# Hydrological Summary

# *for the* United Kingdom

*April 2019*

## General

April was a generally dry and settled month, although bookended by more stormy conditions. Rainfall was notably below average across much of the UK, particularly in eastern England, whilst it was above average in Northern Ireland and Wales with the majority of this rainfall delivered by storm 'Hannah' at month-end. April mean river flows were below normal across much of the UK and notably low in some catchments draining western Scotland, northern England and the English Lowlands. With a predominantly dry month and warm weather over the Easter weekend (temperature records were set in Scotland, Wales and Northern Ireland), Soil Moisture Deficits (SMDs) increased across much of the UK and remained drier than average for the time of year. Groundwater levels were below normal in eastern England, notably so in East Anglia, and generally in the normal range elsewhere. Stocks in most reservoirs declined during April, substantially so in some impoundments in northern England, and were more than 10% below average in Northern Command Zone, Derwent Valley and Bradford Supply. Despite overall reservoir stocks for England & Wales being near average, dry soils and notably low groundwater levels (particularly in eastern England) caused a contracted streamflow network, localised agricultural stress and water restrictions in some areas. River flows in parts of eastern England were comparable to seasonal low flows recorded in previous drought years (e.g. 1976, 1997 and 2011). With the groundwater recharge season over, river flows and groundwater levels are likely to remain persistently low. With the latest seasonal rainfall forecast favouring slightly below average rainfall, increased vigilance will be necessary to avert further restrictions and localised water resource pressure through the summer.

## Rainfall

April began unsettled and cold followed by a fortnight of more stable conditions under high pressure, and closed with more stormy conditions brought by a westerly airflow. On the 3rd, a wintry low pressure system affected northern Britain and Northern Ireland. Difficult driving conditions were reported in the Scottish Highlands (42mm rainfall at Aviemore, Cairngorms) and there were road closures in northern England (13cm snow at Warcop Range, Cumbria). The middle fortnight was dry (with the UK maximum daily rainfall total below 5mm on most days) and warm with several wildfires reported in northern Britain. The unsettled weather returned in the last week, with storm 'Hannah' on the 26th/27th bringing strong winds (which closed bridges and roads and caused power outages for at least 2,000 homes in Wales) and heavy rain (56mm at Capel Curig, north Wales, on the 27th). The UK as a whole received 73% of April average rainfall, with above average rainfall mainly confined to Wales and Northern Ireland. It was notably dry across much of England with a large swathe of the east receiving less than 70% of average and the Yorkshire, Anglian, Thames and Southern regions registering less than 50%. Rainfall deficits are evident in these areas over a range of durations up to 12 months. Over this timeframe (May-April), most of the UK received below average rainfall and less than 70% was recorded across large parts of East Anglia.

## River flows

In responsive catchments, flows increased at the start of the month and peaked on the 3rd/4th - new April peak flow maxima were recorded on the Helmsdale and Naver in records from 1975 and 1977, respectively. Thereafter, the overarching river flow pattern was a steep recession - new April flow minima records were set in the second half of April on the Nith, Luss and Carron (in series of more than 40 years) - with only modest flow responses to storm 'Hannah' on the 27th. In the less responsive catchments, flows generally remained below average throughout April and new daily flow minima were recorded for 12 consecutive days from 19th-30th on the Waveney. The nationwide scale of recessions and low flows is reflected in the outflows from Great Britain which approached seasonal minima in the third week. Monthly mean flows were below normal across most of England and Scotland, whilst flows were generally within the normal range in Northern Ireland, Wales and south-west England. Flows were exceptionally low in some catchments (e.g. Little Ouse, Carron and Nith) and below a third of average on the Nevis, English Leven, Soar and Luss - the latter recorded the lowest average April flows in a series from 1976. For the period since the start of the winter half-year (October-April), deficits are evident in catchments in eastern Britain, with exceptionally low flows on the Helmsdale and Scottish Tyne. A similar pattern is seen in accumulations as far back as the start of summer 2018 and in some catchments daily flows have been below average for almost every day over the same time period (e.g. Bedford Ouse, Colne, Waveney, Lee, Coln, Pang and Itchen).

## Groundwater

SMDs generally increased in April and soils were notably drier than average across the Chalk aquifer of eastern England. Groundwater levels at most Chalk boreholes fell during April, as expected for the time of year. Where increases were recorded they were small, such as at Dalton Holme, Aylesby, Stonor Park and Washpit Farm. Levels in the Chalk of eastern England were below normal and notably low in East Anglia, while the remainder were in the normal range, apart from Westdean No.3 where levels rose to notably high. Levels remained below normal in the Magnesian Limestone, despite a small rise at Aycliffe. In the Jurassic limestones, levels fell and remained below normal at New Red Lion and levels were in the normal range at Ampney Crucis. Levels also fell in the Carboniferous Limestone, with sites ending the month in the normal range. In the Permo-Triassic sandstones levels receded, with Newbridge falling from exceptionally high to above normal in April. Levels in other index boreholes were generally in the normal range, despite having started the recharge season below normal. At Lime Kiln Way in the Upper Greensand, levels remained stable and in the normal range, and in the Fell Sandstone levels rose into the normal range at Royalty Observatory.

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.

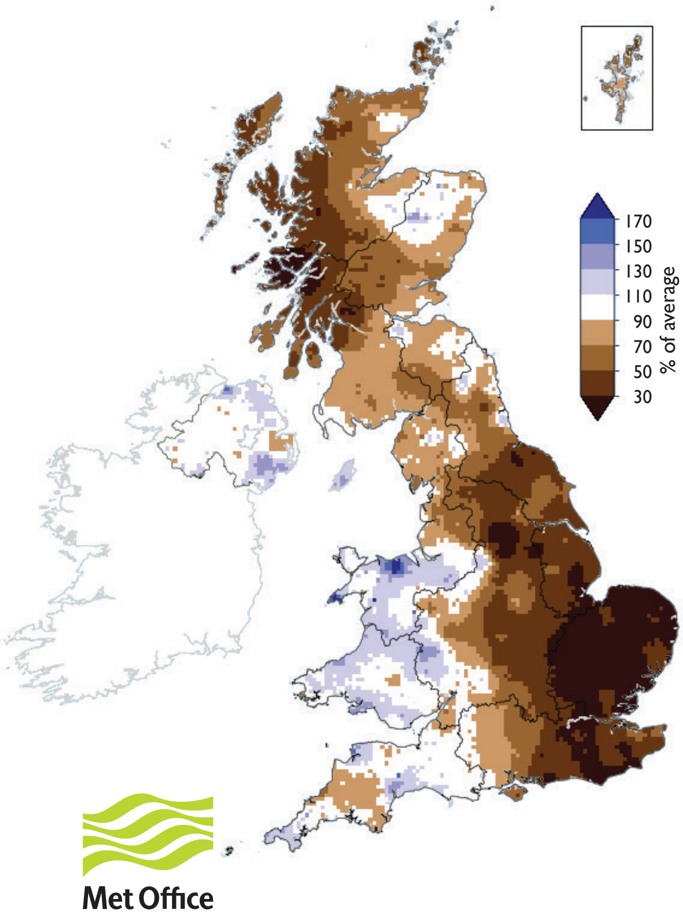
| Region | Rainfall | Apr 2019 | Feb19 – Apr19 | RP | Oct18 – Apr19 | RP | Aug18 – Apr19 | RP | May18 – Apr19 | RP |
|---|---|---|---|---|---|---|---|---|---|---|
| United Kingdom | mm | **51** | 257 | | 667 | | 857 | | 996 | |
| | % | **73** | 103 | 2-5 | 91 | 2-5 | 94 | 2-5 | 88 | 2-5 |
| England | mm | **38** | 176 | | 469 | | 598 | | 695 | |
| | % | **65** | 97 | 2-5 | 89 | 2-5 | 90 | 2-5 | 82 | 8-12 |
| Scotland | mm | **56** | 348 | | 906 | | 1187 | | 1386 | |
| | % | **64** | 99 | 2-5 | 89 | 2-5 | 94 | 2-5 | 91 | 2-5 |
| Wales | mm | **101** | 386 | | 982 | | 1228 | | 1375 | |
| | % | **118** | 126 | 5-10 | 103 | 2-5 | 105 | 2-5 | 97 | 2-5 |
| Northern Ireland | mm | **79** | 313 | | 690 | | 849 | | 1037 | |
| | % | **104** | 123 | 10-15 | 96 | 2-5 | 94 | 2-5 | 91 | 2-5 |
| England & Wales | mm | **47** | 205 | | 540 | | 685 | | 789 | |
| | % | **75** | 103 | 2-5 | 92 | 2-5 | 94 | 2-5 | 85 | 5-10 |
| North West | mm | **60** | 324 | | 752 | | 988 | | 1121 | |
| | % | **84** | 125 | 10-15 | 96 | 2-5 | 100 | 2-5 | 91 | 2-5 |
| Northumbria | mm | **47** | 205 | | 452 | | 610 | | 724 | |
| | % | **77** | 107 | 2-5 | 84 | 2-5 | 90 | 2-5 | 83 | 8-12 |
| Severn-Trent | mm | **43** | 165 | | 408 | | 529 | | 635 | |
| | % | **75** | 99 | 2-5 | 86 | 2-5 | 88 | 2-5 | 81 | 8-12 |
| Yorkshire | mm | **28** | 173 | | 441 | | 560 | | 664 | |
| | % | **46** | 93 | 2-5 | 85 | 2-5 | 85 | 5-10 | 79 | 10-15 |
| Anglian | mm | **13** | 92 | | 286 | | 374 | | 449 | |
| | % | **30** | 72 | 5-10 | 80 | 5-10 | 80 | 5-10 | 72 | 15-25 |
| Thames | mm | **26** | 130 | | 380 | | 477 | | 563 | |
| | % | **49** | 86 | 2-5 | 86 | 2-5 | 86 | 2-5 | 78 | 8-12 |
| Southern | mm | **24** | 149 | | 468 | | 585 | | 678 | |
| | % | **45** | 89 | 2-5 | 89 | 2-5 | 91 | 2-5 | 85 | 5-10 |
| Wessex | mm | **57** | 195 | | 546 | | 662 | | 745 | |
| | % | **96** | 102 | 2-5 | 95 | 2-5 | 93 | 2-5 | 84 | 5-10 |
| South West | mm | **76** | 271 | | 816 | | 977 | | 1074 | |
| | % | **98** | 100 | 2-5 | 98 | 2-5 | 97 | 2-5 | 87 | 2-5 |
| Welsh | mm | **98** | 369 | | 940 | | 1176 | | 1319 | |
| | % | **118** | 125 | 5-10 | 103 | 2-5 | 105 | 2-5 | 96 | 2-5 |
| Highland | mm | **56** | 410 | | 1079 | | 1441 | | 1651 | |
| | % | **55** | 94 | 2-5 | 86 | 2-5 | 94 | 2-5 | 91 | 2-5 |
| North East | mm | **66** | 210 | | 579 | | 726 | | 864 | |
| | % | **101** | 96 | 2-5 | 90 | 2-5 | 90 | 2-5 | 85 | 8-12 |
| Tay | mm | **52** | 290 | | 766 | | 983 | | 1166 | |
| | % | **69** | 95 | 2-5 | 86 | 2-5 | 89 | 2-5 | 87 | 2-5 |
| Forth | mm | **49** | 258 | | 619 | | 812 | | 978 | |
| | % | **73** | 96 | 2-5 | 80 | 2-5 | 83 | 2-5 | 81 | 5-10 |
| Tweed | mm | **55** | 267 | | 573 | | 765 | | 922 | |
| | % | **87** | 121 | 5-10 | 89 | 2-5 | 94 | 2-5 | 90 | 2-5 |
| Solway | mm | **70** | 415 | | 1009 | | 1283 | | 1484 | |
| | % | **79** | 126 | 15-25 | 103 | 5-10 | 105 | 5-10 | 100 | 2-5 |
| Clyde | mm | **51** | 407 | | 1082 | | 1417 | | 1683 | |
| | % | **51** | 98 | 2-5 | 89 | 2-5 | 93 | 2-5 | 92 | 2-5 |

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

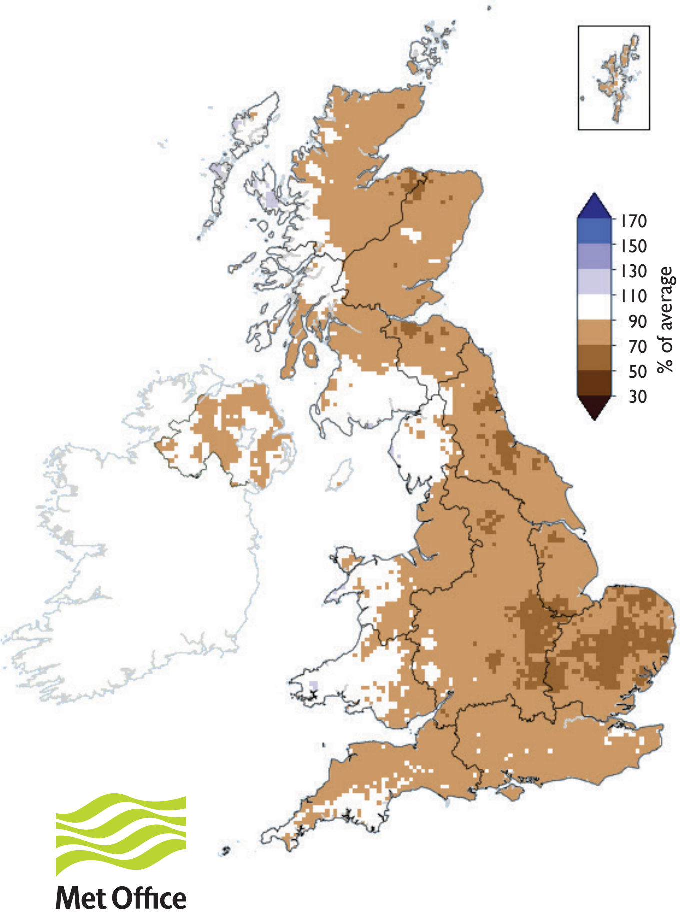
**Important note:** Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1910; they also assume a stable climate. The quoted RPs relate to the specific timespans only; for the same timespans, but beginning in any month the RPs would be substantially shorter. The timespans featured do not purport to represent the critical periods for any particular water resource management zone. For hydrological or water resources assessments of drought severity, river flows and/or groundwater levels normally provide a better guide than return periods based on regional rainfall totals. Note that precipitation totals in winter months may be underestimated due to snowfall undercatch. All monthly rainfall totals since January 2018 are provisional.

# Rainfall . . . Rainfall . . .

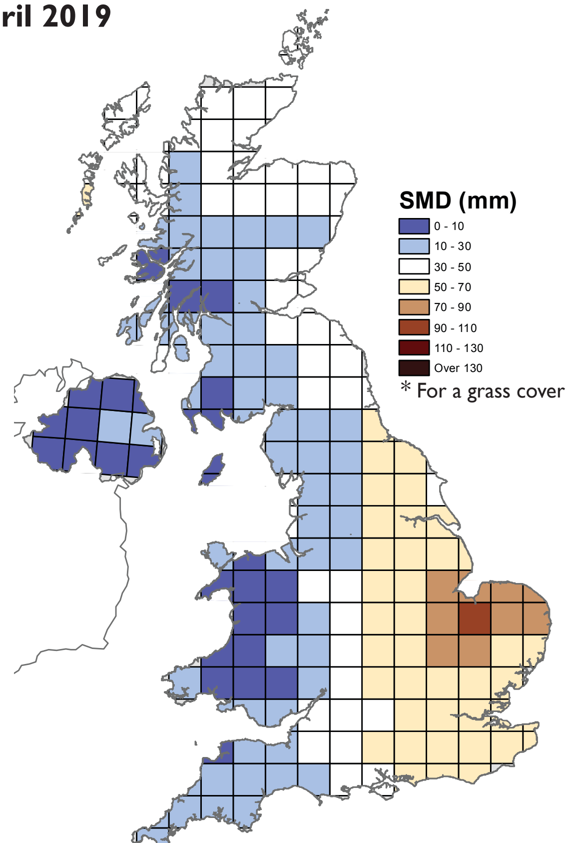
**April 2019 rainfall as % of 1981-2010 average**




**May 2018 - April 2019 rainfall as % of 1981-2010 average**




**MORECS Soil Moisture Deficits* April 2019**






## 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.

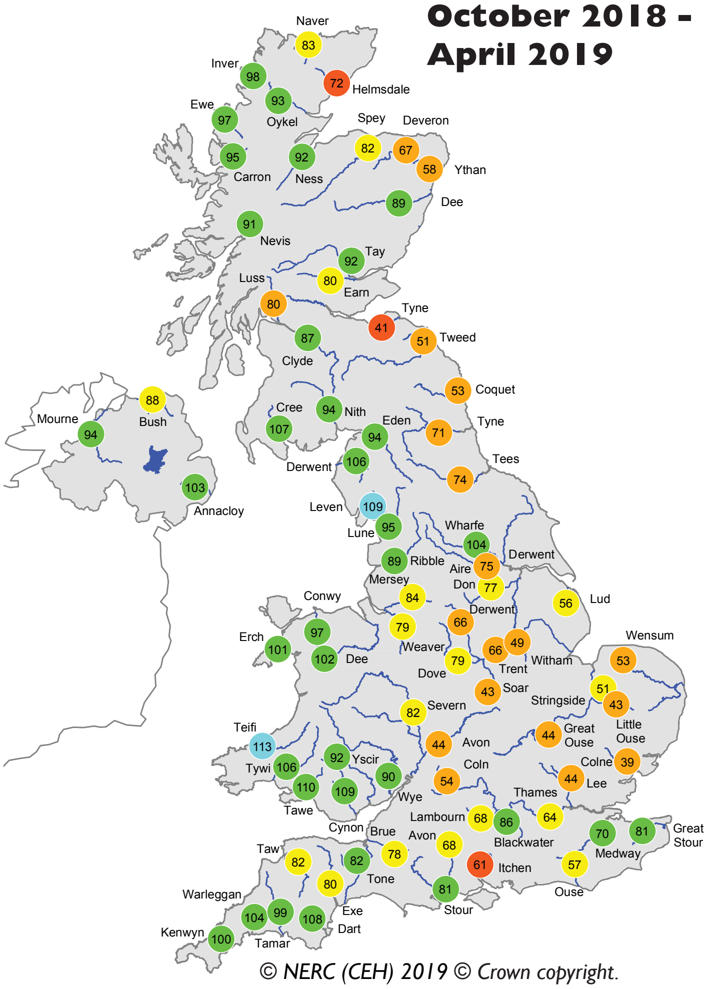
The complete version of the Hydrological Outlook UK can be found at: www.hydoutuk.net/latest-outlook/

**Period:** **from May 2019**
**Issued:** **09.05.2019**
**using data to the end of April 2019**

The overall outlook for river flows is for normal to below normal flows in May, with below normal flows becoming widespread in the three month period to the end of July. Groundwater levels are likely to be normal to below normal during May, falling to below normal over the period to the end of July. There are two exceptions: firstly, in the eastern parts of the Chalk below normal levels in May are likely to become notably low in the period to July, and secondly, groundwater levels in southern coastal areas are likely to be normal in May and through to the end of July.

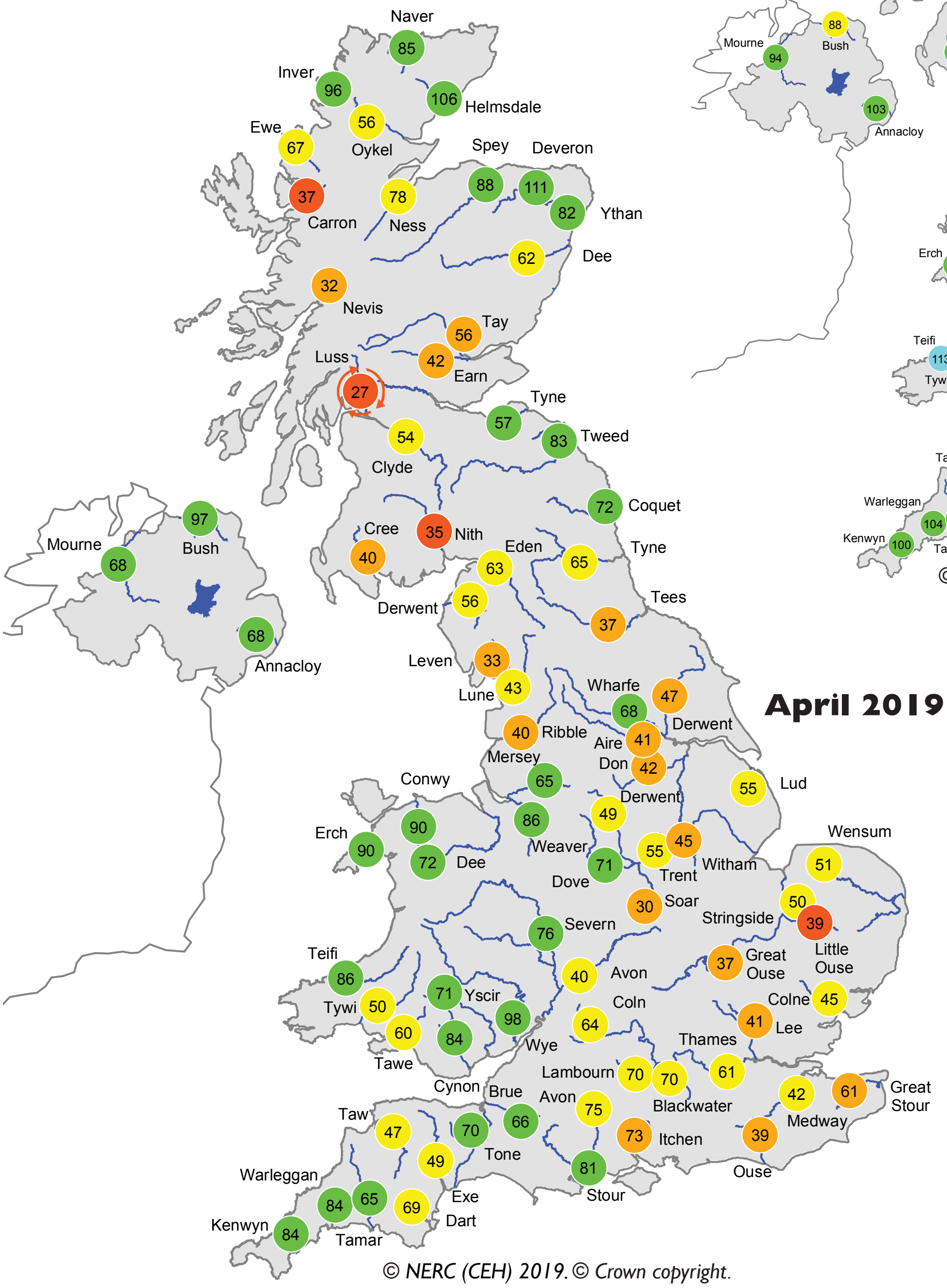
# River flow . . . River flow . . .

## October 2018 - April 2019






## April 2019






### Key

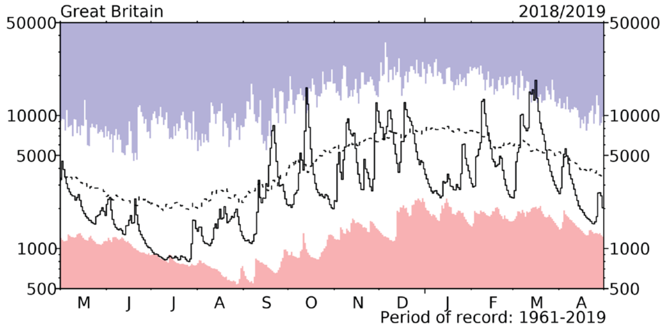
- 25 — % of long-term average (record figure when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

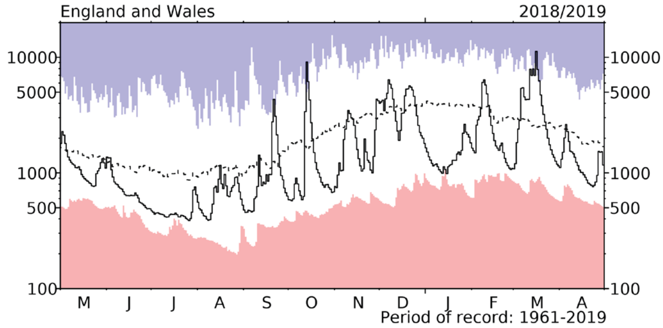
*Based on ranking of the monthly flow**

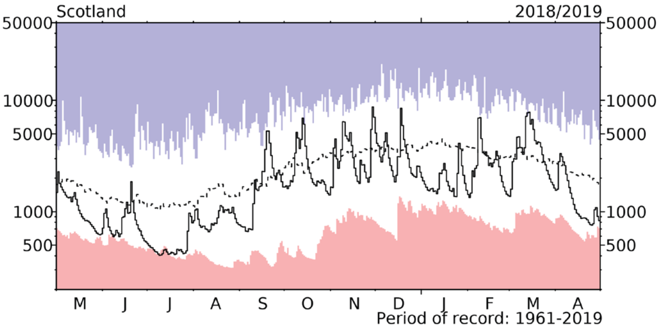
## River flows

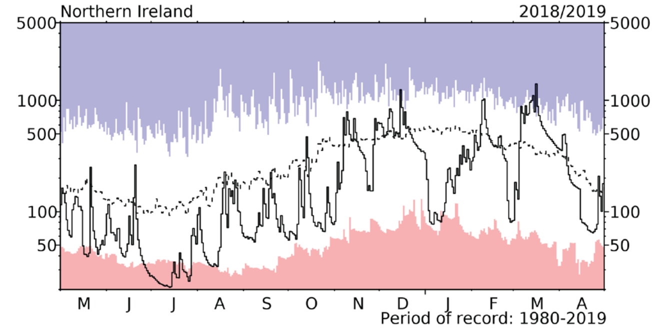
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

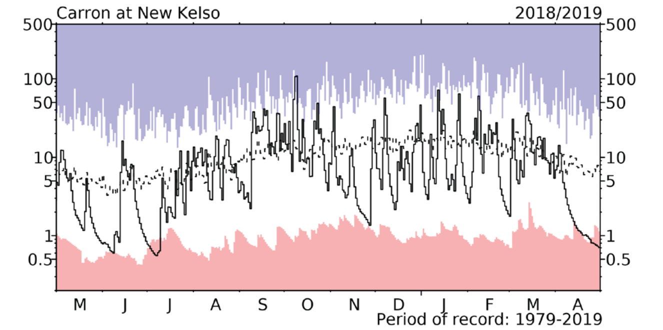
# *River flow . . . River flow . . .*

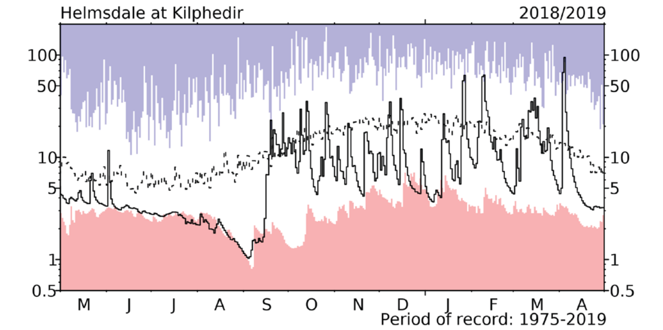


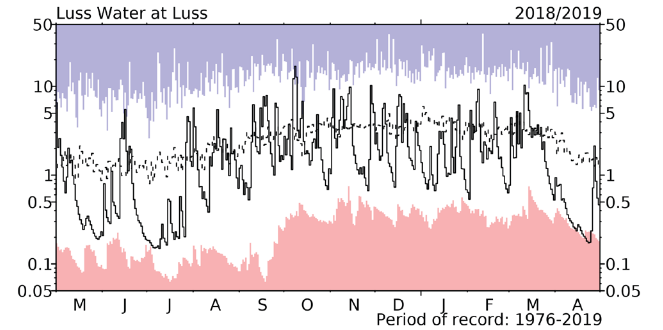



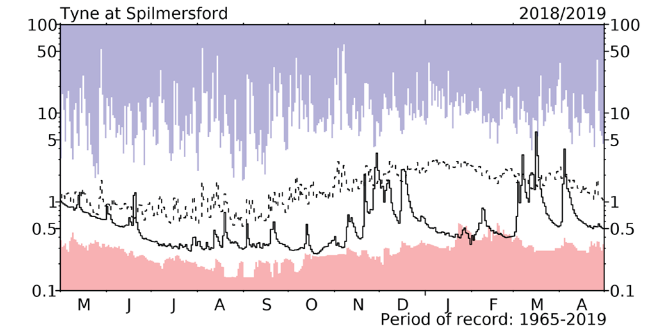



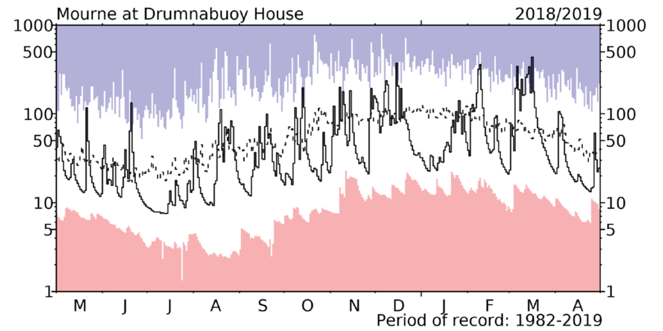



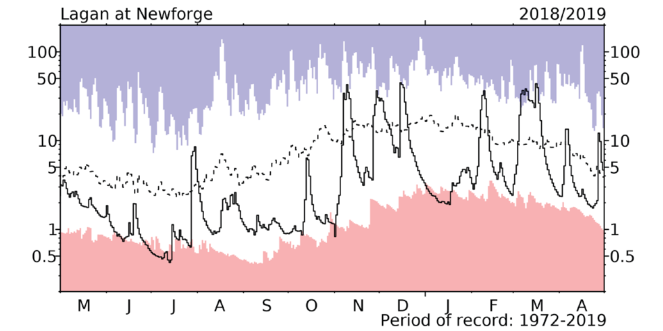



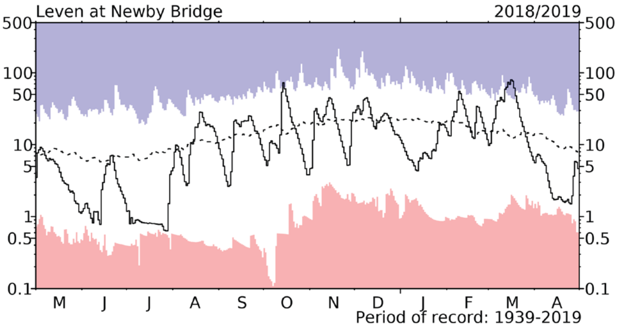



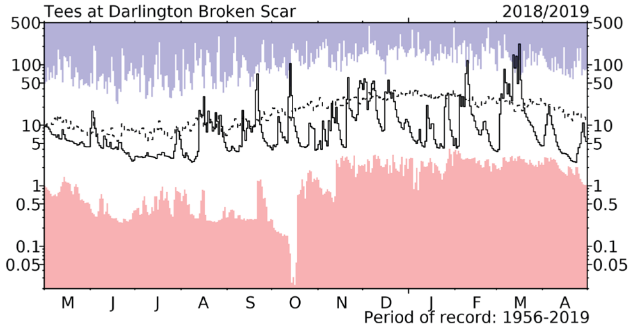



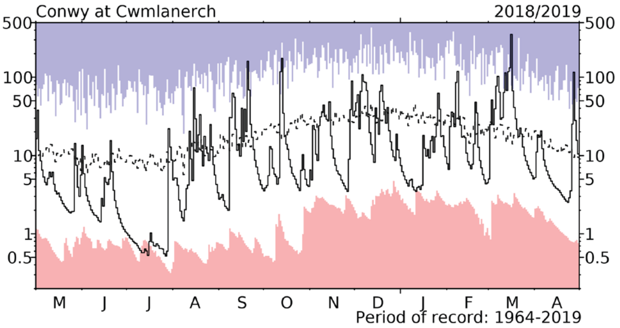

## River flow hydrographs

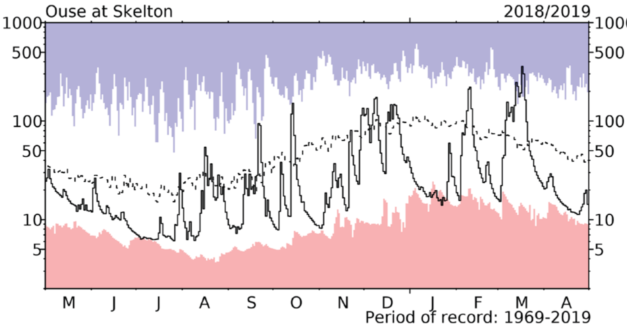
*The river flow hydrographs show the daily mean flows (measured in $m^3s^{-1}$) together with the maximum and minimum daily flows prior to May 2018 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. The dashed line represents the period-of-record average daily flow.

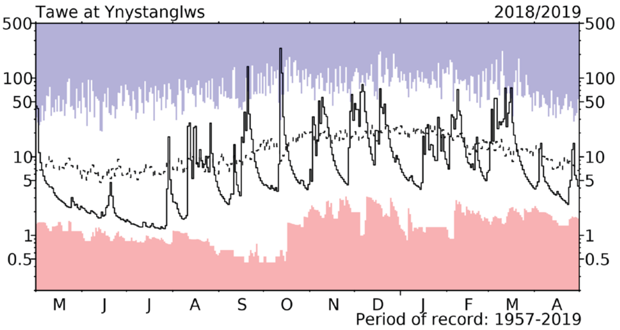
# River flow . . . River flow . . .

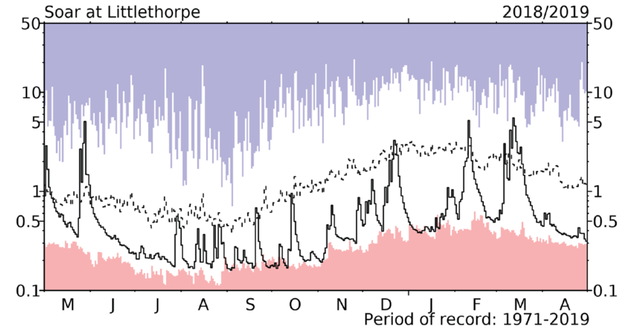


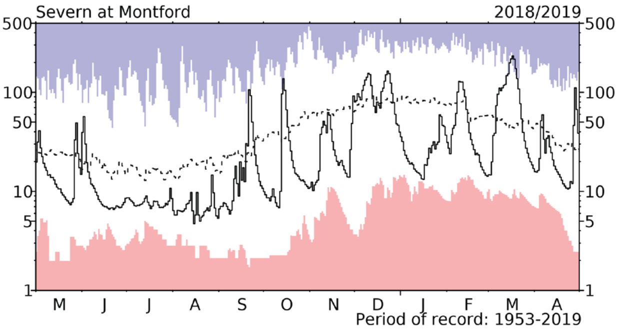



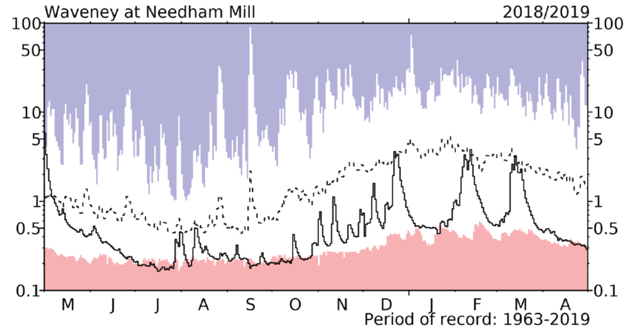



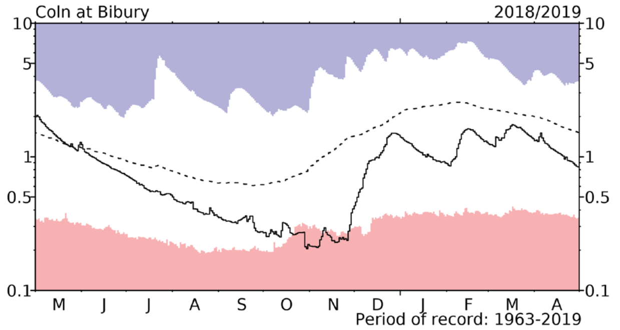



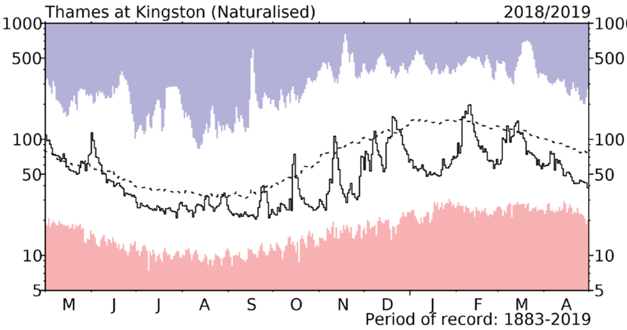



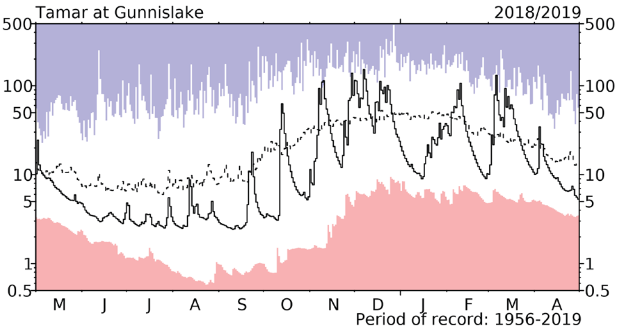



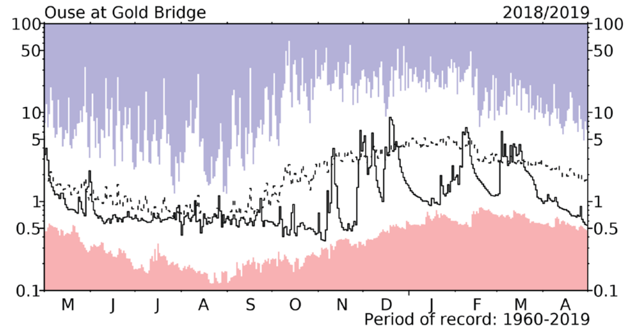



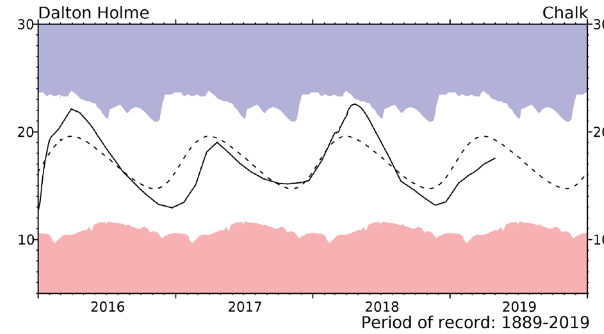



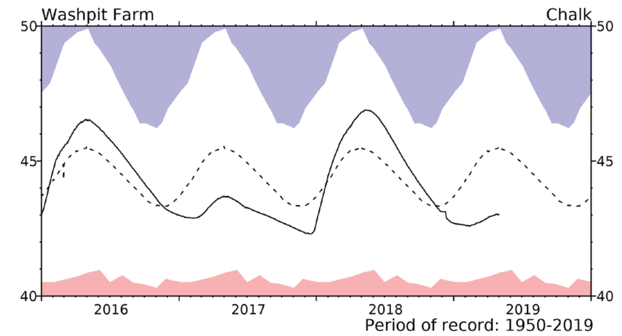



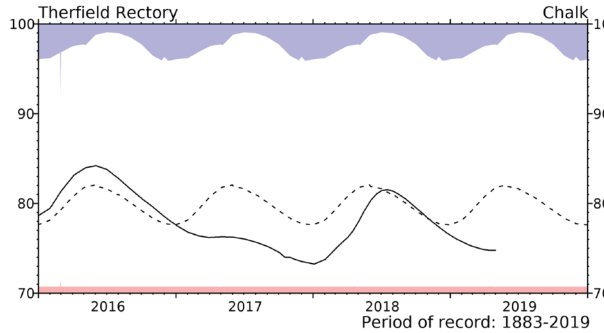



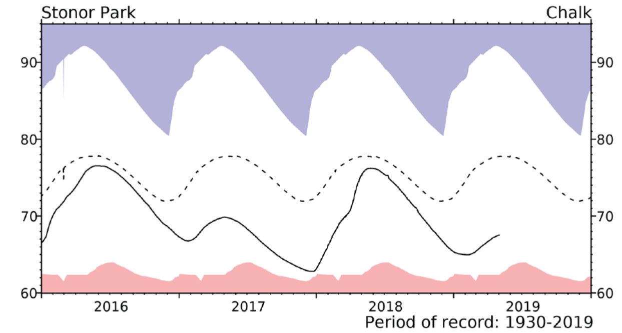



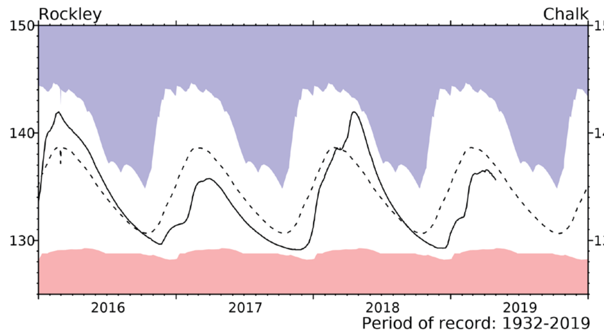
# Groundwater . . . Groundwater

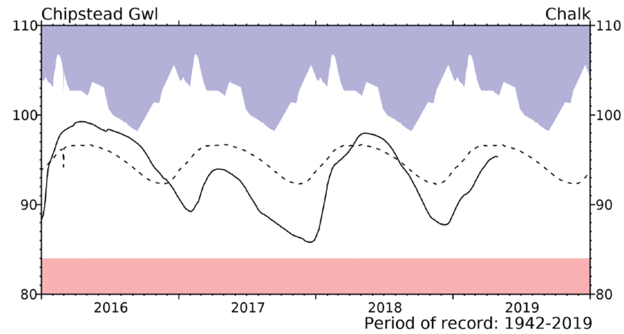


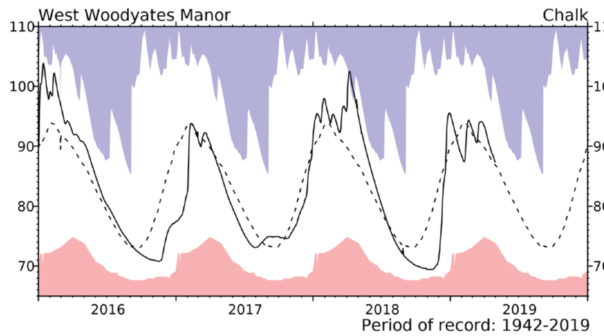



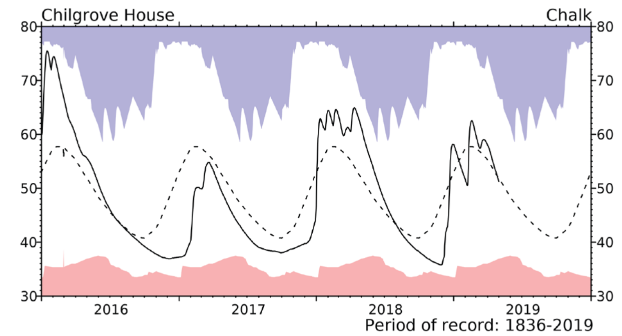



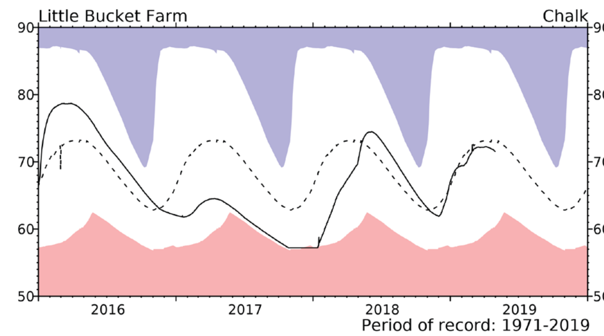



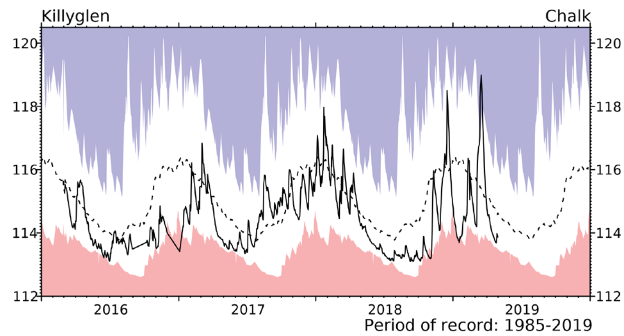



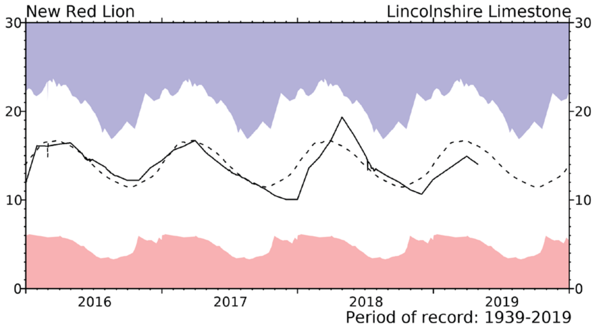



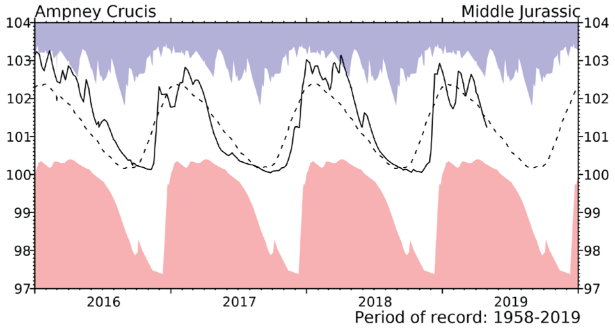



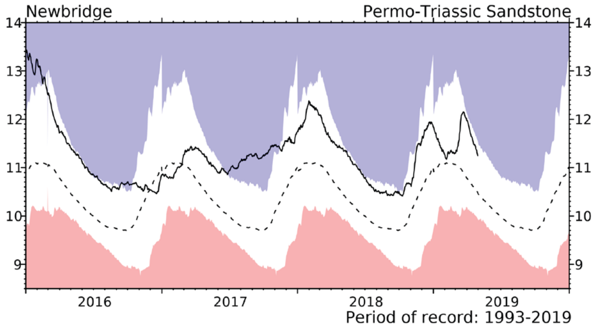



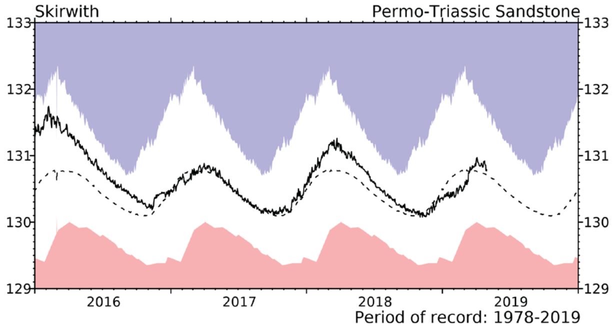

Groundwater levels (measured in metres above ordnance datum) normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is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

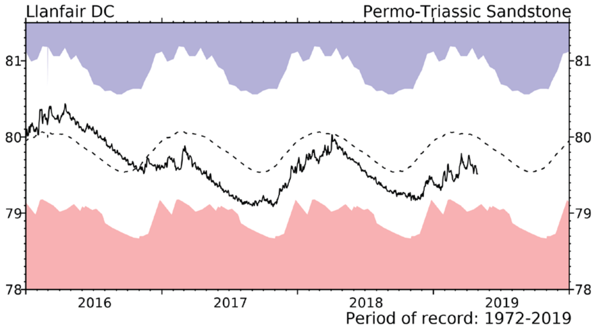
# Groundwater ... Groundwater

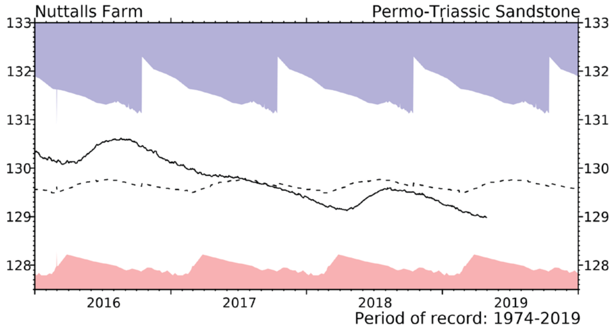


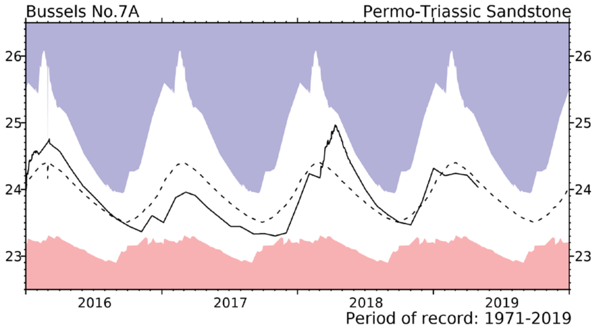



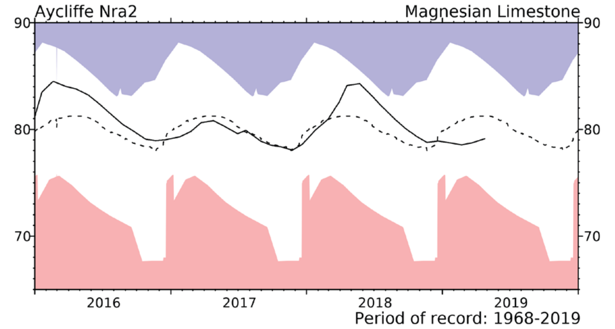



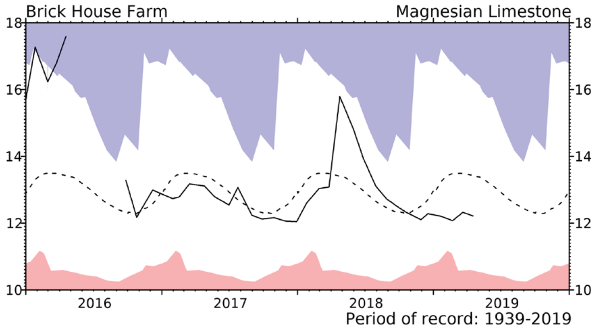



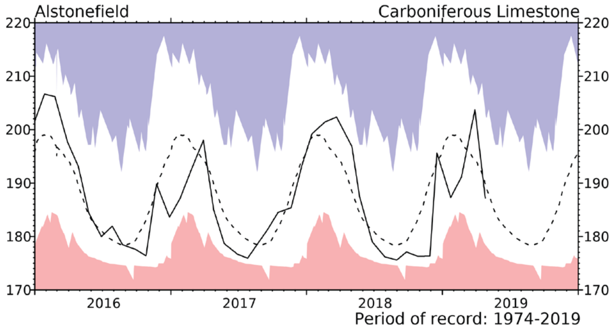



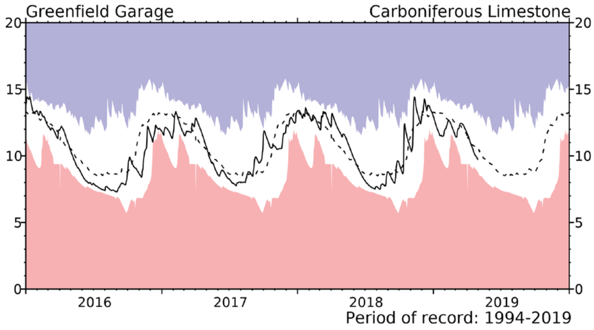



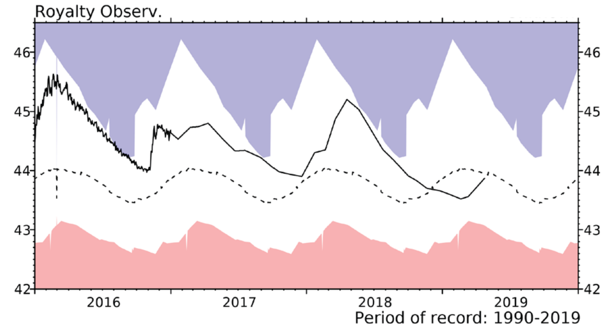



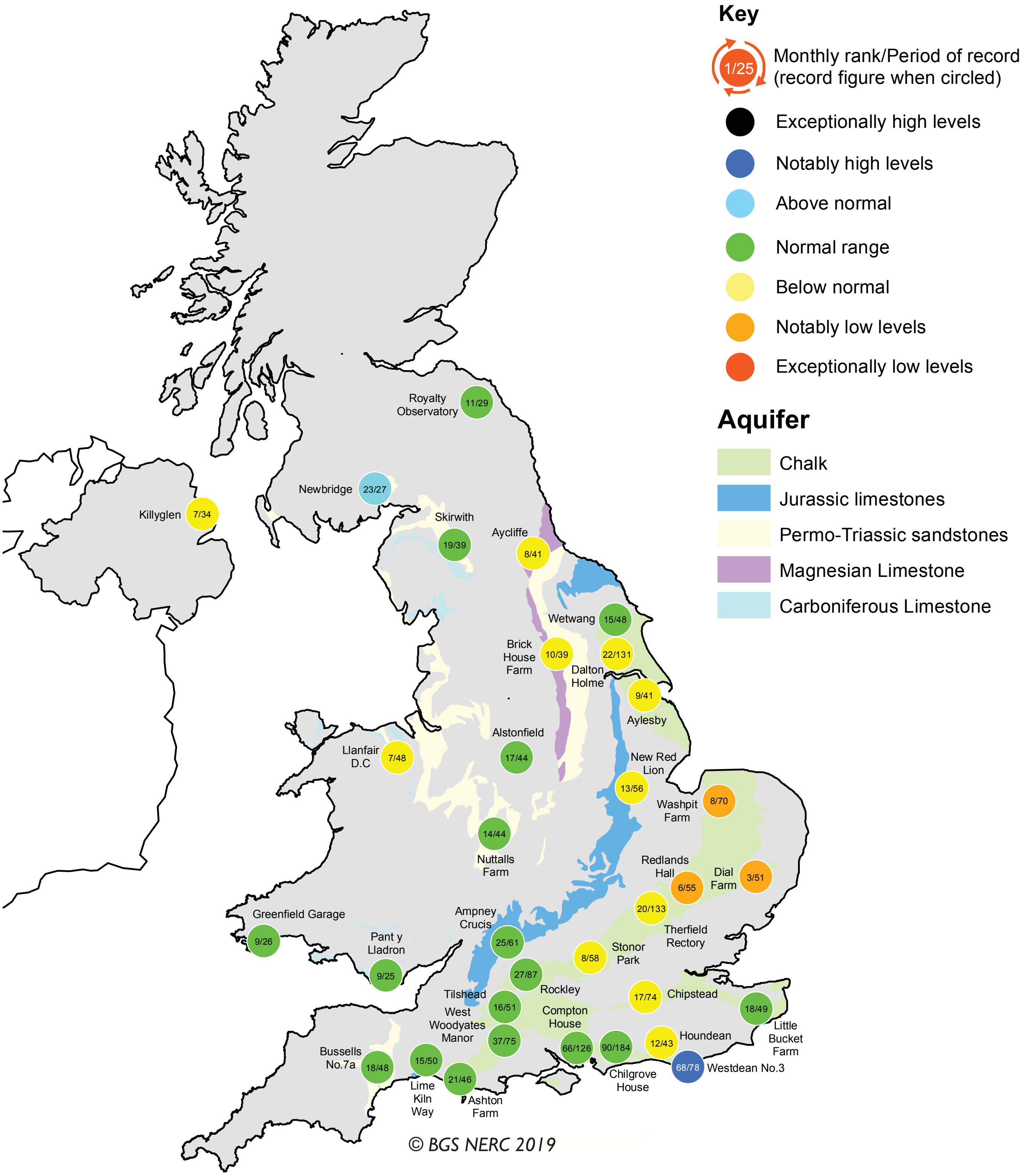



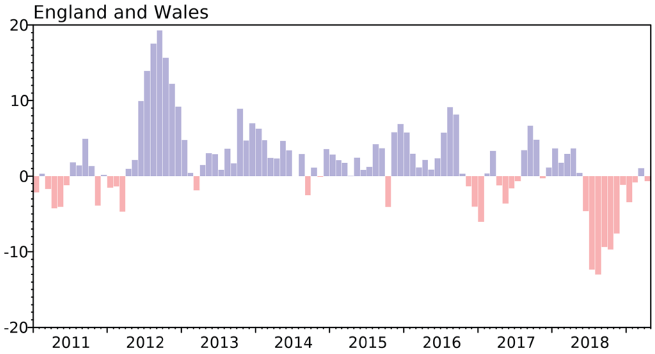



## Groundwater levels - April 2019

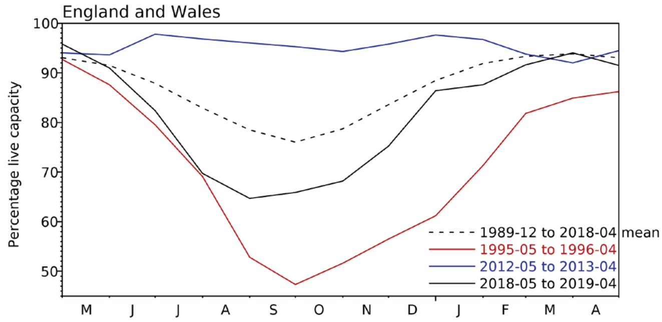
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

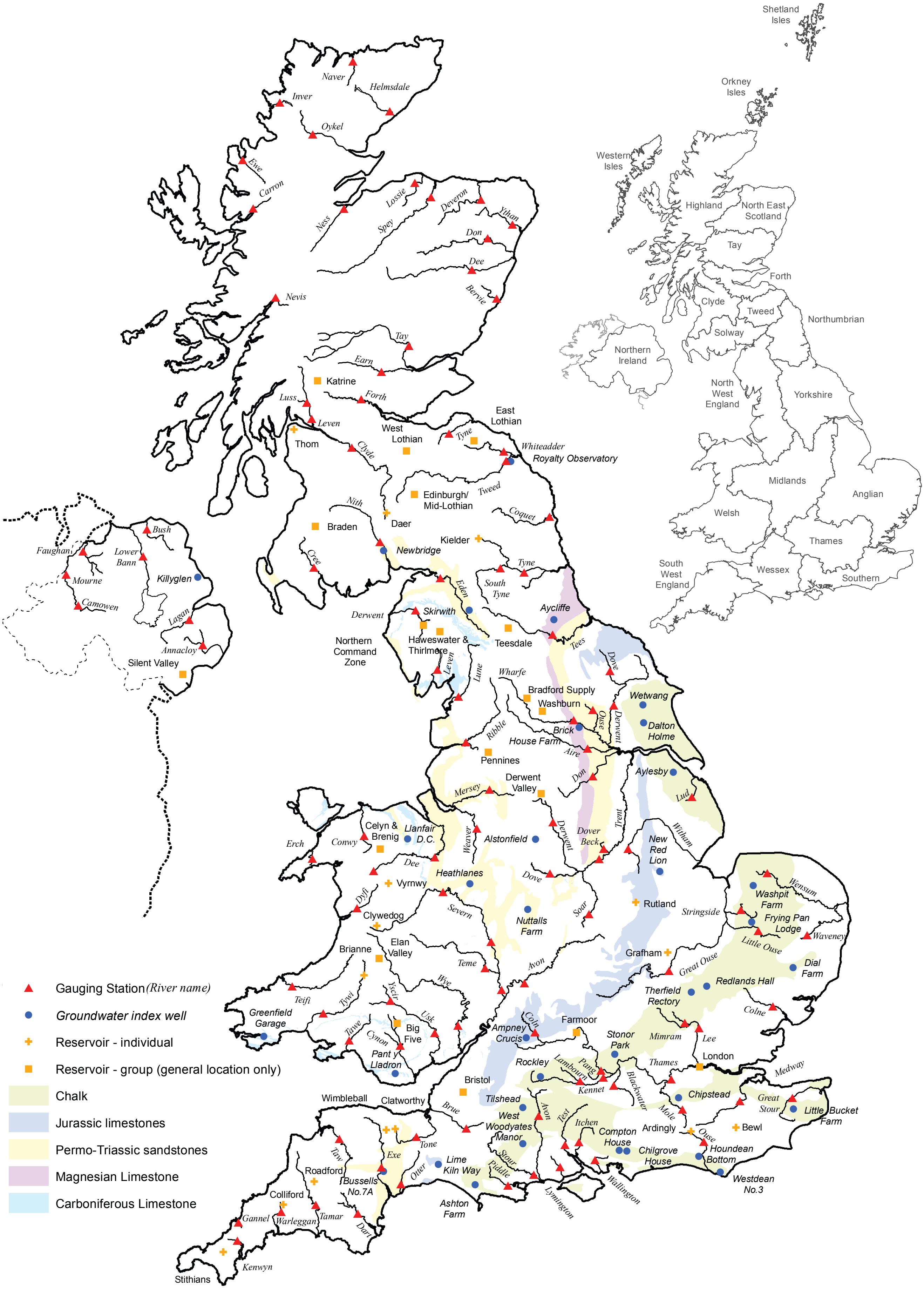
| Area | Reservoir | | Capacity (Ml) | 2019 Feb | 2019 Mar | 2019 Apr | Apr Anom. | Min Apr | Year* of min | 2018 Apr | Diff 19-18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North West | N Command Zone | • | 124929 | 93 | 95 | 80 | -7 | 65 | 1984 | 86 | -6 |
| | Vyrnwy | | 55146 | 98 | 99 | 100 | 7 | 70 | 1996 | 100 | 0 |
| Northumbrian | Teesdale | • | 87936 | 98 | 97 | 93 | 2 | 74 | 2003 | 92 | 1 |
| | Kielder | | (199175) | 89 | 94 | 91 | 0 | 85 | 1990 | 93 | -2 |
| Severn-Trent | Clywedog | | 49936 | 95 | 99 | 100 | 3 | 85 | 1988 | 100 | 0 |
| | Derwent Valley | • | 46692 | 83 | 97 | 86 | -7 | 54 | 1996 | 98 | -13 |
| Yorkshire | Washburn | • | 23373 | 95 | 95 | 86 | -3 | 76 | 1996 | 95 | -9 |
| | Bradford Supply | • | 40942 | 78 | 88 | 77 | -14 | 60 | 1996 | 96 | -19 |
| Anglian | Grafham | | (55490) | 78 | 86 | 91 | -3 | 73 | 1997 | 94 | -3 |
| | Rutland | | (116580) | 90 | 89 | 95 | 3 | 72 | 1997 | 97 | -1 |
| Thames | London | • | 202828 | 92 | 91 | 90 | -4 | 86 | 1990 | 98 | -7 |
| | Farmoor | • | 13822 | 93 | 98 | 98 | 1 | 81 | 2000 | 92 | 6 |
| Southern | Bewl | | 31000 | 98 | 100 | 97 | 7 | 60 | 2012 | 99 | -2 |
| | Ardingly | | 4685 | 95 | 99 | 100 | 1 | 69 | 2012 | 100 | -1 |
| Wessex | Clatworthy | | 5364 | 99 | 100 | 91 | -2 | 81 | 1990 | 100 | -9 |
| | Bristol | • | (38666) | 89 | 97 | 95 | 2 | 83 | 2011 | 97 | -2 |
| South West | Colliford | | 28540 | 83 | 88 | 88 | 0 | 56 | 1997 | 99 | -11 |
| | Roadford | | 34500 | 71 | 77 | 76 | -9 | 41 | 1996 | 96 | -20 |
| | Wimbleball | | 21320 | 97 | 100 | 98 | 3 | 79 | 1992 | 100 | -2 |
| | Stithians | | 4967 | 99 | 99 | 97 | 6 | 65 | 1992 | 100 | -3 |
| Welsh | Celyn & Brenig | • | 131155 | 94 | 95 | 95 | -3 | 75 | 1996 | 100 | -4 |
| | Brianne | | 62140 | 96 | 97 | 96 | -1 | 86 | 1997 | 97 | -1 |
| | Big Five | • | 69762 | 97 | 97 | 95 | 2 | 85 | 2011 | 95 | 0 |
| | Elan Valley | • | 99106 | 98 | 98 | 95 | -1 | 83 | 2011 | 99 | -4 |
| Scotland(E) | Edinburgh/Mid-Lothian | • | 96518 | 93 | 99 | 95 | 2 | 62 | 1998 | 98 | -3 |
| | East Lothian | • | 9374 | 98 | 99 | 100 | 1 | 89 | 1992 | 100 | 0 |
| Scotland(W) | Loch Katrine | • | 110326 | 100 | 100 | 91 | 0 | 80 | 2010 | 96 | -5 |
| | Daer | | 22494 | 100 | 98 | 89 | -5 | 78 | 2013 | 92 | -3 |
| | Loch Thom | | 10798 | 99 | 99 | 93 | -2 | 83 | 2010 | 100 | -7 |
| Northern Ireland | Total+ | • | 56800 | 95 | 95 | 93 | 5 | 77 | 2007 | 95 | -2 |
| | Silent Valley | • | 20634 | 98 | 99 | 93 | 8 | 58 | 2000 | 95 | -3 |

( ) 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.

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



05/2019

UK-SCAPE
UK Status, Change and Projections of the Environment

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