October was a cool and very wet month for most, with a succession of frontal systems delivering persistent heavy rainfall across England and Wales. Although October rainfall for the UK was only marginally above average, there were substantial regional variations; the majority of England and Wales was characterised by notably wet weather, exceptionally so in parts of eastern England. This concluded an exceptionally wet summer and autumn so far (June-October) in northern, central and eastern England; for the Severn-Trent region, it was the wettest June-October on record (in a series from 1910). River flows were substantially above average across most of England and Wales, with exceptionally high flows recorded throughout central areas and in parts of the north-east (many of which were also new October monthly mean flow maxima). Late October soil moisture deficits (SMDs) were near-zero across the UK (away from East Anglia). Correspondingly, groundwater levels in the majority of boreholes increased during October and were above normal or higher, with the exception of the Chalk of eastern England. The wet weather enabled reservoir replenishment (particularly those in the English Lowlands) and overall stocks for England & Wales were comfortably above average, and after five months of wet weather water resources are very healthy. Whilst there were some notably low groundwater levels in the Chalk of the Chilterns and East Anglia, the groundwater recharge season has started earlier than normal. Further wet weather and extreme rainfall totals in early November have caused significant flooding in parts of northern and central England, and the seasonal outlook for continued wet weather (particularly in the north and west) implies a high risk of further flooding this winter.

Rainfall
Adopting an anomalously southern track, the jet stream propelled a series of cyclonic systems across the UK throughout much of October, with the associated wet weather across England and Wales only briefly relenting towards month-end. On the 1st, surface water flooding from intense rainfall (41mm in Carlisle) closed roads and railway lines in parts of northern and central England. On the 6th, heavy rainfall in East Anglia (47mm at Tiberham Airfield, Norfolk) caused flash flooding of properties. The most disruptive wet weather occurred across the 25th-26th, with 48-hour rainfall totals of 80-120mm in the Severn catchment (and 101mm on the 25th at Libanus, Powys). Extensive surface water flooding in mid-Wales and the Midlands closed road and rail networks, necessitated evacuations of homes and inundated agricultural land. For October overall, rainfall totals were more than 130% of average in a band from the south-west to the north-east of England. Parts of Yorkshire, Lincolnshire, Norfolk and the East Midlands registered in excess of 170% of average. It was the wettest October for Yorkshire since 2000, and the fourth wettest in a series from 1910. In contrast, most of Scotland and Northern Ireland received less than 90% of average rainfall. Since the start of summer (June-October), almost all of the UK received above average rainfall. A swath of northern, central and eastern England registered 150% of average, with localised parts of the East Midlands receiving more than 170% of average. For England & Wales, in the last 50 years only the exceptional 2022 was wetter over the June-October timeframe.

River flows
Successive frontal rainfall maintained high flows throughout October in catchments across England and Wales, some of which were high at the start of October, the result of heavy late September rainfall. High flows were particularly numerous and notable in Wales and northern and central England; new October daily flow maxima were established on the Yorkshire Don, Trent, Witham, Weaver, Teme and Usk. On the 27th, high flows culminated in more than 300 Flood Warnings and Flood Alerts across Wales and northern, central and south-west England. In some southern catchments (e.g. the Coln, Dorset Stour and Brue), the persistent rainfall continued to drive dramatic increases from the low flow conditions recorded in early September. In contrast, river flows in Scotland and Northern Ireland were generally in recession through October. October mean flows were generally above normal or higher across England and Wales and within the normal range in Scotland and Northern Ireland. Outflows from England & Wales were the second highest for October in a series from 1961. River flows were exceptionally high in a band from south Wales through the Midlands into Yorkshire, with many at least 300% of average (and exceeding five times the average on the Witham). Many new maximum October mean flows were established, exceeding previous maxima by at least 25% in records for the Severn and Trent (in series from 1921 and 1958, respectively). Over the June-October period, mean flows were above normal or higher (except for south-east England, where flows were generally below average). Flows were notably high throughout Wales and northern and central England, exceptionally so in the Midlands and some catchments draining the southern Pennines (many of which recorded around twice their average flow). New maximum June-October mean flows were established on the Mersey, Trent and Weaver, the latter approaching three times the average.

Groundwater
Groundwater levels in the Chalk fell in the North Downs, Chilterns and most of East Anglia (coinciding with areas still with SMDs), although they started to rise by the end of October at Chipstead. Levels at Dial Farm remained exceptionally low and became such at Stonor Park. Elsewhere, recharge commenced; levels were in the normal range or above in Yorkshire, above normal throughout Wessex and the South Downs, and exceptionally high at Wetwang, Ashton Farm and Westdean No.3. Levels in the Jurassic limestones rose and were exceptionally high, registering a new October record at New Red Lion. In the Magnesian Limestone, levels also rose and were normal or above normal. In the Permo-Triassic sandstones, levels rose and generally ended October above normal to notably high, but remained in the normal range at Bussells No.7a. However, at Nuttalls Farm levels fell and remained below normal. Levels continued to recede in the Upper Greensand at Lime Kiln Way, but were within the normal range. In the Carboniferous Limestone, levels rose and were above normal, notably high at Pant y Ladron and registering a new October record at Alstonfield. Levels in the Fell Sandstone rose but remained in the normal range.
## Rainfall accumulations and return period estimates

Percentages are from the 1981-2010 average.

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**% = 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...

October 2019 rainfall as % of 1981-2010 average

June 2019 - October 2019 rainfall as % of 1981-2010 average

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/](http://www.hydoutuk.net/latest-outlook/)

**Period:** from November 2019

**Issued:** 11.11.2019

using data to the end of October 2019

For river flows, the outlooks for November and over the next three months are for normal to above normal flows across the majority of the UK, with above normal flows most likely in central and parts of north-east England. In November, groundwater levels are likely to be below normal across the Chalk aquifer of the Chilterns and East Anglia. Elsewhere, and over the next three months, the outlook for groundwater levels is less clear owing to the impact of recent wet weather on the onset of recharge.
Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the averaging period on which these percentages are based is 1981-2010. Percentages may be omitted where flows are under review.
River flow hydrographs

*The river flow hydrographs show the daily mean flows (measured in m$^3$/s) together with the maximum and minimum daily flows prior to November 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.
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 levels - October 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

% deviation from long term average

England and Wales


North West

N Command Zone 124929 80 80 78 10 33 2003 67 11

Vyrnwy 55146 98 100 100 24 25 1995 74 27

Northumbrian

Teesdale 87936 91 98 96 20 33 1995 74 23

Kielder (199175) 90 85 82 -4 63 1989 80 2

Severn-Trent

Clywedog 49936 95 100 88 11 38 1995 79 9

Derwent Valley 46692 86 95 100 31 15 1995 37 63

Yorkshire

Washburn 23373 89 95 99 30 15 1995 44 55

Bradford Supply 40942 83 91 100 28 16 1995 46 54

Anglian

Grafton (55490) 81 76 84 1 44 1997 70 14

Rutland (116580) 95 93 96 17 59 1995 79 17

Thames

London 202828 76 65 89 12 46 1996 57 32

Farnoor 13822 96 98 97 8 43 2003 88 9

Southern

Bewl 31000 72 65 77 17 33 1990 64 13

Ardingly 4685 63 54 67 1 15 2003 40 27

Wessex

Clatworthy 5364 70 59 85 24 14 2003 33 52

Bristol (38666) 75 71 88 26 24 1990 53 35

South West

Colliford 28540 55 51 59 -11 38 2006 54 6

Roadford 34500 50 48 58 -13 18 1995 46 12

Wimbleball 21320 78 71 88 23 26 1990 40 49

Stithians 4967 72 70 99 42 18 1990 35 64

Welsh

Celyn & Brenig 131155 89 89 84 0 48 1989 71 14

Brianne 62140 97 100 100 7 57 1995 100 0

Big Five 69762 82 85 87 11 38 2003 73 14

Elan Valley 99106 83 91 97 13 37 1995 73 24

Scotland(E)

Edinburgh/Mid-Lothian 97223 84 87 88 7 48 2003 81 7

East Lothian 9317 100 100 100 16 38 2003 67 33

Scotland(W)

Loch Katrine 110326 91 95 95 8 40 2003 89 6

Daer 22494 99 97 100 10 42 2003 86 14

Loch Thom 10798 100 100 96 6 66 2007 100 -4

Northern

Total* 56800 92 92 96 15 39 1995 66 30

Ireland

Silent Valley 20634 94 90 97 21 34 1995 58 39

( ) figures in parentheses relate to gross storage  * denotes reservoir groups  last occurrence

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.

NERC (CEH) 2019.
Minor aquifers have been omitted

Location map... Location map

- Reservoir - group (general location only)
- Groundwater index well
- Reservoir - individual
- Reservoir - group (general location only)

Chalk
Jurassic limestones
Permian-Triassic sandstones
Magnesian Limestone
Carboniferous Limestone

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.

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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