# Hydrological Summary
## *for the* United Kingdom

December 2019

### General

December was a mixed month with wet weather bookended by settled spells. Overall December was mild, with only a few cold snaps, and a new December UK maximum temperature record of 18.7°C was set in Achfary (Highland) on the 28th. Rainfall was above average at the national scale, and particularly so in southern England. Conversely areas of north-east Britain received substantially below average rainfall. River flows in England and south Wales were generally above normal, exceptionally so in places, whilst in northern Britain and Northern Ireland flows were largely in the normal range. Soil moisture deficits (SMDs) were negligible across most of the country, and groundwater levels remained exceptionally high across large parts of the UK, particularly in north-east and central-southern England where several new records were established. At the national scale, reservoir stocks remained healthy following successive months of wet weather, notably so in impoundments in southern Britain. For seven consecutive months UK rainfall has been above average, and as a result the water resources outlook for 2020 is healthy. High river flows, saturated soils, an early start to the recharge season and exceptionally high groundwater levels increase the risk of further fluvial and groundwater flooding over the coming months.

### Rainfall

A settled start to December gave way to regular frontal systems mid-month before a return to a drier final week. On the 5th, a persistent belt of rain crossed England and Wales (a 24-hour rainfall total of 135mm was recorded at Seathwaite, Cumbria), 5,500 properties lost power and there was disruption to roads and rail and in south-west England. On the 8th/9th storm 'Atiyah' brought mainly windy conditions to Wales and south-west England, leading to transport disruption. Further successive low pressure systems traversed the UK over the next 10 days bringing sustained rainfall and on the 21st a tornado was reported in Chertsey (Surrey) causing some localised damage to property. For December as a whole, rainfall was above average in southern England, south Wales and western Scotland, with areas of south-east England receiving more than 170% of the long term average. In contrast, north east Britain recorded below average rainfall, substantially so in Northumbria where less than 50% of average rainfall was received. For the winter half-year so far (October-December), above average rainfall was registered across much of England and Wales, with areas around the Humber receiving more than 170% of average. The Severn-Trent region recorded its sixth wettest October-December since 1910. For 2019 as a whole, rainfall was above average at the UK scale, more so in central and northern England, and near average elsewhere.

### River flows

River flows remained high into the start of December, but generally began to fall following the settled start to the month. Further rainfall in the coming days led to increasing flows and by the 21st over 100 Flood Warnings were in force. Pumping stations removed excess water from the Somerset Levels and flooding was reported on the Hayle (Cornwall) and Medway (Kent) with 90 properties flooded but over 18,000 protected by defences across England. Towards the end of the month flows began to recede as conditions became more settled. December mean flows in southern England were generally above normal or higher, notably and exceptionally high in a band from Wessex to the Humber and a number of catchments exceeding two times the average (e.g. Coln, Medway, Hampshire Avon, Stour). A new December mean flow record was established on the Lud (record since 1968) and it recorded new daily mean flow maxima for 16 consecutive days. In contrast, flows in northern Britain were generally in the normal range, with below normal flows recorded on the Coquet and Bush. For October-December flows were above average for most of England and Wales and new maximum mean flow records were established on six catchments from Cornwall to the Humber with the Warwickshire Avon and Lud exceeding three times the average for this period. October-December outflows from England and Wales were the second highest on record in a series from 1961. For 2019 as a whole, flows were above average in central and northern England, while flow deficits originating from the dry summer of 2018 are evident in eastern England with the Lee and Little Ouse recording less than two thirds of the average.

### Groundwater

Groundwater levels generally rose in December due to the lack of SMDs, with responses dependent on geographic location and the amount of rainfall and recharge received. Sites from the Midlands northwards remained in the same category as last month, whilst levels generally rose further above normal in the south. In the Chalk, levels rose during December at all index sites except Wetwang and Killyglen, leading to exceptionally high levels in the north-east and southern parts of the outcrop. Groundwater flood alerts were issued in central-southern England during December and three new record levels for December were established at Aylesby (for the second consecutive month), Rockley and West Woodyates Manor. In contrast, levels in the eastern Chilterns and at some sites in East Anglia remained below normal. In the Jurassic limestones, levels rose with a record level for the third successive month at New Red Lion, but fell at Ampney Crucis from exceptionally high to above average. In the Magnesian Limestone levels rose and remained exceptionally high. At Lime Kiln Way in the Upper Greensand, levels rose but remained in the normal range. Levels in the Permo-Triassic sandstones rose and remained in the normal range or above, with levels at Weir Farm becoming exceptionally high. In the Carboniferous Limestone, levels fell overall in south Wales dropping back into the normal range at Greenfield Garage but rose at Alstonfield where levels remained exceptionally high. Levels in the Fell sandstone at Royalty Observatory rose and remained above normal for time of the year.

UK Centre for Ecology & Hydrology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

# Rainfall . . . Rainfall . . .

Met Office

## Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

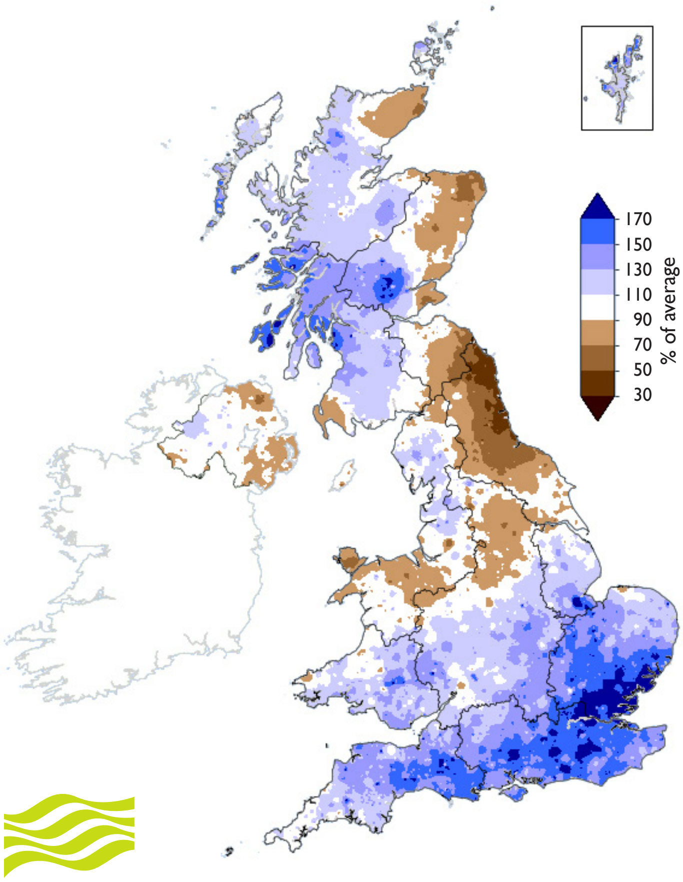
| Region | Rainfall | Dec 2019 | Nov19 – Dec19 | RP | Oct19 – Dec19 | RP | Jul19 – Dec19 | RP | Jan19 – Dec19 | RP |
|---|---|---|---|---|---|---|---|---|---|---|
| United Kingdom | mm | **139** | 257 | | 395 | | 743 | | 1240 | |
| | % | **119** | 109 | 2-5 | 110 | 2-5 | 121 | 15-25 | 110 | 10-20 |
| England | mm | **103** | 219 | | 344 | | 602 | | 968 | |
| | % | **120** | 127 | 5-10 | 131 | 10-15 | 130 | 15-25 | 115 | 8-12 |
| Scotland | mm | **192** | 296 | | 449 | | 935 | | 1593 | |
| | % | **123** | 93 | 2-5 | 92 | 2-5 | 114 | 5-10 | 105 | 5-10 |
| Wales | mm | **180** | 353 | | 551 | | 931 | | 1612 | |
| | % | **112** | 111 | 2-5 | 114 | 5-10 | 118 | 5-10 | 114 | 8-12 |
| Northern Ireland | mm | **109** | 238 | | 338 | | 694 | | 1230 | |
| | % | **96** | 105 | 2-5 | 98 | 2-5 | 113 | 2-5 | 108 | 5-10 |
| England & Wales | mm | **114** | 238 | | 373 | | 647 | | 1056 | |
| | % | **118** | 123 | 5-10 | 127 | 8-12 | 128 | 10-20 | 115 | 10-15 |
| North West | mm | **142** | 243 | | 379 | | 876 | | 1445 | |
| | % | **108** | 94 | 2-5 | 96 | 2-5 | 128 | 10-20 | 119 | 15-25 |
| Northumbria | mm | **58** | 189 | | 289 | | 625 | | 1024 | |
| | % | **67** | 107 | 2-5 | 110 | 2-5 | 131 | 20-30 | 118 | 10-20 |
| Severn-Trent | mm | **84** | 212 | | 332 | | 593 | | 974 | |
| | % | **109** | 140 | 5-10 | 144 | 15-25 | 141 | 30-50 | 125 | 30-50 |
| Yorkshire | mm | **76** | 208 | | 353 | | 636 | | 998 | |
| | % | **88** | 123 | 2-5 | 141 | 15-25 | 141 | 20-30 | 119 | 10-20 |
| Anglian | mm | **74** | 158 | | 255 | | 418 | | 683 | |
| | % | **139** | 139 | 5-10 | 145 | 15-25 | 123 | 5-10 | 109 | 2-5 |
| Thames | mm | **103** | 199 | | 305 | | 474 | | 765 | |
| | % | **146** | 138 | 5-10 | 137 | 10-15 | 122 | 5-10 | 107 | 2-5 |
| Southern | mm | **133** | 251 | | 373 | | 544 | | 850 | |
| | % | **153** | 141 | 5-10 | 135 | 8-12 | 122 | 5-10 | 107 | 2-5 |
| Wessex | mm | **139** | 250 | | 394 | | 615 | | 975 | |
| | % | **142** | 128 | 5-10 | 134 | 8-12 | 127 | 5-10 | 111 | 2-5 |
| South West | mm | **182** | 377 | | 573 | | 889 | | 1374 | |
| | % | **127** | 134 | 5-10 | 136 | 10-20 | 132 | 15-25 | 112 | 5-10 |
| Welsh | mm | **175** | 343 | | 537 | | 903 | | 1559 | |
| | % | **114** | 113 | 2-5 | 116 | 5-10 | 119 | 5-10 | 114 | 8-12 |
| Highland | mm | **230** | 313 | | 488 | | 1004 | | 1815 | |
| | % | **119** | 81 | 2-5 | 84 | 2-5 | 104 | 2-5 | 101 | 2-5 |
| North East | mm | **94** | 249 | | 346 | | 670 | | 1160 | |
| | % | **103** | 124 | 5-10 | 108 | 2-5 | 120 | 5-10 | 114 | 8-12 |
| Tay | mm | **169** | 300 | | 427 | | 843 | | 1389 | |
| | % | **127** | 109 | 2-5 | 100 | 2-5 | 117 | 5-10 | 104 | 2-5 |
| Forth | mm | **149** | 258 | | 386 | | 799 | | 1281 | |
| | % | **125** | 109 | 2-5 | 104 | 2-5 | 123 | 15-25 | 107 | 5-10 |
| Tweed | mm | **93** | 217 | | 318 | | 711 | | 1167 | |
| | % | **90** | 105 | 2-5 | 100 | 2-5 | 127 | 15-25 | 114 | 10-15 |
| Solway | mm | **173** | 288 | | 439 | | 1025 | | 1677 | |
| | % | **109** | 91 | 2-5 | 90 | 2-5 | 124 | 10-20 | 113 | 10-20 |
| Clyde | mm | **273** | 361 | | 560 | | 1194 | | 1909 | |
| | % | **143** | 95 | 2-5 | 96 | 2-5 | 119 | 10-15 | 105 | 5-10 |

*% = 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.

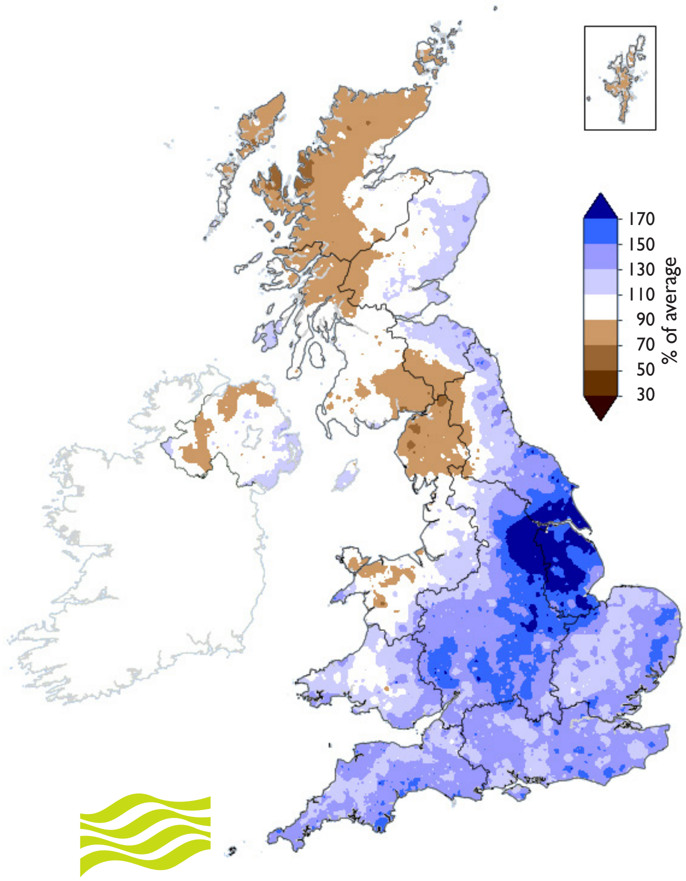
# Rainfall . . . Rainfall . . .

**December 2019 rainfall as % of 1981-2010 average**



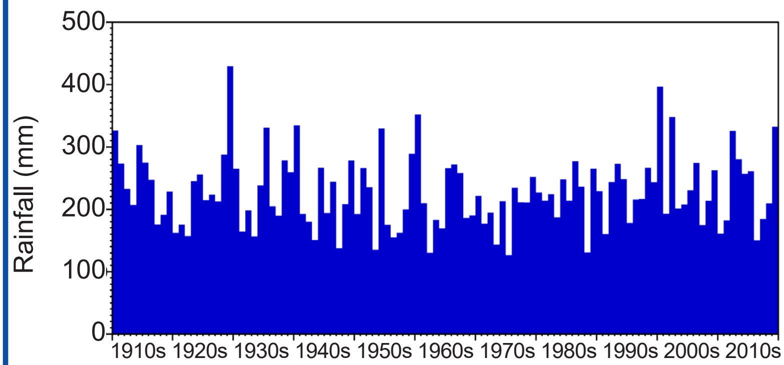

Met Office

**October 2019 - December 2019 rainfall as % of 1981-2010 average**

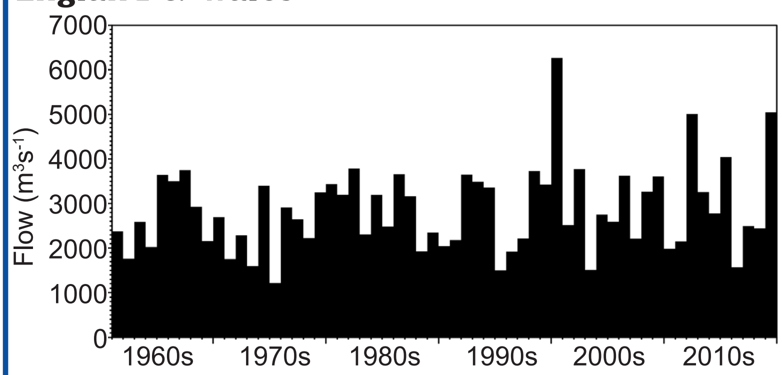



Met Office

**October - December rainfall for Severn-Trent**




**October - December average outflows for England & Wales**




## 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.

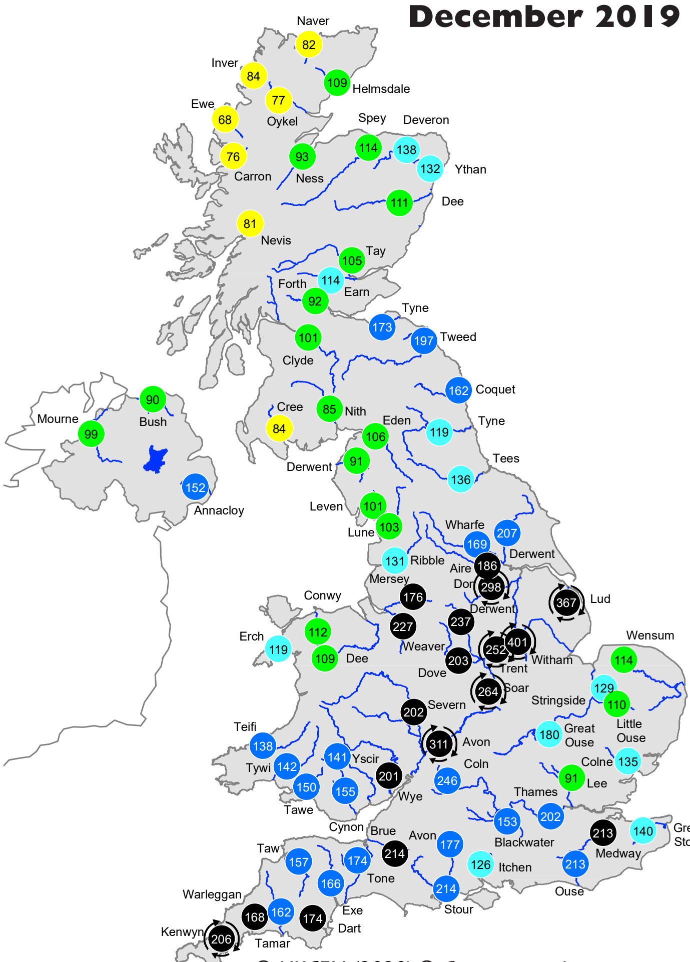
The complete version of the Hydrological Outlook UK can be found at: www.hydoutuk.net/latest-outlook/

**Period:** **from January 2020**
**Issued:** **09.01.2020**
**using data to the end of December 2019**

The outlook for January is for river flows to be within the normal range across the majority of northern and western parts of the UK, as well as in the groundwater fed catchments of East Anglia and the Chilterns. River flows in the East Midlands, central-southern and south-eastern England are likely to be normal to above normal for January. Over the next three months, river flows in northern and western parts of the UK are likely to be normal to above normal. Groundwater levels are expected to follow a similar pattern with normal levels being likely in East Anglia and the Chilterns over the next one to three months. Normal to exceptionally high groundwater levels, with a variable spatial pattern, are likely to extend across the remainder of the UK for the next three months.

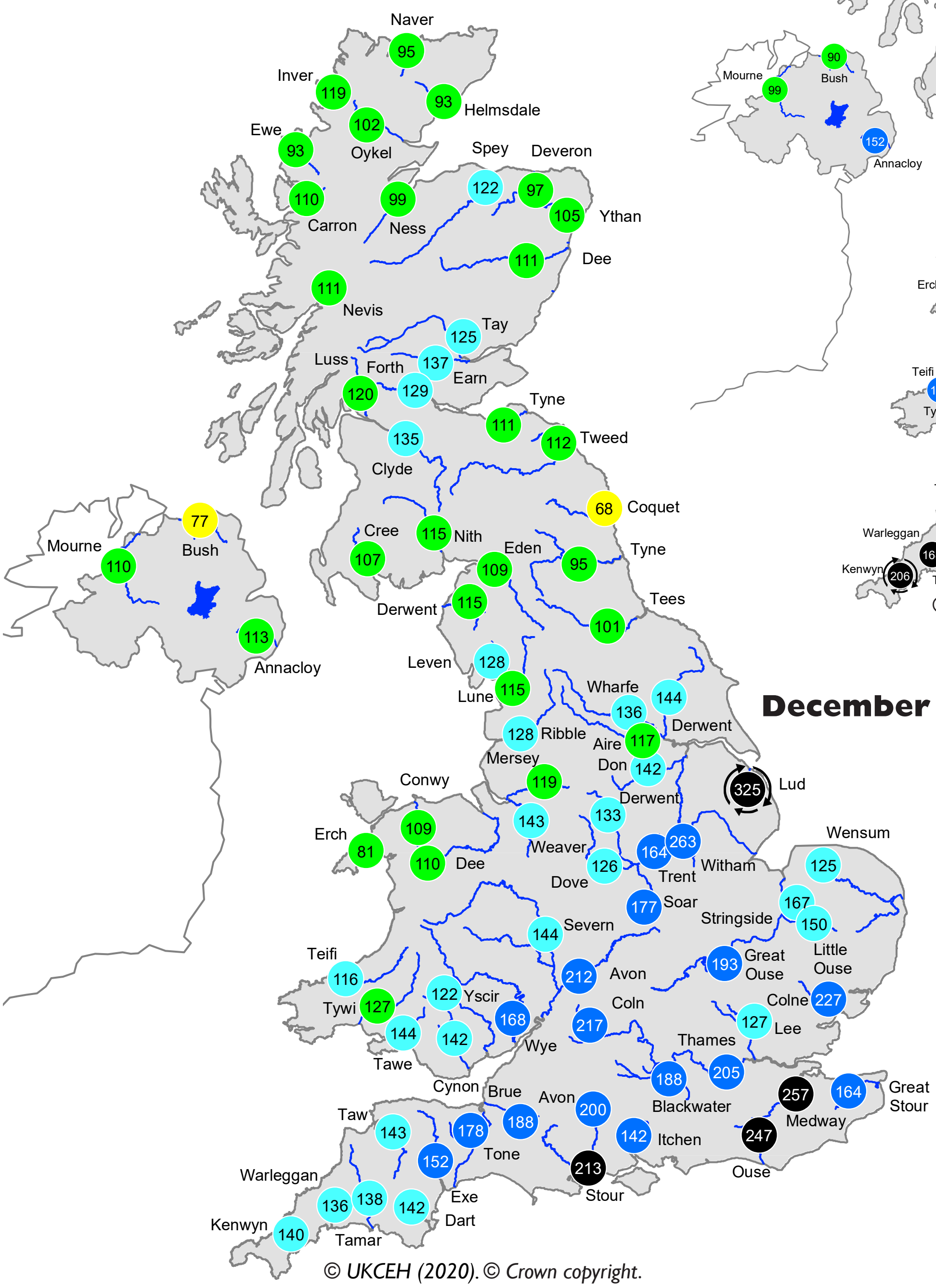
# River flow . . . River flow . . .

## October 2019 - December 2019






## December 2019






**Key**

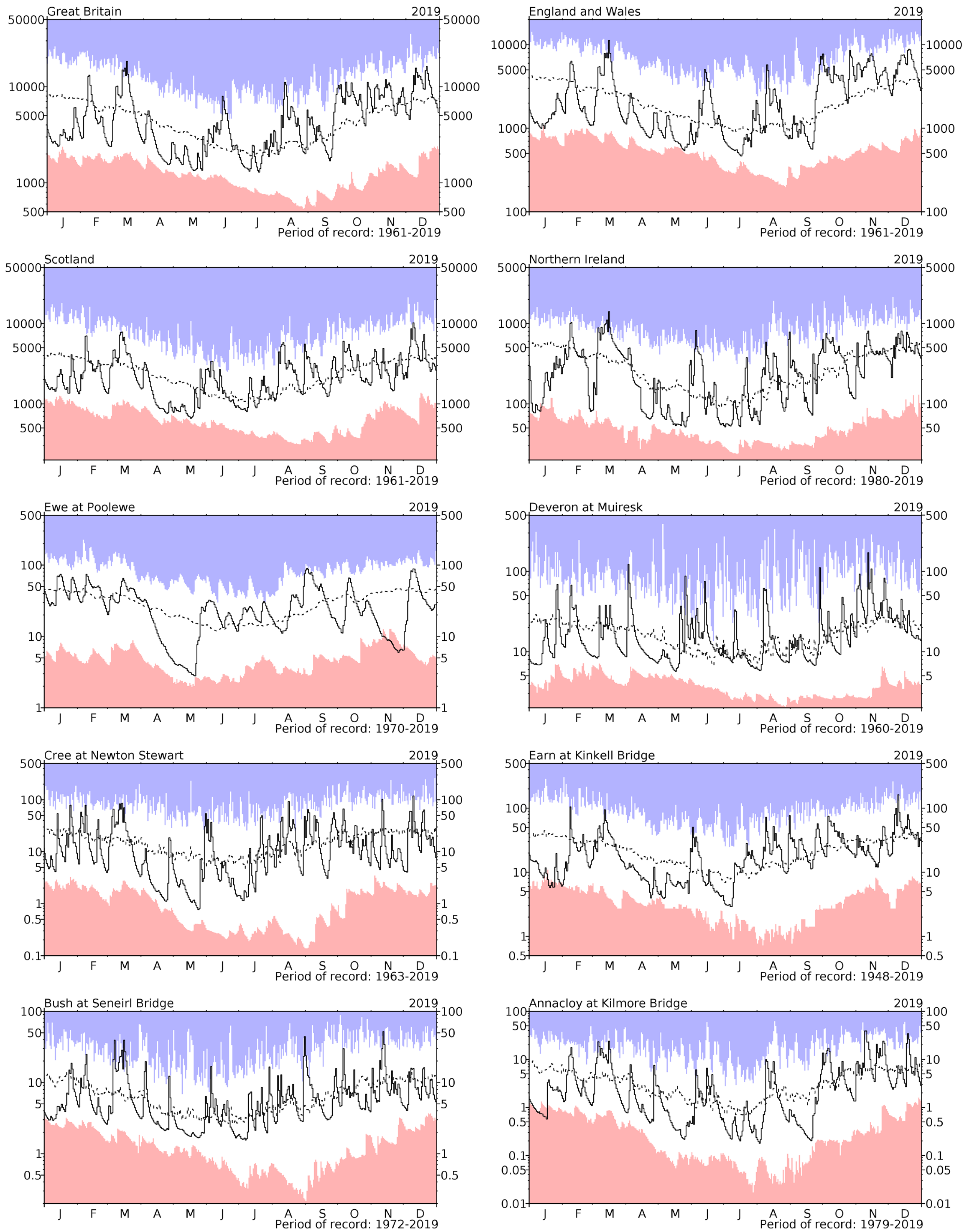
- 25 — % of long-term average (record figure when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

*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.

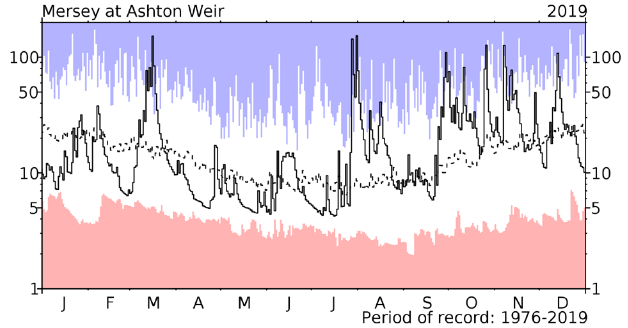
# River flow . . . River flow . . .

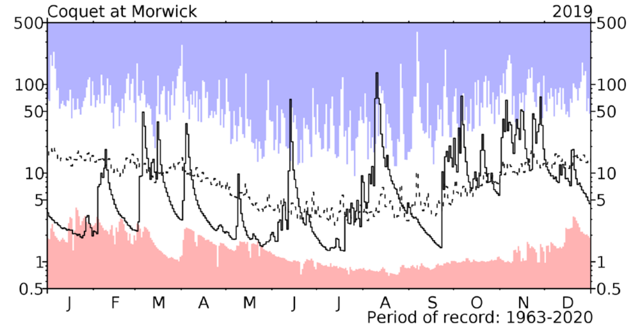


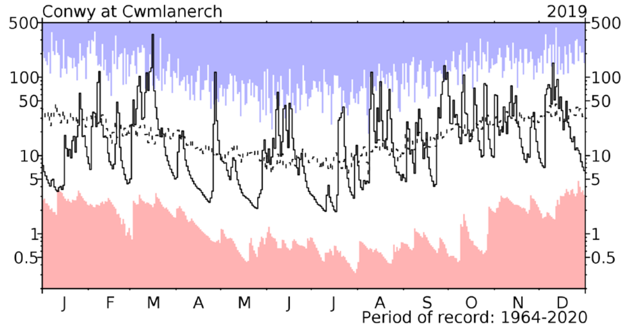

## River flow hydrographs

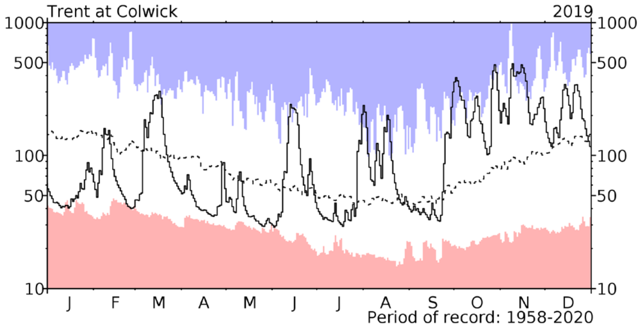
*The river flow hydrographs show the daily mean flows (measured in $m^3s^{-1}$) together with the maximum and minimum daily flows prior to January 2019 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed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

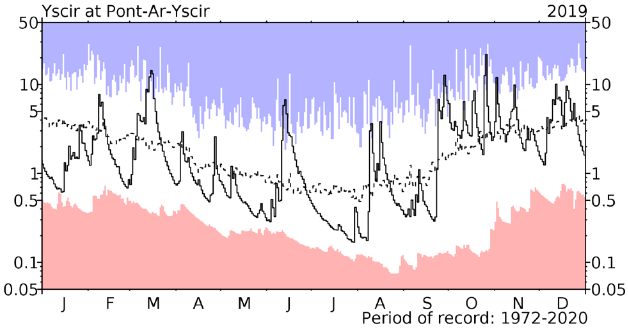
# *River flow ... River flow ...*

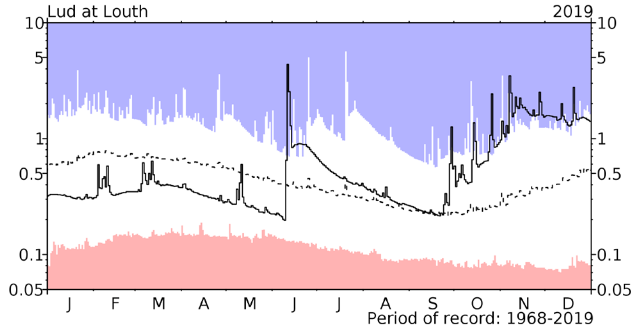


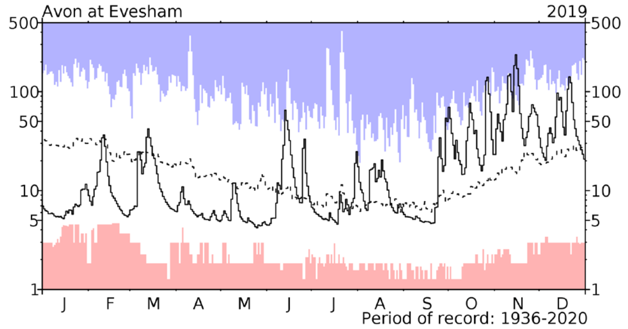



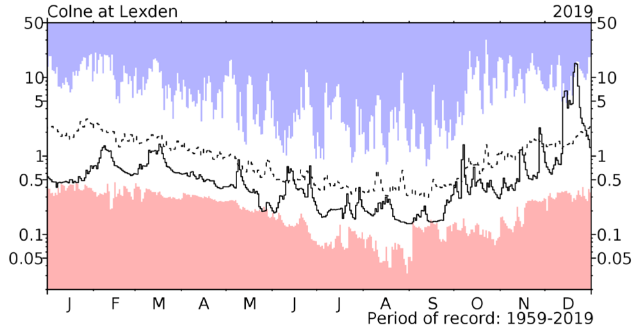



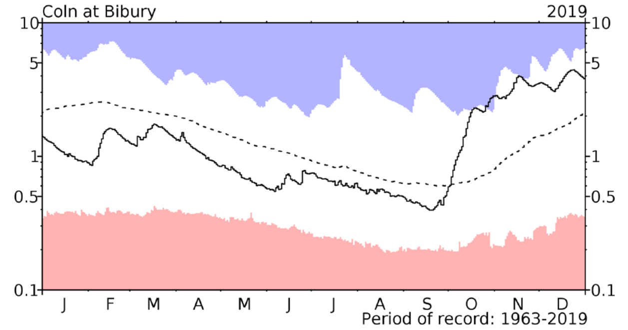



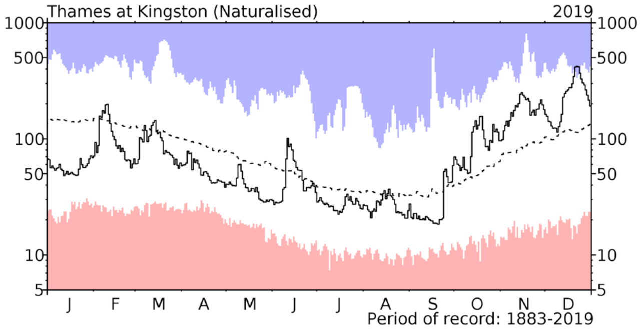



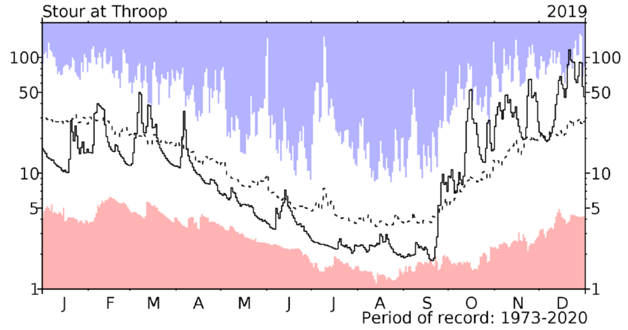



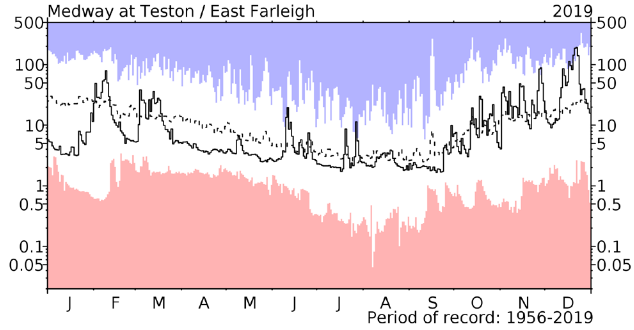



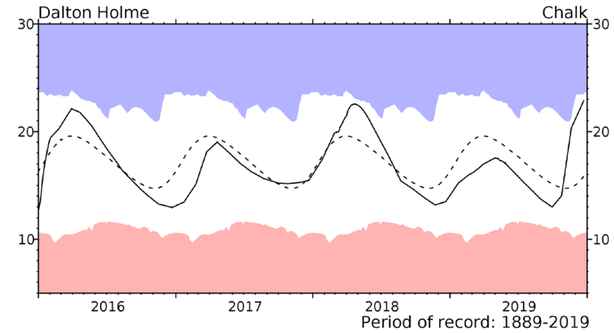



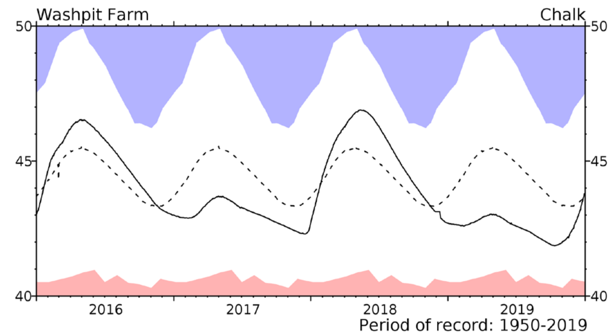



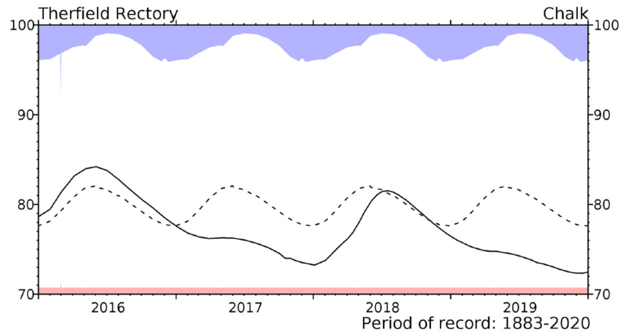



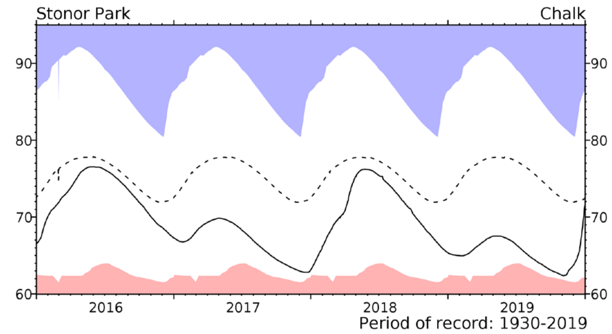



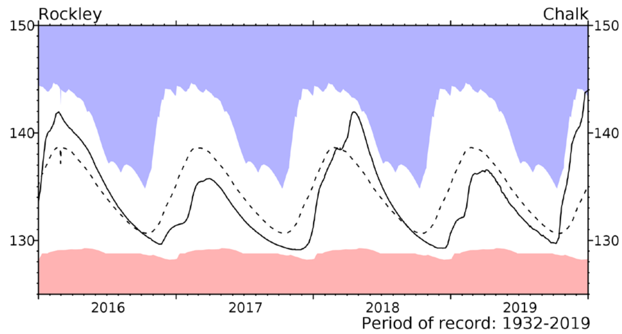
# Groundwater . . . Groundwater

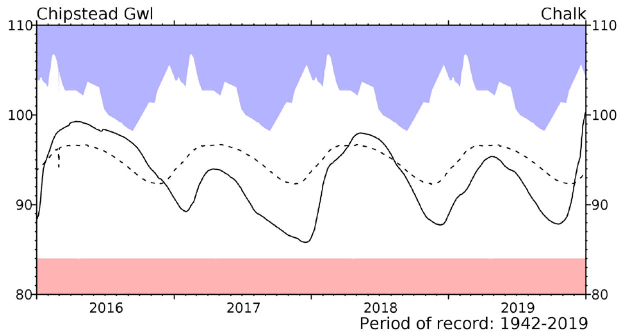


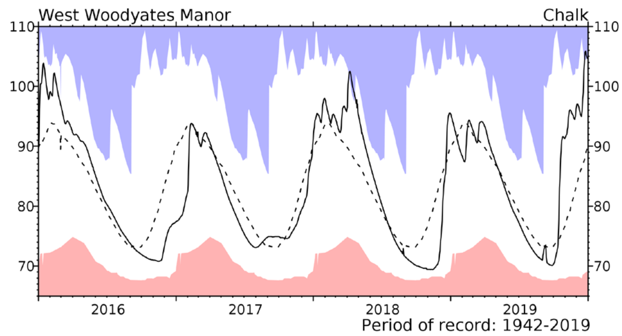



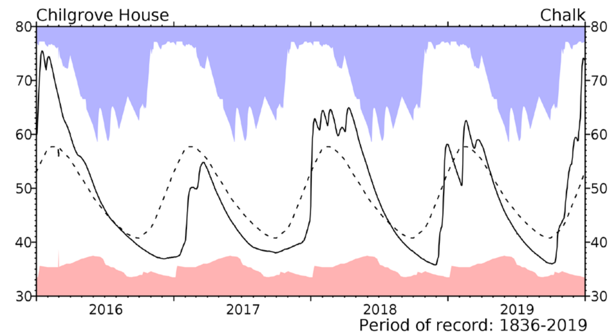



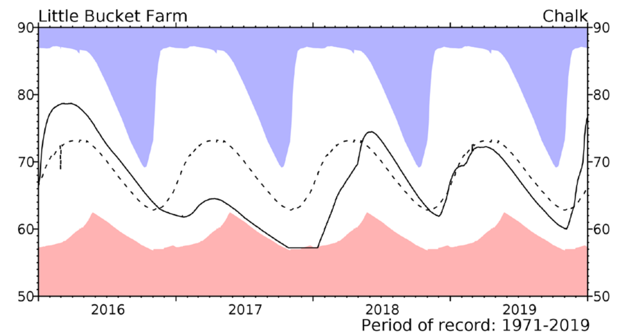



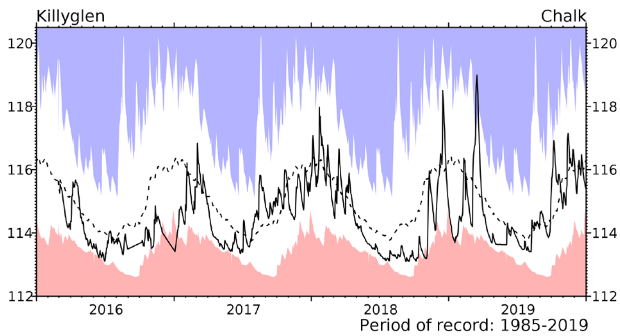



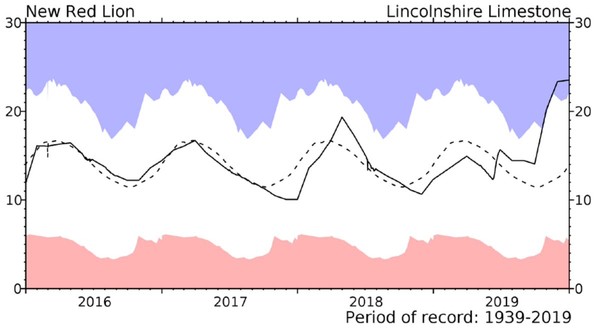



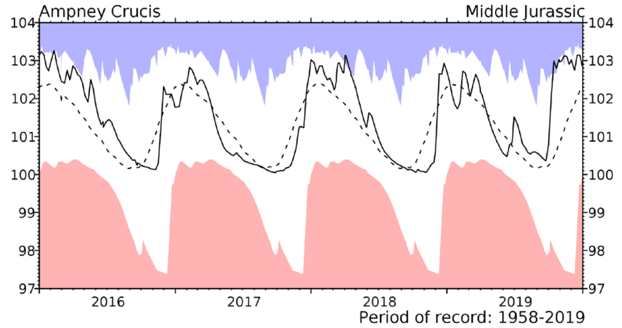



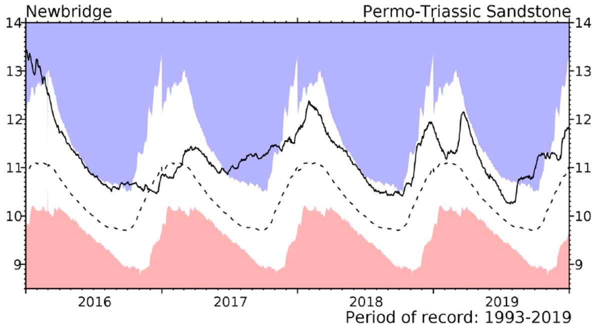



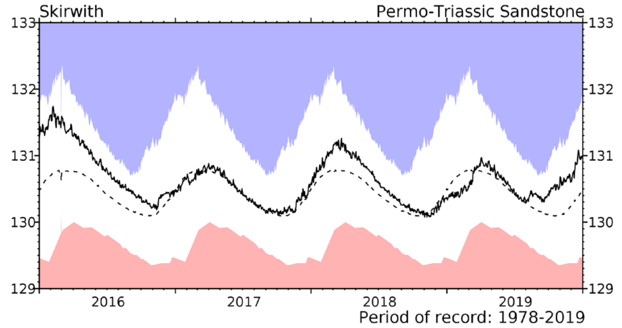



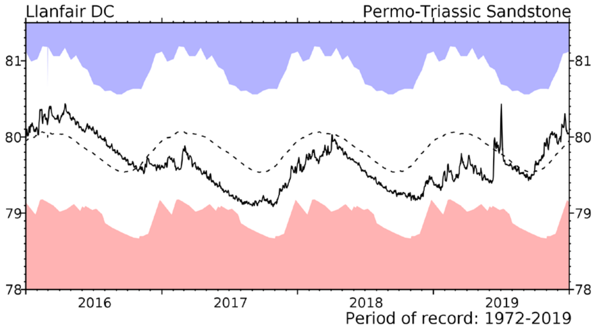

Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

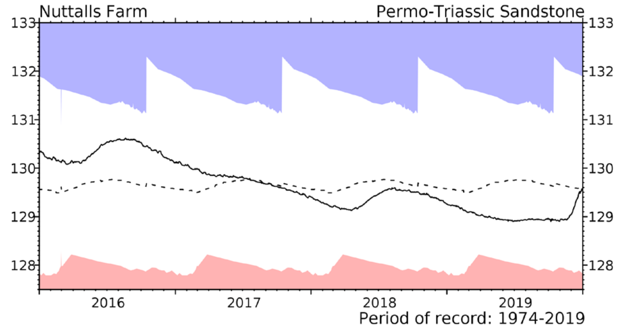

New Red Lion
Lincolnshire Limestone
Period of record: 1939-2019

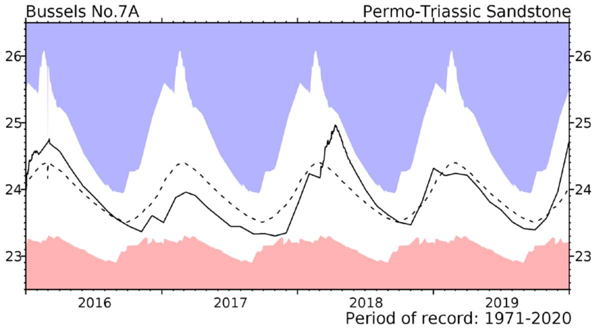

Ampney Crucis
Middle Jurassic
Period of record: 1958-2019

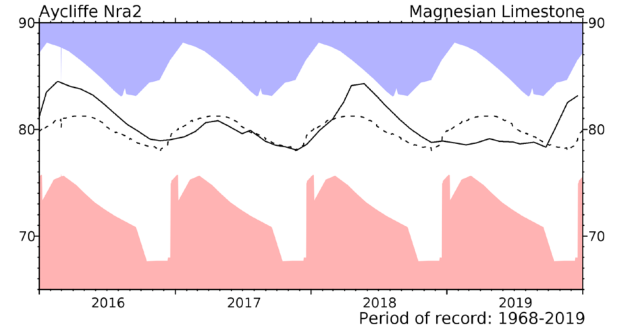

Newbridge
Permo-Triassic Sandstone
Period of record: 1993-2019

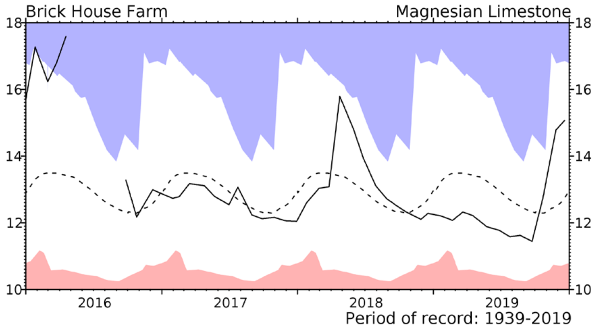

Skirwith
Permo-Triassic Sandstone
Period of record: 1978-2019

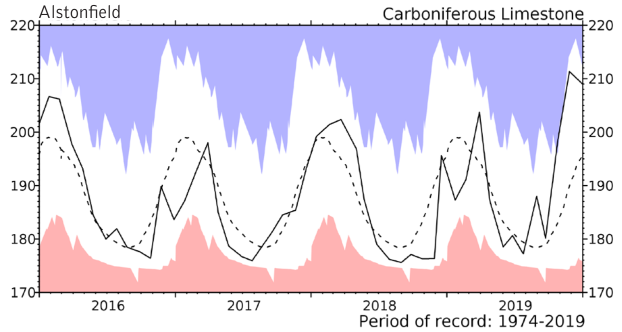

Llanfair DC
Permo-Triassic Sandstone
Period of record: 1972-2019

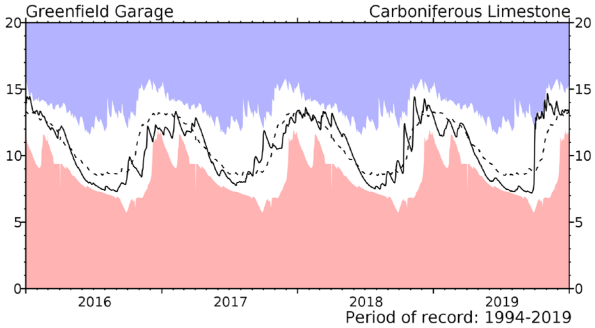

Nuttalls Farm
Permo-Triassic Sandstone
Period of record: 1974-2019

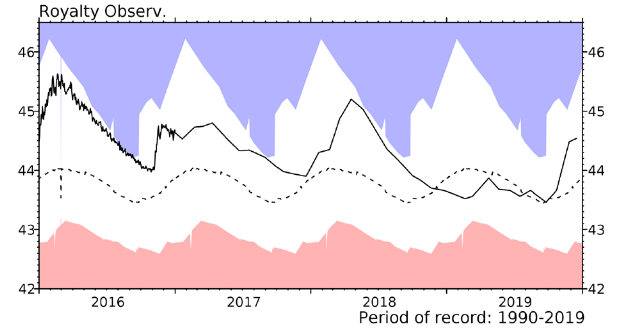

Bussels No.7A
Permo-Triassic Sandstone
Period of record: 1971-2020


Aycliffe Nra2
Magnesian Limestone
Period of record: 1968-2019

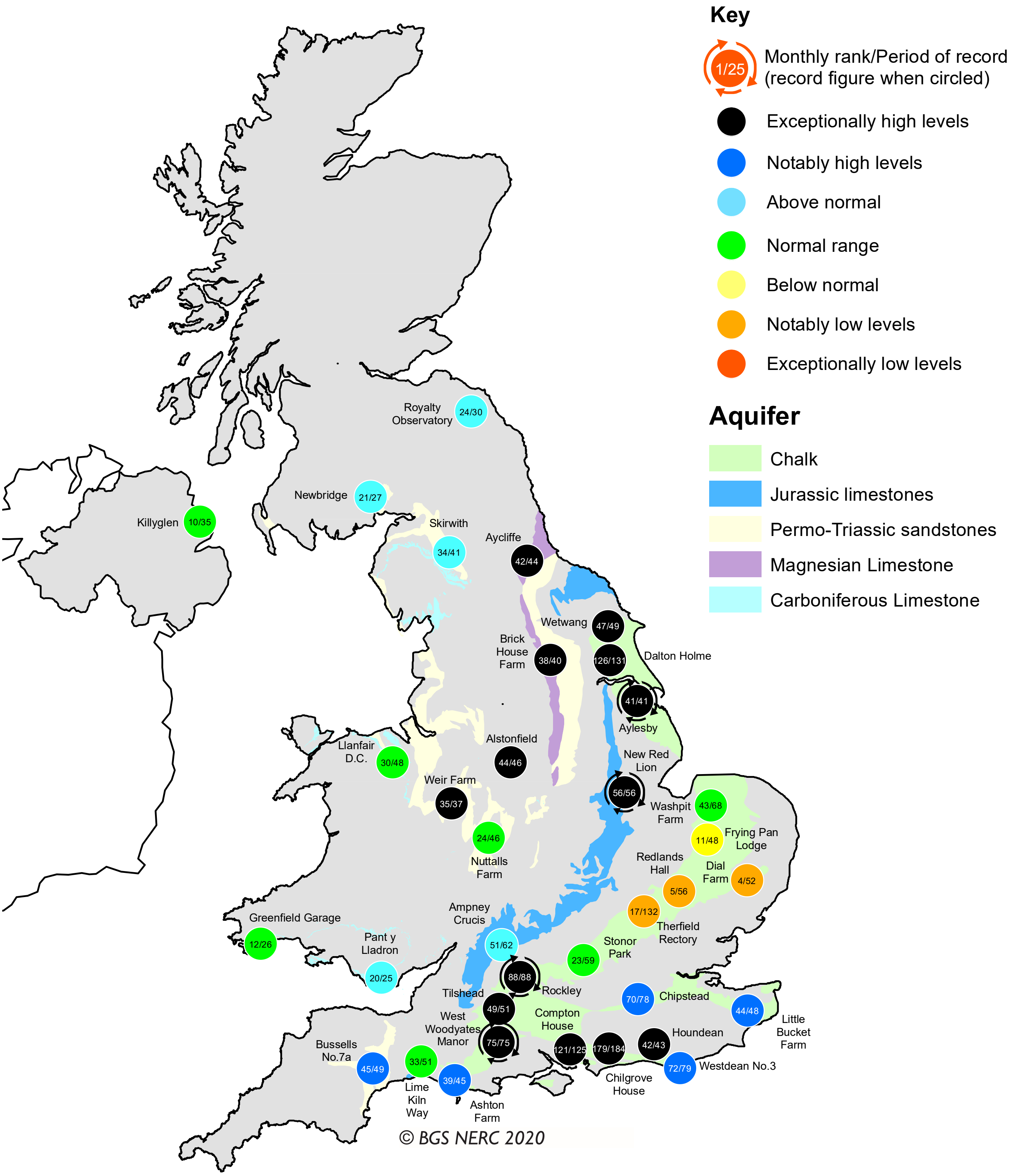

Brick House Farm
Magnesian Limestone
Period of record: 1939-2019


Alstonfield
Carboniferous Limestone
Period of record: 1974-2019


Greenfield Garage
Carboniferous Limestone
Period of record: 1994-2019


Royalty Observ.
Period of record: 1990-2019

# Groundwater ... Groundwater

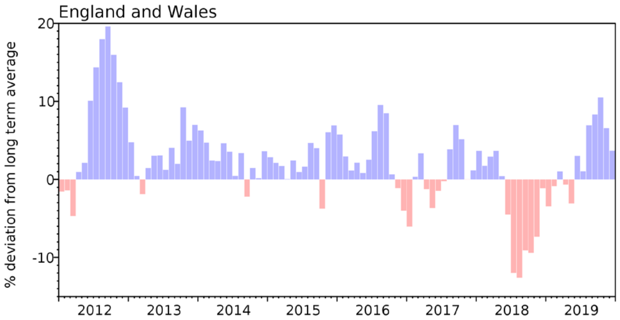



## Groundwater levels - December 2019

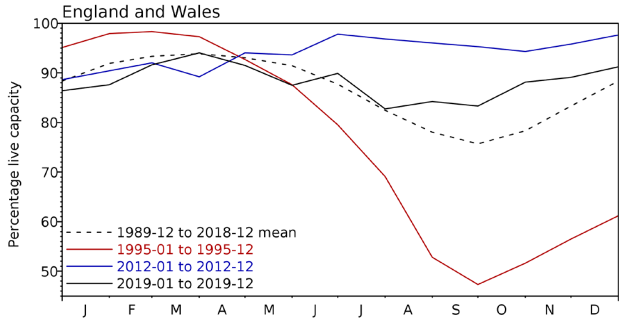
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

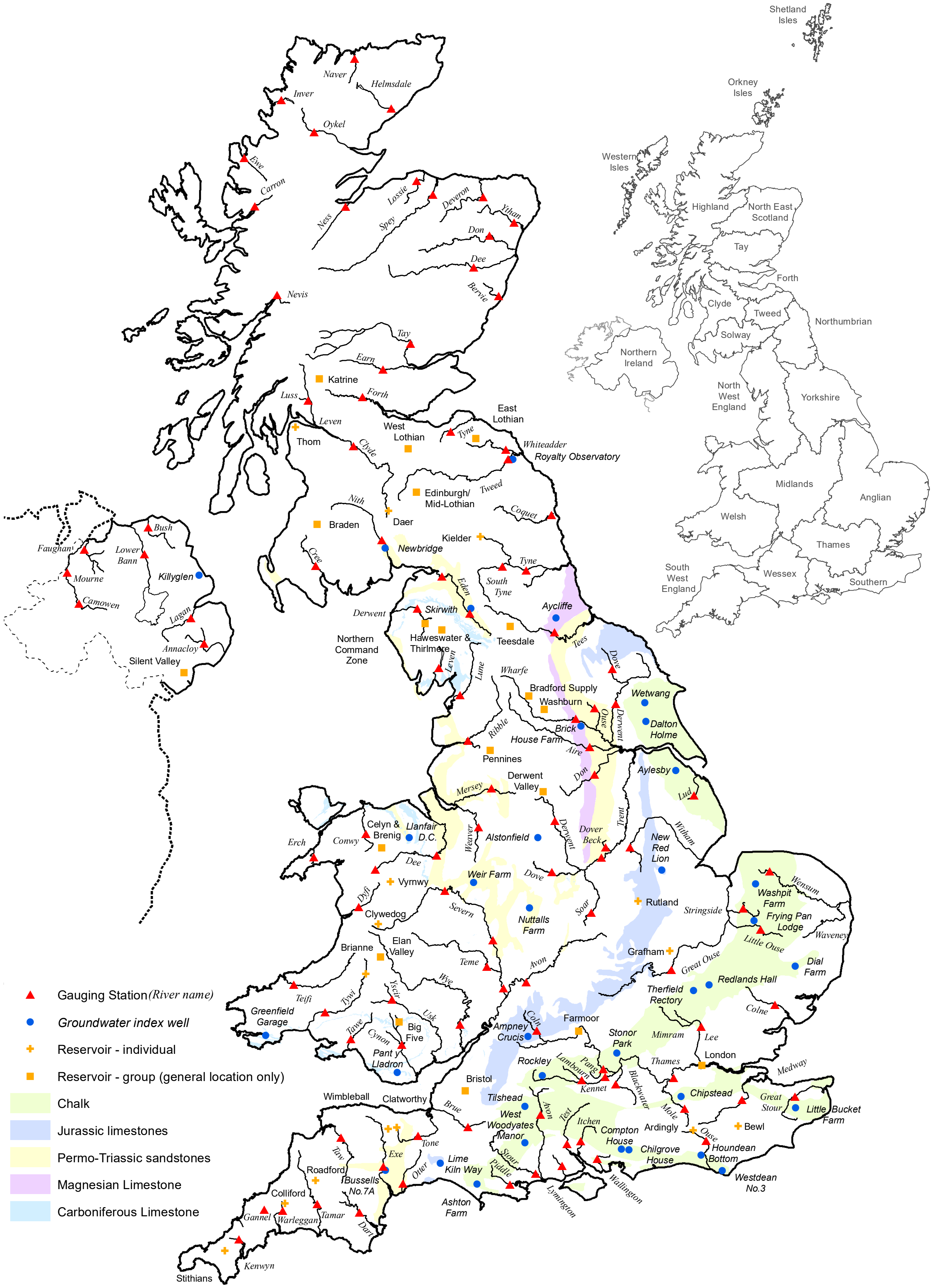
| Area | Reservoir | | Capacity (Ml) | 2019 Oct | 2019 Nov | 2019 Dec | Dec Anom. | Min Dec | Year* of min | 2018 Dec | Diff 19-18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North West | N Command Zone | • | 124929 | 78 | 74 | 85 | -1 | 51 | 1995 | 90 | -5 |
| | Vyrnwy | | 55146 | 100 | 96 | 95 | 4 | 35 | 1995 | 88 | 8 |
| Northumbrian | Teesdale | • | 87936 | 96 | 100 | 99 | 8 | 41 | 1995 | 99 | -1 |
| | Kielder | | (199175) | 82 | 81 | 84 | -7 | 70 | 1989 | 84 | 1 |
| Severn-Trent | Clywedog | | 49936 | 88 | 86 | 88 | 3 | 54 | 1995 | 87 | 0 |
| | Derwent Valley | • | 46692 | 100 | 100 | 99 | 9 | 10 | 1995 | 74 | 25 |
| Yorkshire | Washburn | • | 23373 | 99 | 92 | 91 | 5 | 23 | 1995 | 96 | -5 |
| | Bradford Supply | • | 40942 | 100 | 100 | 100 | 10 | 22 | 1995 | 76 | 24 |
| Anglian | Grafham | | (55490) | 84 | 88 | 88 | 5 | 57 | 1997 | 66 | 22 |
| | Rutland | | (116580) | 96 | 96 | 96 | 14 | 60 | 1990 | 82 | 14 |
| Thames | London | • | 202828 | 89 | 92 | 91 | 4 | 60 | 1990 | 87 | 4 |
| | Farmoor | • | 13822 | 97 | 95 | 99 | 9 | 71 | 1990 | 88 | 11 |
| Southern | Bewl | | 31000 | 77 | 85 | 89 | 17 | 34 | 2005 | 89 | 0 |
| | Ardingly | | 4685 | 67 | 100 | 100 | 16 | 30 | 2011 | 70 | 30 |
| Wessex | Clatworthy | | 5364 | 85 | 100 | 100 | 9 | 54 | 2003 | 100 | 0 |
| | Bristol | • | (38666) | 88 | 99 | 99 | 20 | 40 | 1990 | 82 | 17 |
| South West | Colliford | | 28540 | 59 | 68 | 75 | -3 | 46 | 1995 | 74 | 1 |
| | Roadford | | 34500 | 58 | 66 | 75 | -2 | 20 | 1989 | 67 | 9 |
| | Wimbleball | | 21320 | 88 | 100 | 100 | 18 | 46 | 1995 | 77 | 23 |
| | Stithians | | 4967 | 99 | 100 | 100 | 21 | 33 | 2001 | 90 | 10 |
| Welsh | Celyn & Brenig | • | 131155 | 84 | 84 | 89 | -4 | 54 | 1995 | 87 | 2 |
| | Brianne | | 62140 | 100 | 99 | 100 | 2 | 76 | 1995 | 100 | 0 |
| | Big Five | • | 69762 | 87 | 86 | 88 | -2 | 67 | 1995 | 90 | -2 |
| | Elan Valley | • | 99106 | 97 | 99 | 99 | 2 | 56 | 1995 | 100 | -1 |
| Scotland(E) | Edinburgh/Mid-Lothian | • | 97223 | 88 | 90 | 94 | 3 | 60 | 1998 | 92 | 2 |
| | East Lothian | • | 9317 | 100 | 100 | 100 | 4 | 48 | 1989 | 95 | 5 |
| Scotland(W) | Loch Katrine | • | 110326 | 95 | 95 | 100 | 9 | 75 | 2007 | 96 | 4 |
| | Daer | | 22494 | 100 | 97 | 100 | 3 | 83 | 1995 | 98 | 2 |
| | Loch Thom | | 10798 | 96 | 89 | 91 | -6 | 80 | 2007 | 100 | -9 |
| Northern Ireland | Total+ | • | 56800 | 96 | 99 | 100 | 11 | 61 | 2001 | 95 | 5 |
| | Silent Valley | • | 20634 | 97 | 99 | 100 | 14 | 39 | 2001 | 99 | 1 |

( ) 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 UK Centre for Ecology & Hydrology (UKCEH) and the British Geological Survey (BGS). The NHMP aims to provide an authoritative voice on hydrological conditions throughout the UK, to place them in a historical context and, over time, identify and interpret any emerging hydrological trends. Hydrological analysis and interpretation within the Programme is based on the data holdings of the National River Flow Archive (NRFA; maintained by UKCEH) and National Groundwater Level Archive (NGLA; maintained by BGS), including rainfall, river flows, borehole levels, and reservoir stocks.

The Hydrological Summary is supported by the Natural Environment Research Council award number NE/R016429/1 as part of the UK-SCAPE programme delivering National Capability.

## Data Sources

The NHMP depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged. River flow and groundwater level data are provided by the Environment Agency (EA), Natural Resources Wales - Cyfoeth Naturiol Cymru (NRW), the Scottish Environment Protection Agency (SEPA) and, for Northern Ireland, the Department for Infrastructure - Rivers and the Northern Ireland Environment Agency. In all cases the data are subject to revision following validation (high flow and low flow data in particular may be subject to significant revision).

Details of reservoir stocks are provided by the Water Service Companies, the EA, Scottish Water and Northern Ireland Water.

The Hydrological Summary and other NHMP outputs may also refer to and/or map soil moisture data for the UK. These data are provided by the Meteorological Office Rainfall and Evaporation Calculation System (MORECS). MORECS provides estimates of monthly soil moisture deficit in the form of averages over 40 x 40 km grid squares over Great Britain and Northern Ireland. The monthly time series of data extends back to 1961.

Rainfall data are provided by the Met Office. To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA, NRW and SEPA. The areal rainfall figures have been produced by the Met Office National Climate Information Centre (NCIC), and are based on 5km resolution gridded data from rain gauges. The majority of the full rain gauge network across the UK is operated by the EA, NRW, SEPA and Northern Ireland Water; supplementary rain gauges are operated by the Met Office. The Met Office NCIC monthly rainfall series extend back to 1910 and form the official source of UK areal rainfall statistics which have been adopted by the NHMP. The gridding technique used is described in Perry MC and Hollis DM (2005) available at
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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