100 | 100 | 8 | 57 | 1995 | 98 | 2 |
| | Big Five | • | 69762 | 78 | 77 | 79 | 3 | 38 | 2003 | 72 | 7 |
| | Elan Valley | • | 99106 | 68 | 80 | 89 | 4 | 37 | 1995 | 82 | 7 |
| Scotland(E) | Edinburgh/Mid-Lothian | • | 96518 | 84 | 84 | 87 | 7 | 48 | 2003 | 82 | 5 |
| | East Lothian | • | 9374 | 98 | 98 | 95 | 10 | 38 | 2003 | 98 | -3 |
| Scotland(W) | Loch Katrine | • | 110326 | 94 | 95 | 99 | 13 | 40 | 2003 | 89 | 10 |
| | Daer | | 22412 | 87 | 86 | 98 | 8 | 42 | 2003 | 80 | 18 |
| | Loch Thom | | 10798 | 81 | 89 | 100 | 11 | 66 | 2007 | 93 | 7 |
| Northern Ireland | Total+ | • | 56800 | 88 | 98 | 99 | 18 | 39 | 1995 | 74 | 25 |
| | Silent Valley | • | 20634 | 87 | 100 | 99 | 23 | 34 | 1995 | 68 | 31 |

( ) 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

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