Monthly water situation report

England

Summary – March 2019

March was particularly wet across much of England, with two named storms bringing widespread heavy rainfall during the first half of the month. The monthly rainfall total for England was well above average at 134% of the March long term average. Most rivers were normal or higher for the time of year and at two-thirds of rivers that we monitor, river flows increased compared to February. Groundwater levels generally continued to rise during March but two-thirds of sites we monitor remained below normal or lower at the end of March. Soils were slightly drier at the end of March than at the start of the month. Total reservoir stocks for England increased to 95% of total capacity at the end of March.

Rainfall

The majority of March's rainfall fell during the first half of the month, with Storm Freya (3 to 4 March) and Storm Gareth (12 to 13 March) bringing widespread heavy rainfall, particularly to north-west England. Thereafter conditions became more settled with drier weather prevailing across much of England. March rainfall totals were highest in north-west England, with the Kent and Esk catchments receiving more than 250mm (around 200% of the long term average (LTA)). Rainfall totals were lowest in parts of east and south-east England at less than 50mm (around 70 to 85% of the LTA) (Figure 1.1).

March rainfall totals were classed as normal or higher for the time of year across all catchments in England. In north-west England, rainfall totals were notably high or exceptionally high across all catchments. It was the wettest March on record in the Esk and Eden catchments in north-west England and within the top 5 wettest Marches on record in a further 10 catchments across north-west, north-east and central England. In contrast, cumulative rainfall totals for the past 3 and 6 months were below normal across parts of England, whilst cumulative totals for the past 12 months were below normal or notably low across most of England (Figure 1.2).

The March rainfall total for England was 89.2mm which is 134% of the 1961 to 1990 LTA (139% of the 1981 to 2010 LTA). At a regional scale, March rainfall totals ranged from 105% of the LTA in south-east England to 198% in north-west England. It was the second and fifth wettest March on record in north-west and north-east England respectively and the wettest since 1981 in both regions (Figure 1.3).

Soil moisture deficit

Soil moisture deficits (SMDs) decreased during the first part of March in response to the wet weather but by the end of the month, soils were slightly drier than at the start and drier than average across all but the north-west and far north-east of England (Figure 2.1).

At a regional scale, SMDs increased slightly in all but north-west England during March and by the end of the month, soils were slightly drier than average across all regions (Figure 2.2).

River flows

March monthly mean river flows were higher than February flows at two thirds of indicator sites. However, the drier end to the month resulted in March flows being lower than February flows at the remaining third of sites, which were located in east, south-east and south-west England.

River flows were classed as normal or higher for the time of year at just over three-quarters of indicator sites, with all sites in north-west England and most in north-east England being notably high or exceptionally high. The flow on the River Wharfe in north-east England was the highest March flow on record. Flows at 8 sites across east and south-east England were below normal for the time of year, whilst the River Ely Ouse and the River Cam were below normal and exceptionally low respectively (Figure 3.1).

March monthly mean flows at the regional indicator sites were normal or higher for the time at year at all sites apart from the Bedford Ouse in east England which was below normal (Figure 3.2).

Groundwater levels

Groundwater levels continued to rise during March at almost two thirds of indicator sites, but by the end of March, groundwater levels remained classed as below normal or lower for the time of year at over two thirds of sites (Figures 4.1). Sites where groundwater levels decreased during March were mainly in the slow responding sandstone aquifers in central and north-west England.

End of March groundwater levels remained normal or higher for the time of year at three of the major aquifer index sites: Chilgrove (Chichester Chalk aquifer), Little Bucket (East Kent Chalk aquifer) and Skirwith (Carlisle Basin and Eden Valley Sandstone aquifer). Groundwater levels at Dalton Holme (Hull and East Riding Chalk aquifer) and Jackaments Bottom (Burford Jurassic Limestone aquifer) were below normal by the end of March, whilst Stonor Park (South-west Chilterns Chalk aquifer) remained notably low for the time of year (Figure 4.2).

Reservoir storage

Reservoir stocks increased or remained stable during March at all but two reservoirs or reservoir groups reported on in England. The largest increases, as a proportion of total storage, occurred in central England at the Derwent Valley reservoir group (+14%), Draycote Water reservoir (+11%) and Blithfield reservoir (+10%). Storage decreases occurred in the Lower Lee reservoir group (-7%) in south east England, as a result of extended outage on the Thames-Lee tunnel, and Stithians reservoir in south-west England (-1%). End of month stocks in nearly three quarters of reservoirs and reservoir groups reported on were classed as normal or higher for the time of year, with the remaining sites classed as below normal or lower (Figure 5.1).

At a regional scale, total reservoir storage increased during March across all geographical regions, with the exception of south-east England where there was a very slight decrease in reservoir storage. The largest increase occurred in east England, where reservoir stocks increased by 7% of total capacity. Total reservoir stocks for England were 95% of total capacity at the end of March (Figure 5.2).

Forward look

The early part of April is likely to be unsettled, with changeable weather conditions resulting in periods of dry weather interspersed with rain, possibly heavy at times. Drier, brighter weather is likely towards the middle of April, especially in the north of England, although unsettled periods are still possible particularly in the south and south-west of England. Towards the end of the month, settled conditions are likely to dominate, with lots of dry weather, especially in the north and north-west of England. Some wetter spells are still possible, although these are most likely to be seen in the south and south-west of England. For both April, and the 3 month period April to June, below average precipitation is slightly more likely than above average precipitation[1].

Projections for river flows at key sites[2]

By the end of September 2019, just over half of the modelled sites have a greater than expected chance of cumulative river flows being notably low or lower for the time of year, increasing to three-quarters of the modelled sites by the end of March 2020.

For scenario based projections of cumulative river flows at key sites by September 2019 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by March 2020 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by September 2019 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by March 2020 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

Approximately two thirds of the modelled sites have a greater than expected chance of groundwater levels being below normal or lower for the time of year by the end of both September 2019 and March 2020.

For scenario based projections of groundwater levels in key aquifers in September 2019 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in March 2020 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2019 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2020 see Figure 6.8

Authors: National Water Resources Hydrology Team

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).

Rainfall

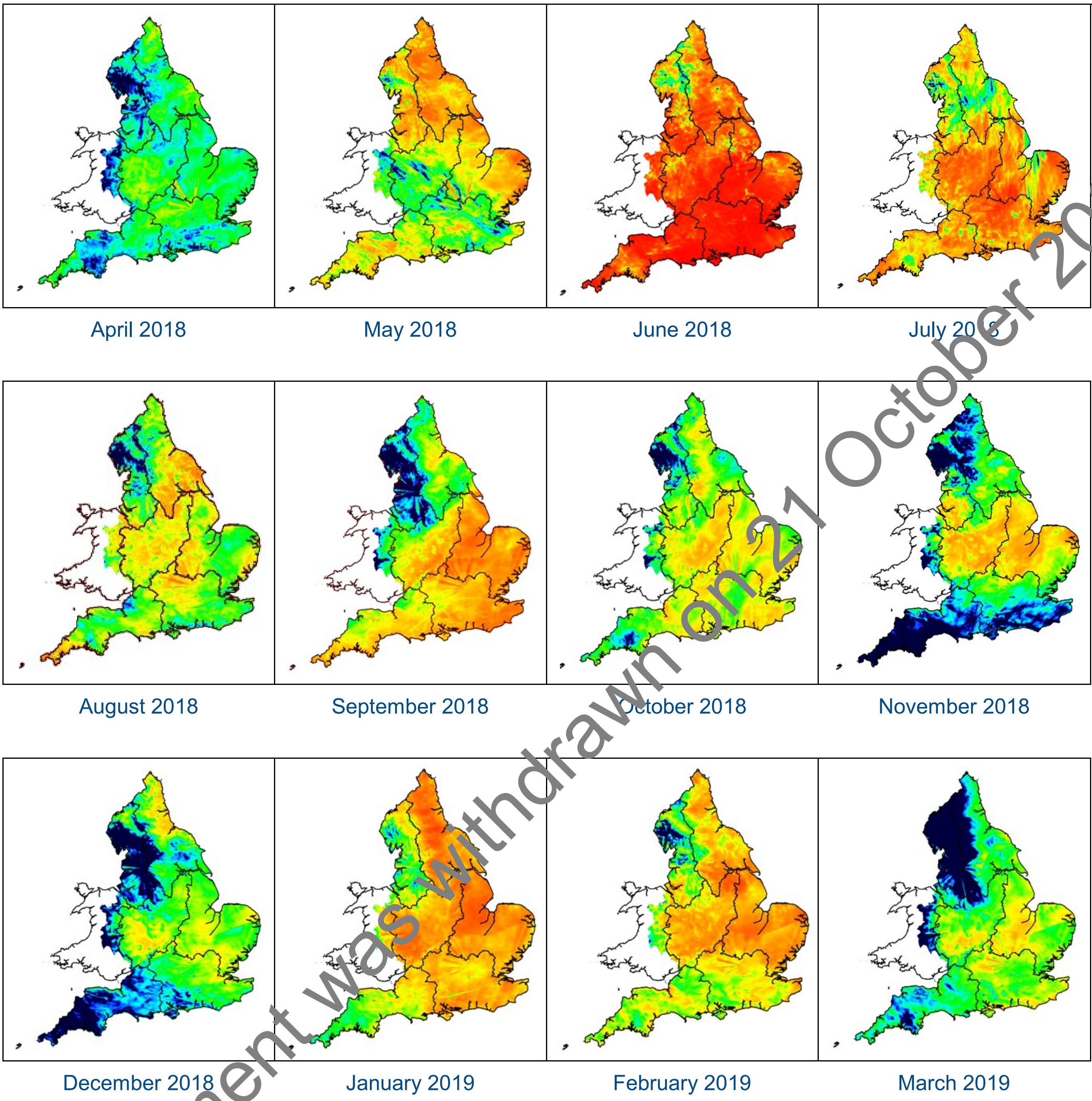
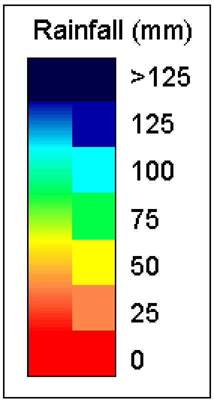


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2019). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.



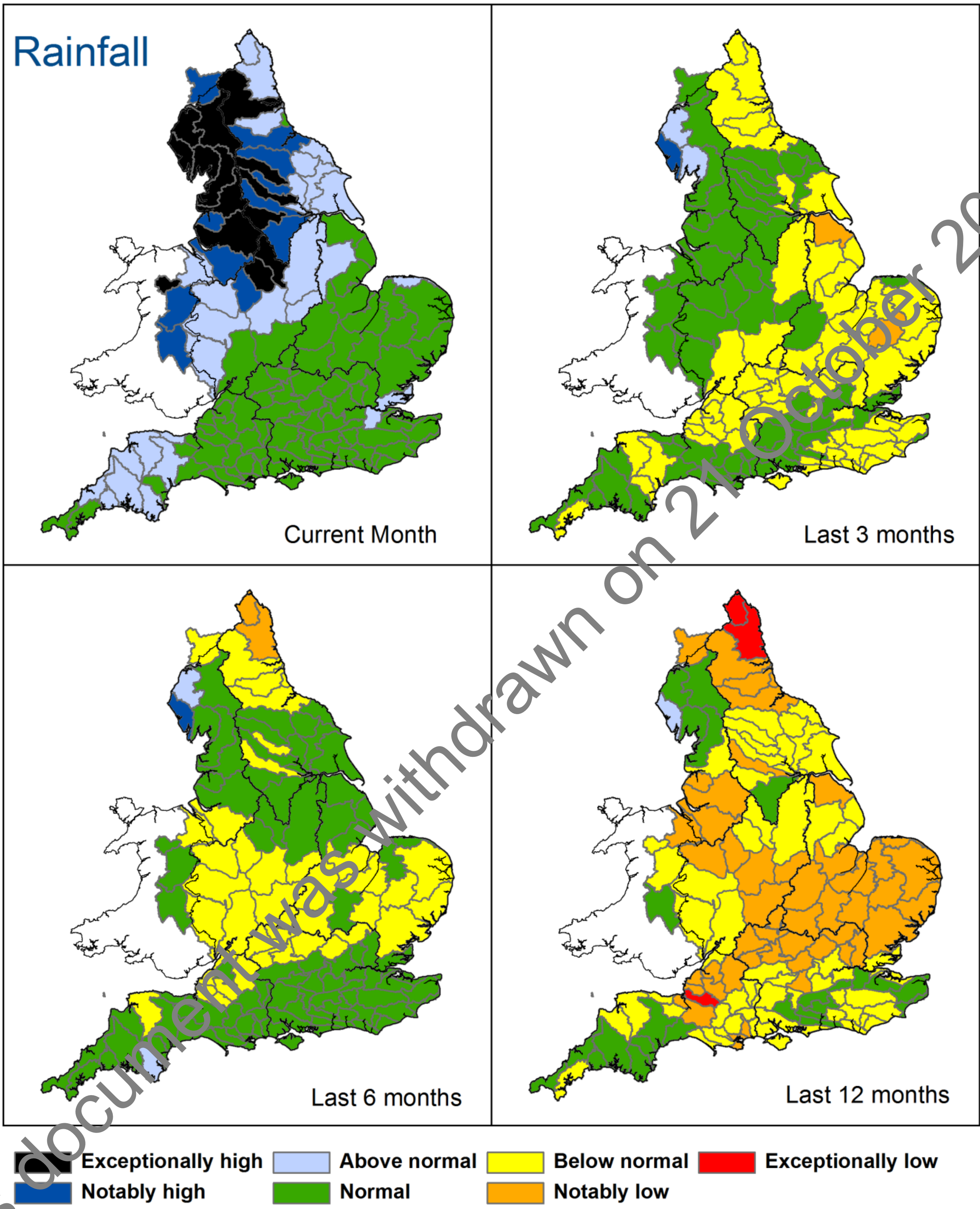


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 March), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges (Source: Met Office © Crown Copyright, 2019). 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, 2019.

Rainfall charts

Above average rainfall

Below average rainfall

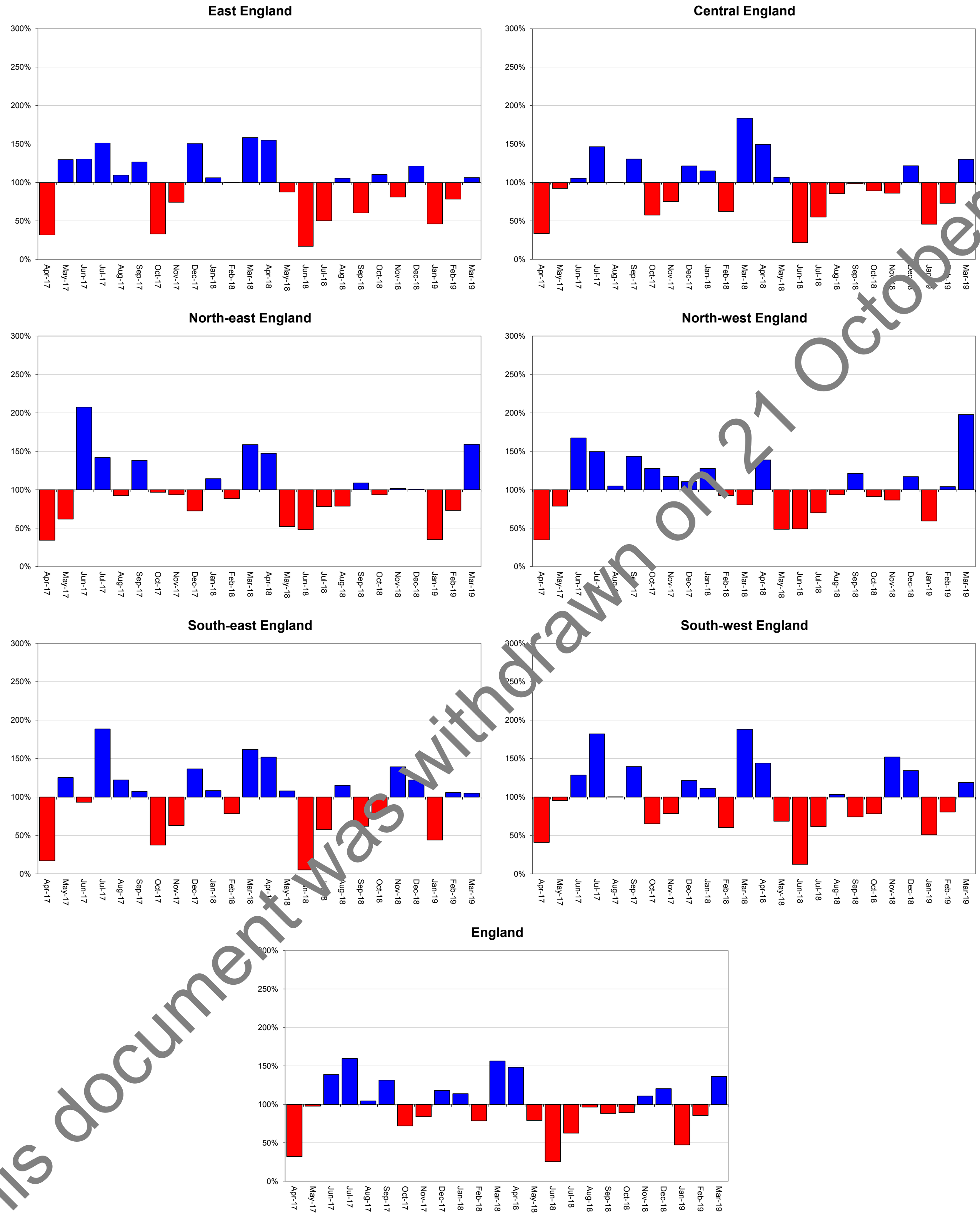


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2019).

Soil moisture deficit

End of February 2019[1]	End of March 2019[2]

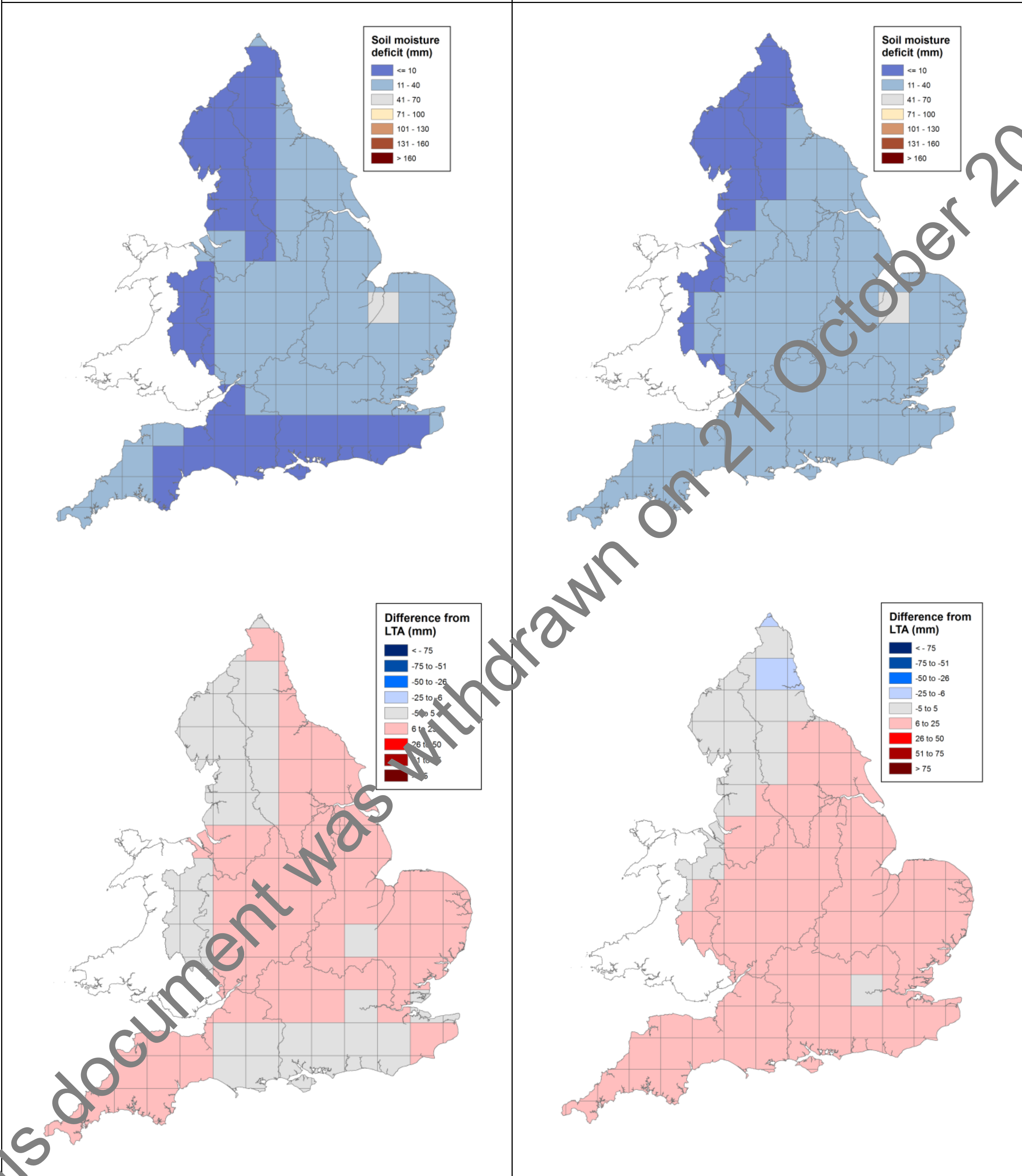


Figure 2.1: Soil moisture deficits for weeks ending 26 February 2019[1] (left panel) and 2 April 2019[2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2019). Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.

Soil moisture deficit charts

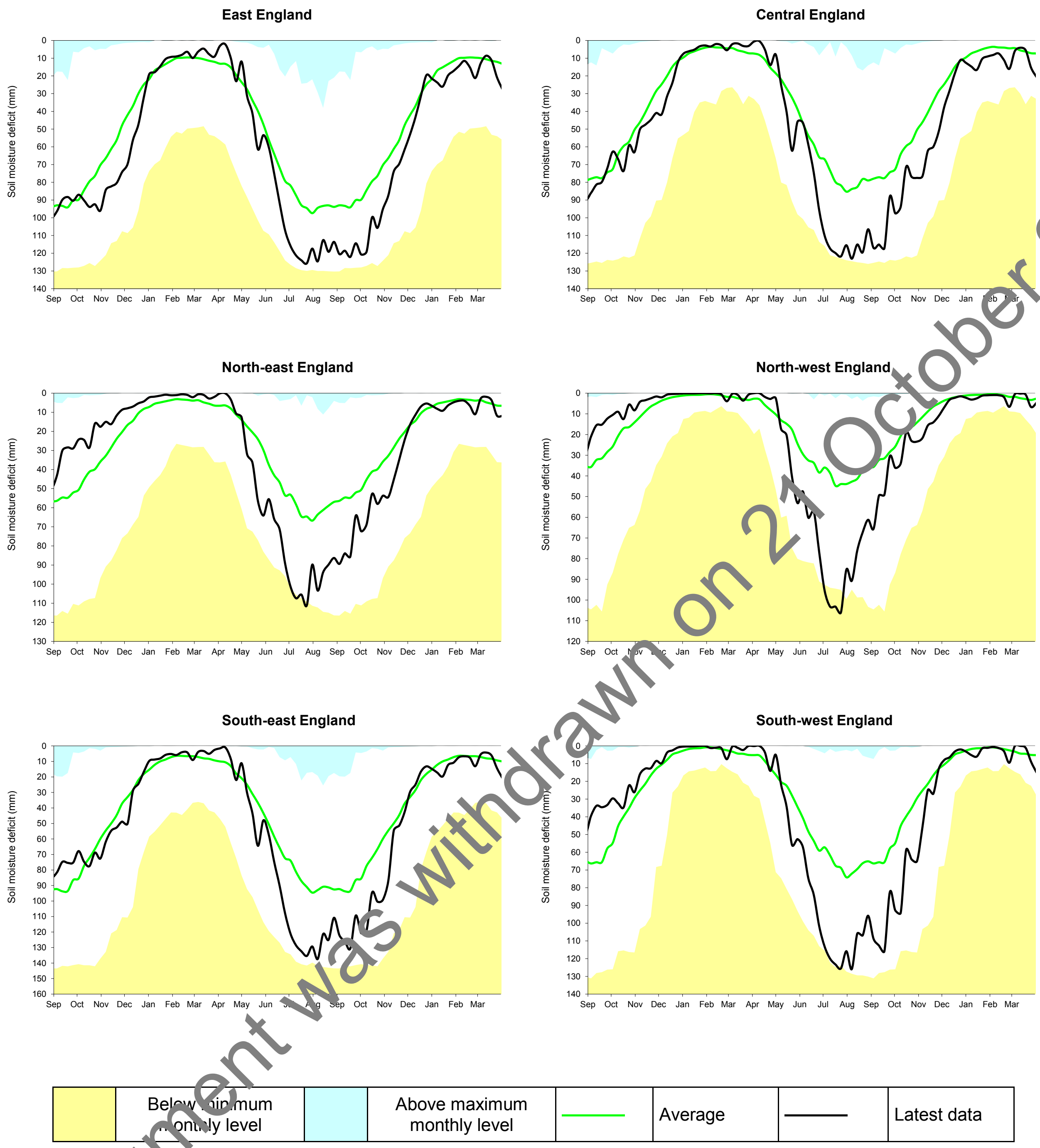
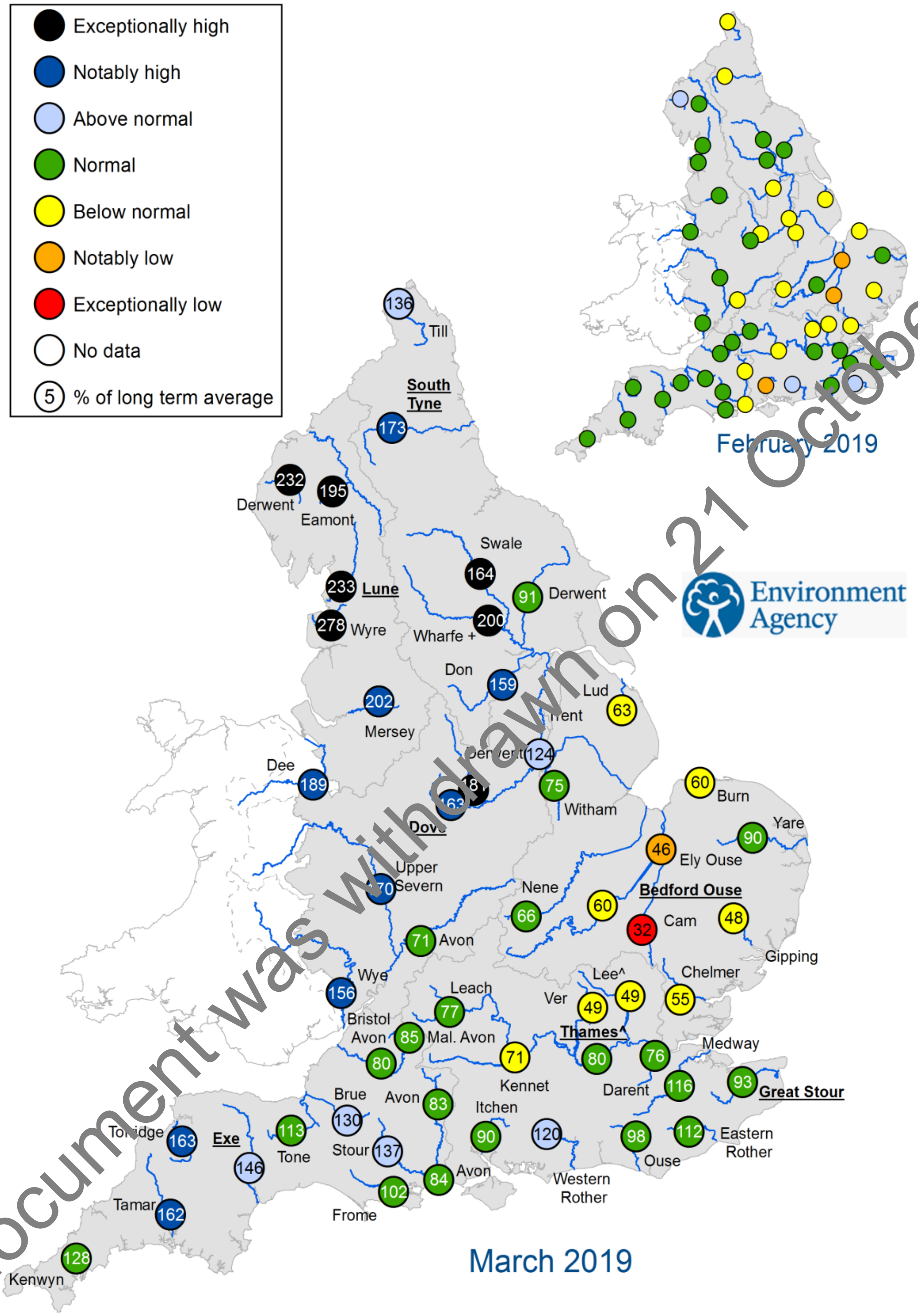


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2019).

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 February and March 2019, expressed as a percentage of the respective long term average and classed relative to an analysis of historic February and March monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.

River flow charts

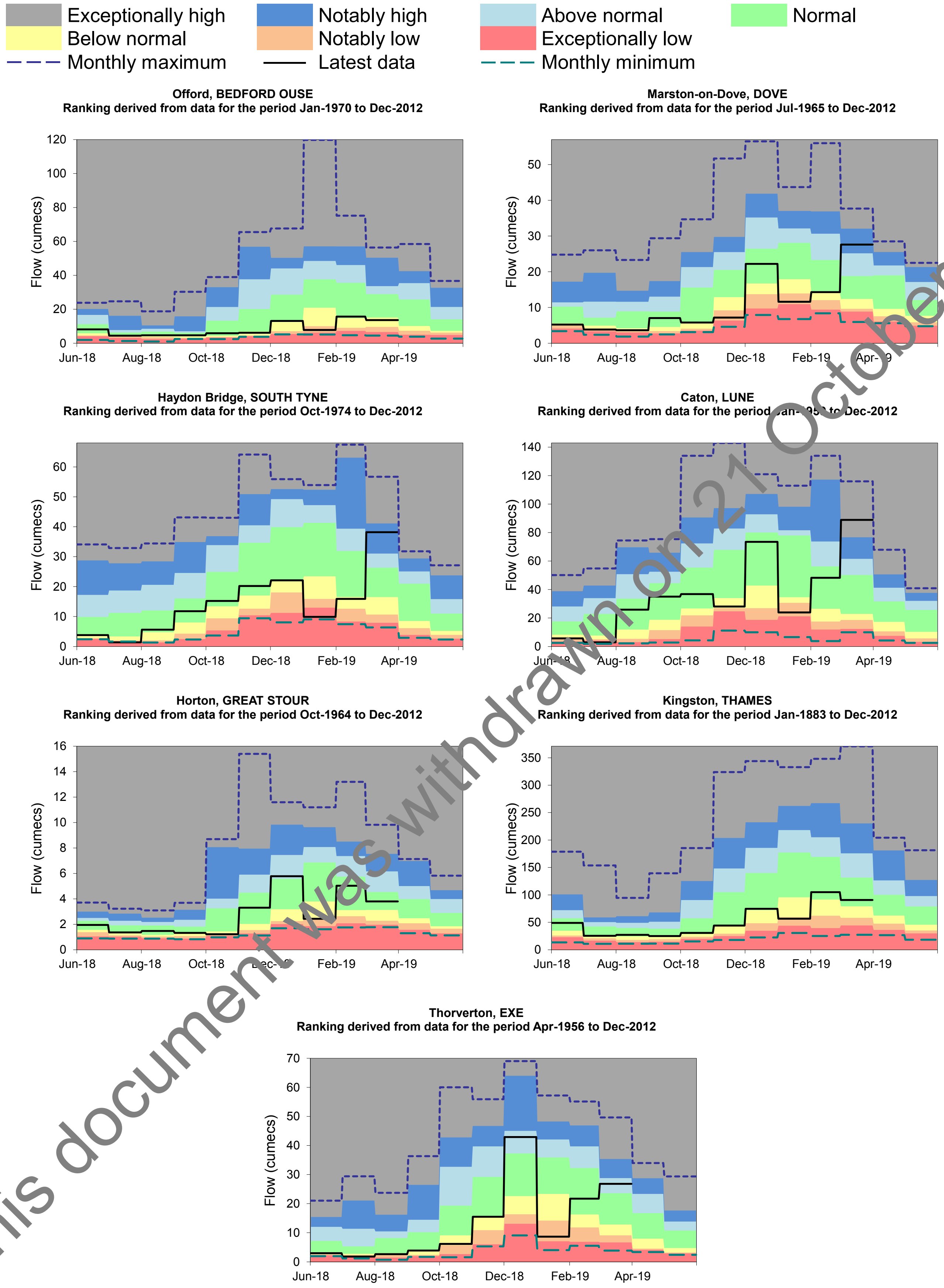
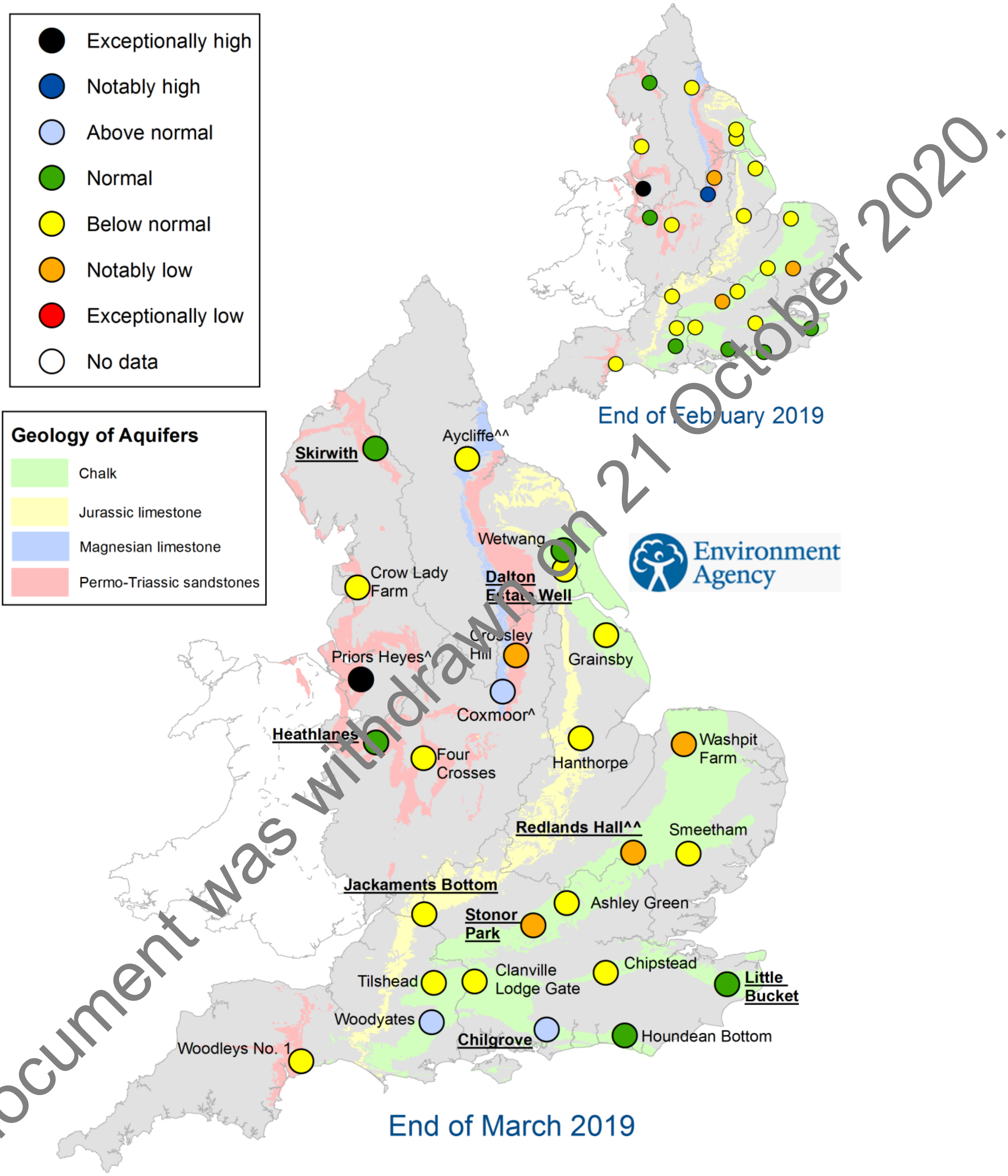


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows (Source: Environment Agency).

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
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 February and March 2019, classed relative to an analysis of respective historic February and March levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.

Groundwater level charts

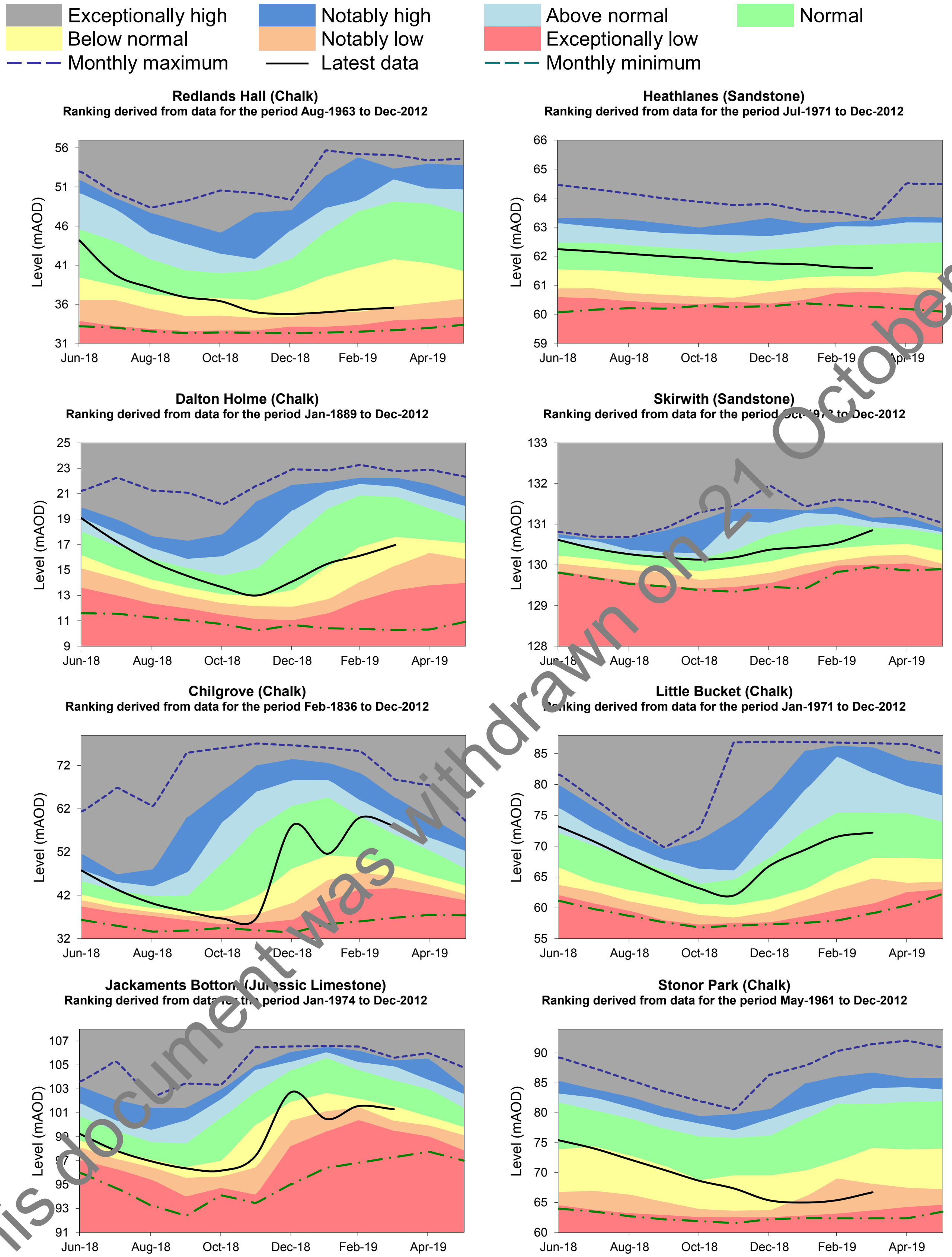
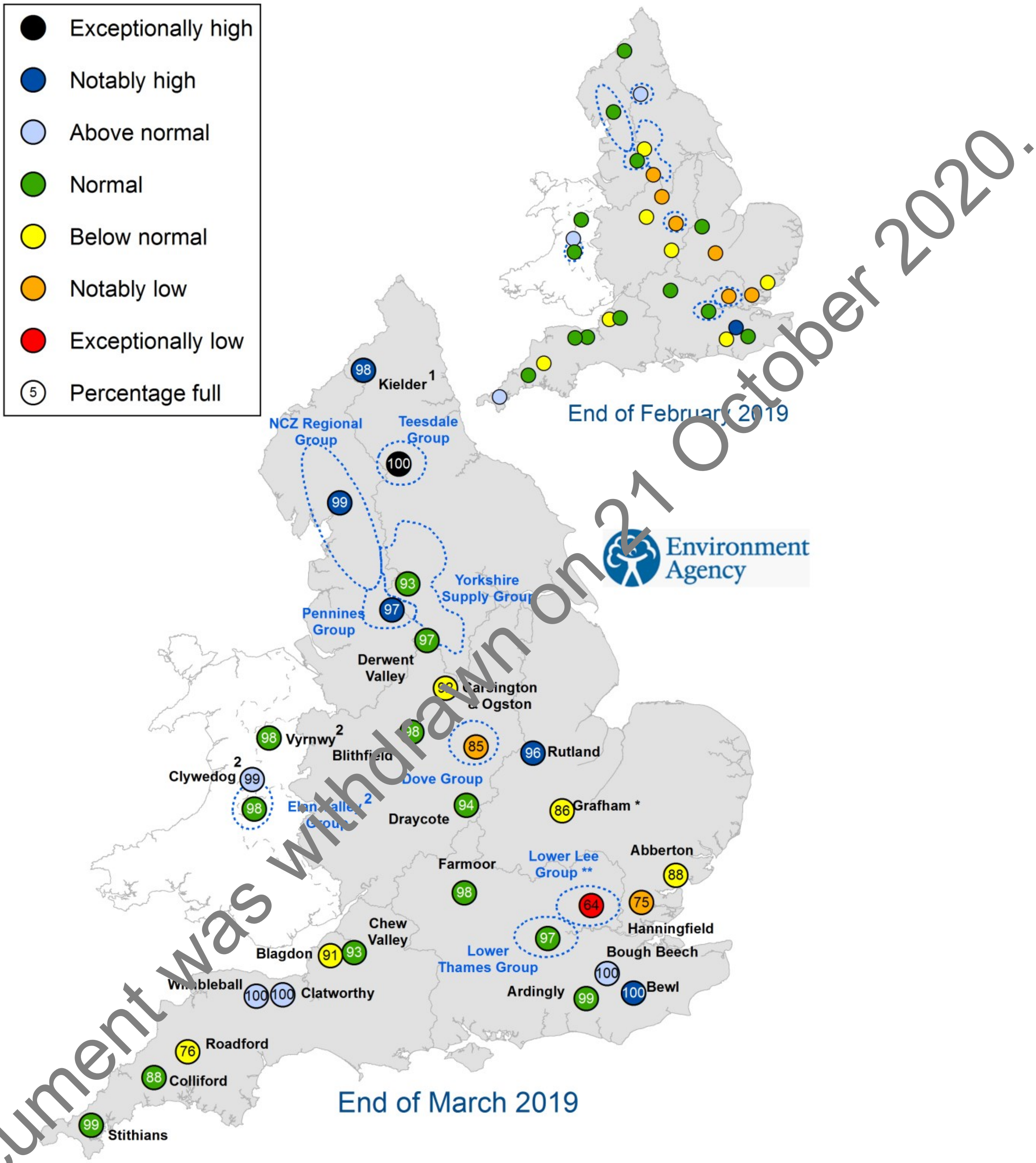


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2019).

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
* Levels at Grafham affected by engineering works in late 2018
** Maintenance of the Thames Lee Tunnel since mid-January has resulted in the reservoirs being drawn down

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of February and March 2019 as a percentage of total capacity and classed relative to an analysis of historic February and March 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, 2019.

Reservoir storage charts

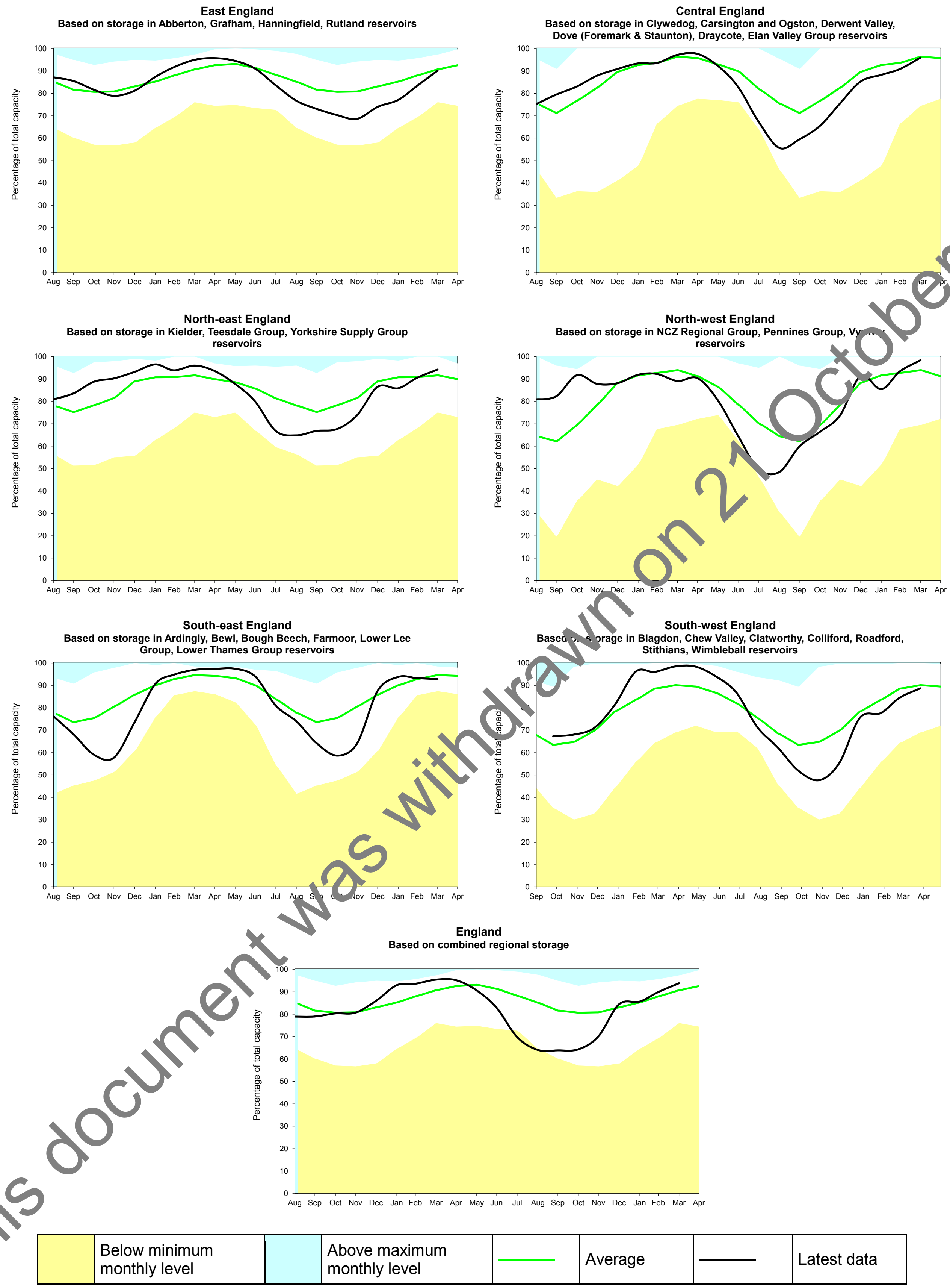


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

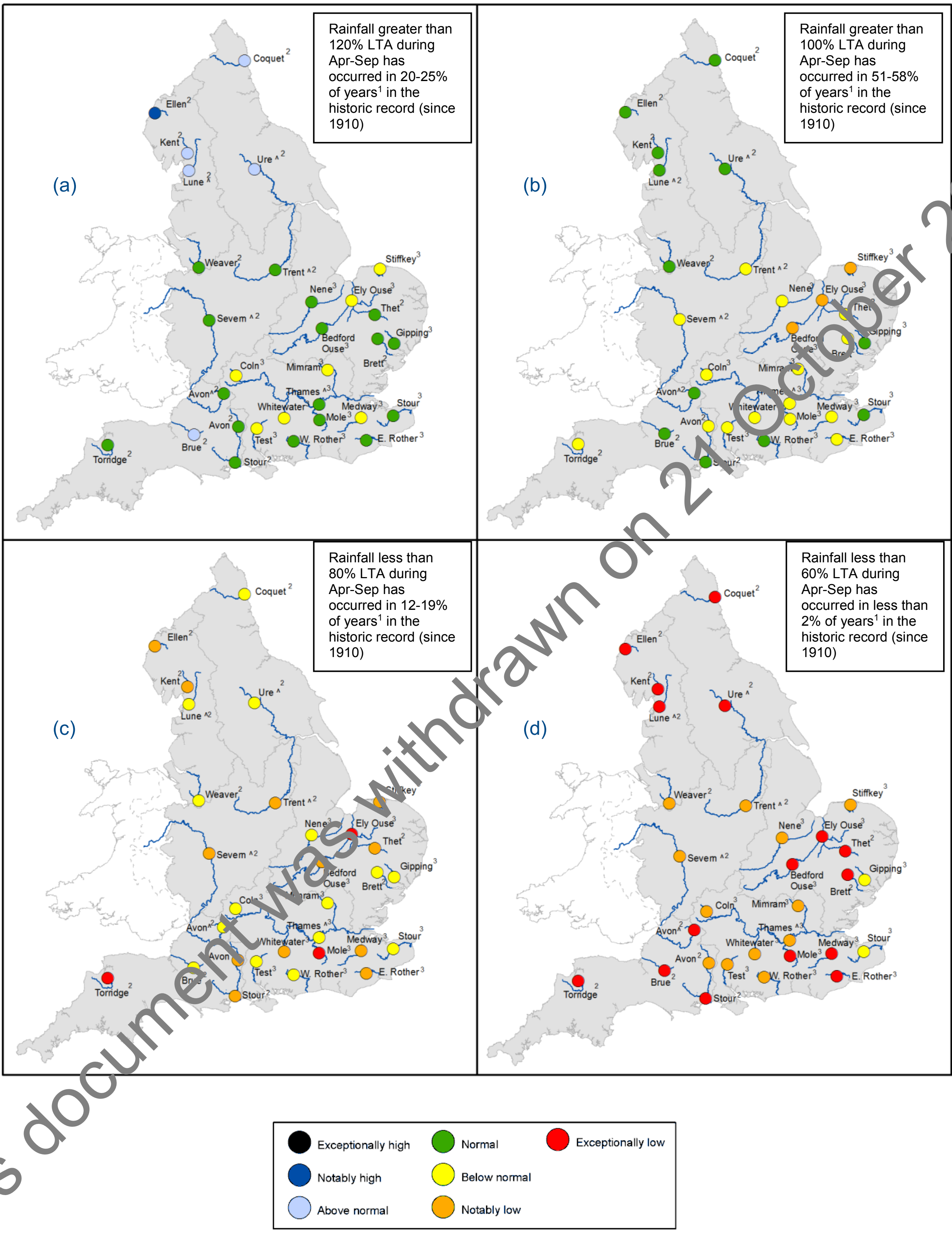


Figure 6.1: Projected river flows at key indicator sites up until the end of September 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April and September 2019 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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*

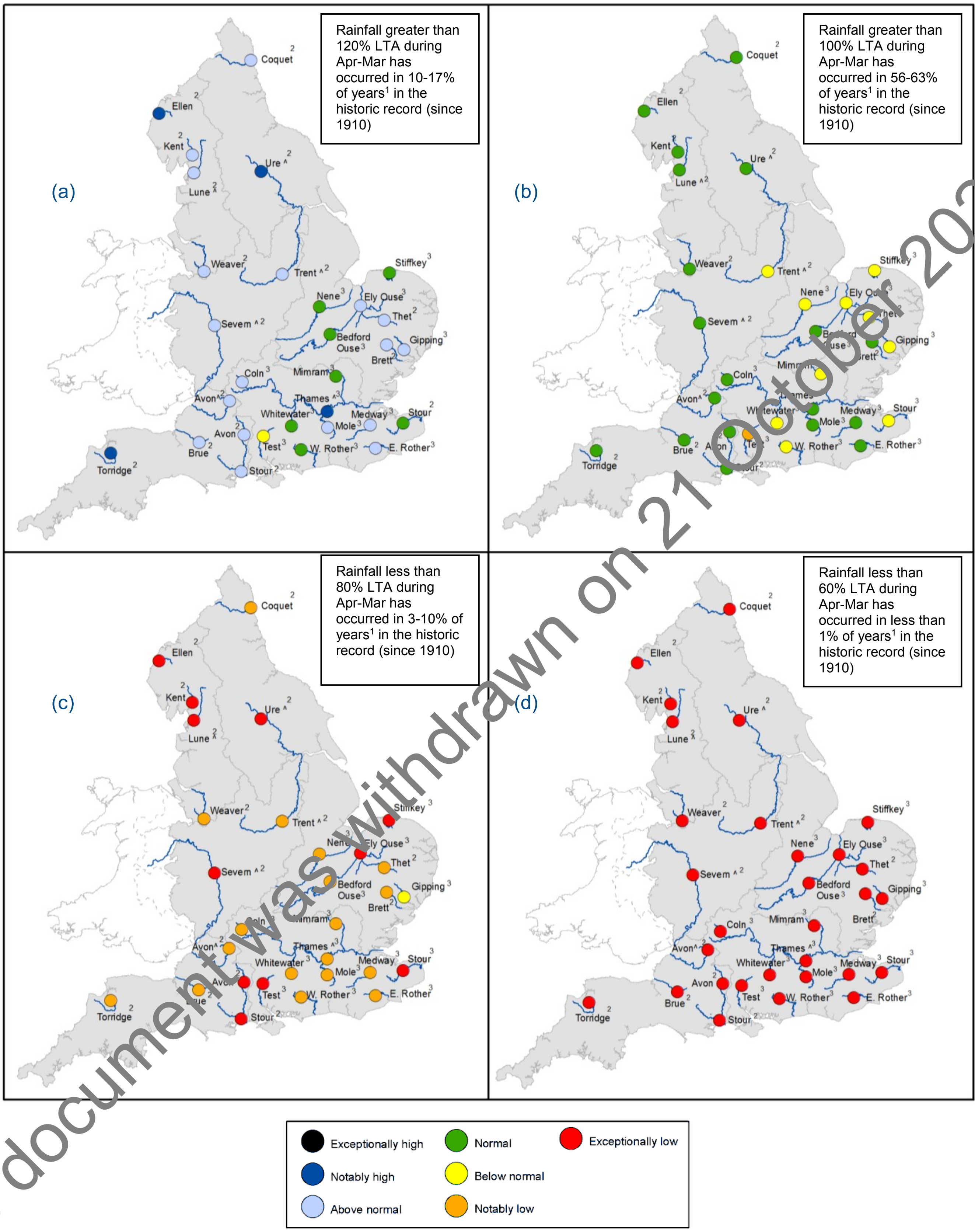


Figure 6.2: Projected river flows at key indicator sites up until the end of March 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2019 and March 2020 (Source: Centre for Ecology and Hydrology, Environment Agency).

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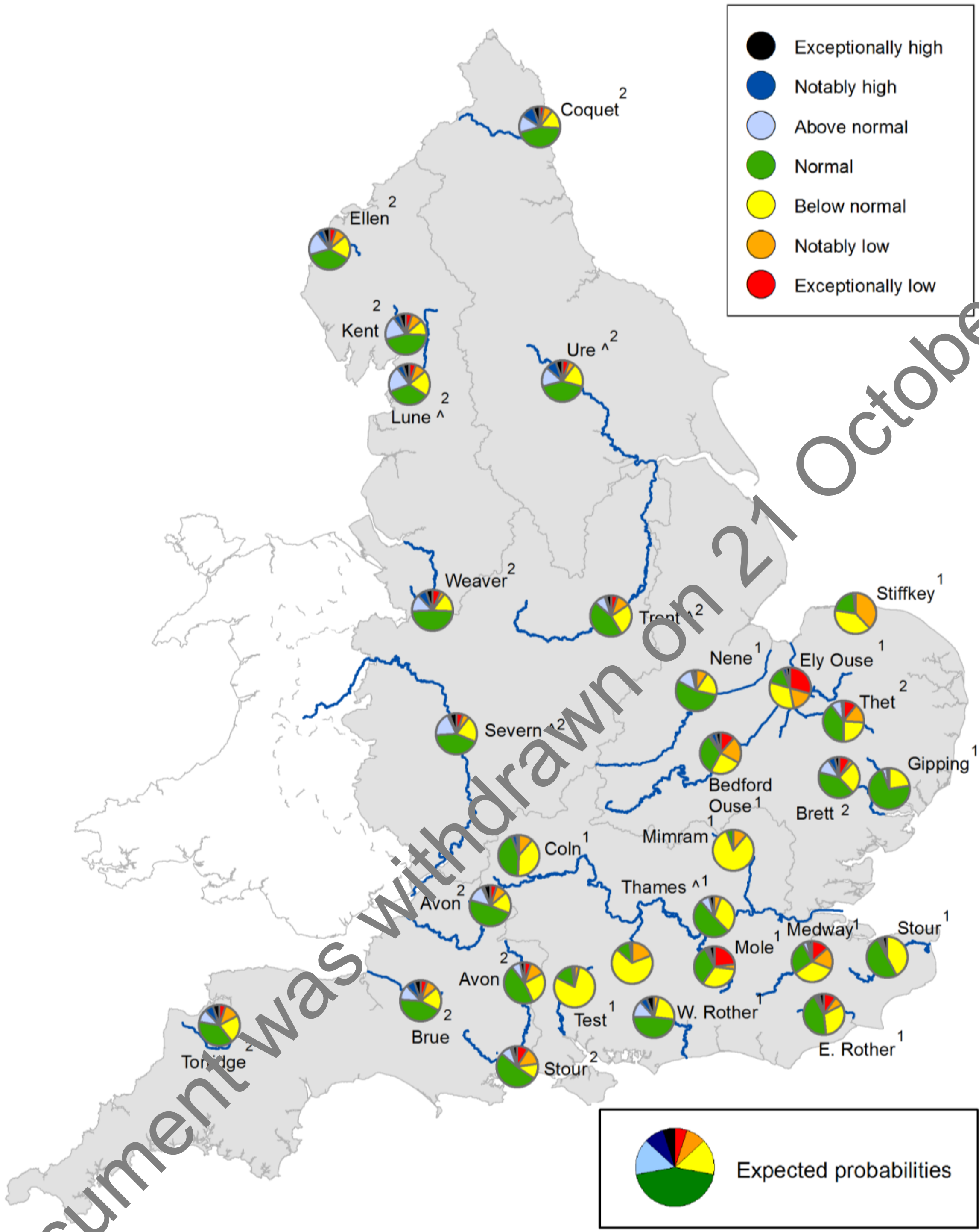

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 September 2019. 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).

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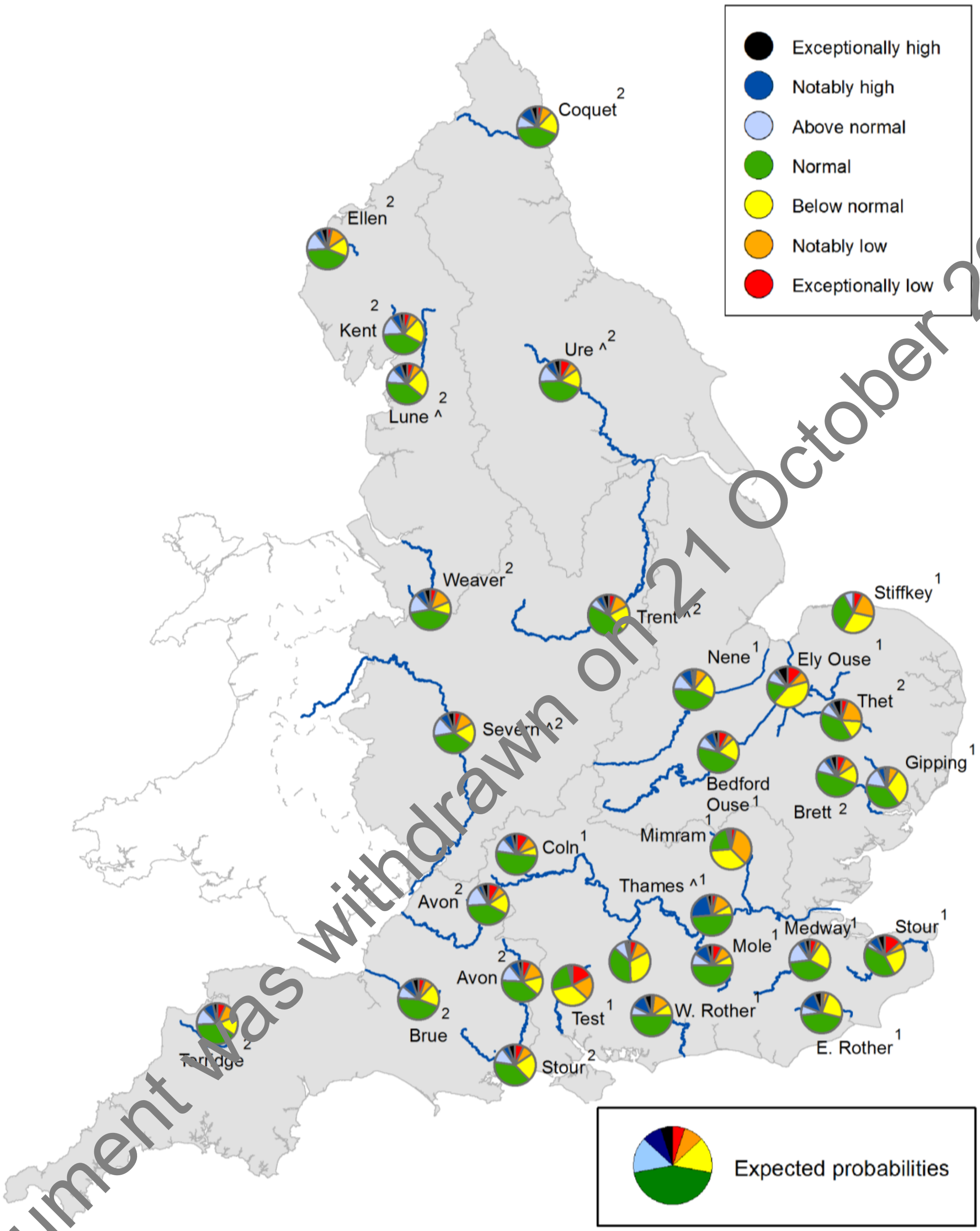
^"Naturalised" flows are projected for these sites



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 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

Forward look - groundwater

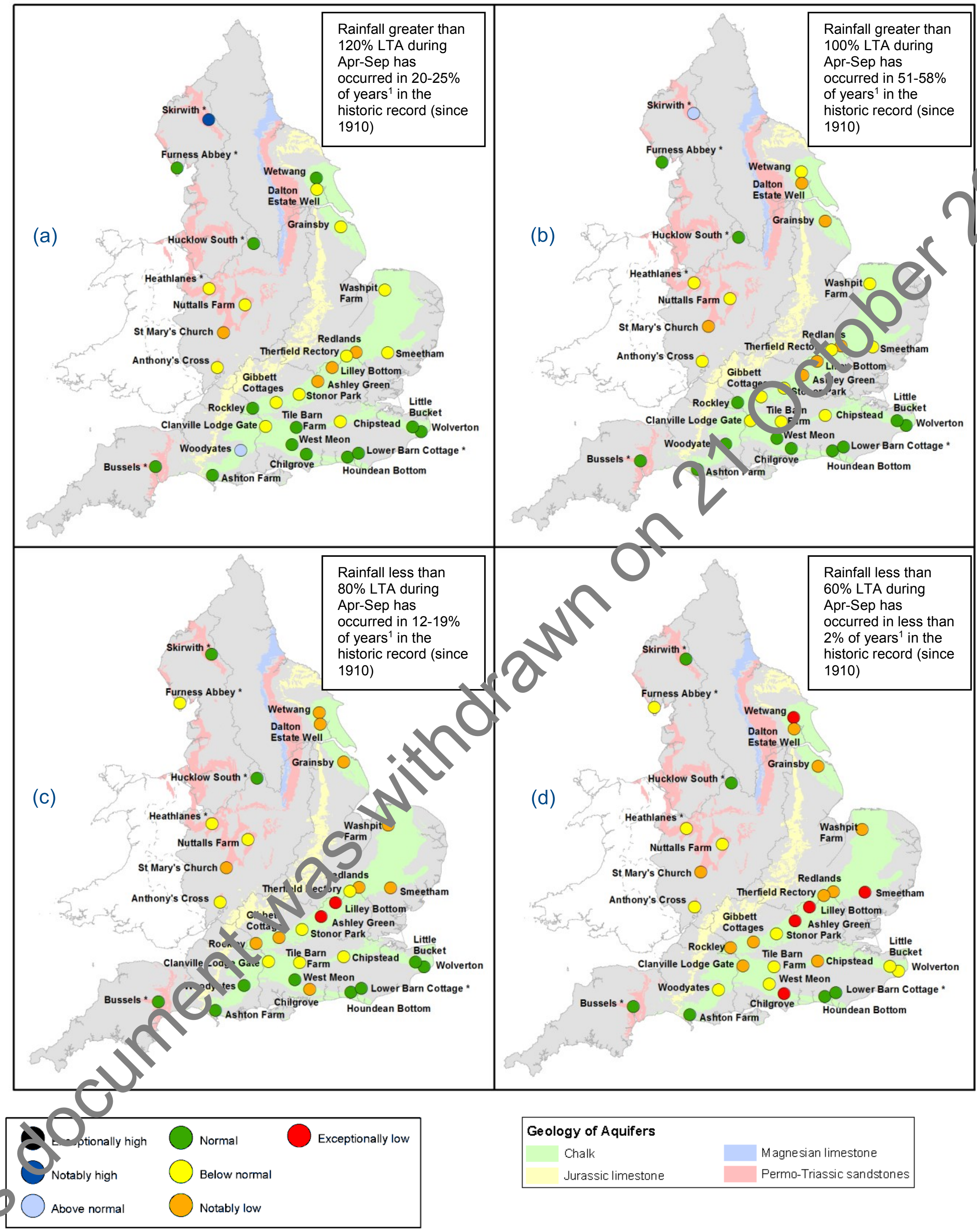


Figure 6.5: Projected groundwater levels at key indicator sites at the end of September 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April and September 2019 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2019.

* Projections for these sites are produced by BGS

[1] This range of probabilities is a regional analysis

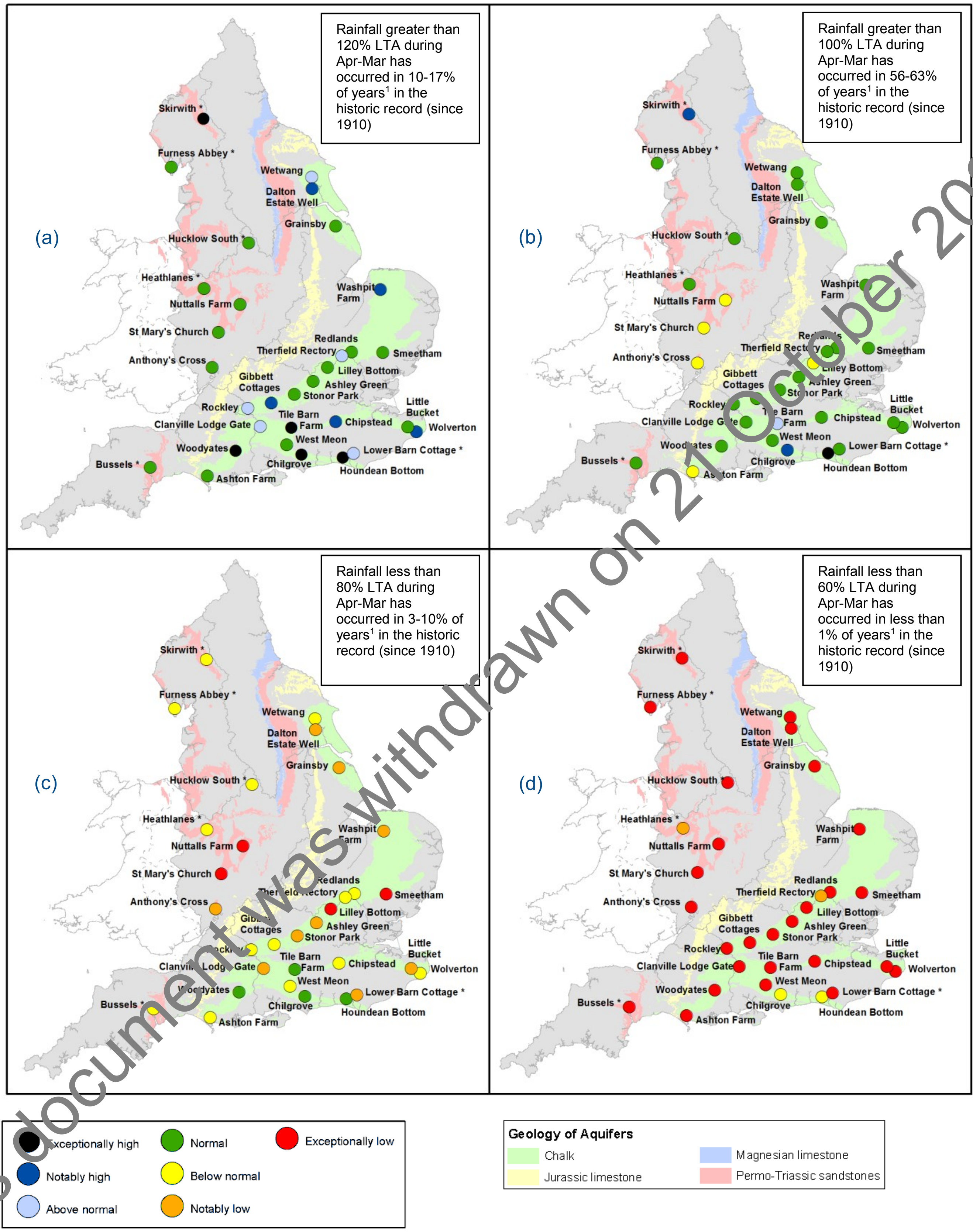
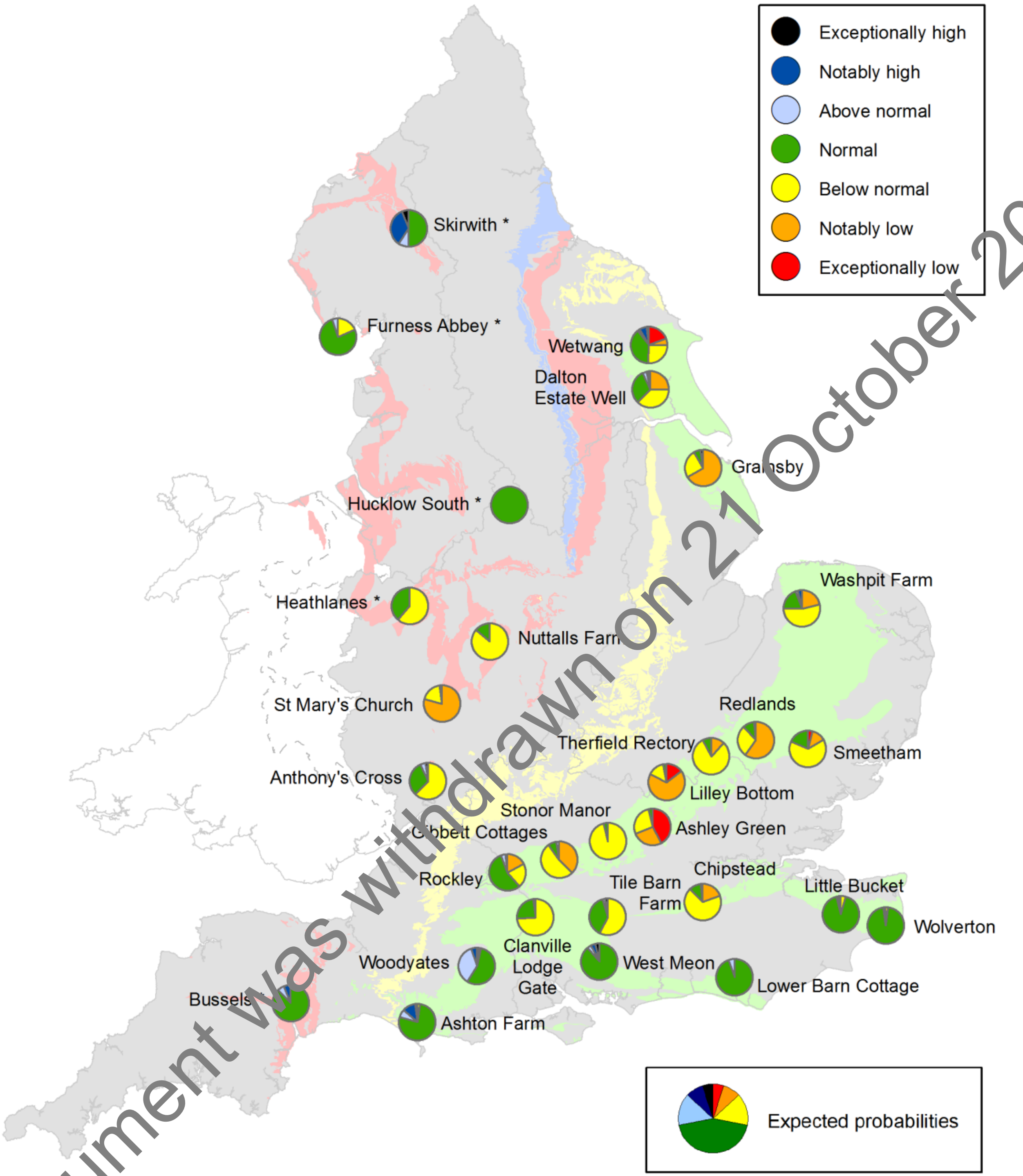


Figure 6.6: Projected groundwater levels at key indicator sites at the end of March 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2019 and March 2020 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2019.

* 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 September 2019. 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, 2019.

* Projections for these sites are produced by BGS

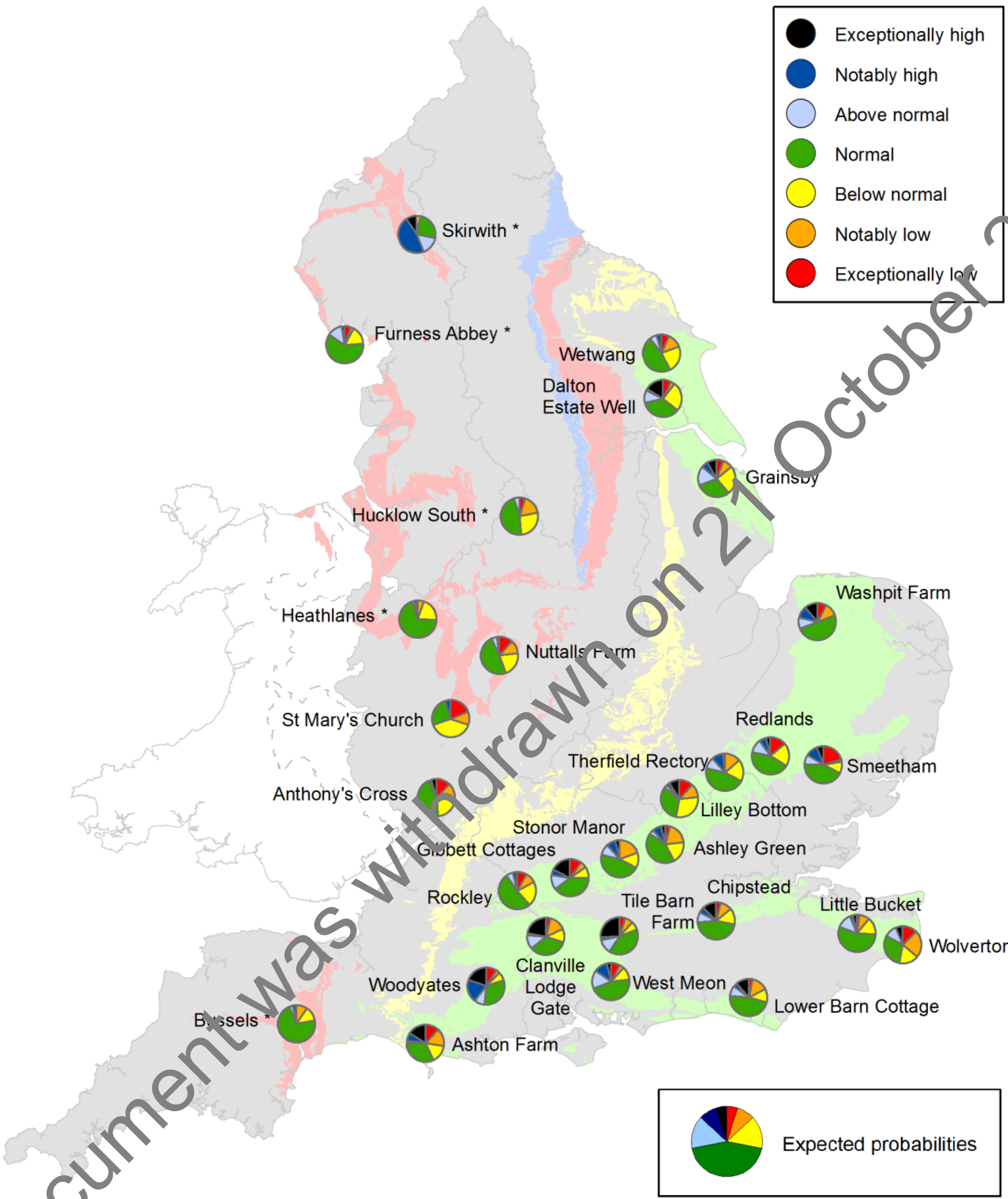


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Figure 6.8: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of March 2020. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the 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, 2019.

* 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 1961-1990, 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