Monthly water situation report

England

Summary – December 2019

England received above average rainfall during December. Catchments across southern England received above normal or notably high rainfall, while in northern England, rainfall was mostly classed as normal for the time of year. At the end of December, soils were wetter than average for the time of year across the country. Monthly mean flows for December were classed as above normal or higher at over three-quarters of the rivers we report on. Monthly mean flows for December were the highest on record at 3 sites. Groundwater levels at all reported sites are now showing signs of recovery from the cumulative impact of successive years of lower than average groundwater recharge. The end of month groundwater levels for December were the highest on record at 4 sites. The total reservoir stocks across England increased during December and were at 91% of capacity at the end of the month.

Rainfall

The December rainfall total for England was 103 mm which is 122% of the 1961-90 long term average (LTA) (118% of the 1981-2010 LTA), and above normal for the time of year. December was the 7th consecutive month of above average rainfall across England. The highest rainfall totals were recorded across southern, western and north-west England. (Figure 1.1)

There was a roughly north-south split to the rainfall in December. Rainfall across eastern, southern and south-western catchments received notably high or above normal rainfall. Rainfall across northern England was mostly classed as normal, with a few catchments in the north-east receiving below normal or notably low rainfall. The highest rainfall total as a percentage of LTA was recorded in the South Essex catchment (189% of LTA). The lowest December rainfall totals as a percentage of LTA were recorded in a group of 6 catchments within the counties of Cumbria, Northumberland, North Yorkshire, County Durham and Tyne and Wear (50%-76% of LTA); rainfall in these catchments were classed as notably low or below normal.

Over the past 3 and 6 months cumulative rainfall totals have been exceptionally high for much of south-west, central and north-east England. It was the wettest 3 months on record in 2 catchments in Lincolnshire (Louth Grimsby and Ancholme, and Witham to Chapel Hill), and the wettest year on record in 2 catchments (River Dove in Staffordshire / Derbyshire and South Forty Foot in Lincolnshire); records used since 1891. Catchments in eastern and southern England have received normal or notably high cumulative rainfall totals over the past 12 months. The December total for Seaham Area (County Durham) was notably low at 50% of LTA. (Figure 1.2)

At a regional scale, December rainfall totals were normal in central, north-east and north-west England, and above normal in eastern, south-eastern and south-western England. (Figure 1.3)

Soil moisture deficit

Soils got wetter across southern and eastern England during December. The rest of England already had soil moisture deficits close to zero. By the end of the month, soil moisture deficits were less than 10 mm across England, apart from 2 small areas in East Anglia and around London. Soils across nearly all of England are now wetter than average, with the exception of north-west and south-west England where the deficit is close to average for the time of year. (Figure 2.1)

At the regional scale, soils at the end of December were wetter than average in all regions. All regions now have soil moisture deficits which are less than 10 mm. (Figure 2.2)

River flows

Monthly mean river flows increased at over three-quarters of indicator sites, relative to November (a wet month itself). The sites where flows decreased were mostly in central and north-east England where they receded from November's exceptionally high flows. (Figure 3.1)

December monthly mean flows were generally normal in north-west and north-east England, while flows in the south ranged from above normal to exceptionally high. Flows were above normal, notably high or exceptionally high at over three-quarters of indicator sites. The Lud at Louth Weir in Lincolnshire (records from 1968), the Eastern Rother at Udiam in East Sussex (records from 1962) and the Middle Stour at Hammoon in Dorset (records since 1968) have recorded their highest December monthly mean flows on record. (Figure 3.1)

Flows on the River Cam (Cambridgeshire), which had been classed as either notably low or exceptionally low since September 2018, are now normal for the time of year. (Figure 3.2)

Groundwater levels

Groundwater levels increased at all but 3 indicator sites during December. By the end of December, groundwater levels at all but 2 indicator sites were classed as normal or higher for the time of year; this contrasts with just over three-quarters of sites at the end of November. (Figures 4.1 and 4.2)

All groundwater level indicator sites have started to show signs of recovery from the cumulative impact of successive years of lower than average groundwater recharge. The very wet autumn saw groundwater levels start to rise slightly earlier than in typical years. Groundwater levels at some indicator sites in the chalk aquifers have risen significantly during December. Indicator sites at the Northern Chalk aquifer at Grainsby (records since 1977), Whitam aquifer at Hanthorpe (records since 1972), West Cheshire Sandstone aquifer at Priors Heyes (records since 1972) and the Upper Dorset Stour aquifer at Woodyates (records since 1942) recorded their highest December month end groundwater levels on record. In the Cam and Ely Ouse chalk aquifer at Redlands Hall, the groundwater level has continued to rise during December although at the end of the month it is still classed as notably low for the time of year. (Figures 4.1 and 4.2)

Reservoir storage

Reservoir stocks increased at over half of reported reservoirs and reservoir groups during December. The end of month reservoir stocks were classed as normal or higher at all but 2 of the reported reservoirs and reservoir groups. Kielder in northern England ended the month classed as notably low for the time of year at 84% of total storage capacity and the Dee system was below normal at 88% of total storage capacity. The biggest increases in reservoir stocks, as a proportion of total capacity, were seen in Hanningfield reservoir in eastern England, with an increase of 12%, and Haweswater and Thirlmere with an increase of 15%. (Figure 5.1)

At the end of December about a third of reported reservoirs and reservoir groups had stocks classed as notably high or exceptionally high for the time of year.

The total reservoir stocks across England were at 91% of capacity at the end of December. This is a slight increase from the end of November. At a regional scale, total reservoir stocks were at or above the long term average in all regions; at the end of December they ranged from 86% of total capacity in east England to 96% of total capacity in central England (Figure 5.2).

Forward look

During the first part of January, unsettled weather is forecast across most parts of England, with some drier interludes also possible. Towards the middle of the month, the weather is likely to be unsettled in north-west England with showers and heavy rain, but more settled in south-east England, with these drier conditions becoming more widespread. The latter part of January is likely to be wettest in north-west England, with snow possible on northern hills, but much drier and brighter in southern areas, with some prolonged dry spells possible.

For the 3 month period January to March, above average precipitation is more likely than below average[1].

Projections for river flows at key sites[2]

Three quarters of modelled sites have a greater than expected chance of cumulative river flows being above normal or higher for the time of year by the end of March 2020. By the end of September 2020, three-quarters of modelled sites have a greater than expected chance of river flows being normal or higher for the time of year.

For scenario based projections of cumulative river flows at key sites by March 2020 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by September 2020 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by March 2020 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by September 2020 see Figure 6.4

1 Source: Met Office
2 Information produced by the Water Situation Forward Look group led by Environment Agency in partnership with the Centre for Ecology and Hydrology, British Geological Survey, Met Office (www.hydoutuk.net).

Projections for groundwater levels in key aquifers[2]
Two-thirds of modelled sites have a greater than expected chance of groundwater levels being above normal or higher for the time of year by the end of March 2020. By the end of September 2020, more than three-quarters of modelled sites have a greater than expected chance of groundwater levels being normal or higher for the time of year.

For scenario based projections of groundwater levels in key aquifers in March 2020 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2020 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2020 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2020 see Figure 6.8

Authors: National Water Resources Hydrology Team

Rainfall

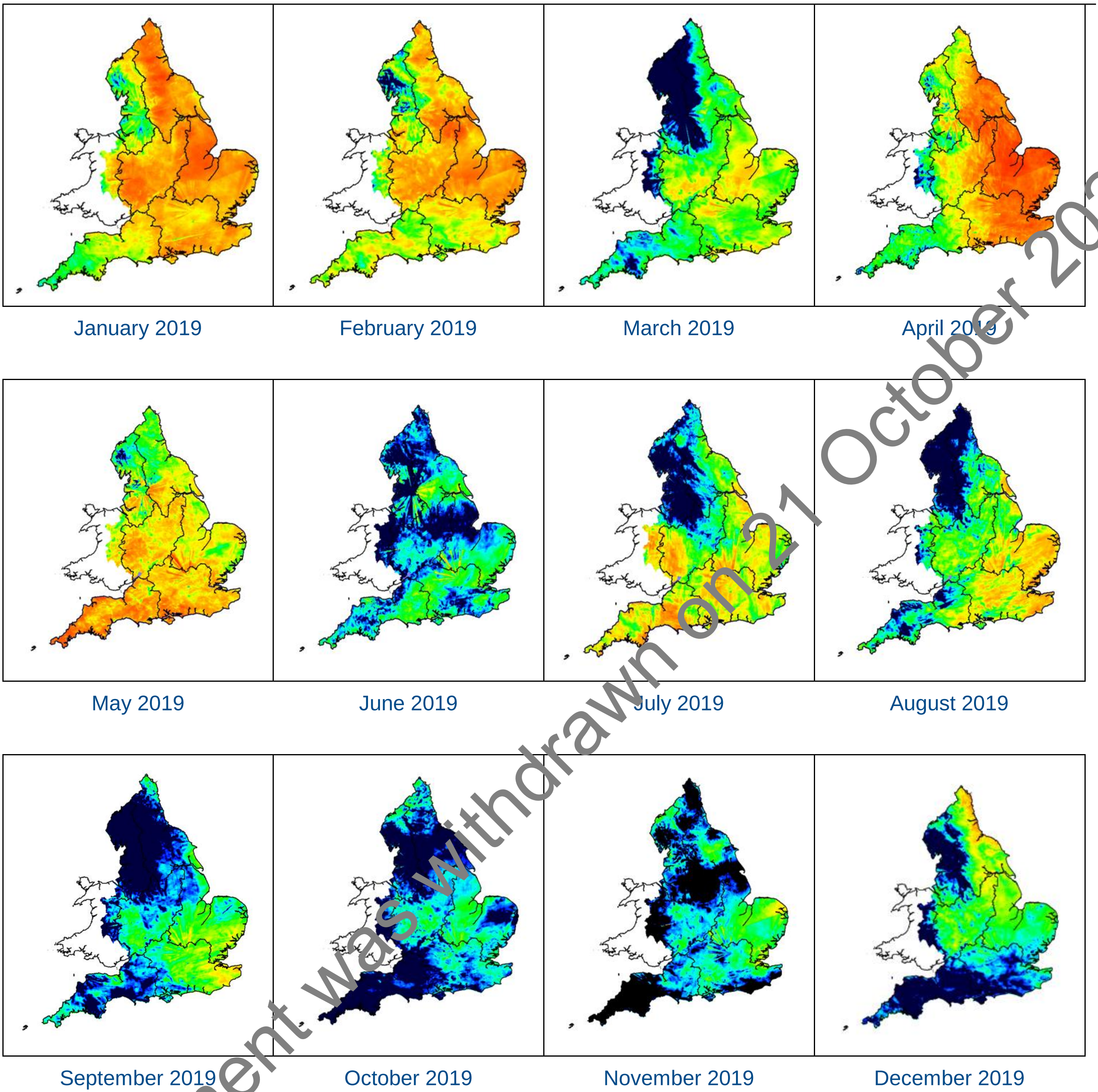
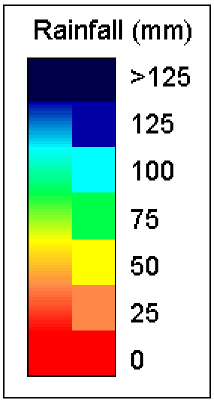


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2020). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2020.



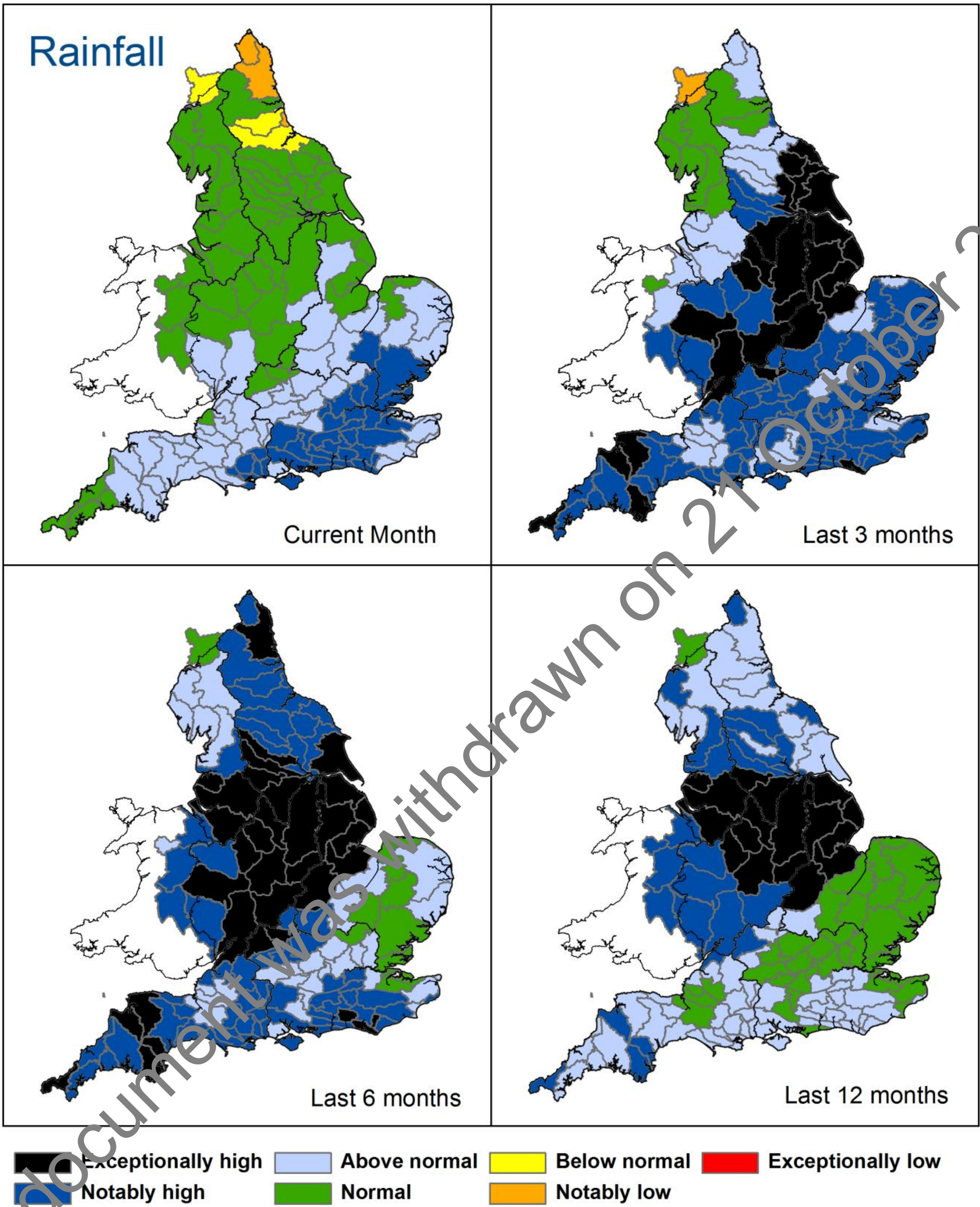


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 December), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. HadUK data based on the Met Office 1km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2020).* Provisional data based on Environment Agency 1km gridded rainfall dataset derived from Environment Agency intensity rain gauges. Crown copyright. All rights reserved. Environment Agency, 100026380, 2020.

Rainfall charts

Above average rainfall | Below average rainfall

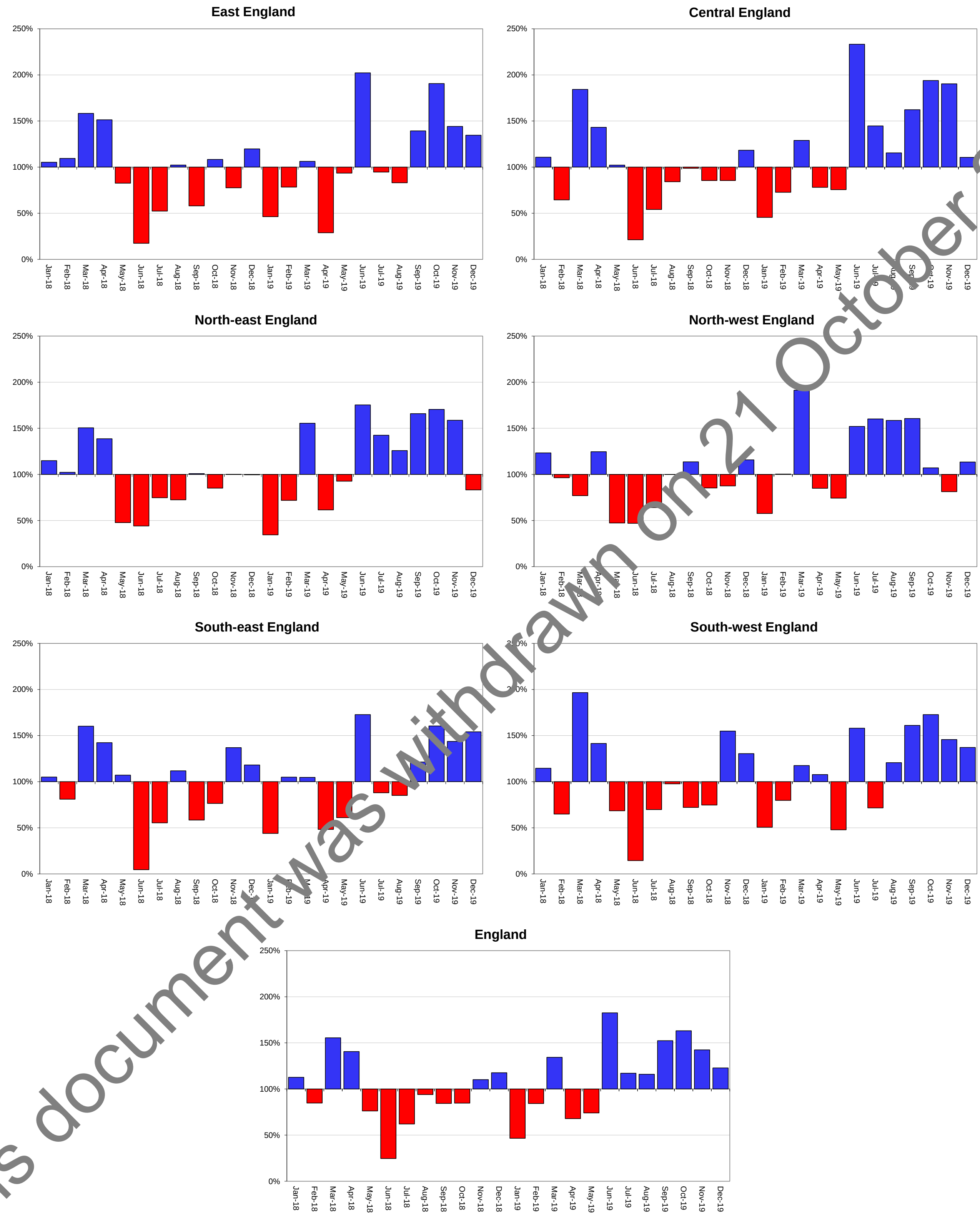


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. HadUK rainfall data. (Source: Met Office © Crown Copyright, 2020).

Soil moisture deficit

End of November 2019[1]	End of December 2019[2]

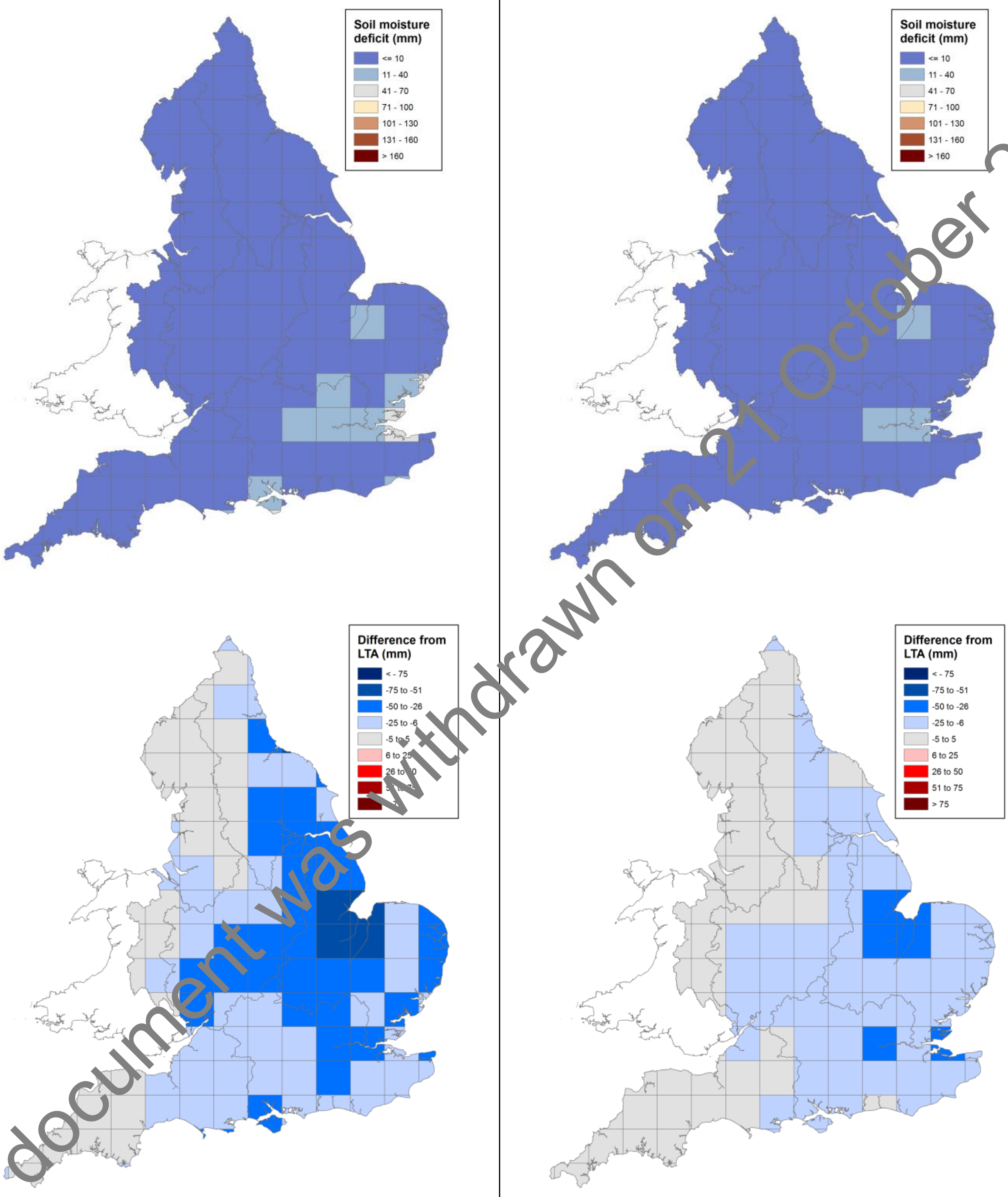


Figure 2.1: Soil moisture deficits for weeks ending 29 November 2019 [1] (left panel) and 31 December 2019 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961 to 90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2020). Crown copyright. All rights reserved. Environment Agency, 100026380, 2020

Soil moisture deficit charts

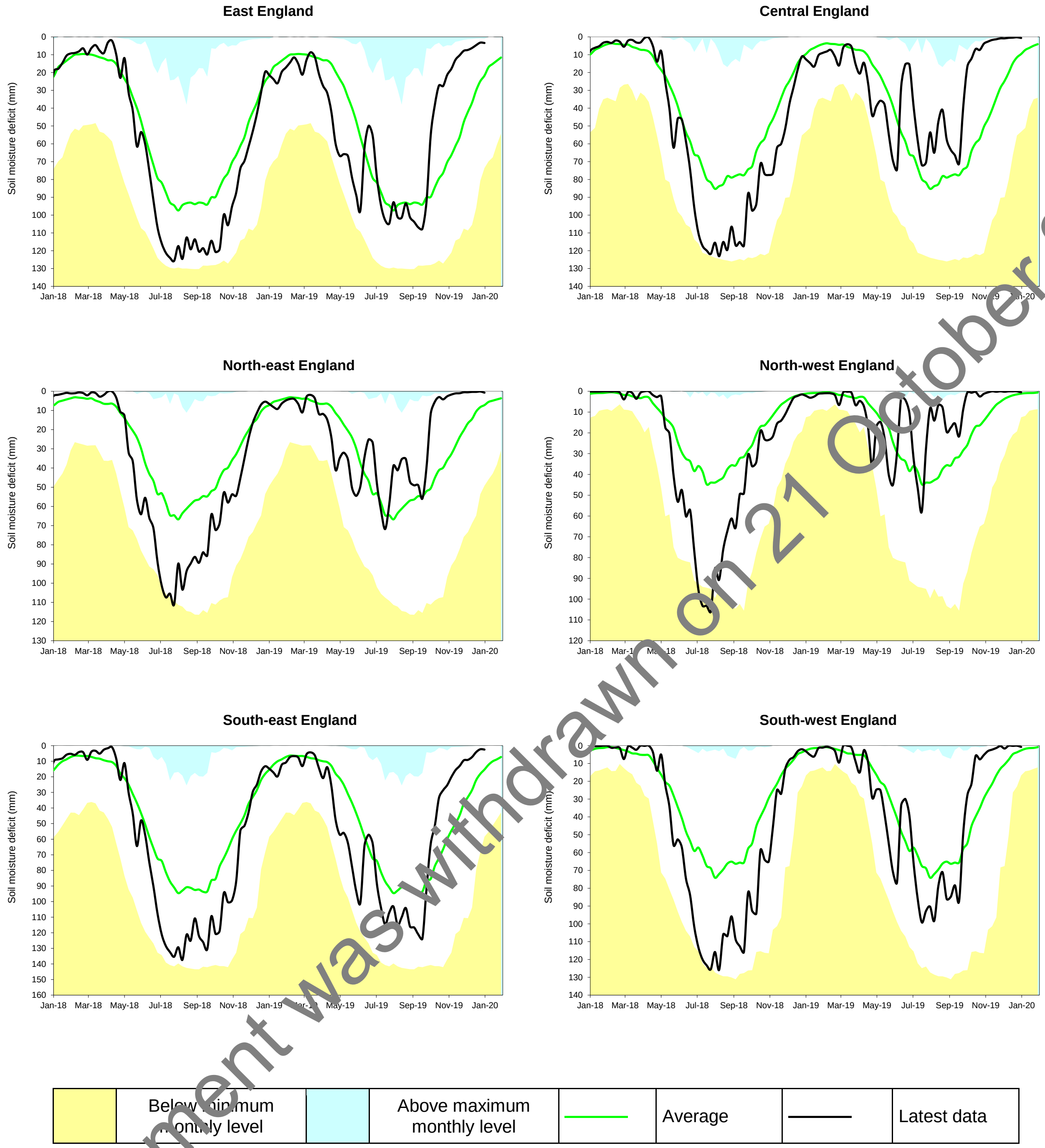
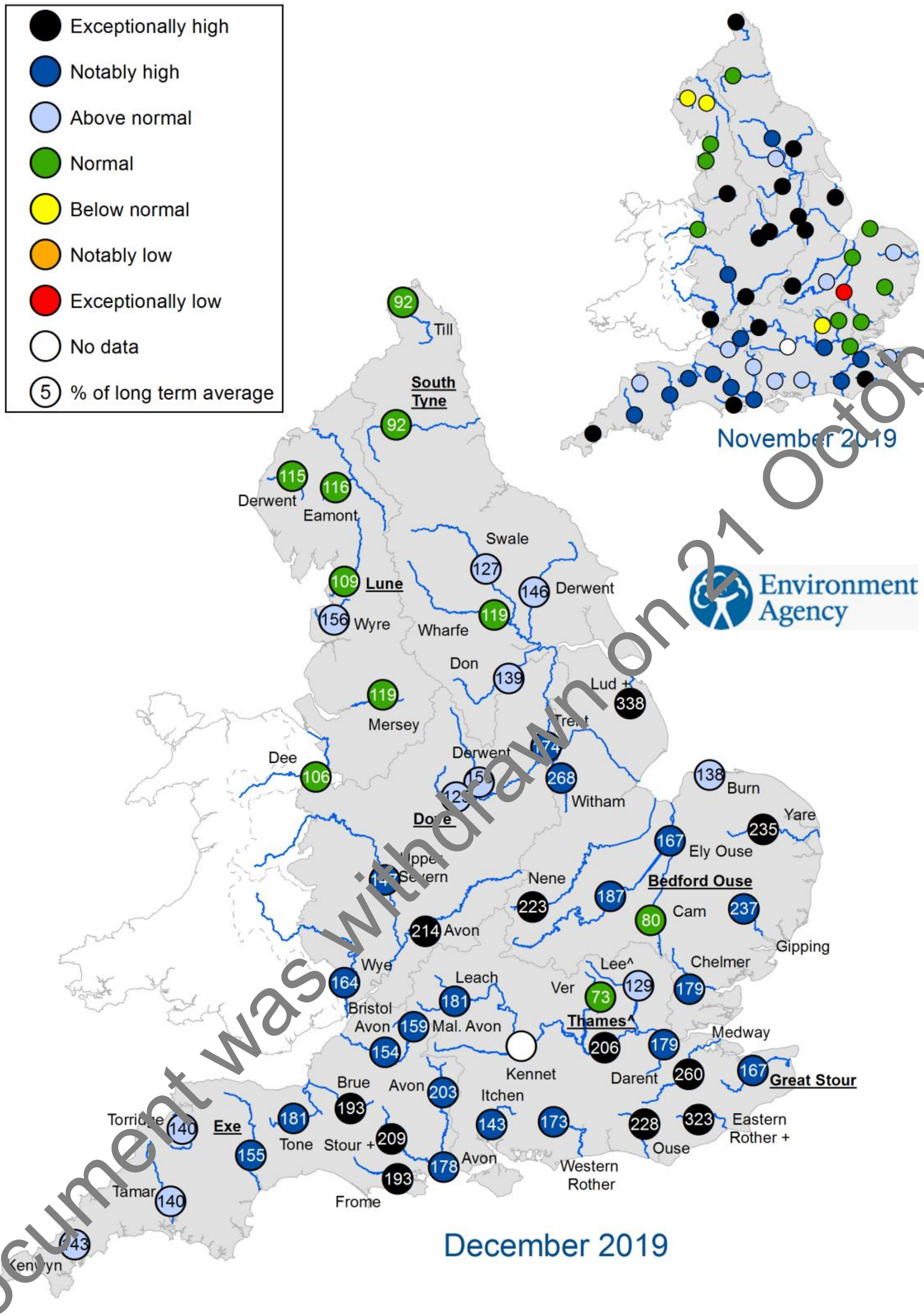


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961 to 90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2020).

River flows



^ "Naturalised" flows are provided for the River Thames at Kingston and the River Lee at Feildes Weir
\+ Monthly mean flow is the highest on record for the current month (note that record length varies between sites)
Underlined sites are regional index sites and are shown on the hydrographs in Figure 3.2

Figure 3.1: Monthly mean river flow for indicator sites for November and December 2019, expressed as a November and December monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2020.

River flow charts

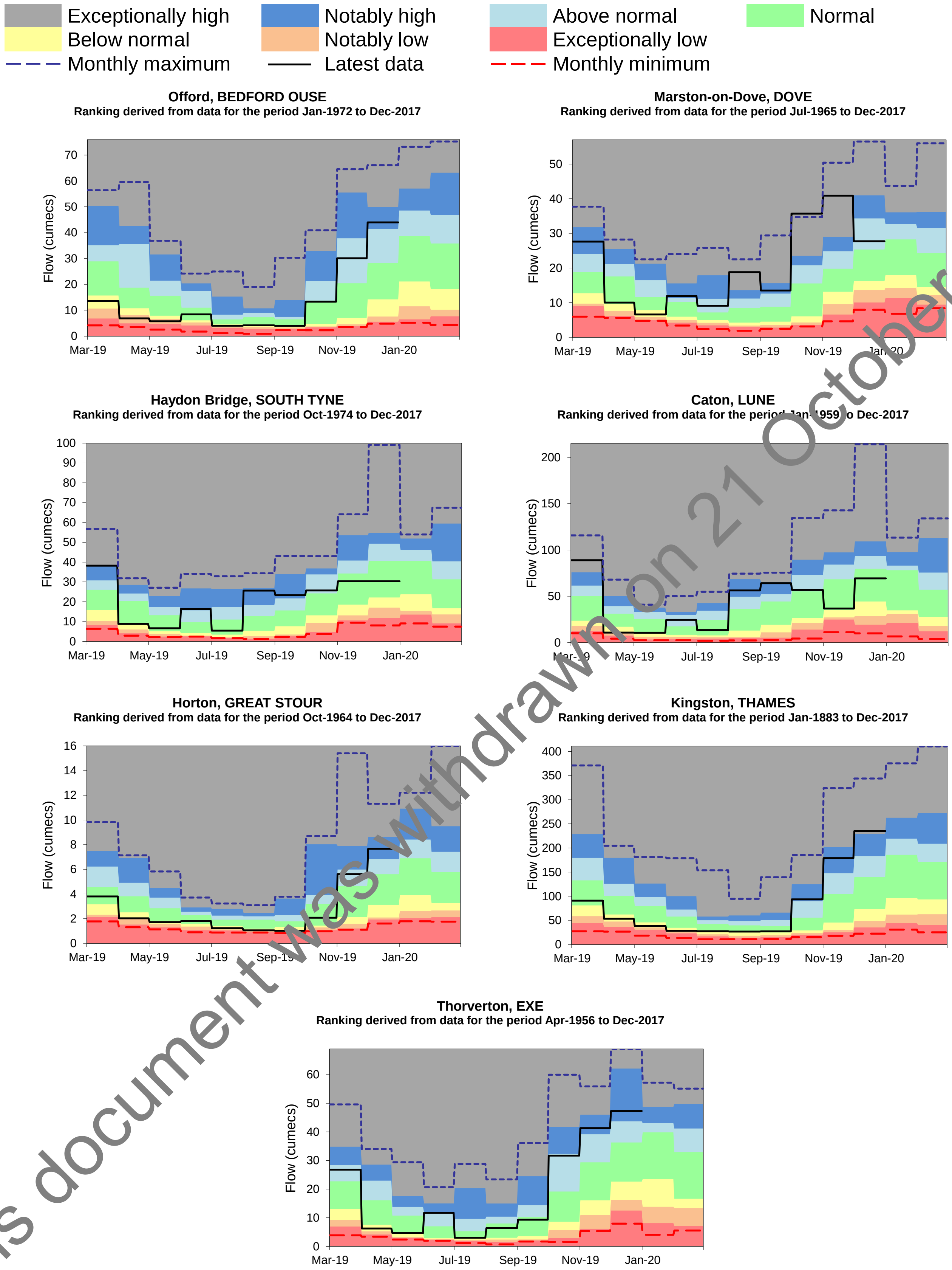
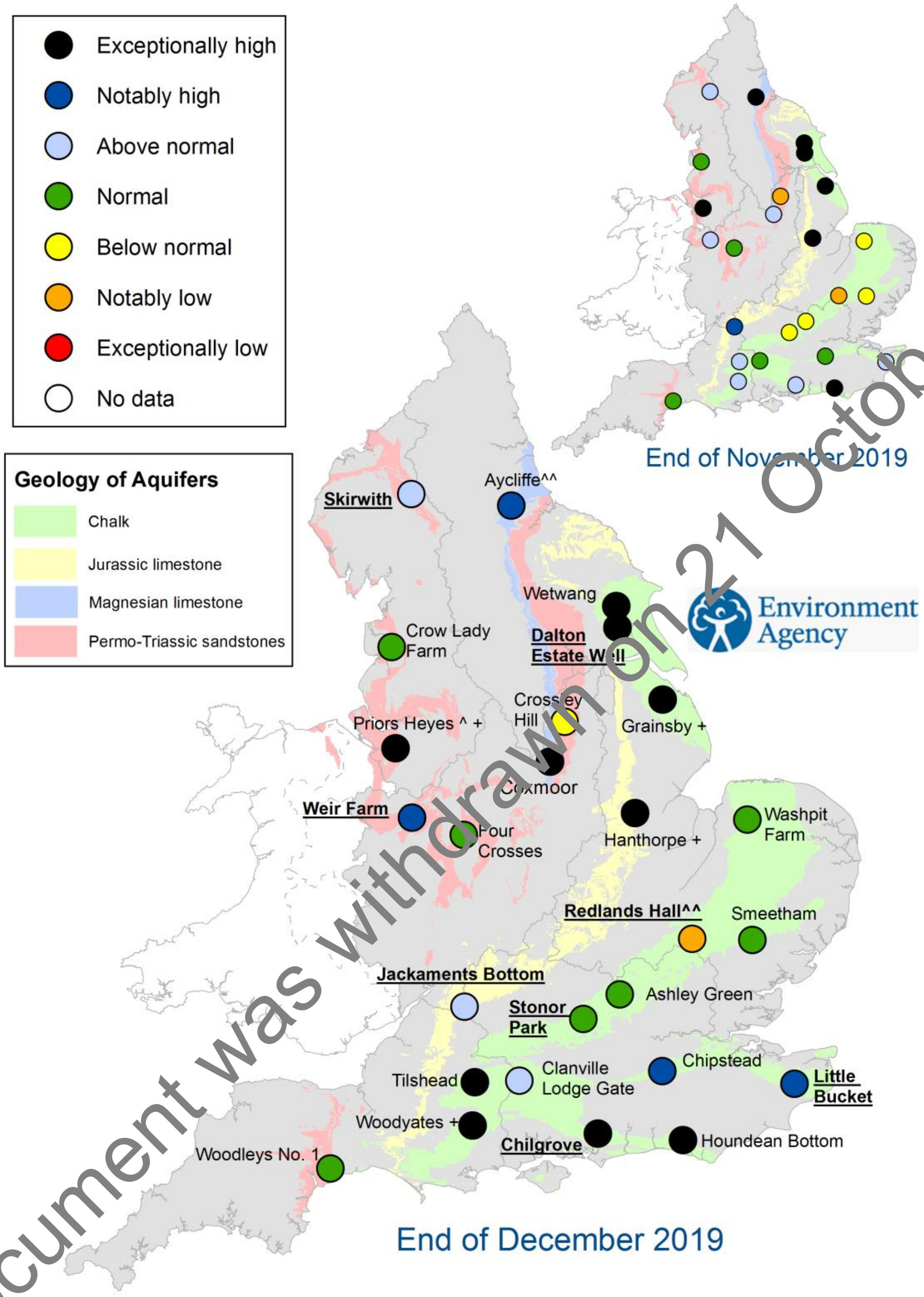


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

Groundwater levels



^ The level at Priors Heyes remains high compared to historic levels because the aquifer is recovering from the effects of historic abstraction
^^ Sites are manually dipped at different times during the month. They may not be fully representative of levels at the month end
\+ End of month groundwater level is the highest on record for the current month (note that record length varies between sites).
Underlined sites are major aquifer index sites and are shown in the groundwater level charts in Figure 4.2

Figure 4.1: Groundwater levels for indicator sites at the end of November and December 2019, classed relative to an analysis of respective historic November and December levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2020.

Groundwater level charts

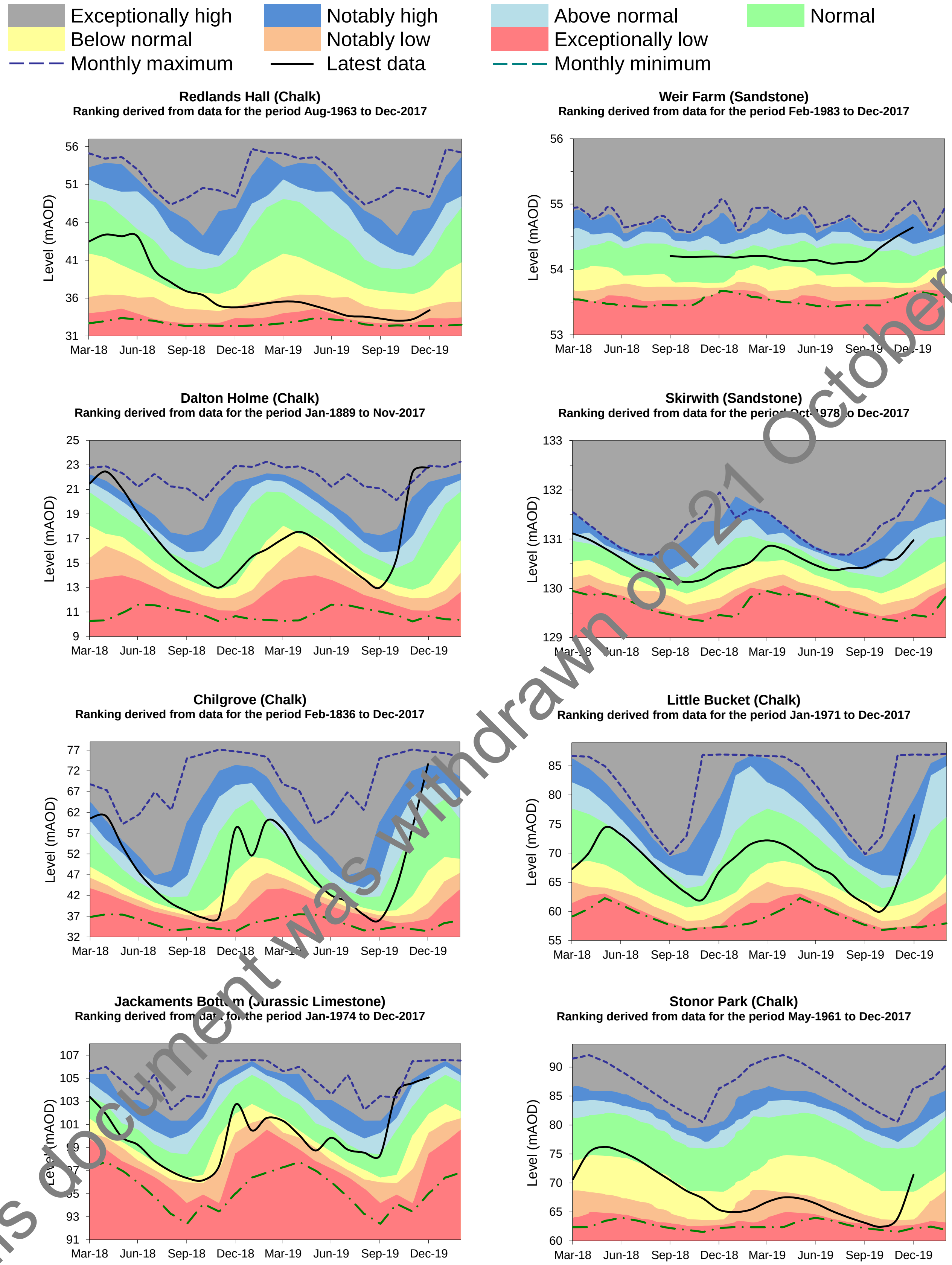
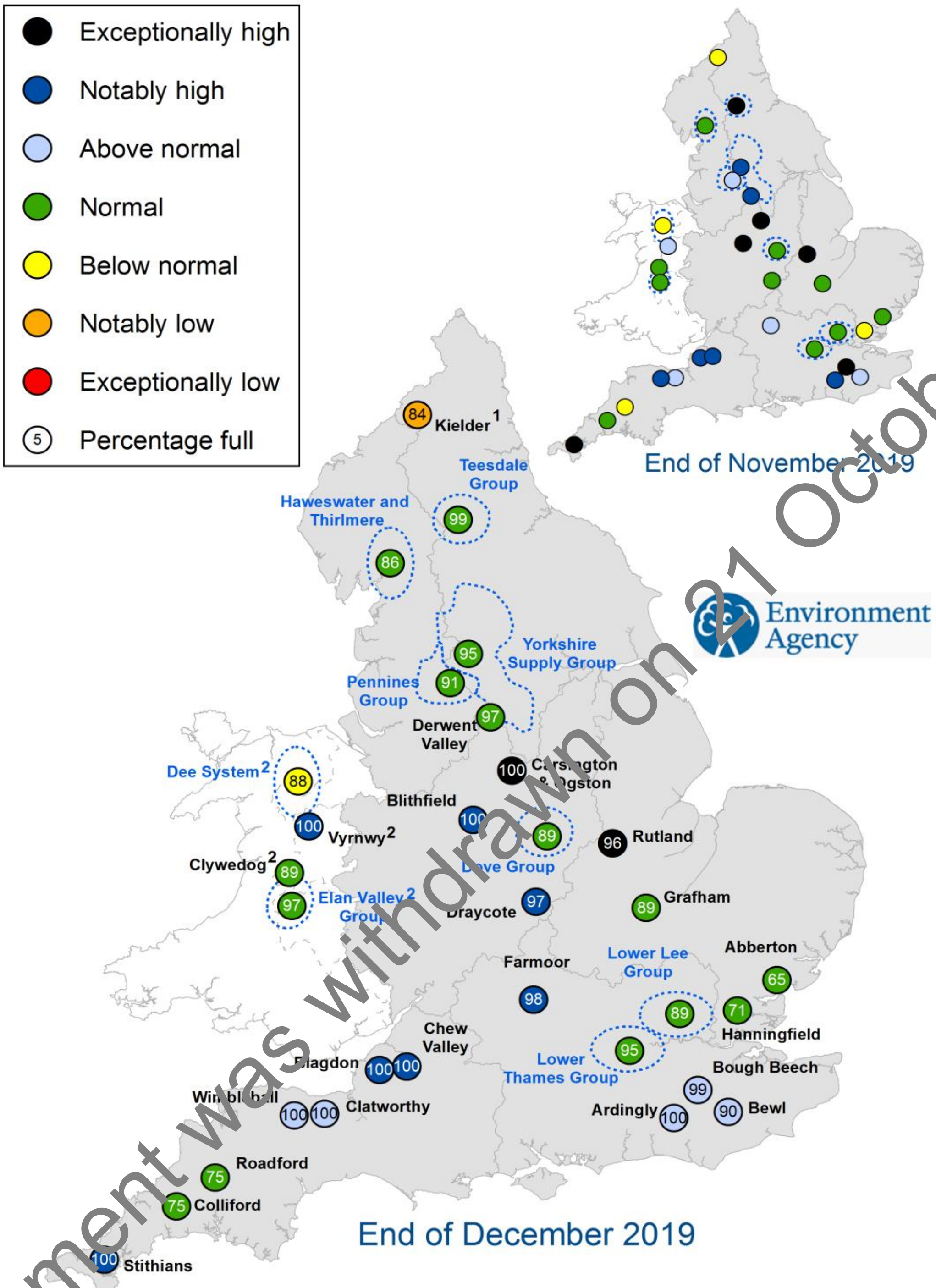


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2020).

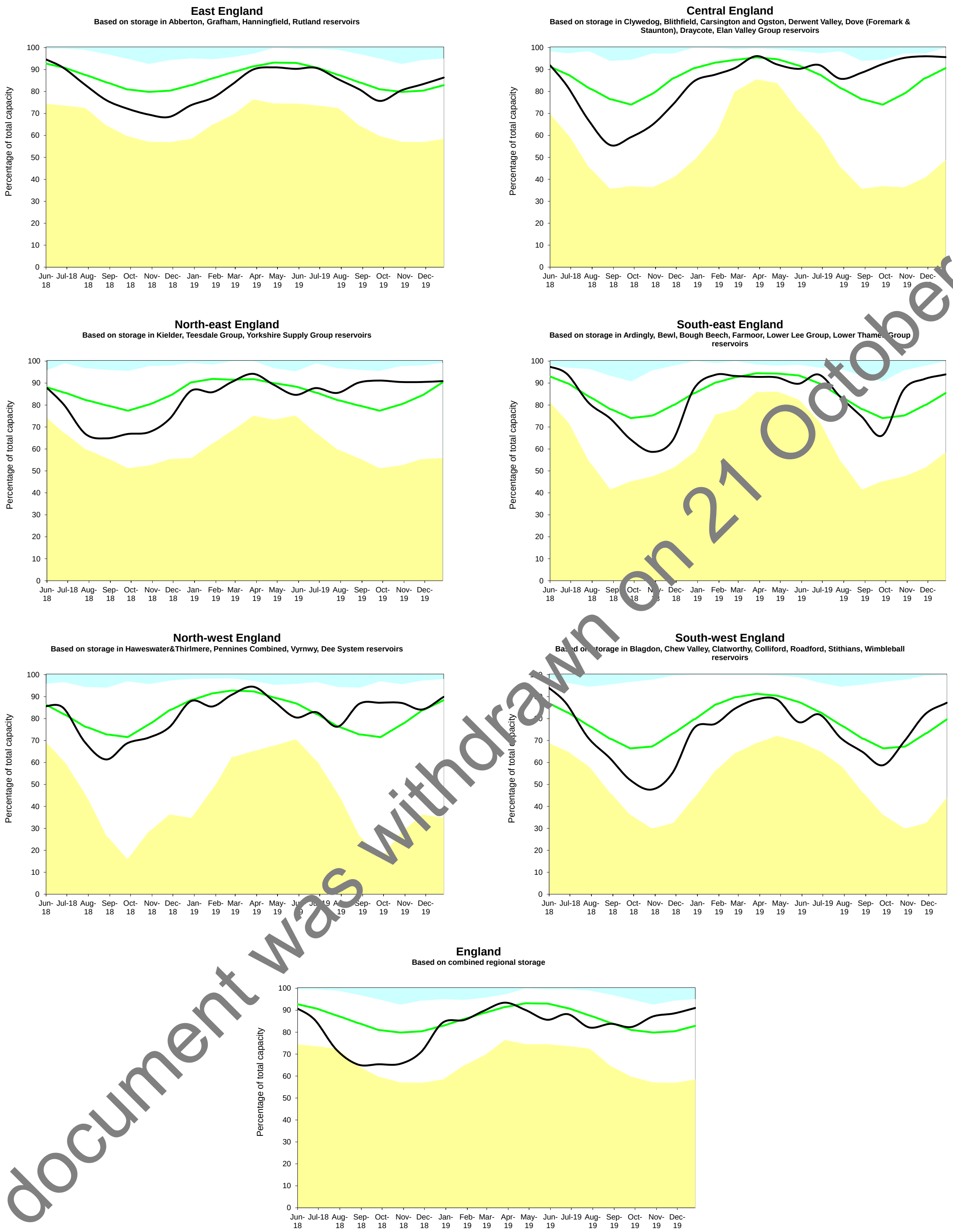
Reservoir storage



1. Current levels at Kielder are lower than historical levels due to the implementation of a new flood alleviation control curve
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of November 2019 and December 2019 as a percentage of total capacity and classed relative to an analysis of historic November and December values respectively (Source: Water Companies). Note: Classes shown may not necessarily relate to control curves or triggers for drought actions. As well as for public water supply, some reservoirs are drawn down to provide flood storage, river compensation flows or for reservoir safety inspections. In some cases current reservoir operating rules may differ from historic ones. Crown copyright. All rights reserved. Environment Agency, 100026380, 2020.

Reservoir storage charts



	Below minimum monthly level		Above maximum monthly level		Average		Latest data

Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look: river flow

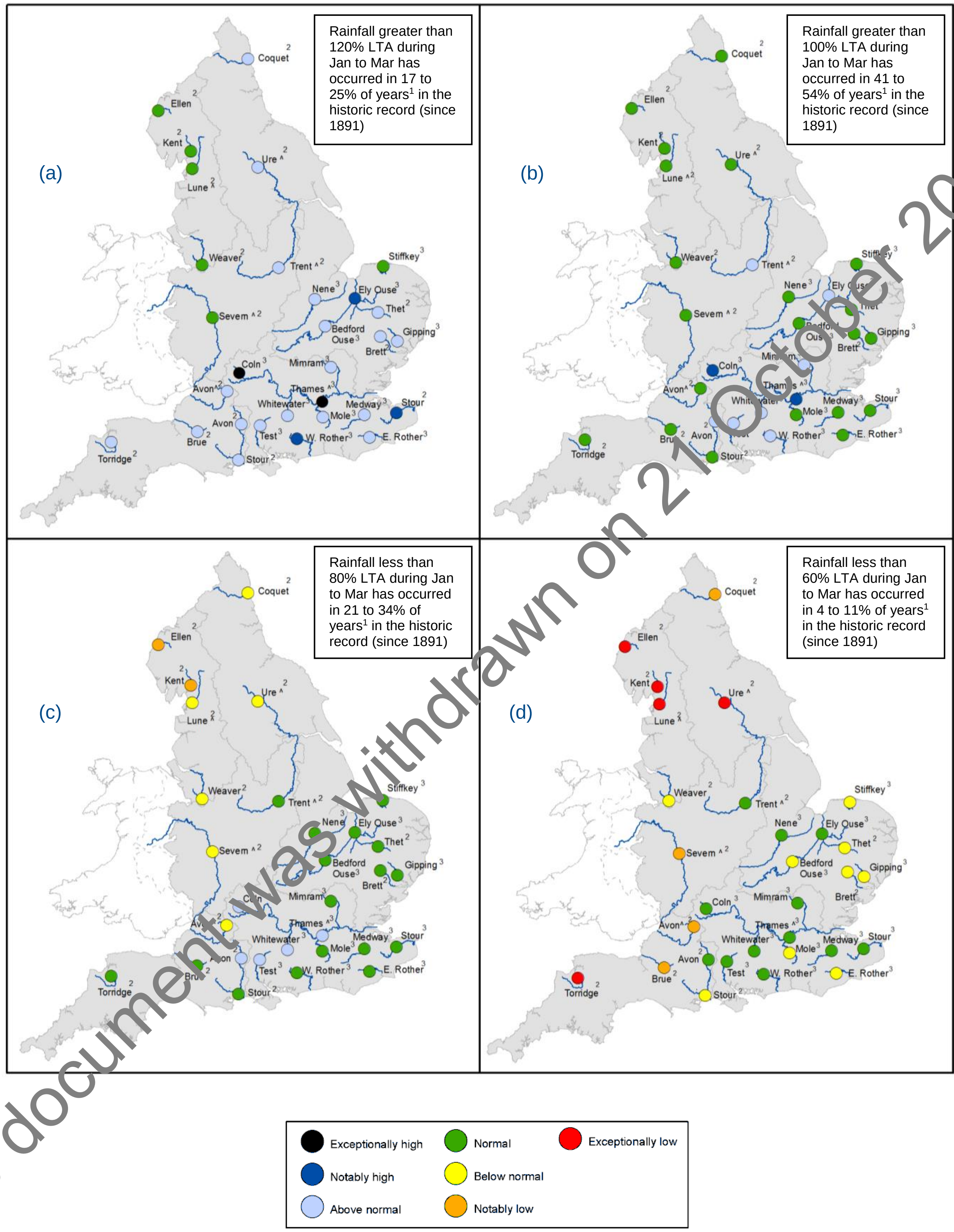


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2020 and March 2020 (Source: Centre for Ecology and Hydrology, Environment Agency).

[1] This range of probabilities is a regional analysis
[2] Projections for these sites are produced by CEH
[3] Projections for these sites are produced by the Environment Agency
^ *"Naturalised" flows are projected for these sites*

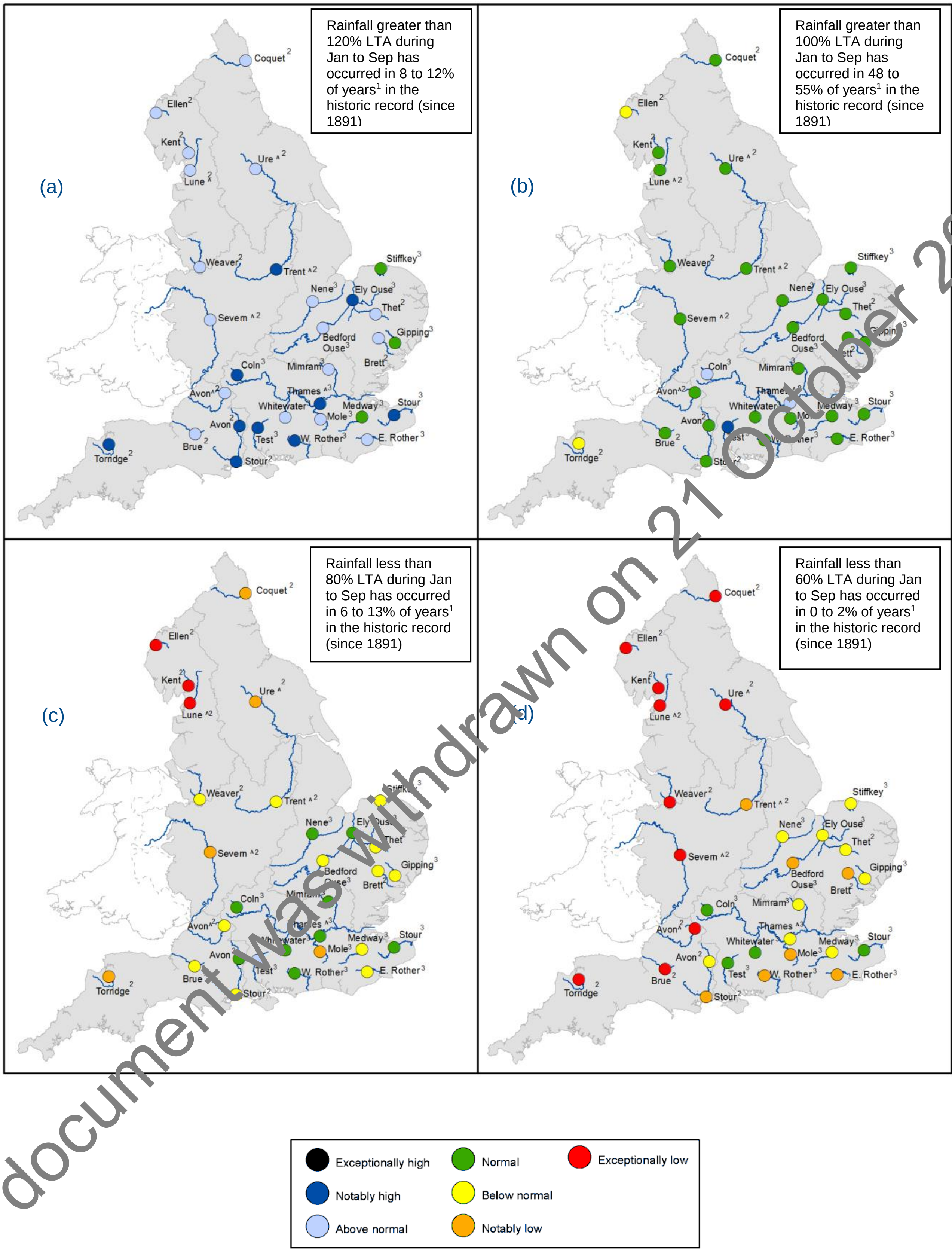
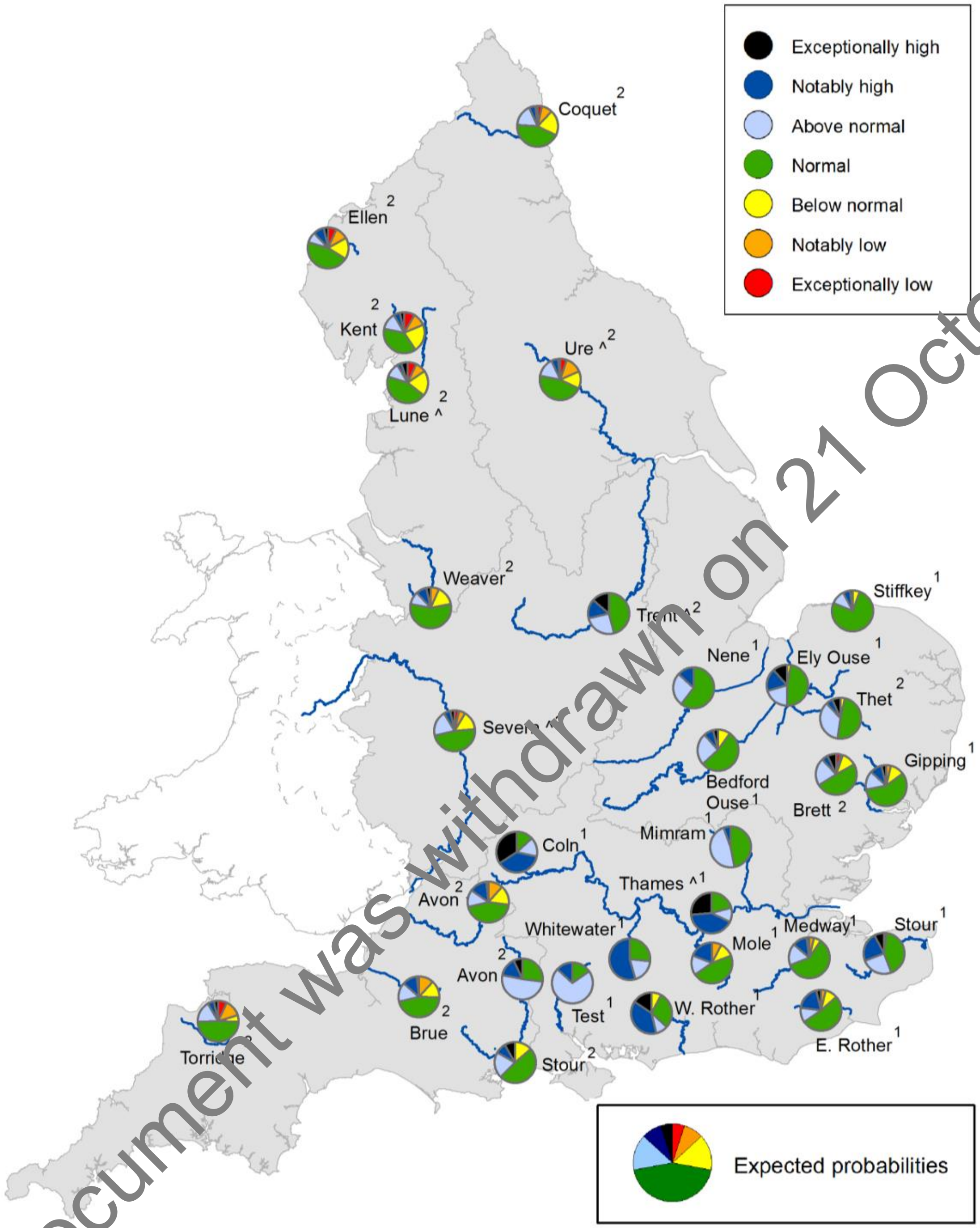


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2020 and September 2020 (Source: Centre for Ecology and Hydrology, Environment Agency)

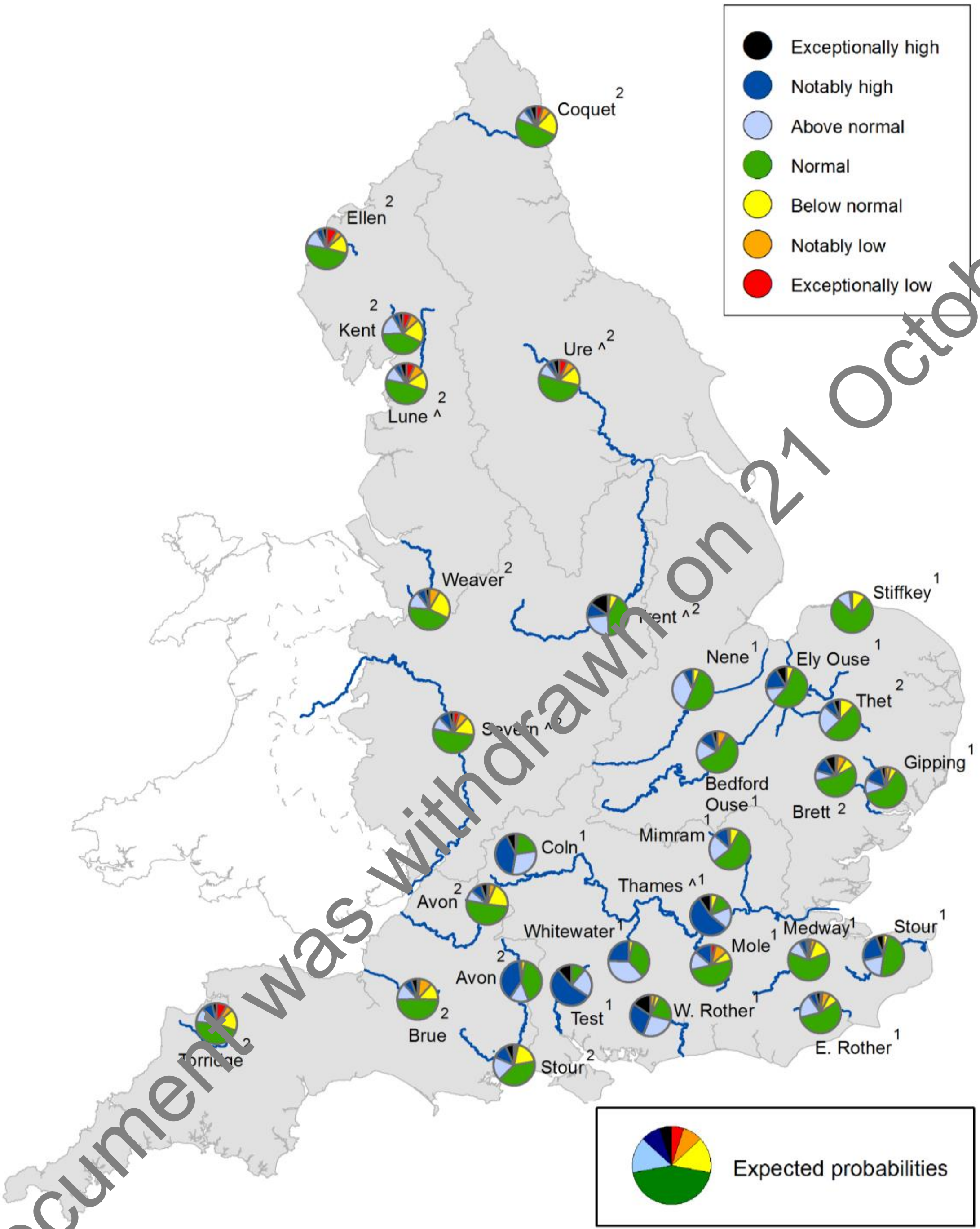
[1] This range of probabilities is a regional analysis
[2] Projections for these sites are produced by CEH
[3] Projections for these sites are produced by the Environment Agency
^ *"Naturalised" flows are projected for these sites*



Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.3: Probabilistic ensemble projections of river flows at key indicator sites up until the end of March 2020. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

[1] Projections for these sites are produced by the Environment Agency
[2] Projections for these sites are produced by CEH
^"Naturalised" flows are projected for these sites



Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2020. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

[1] Projections for these sites are produced by the Environment Agency
[2] Projections for these sites are produced by CEH
^"Naturalised" flows are projected for these sites

Forward look: groundwater

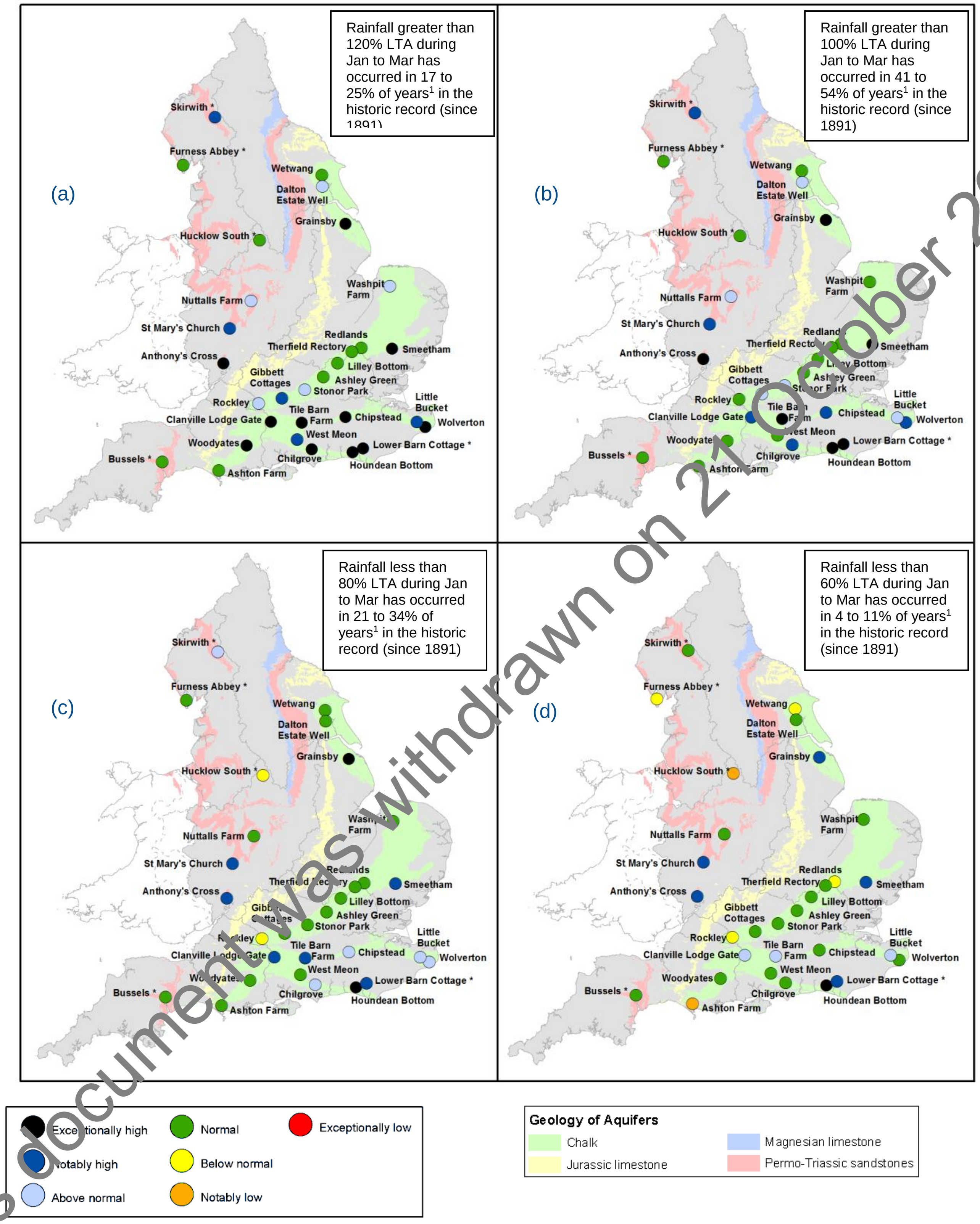


Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2020 and March 2020 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2020.

* Projections for these sites are produced by BGS
[1] This range of probabilities is a regional analysis

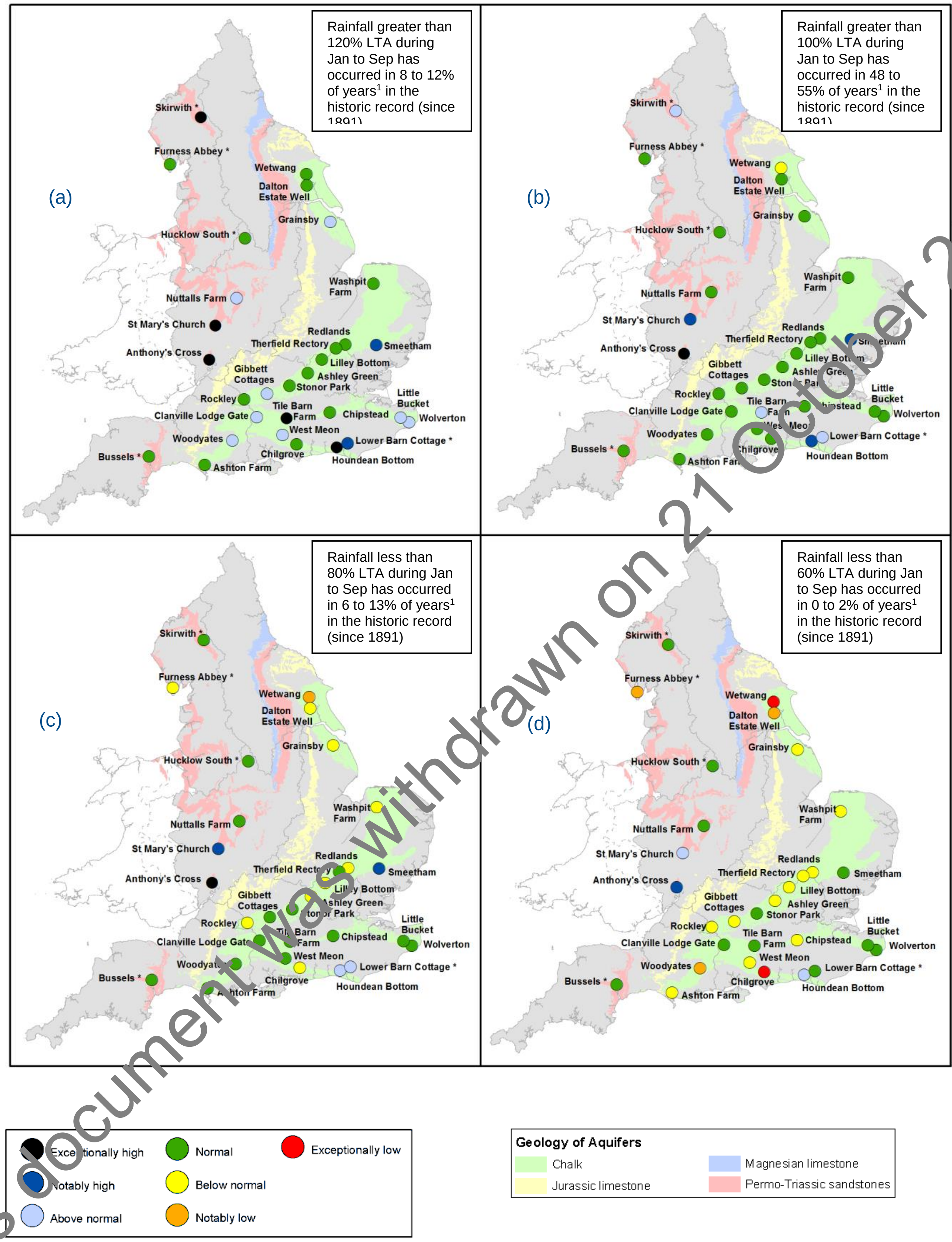
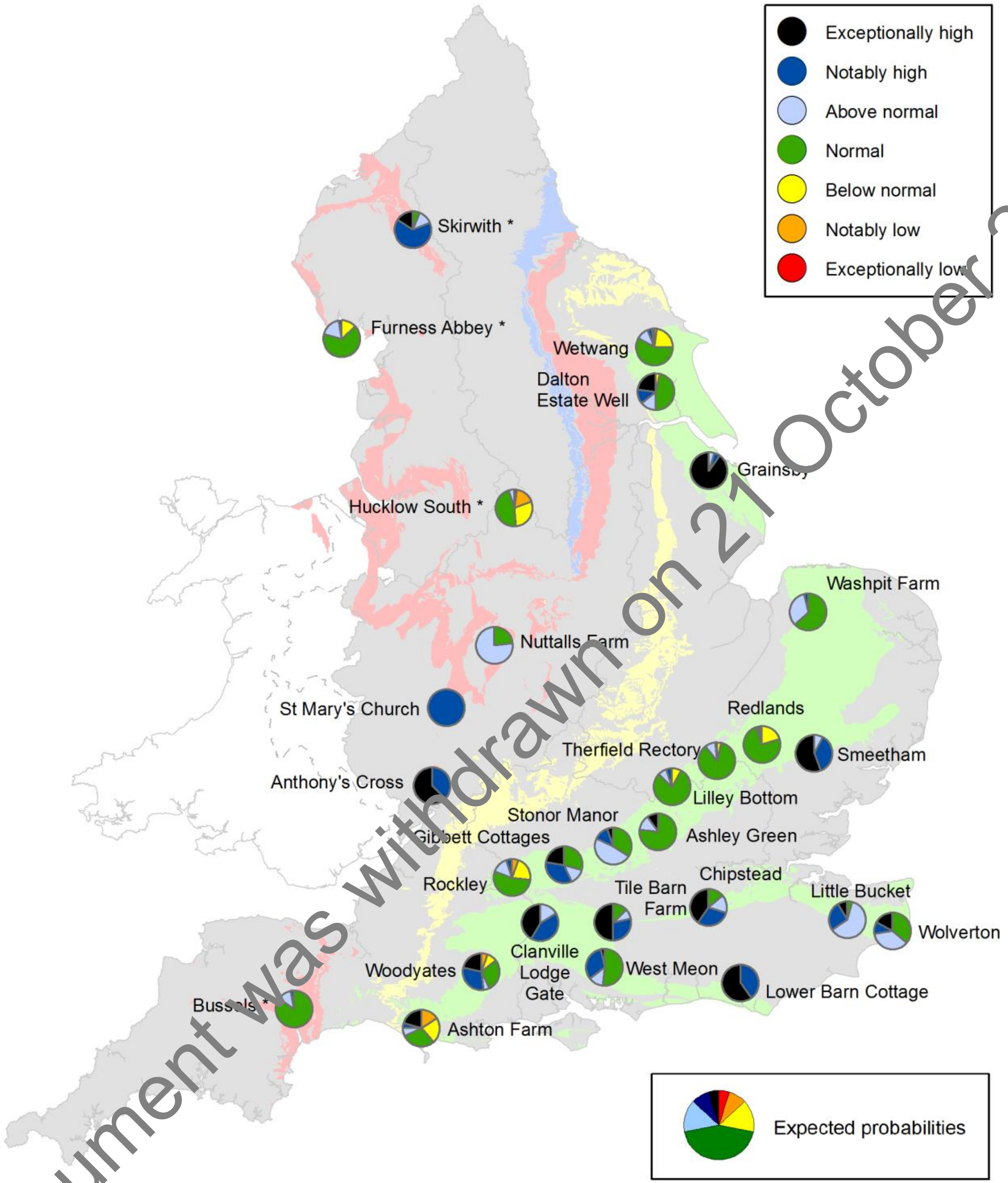


Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January 2020 and September 2020 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2020.

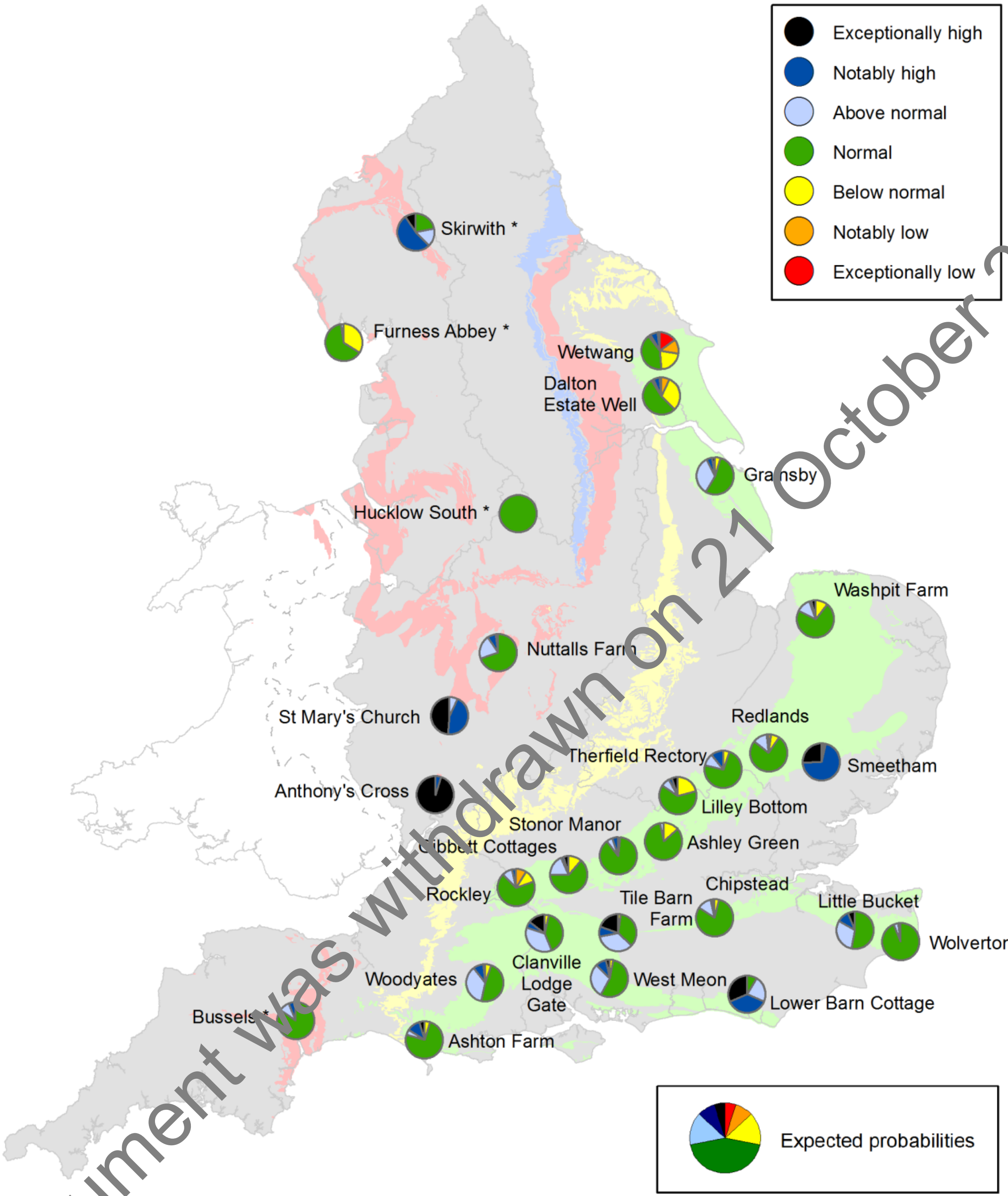
* Projections for these sites are produced by BGS
[1] This range of probabilities is a regional analysis



Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.7: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of March 2020. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the time of year. (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2020.

** Projections for these sites are produced by BGS*



Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.8: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of September 2020. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the time of year. (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2020.

* Projections for these sites are produced by BGS

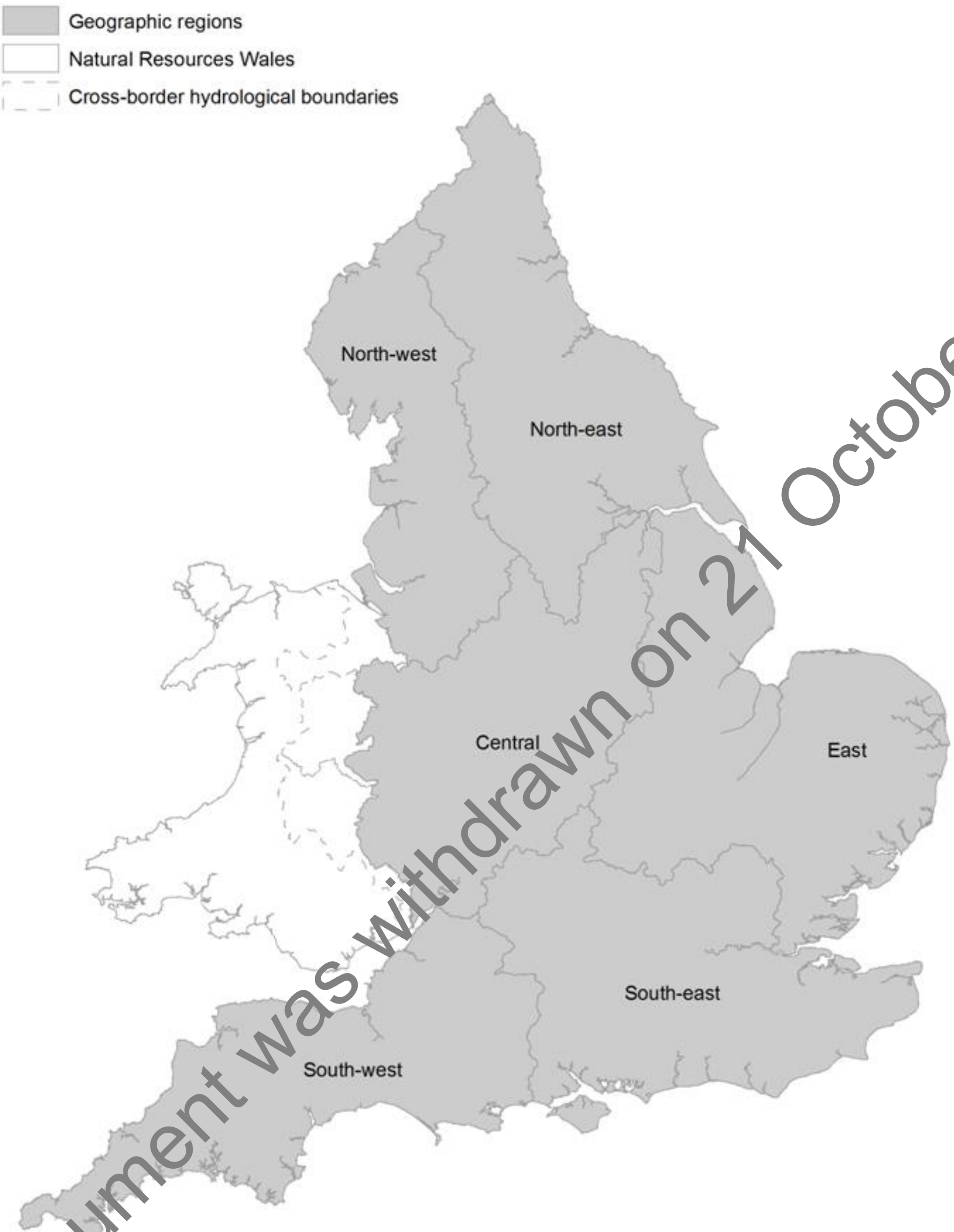


Figure 7.1: Geographic regions

Glossary

Term	Definition
Aquifer	A geological formation able to store and transmit water.
Areal average rainfall	The estimated average depth of rainfall over a defined area. Expressed in depth of water (mm).
Artesian	The condition where the groundwater level is above ground surface but is prevented from rising to this level by an overlying continuous low permeability layer, such as clay.
Artesian borehole	Borehole where the level of groundwater is above the top of the borehole and groundwater flows out of the borehole when unsealed.
Cumecs	Cubic metres per second (m^3s^{-1})
Effective rainfall	The rainfall available to percolate into the soil or produce river flow. Expressed in depth of water (mm).
Flood Alert/Flood Warning	Three levels of warnings may be issued by the Environment Agency. Flood Alerts indicate flooding is possible. Flood Warnings indicate flooding is expected. Severe Flood Warnings indicate severe flooding.
Groundwater	The water found in an aquifer.
Long term average (LTA)	The arithmetic mean, calculated from the historic record. For rainfall and soil moisture deficit, the period refers to 1961 to 1990, unless otherwise stated. For other parameters, the period may vary according to data availability
mAOD	Metres Above Ordnance Datum (mean sea level at Newlyn Cornwall).
MORECS	Met Office Rainfall and Evaporation Calculation System. Met Office service providing real time calculation of evapotranspiration, soil moisture deficit and effective rainfall on a 40 x 40 km grid.
Naturalised flow	River flow with the impacts of artificial influences removed. Artificial influences may include abstractions, discharges, transfers, augmentation and impoundments.
NCIC	National Climate Information Centre. NCIC area monthly rainfall totals are derived using the Met Office 5 km gridded dataset, which uses rain gauge observations.
Recharge	The process of increasing the water stored in the saturated zone of an aquifer. Expressed in depth of water (mm).
Reservoir gross capacity	The total capacity of a reservoir.
Reservoir live capacity	The capacity of the reservoir that is normally usable for storage to meet established reservoir operating requirements. This excludes any capacity not available for use (e.g. storage held back for emergency services, operating agreements or physical restrictions). May also be referred to as ‘net’ or ‘deployable’ capacity.
Soil moisture deficit (SMD)	The difference between the amount of water actually in the soil and the amount of water the soil can hold. Expressed in depth of water (mm).

Categories

Exceptionally high	Value likely to fall within this band 5% of the time
Notably high	Value likely to fall within this band 8% of the time
Above normal	Value likely to fall within this band 15% of the time
Normal	Value likely to fall within this band 44% of the time
Below normal	Value likely to fall within this band 15% of the time
Notably low	Value likely to fall within this band 8% of the time
Exceptionally low	Value likely to fall within this band 5% of the time