Monthly water situation report

England

Summary – June 2019

June's rainfall was above average across England at 181% of the long term average. Soils became wetter throughout much of England by the end of June, but remain drier than average in south-east and south-west England. River flows increased at the majority of sites during June, and were classed as normal or higher for the time of year at four-fifths of the sites reported on. Groundwater levels continued to decline during June at the majority of sites we report on, and at the end of the month were lower than normal for the time of year at nearly two-thirds of sites. Total reservoir stocks for England were at 88% of capacity at the end of June, a slight increase compared with stocks at the end of May.

Rainfall

The June rainfall total for England was 110mm, which is 181% of the 1961-90 long term average (LTA) (177% of the 1981-2010 LTA). Above average rainfall for June was seen across almost all parts of England, bringing a marked change from the previous two months of below average rainfall seen in most regions. The highest rainfall totals relative to the June LTA were seen mostly in parts of central and east England, notably in parts of Lincolnshire and Norfolk where some areas had more than 290% of the June LTA rainfall, and parts of Norfolk, Shropshire, Warwickshire, Staffordshire and Leicestershire which had more than 200% of the June LTA rainfall (Figure 1.1).

June rainfall totals were classed as exceptionally high for the time of year in the majority of catchments across central and east England. Elsewhere, rainfall totals were classed as above normal or notably high across most of the catchments, with a small number of catchments classed as normal for the time of year, mostly in north-west England. It was the 2nd wettest June on record in the Dee catchment, on the Shropshire plains, and in the Steeping Great Eau and Long Eau, and South Forty Foot and Hobhole catchments in Lincolnshire as well as the Seaham area in County Durham. Cumulative rainfall totals for the past 6 months were mostly normal across north-west and north-east England, central and parts of east England, and mostly below normal in south-east England and parts of east and south-west England (Figure 1.2).

For England as a whole, this was the 8th wettest June on record (records assessed from 1891) and the wettest since 2012. At a regional scale, it has been the 3rd wettest June on record for central England, and the 6th wettest June on record for east England. June rainfall totals were well above average across England, most notably in central and east England where rainfall totals were 233% and 202% of the LTA rainfall respectively. Elsewhere, totals ranged from 152% of the LTA in north-west England to 175% LTA in north-east England (Figure 1.3).

Soil moisture deficit

Soils became wetter across much of England during June, most notably in central areas, with parts of Derbyshire, Nottinghamshire, Staffordshire, Leicestershire and Lincolnshire seeing decreases in soil moisture deficits (SMDs) of more than 30mm. In contrast, in parts of Yorkshire, Kent, Hampshire and Sussex soil moisture deficits increased by around 20mm by the end of the month. Soils remained drier than average across much of south-west, south-east and east England (Figure 2.1).

At a regional scale, SMDs decreased during June in all regions, and by the end of the month soils were wetter than average for the time of year in central, north-east and north-west England, close to average in east England but remained drier than average in south-east and south-west England (Figure 2.2).

River flows

Monthly mean river flows for June increased at almost four-fifths of the indicator sites, compared with May flows, following the above average rainfall across much of England during June. Sites where monthly mean river flows decreased compared with May are all located in south-east and south-west England, with the exception of the Cam at Dernford in east England (Figure 3.1).

Monthly mean river flows were classed as normal or higher for the time of year at four-fifths of the sites reported on across England. River flows were classed as notably high for the time of year at 8 sites, and exceptionally high at 4 sites; the Upper Witham at Claypole and the Lud at Louth Weir in east England, the Severn at Bewdley in central England and the Dee at Manley Hall in Wales. Monthly mean flows on the River Cam were classed as exceptionally low for the fourth consecutive month, and are the lowest mean June flow on record (records since 1966) for this river (Figure 3.1).

At the regional index sites, June flows were normal or higher for the time of year at all except one site, the Thames at Kingston, where flows were classed as below normal. Flows on the River Dove (central England) and South Tyne (north-east England) were notably high (Figure 3.2).

Groundwater levels

Groundwater levels continued to recede during June at the majority of sites, and at the end of the month, levels were lower than at the end of May at around three-quarters of the indicator sites. As a result of above average rainfall totals there was some recovery in the fast responding limestone aquifers where levels were classed as normal for the time of year. Elsewhere, at nearly two-thirds of the sites, end of month groundwater levels were classed as below normal or lower (Figure 4.1).

At the major aquifer index sites, the end of month groundwater levels were classed as notably low at Redlands Hall (Cam and Ely Ouse chalk aquifer) and Stonor Park (South West Chilterns chalk aquifer). Dalton Estate Well (Hull and East Riding chalk aquifer) was below normal whilst the remaining sites were classed as normal (Figures 4.1 and 4.2).

Reservoir storage

Reservoir stocks increased during June at more than half of the reported reservoirs and reservoir groups in England. The largest increases as a proportion of total storage capacity were seen in south-west, south-east and central England, with storage at Wimbleball being 16% greater than the previous month. Reservoir stocks at the end of June were classed as normal for the time of year at nearly half of reported reservoirs and reservoir groups. Around a third of sites reported on were classed as below normal or lower for the time of year (Figure 5.1)

At a regional scale, total reservoir stocks increased across England, with the largest increase of 4% of total capacity seen in south-east and south-west England at the end of June. Total reservoir stocks for England were at 88% of capacity by the end of the month, which is below average for the time of year (Figure 5.2).

Forward look

July is expected to be dry and settled everywhere to begin with, with unsettled conditions moving into the north of England in the second week, spreading to all areas. High pressure is expected to become established to the south of the UK from mid-July, with low pressure to the north. This will bring outbreaks of rain and showers, particularly in the north. For July, for the UK, wetter than average conditions are marginally more likely. For the three month period July to September, the chances of above or below average precipitation are similar[1].

Projections for river flows at key sites[2]

Nearly two-thirds of the modelled sites have a greater than expected chance of cumulative river flows being normal or higher for the time of year by the end of September 2019. By the end of March 2020, just over half of the modelled sites have a greater than expected chance of flows being below normal or lower for the time of year.

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]

Nearly 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 September 2019, increasing to three-quarters of sites by the end of 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

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).

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

Rainfall

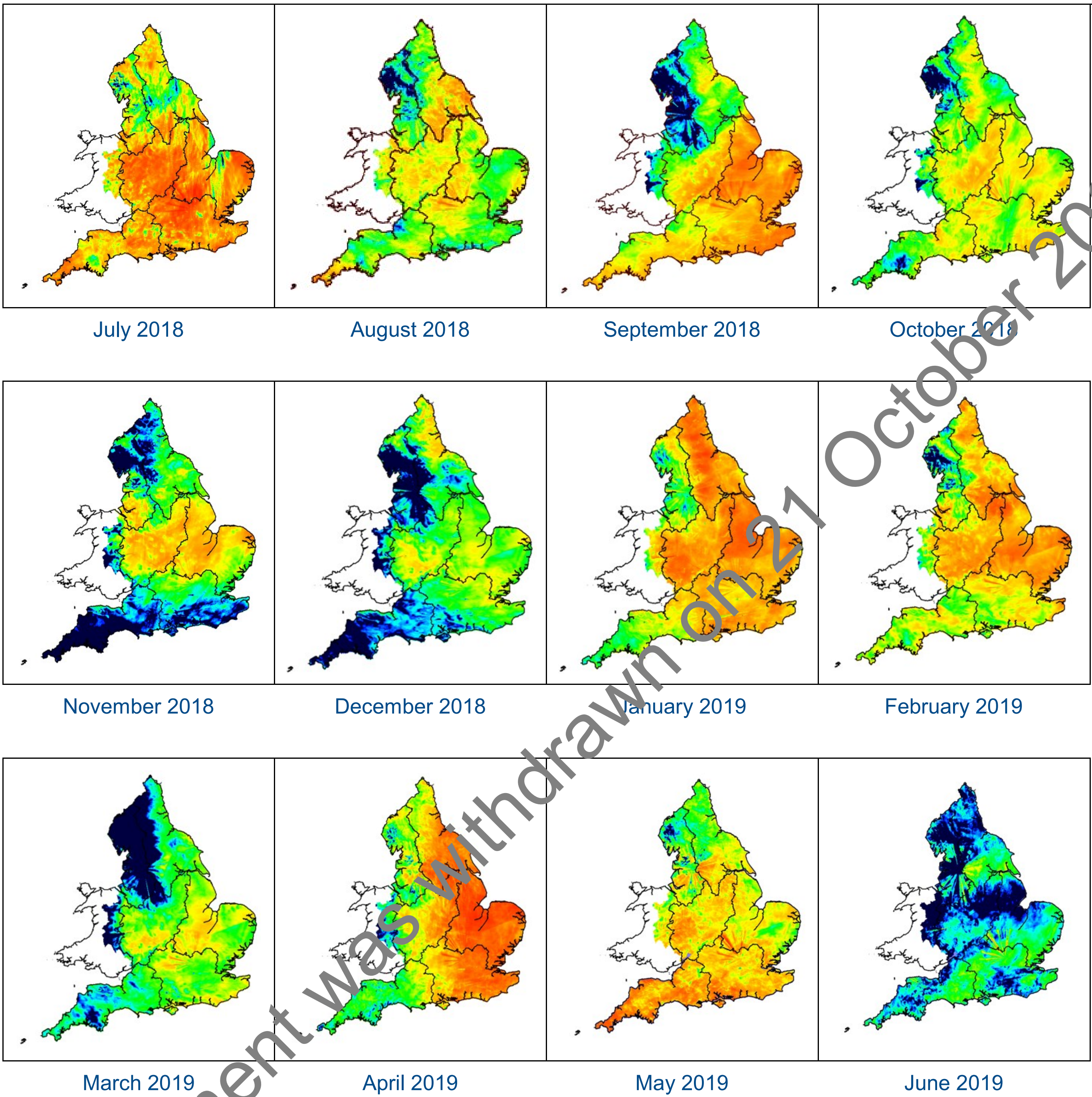
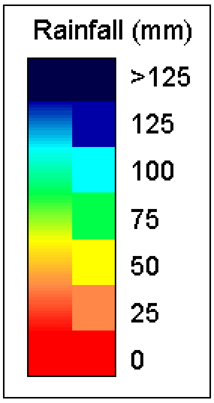


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2019). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.



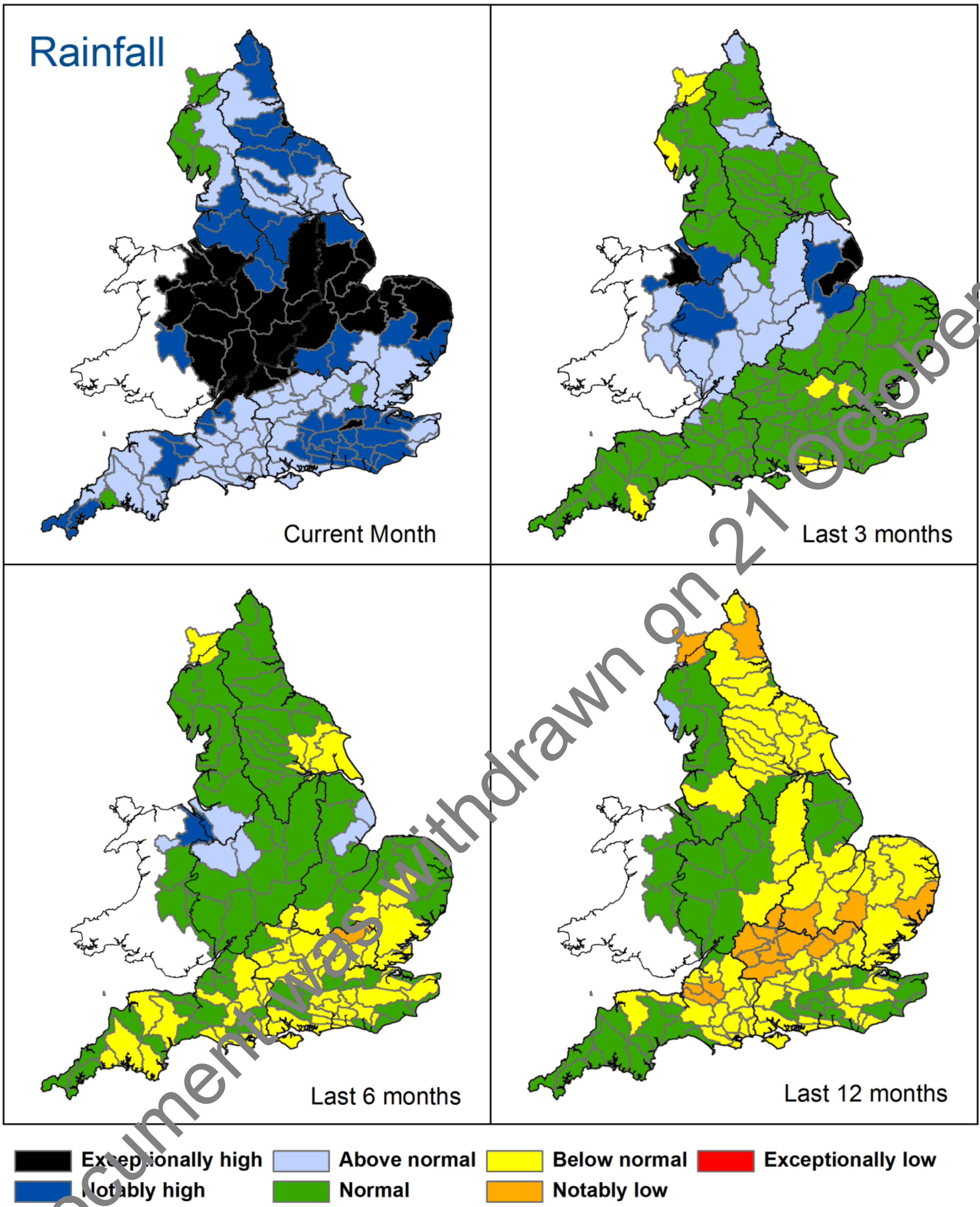


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 June), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final HadUK-Grid data based on the Met Office 1km gridded rainfall dataset 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

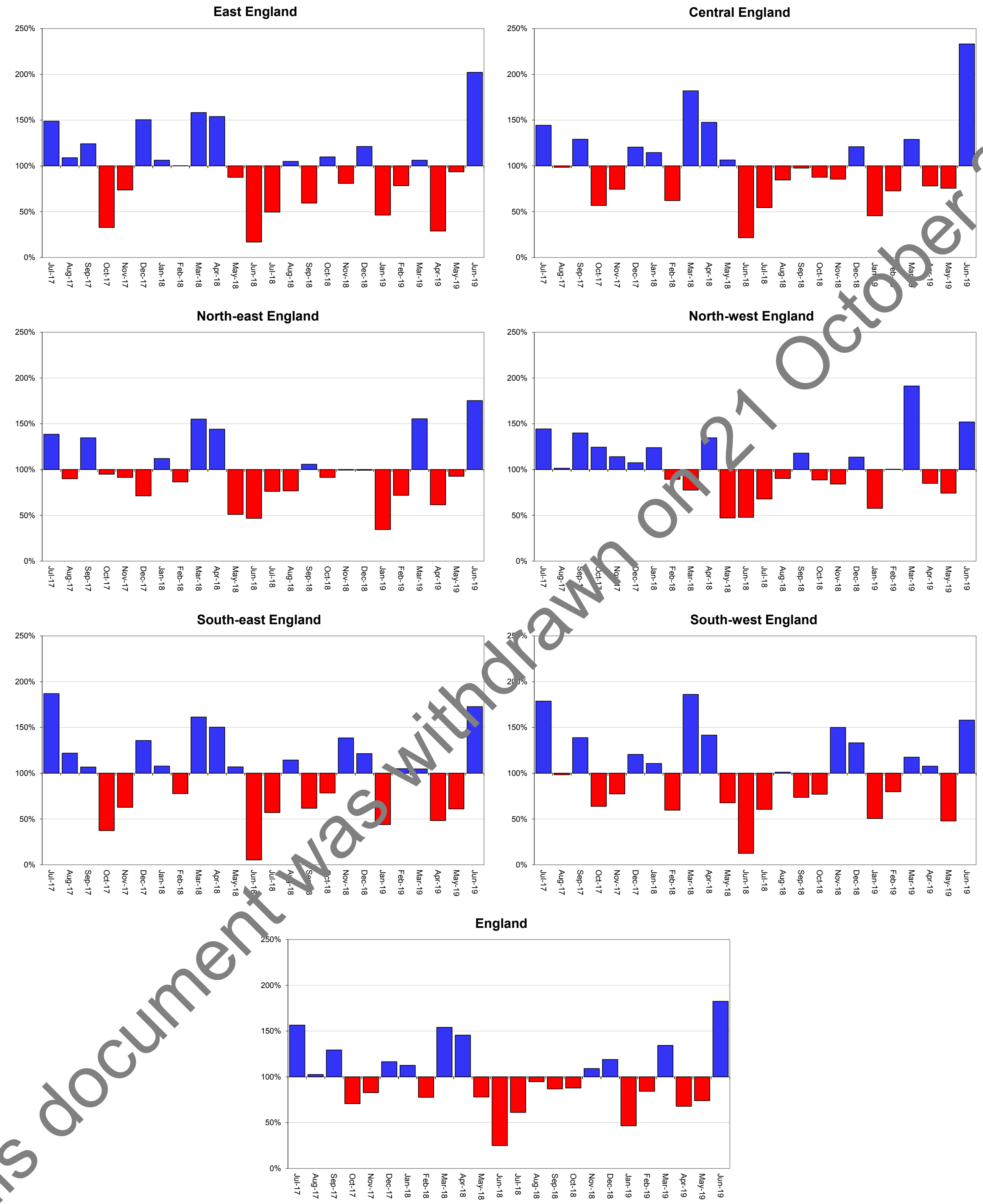


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. HadUK-Grid data. (Source: Met Office © Crown Copyright, 2019).

Soil moisture deficit

End of May 2019[1]	End of June 2019[2]

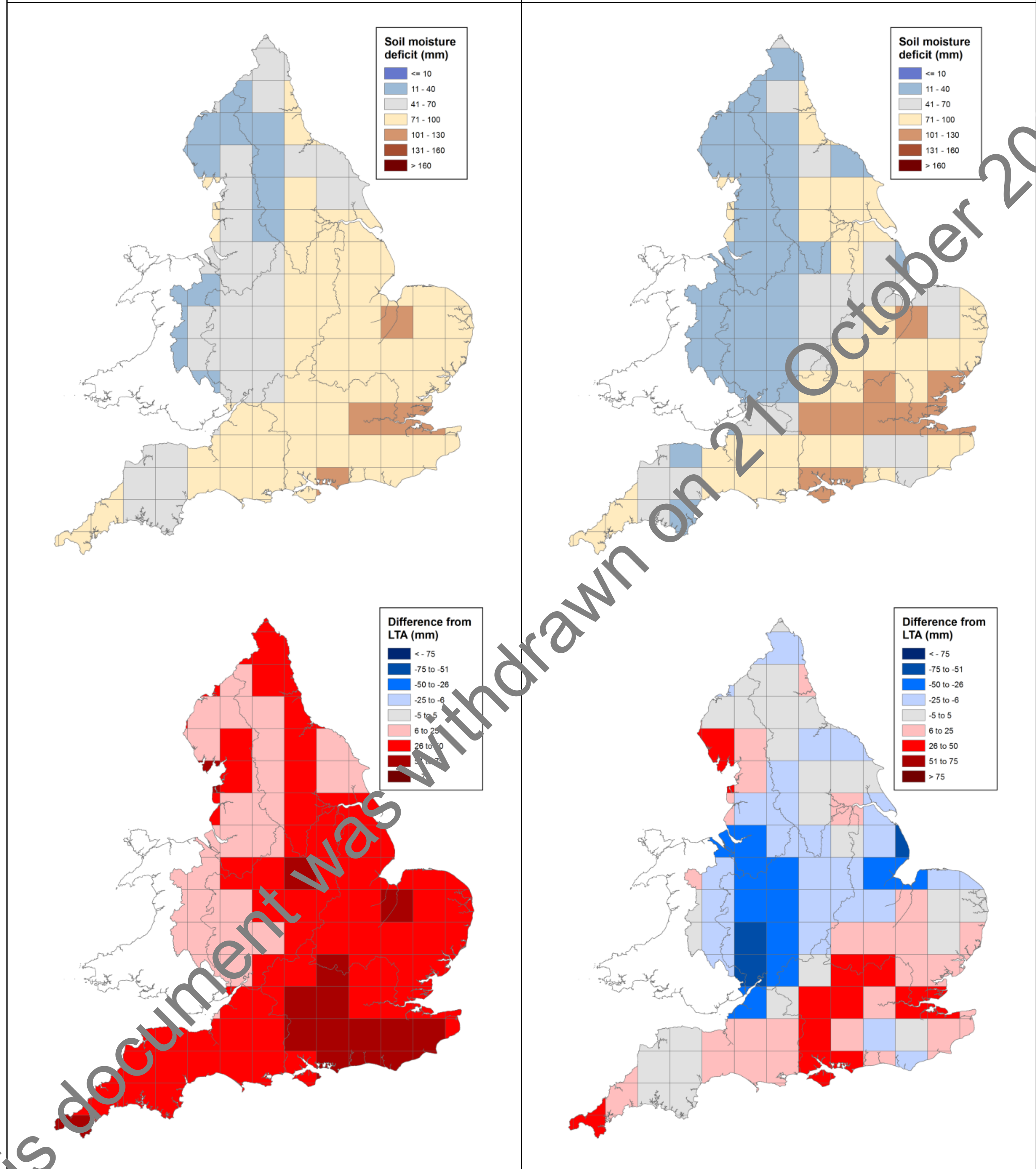
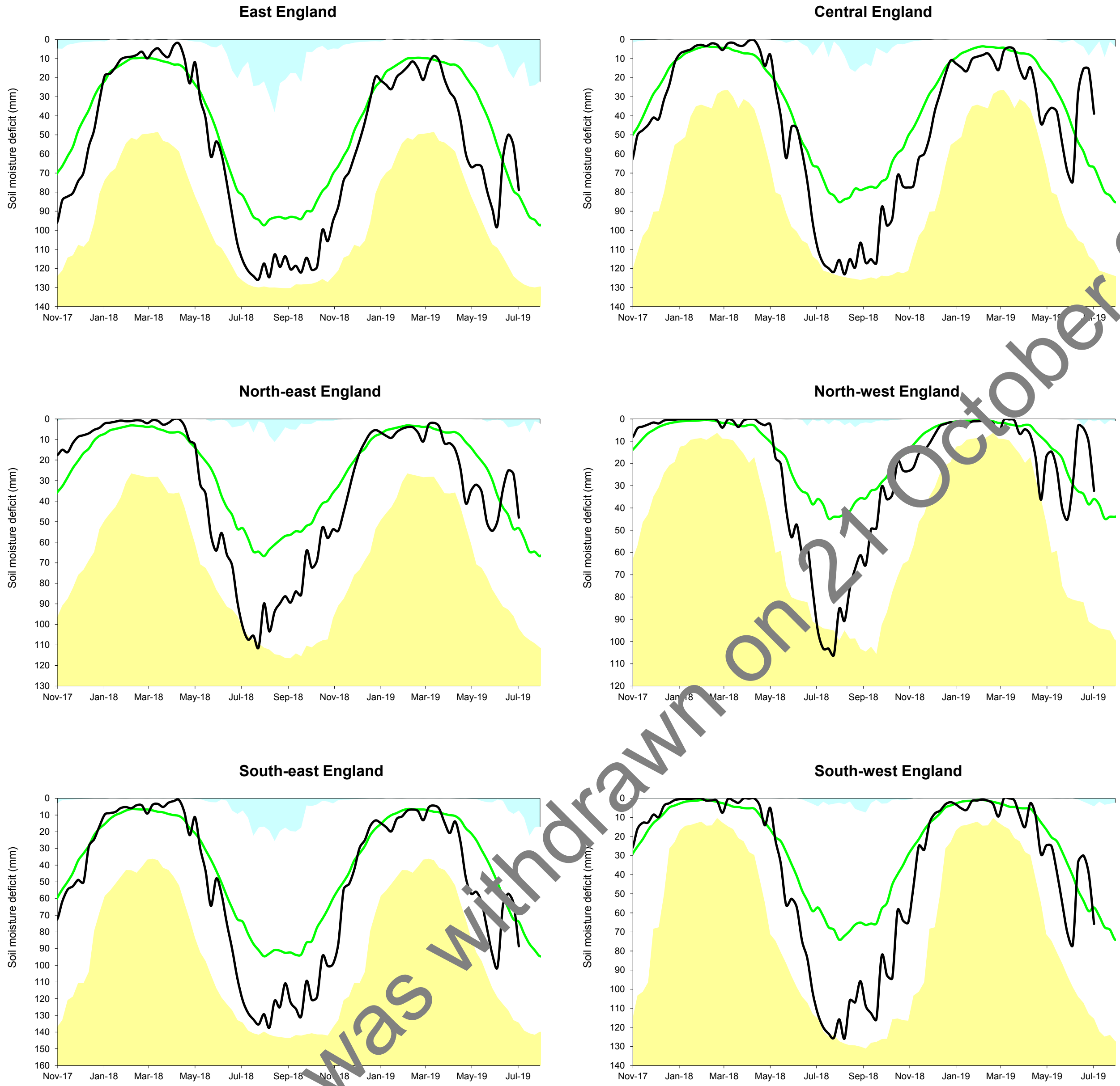


Figure 2.1: Soil moisture deficits for weeks ending 28 May 2019 [1] (left panel) and 2 July 2019 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2019). Crown copyright. All rights reserved. Environment Agency, 100026380, 2019

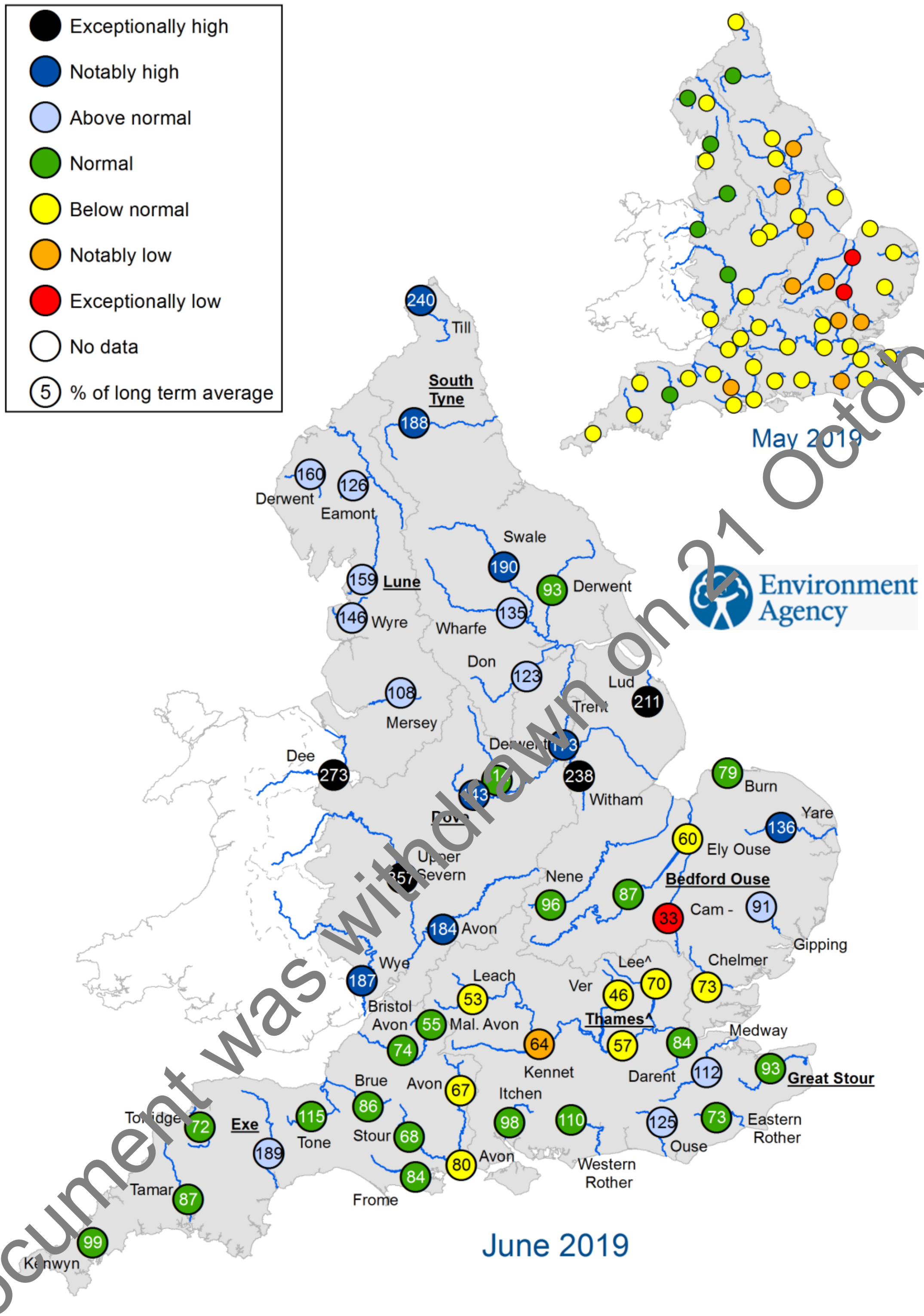
Soil moisture deficit charts



	Below minimum monthly level		Above maximum monthly level		Average		Latest data

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

River flow charts

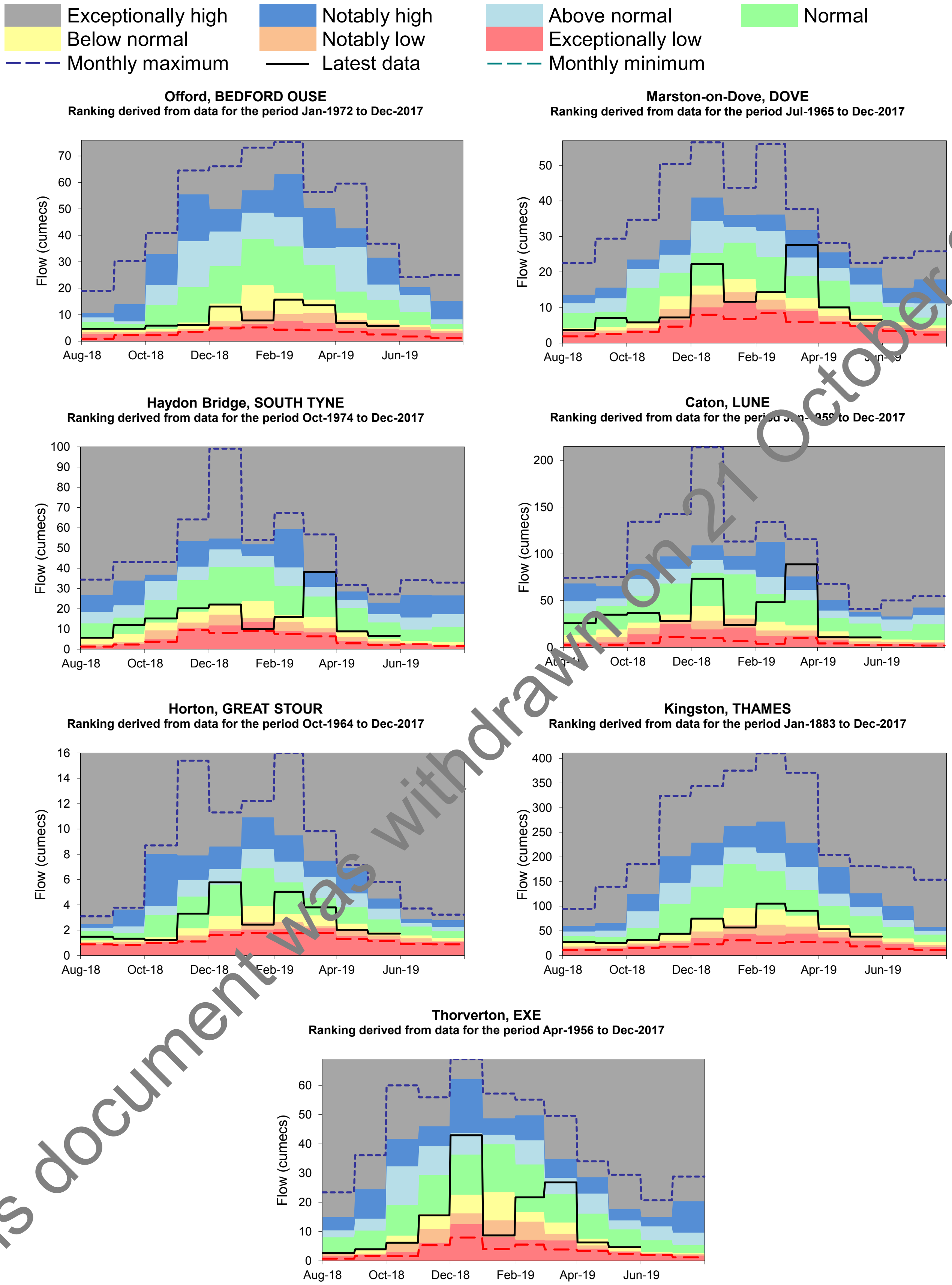
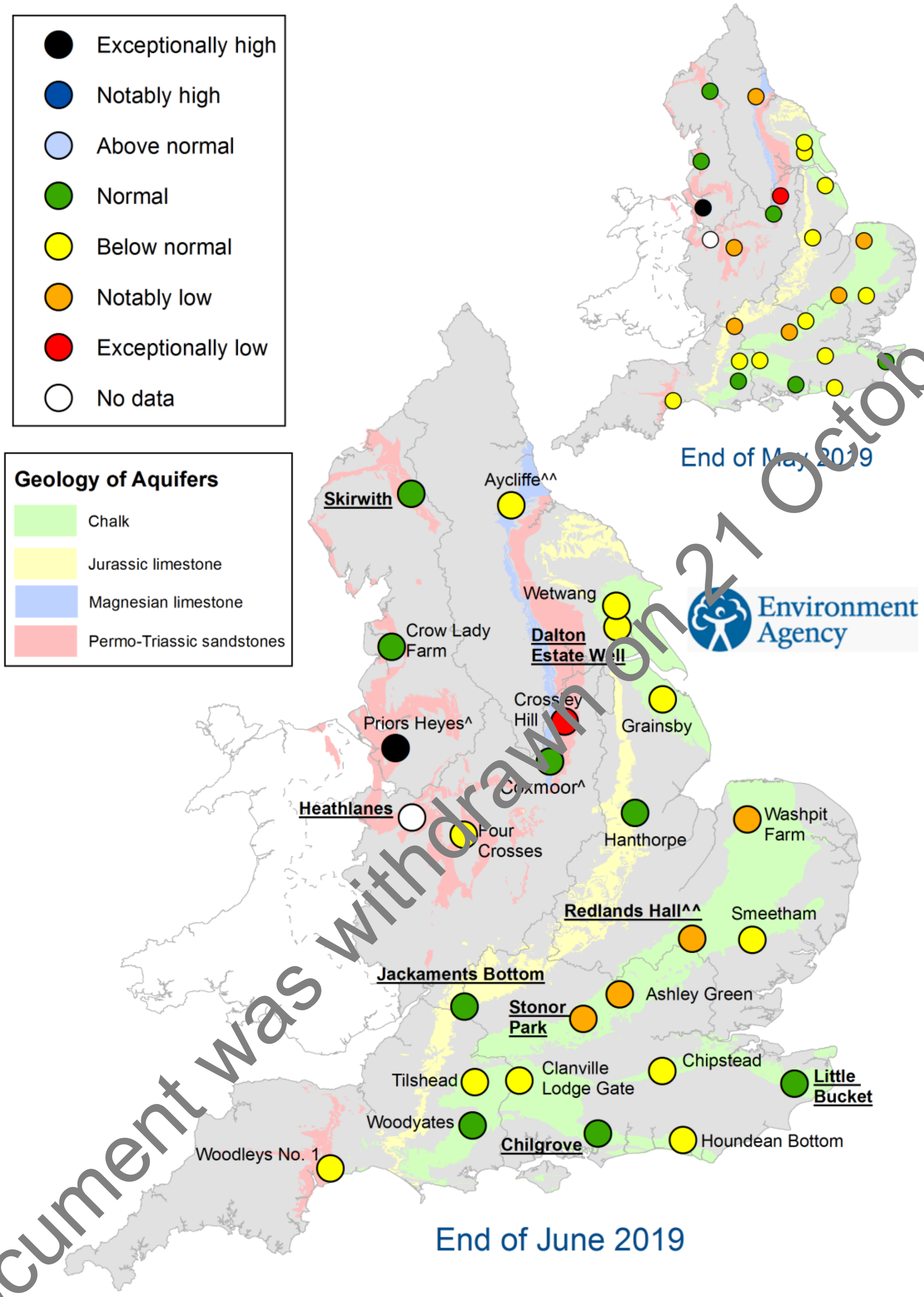


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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
+/- End of month groundwater level is the highest/lowest 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 May and June 2019, classed relative to an analysis of respective historic May and June 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

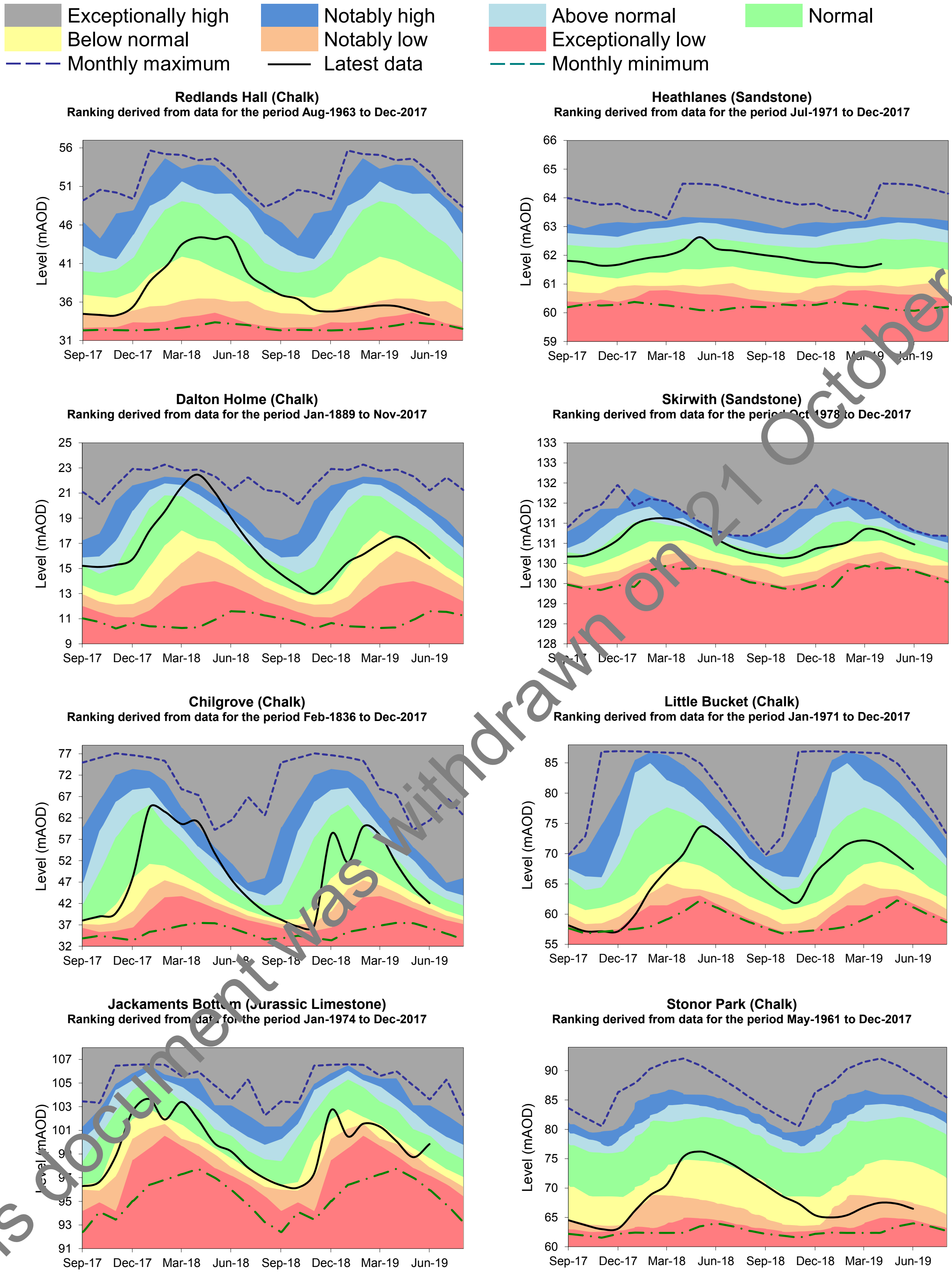
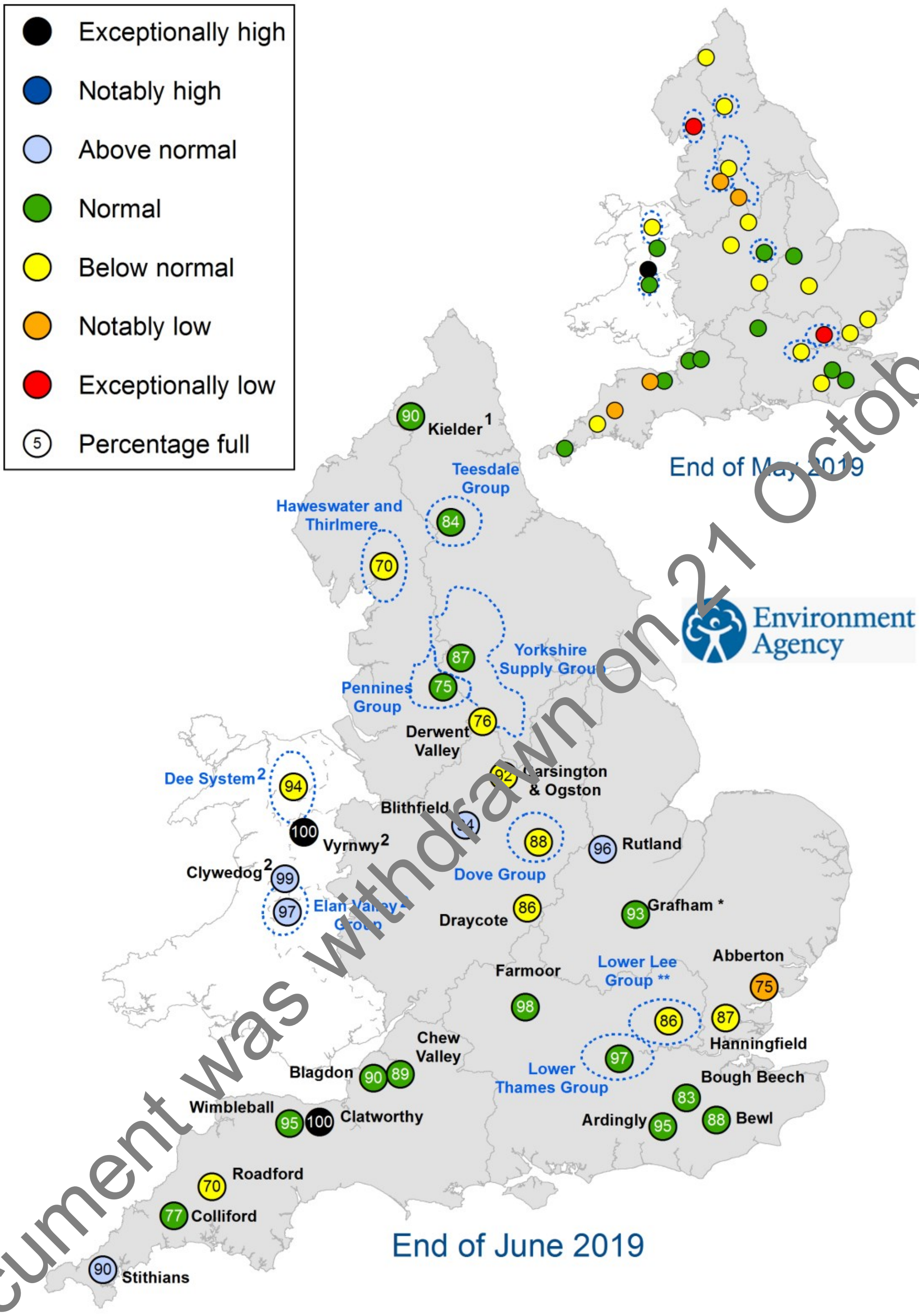


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2019).

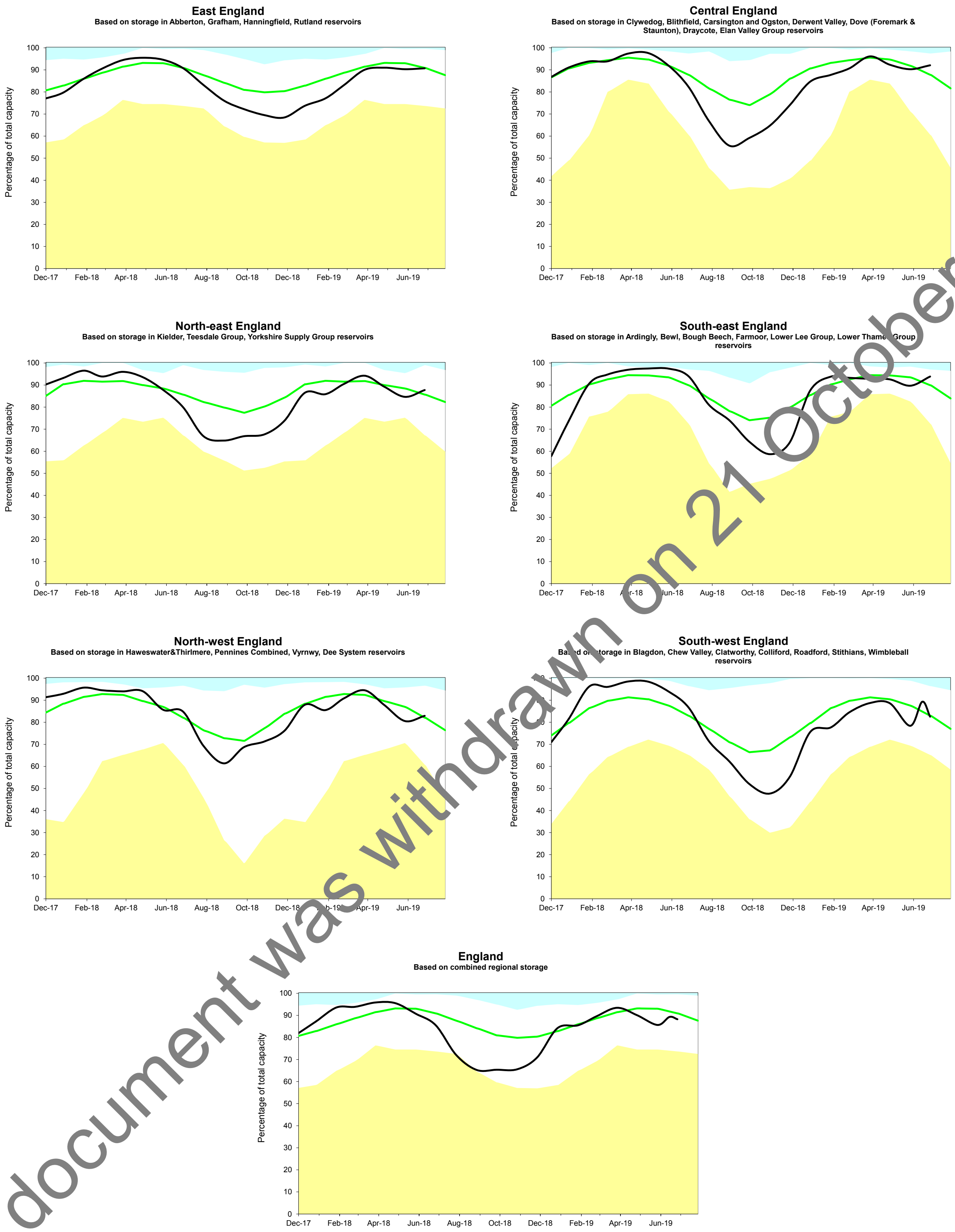
Reservoir storage



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

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



	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

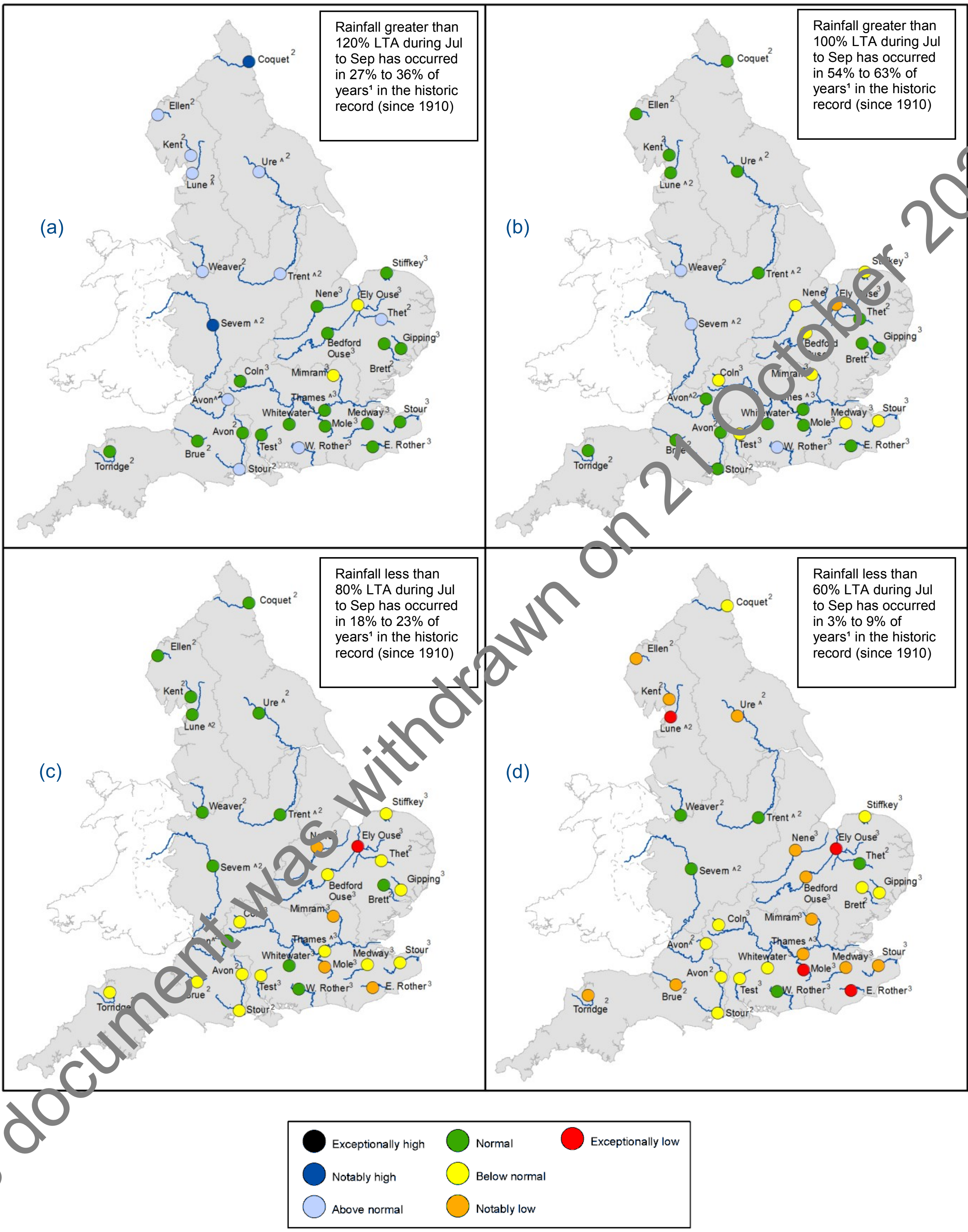


Figure 6.1: Projected river flows at key indicator sites up until the end of September 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July and September (Source: Centre for Ecology and Hydrology, Environment Agency).

[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*

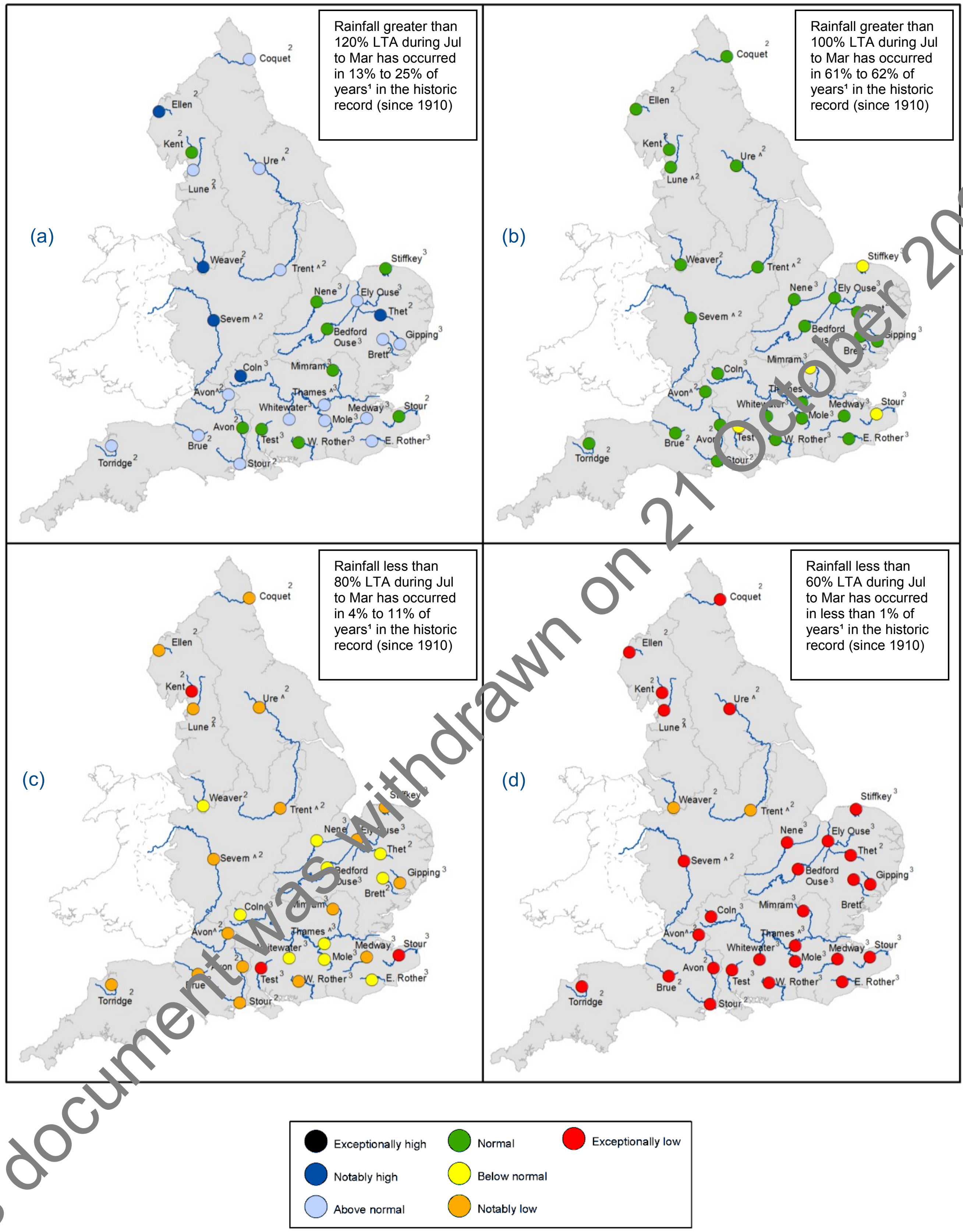


Figure 6.2: Projected river flows at key indicator sites up until the end of March 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July and March (Source: Centre for Ecology and Hydrology, Environment Agency).

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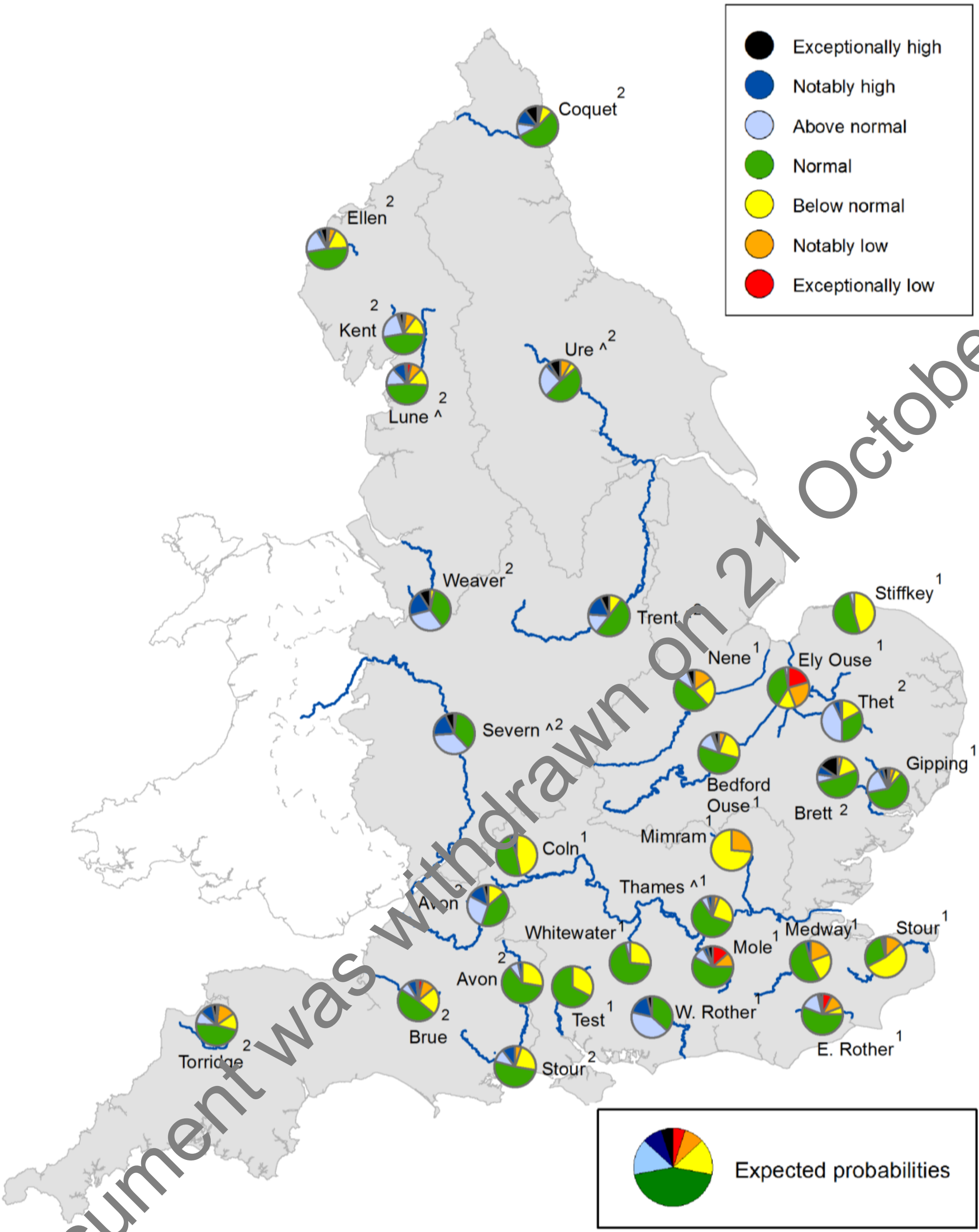

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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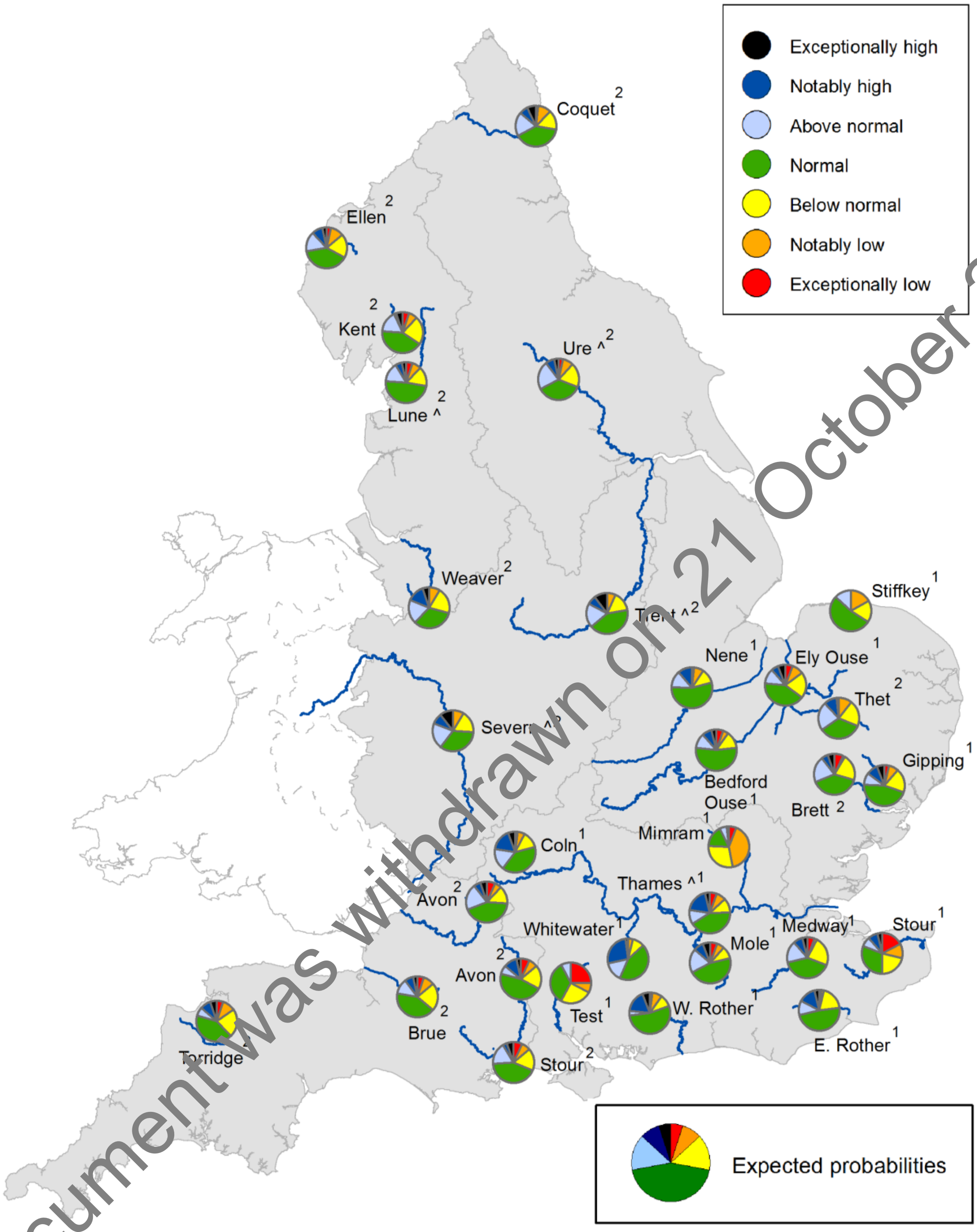

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

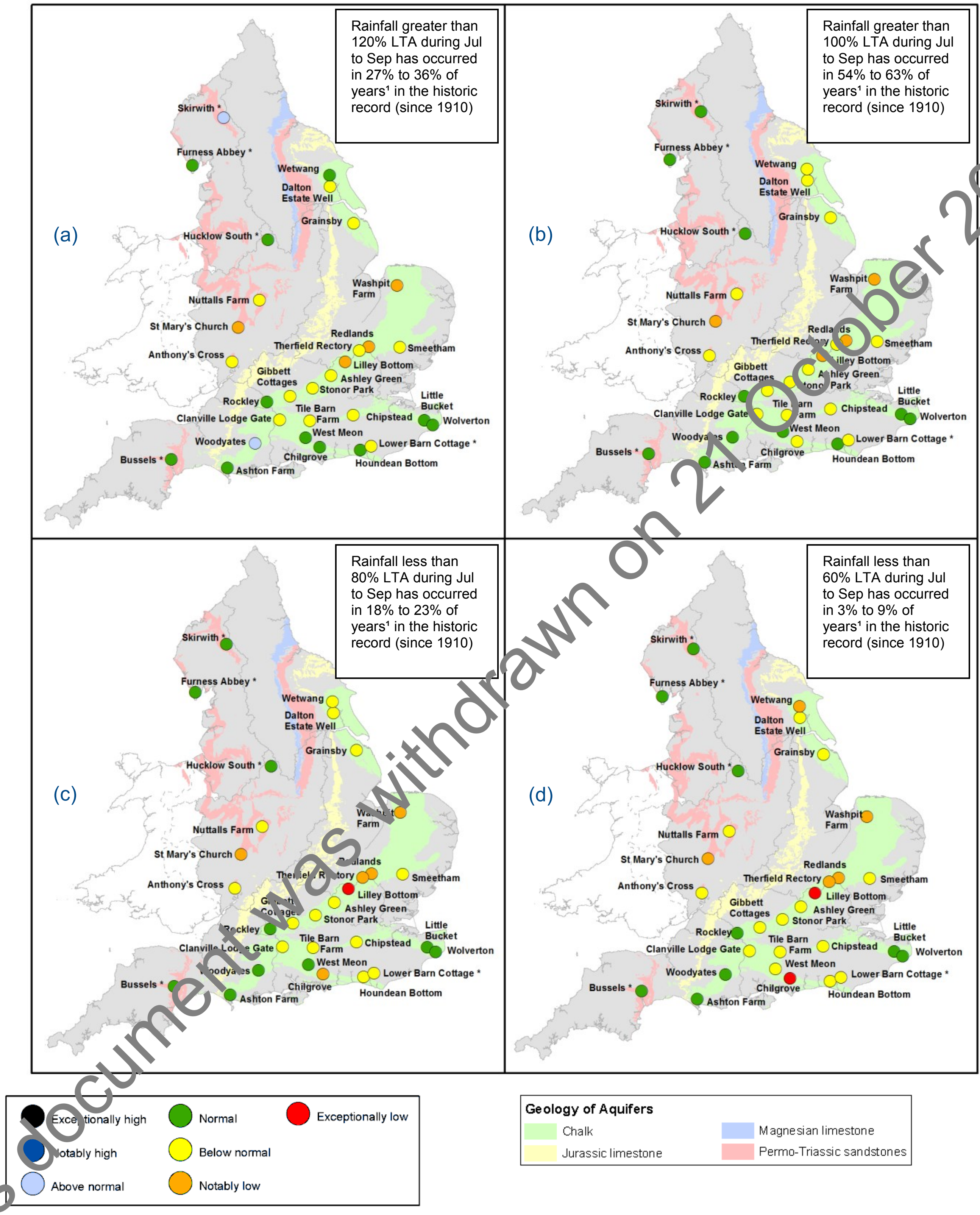

Figure 6.5: Projected groundwater levels at key indicator sites at the end of September 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July and September (Source: Environment Agency). Geological map reproduced with kind permission 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

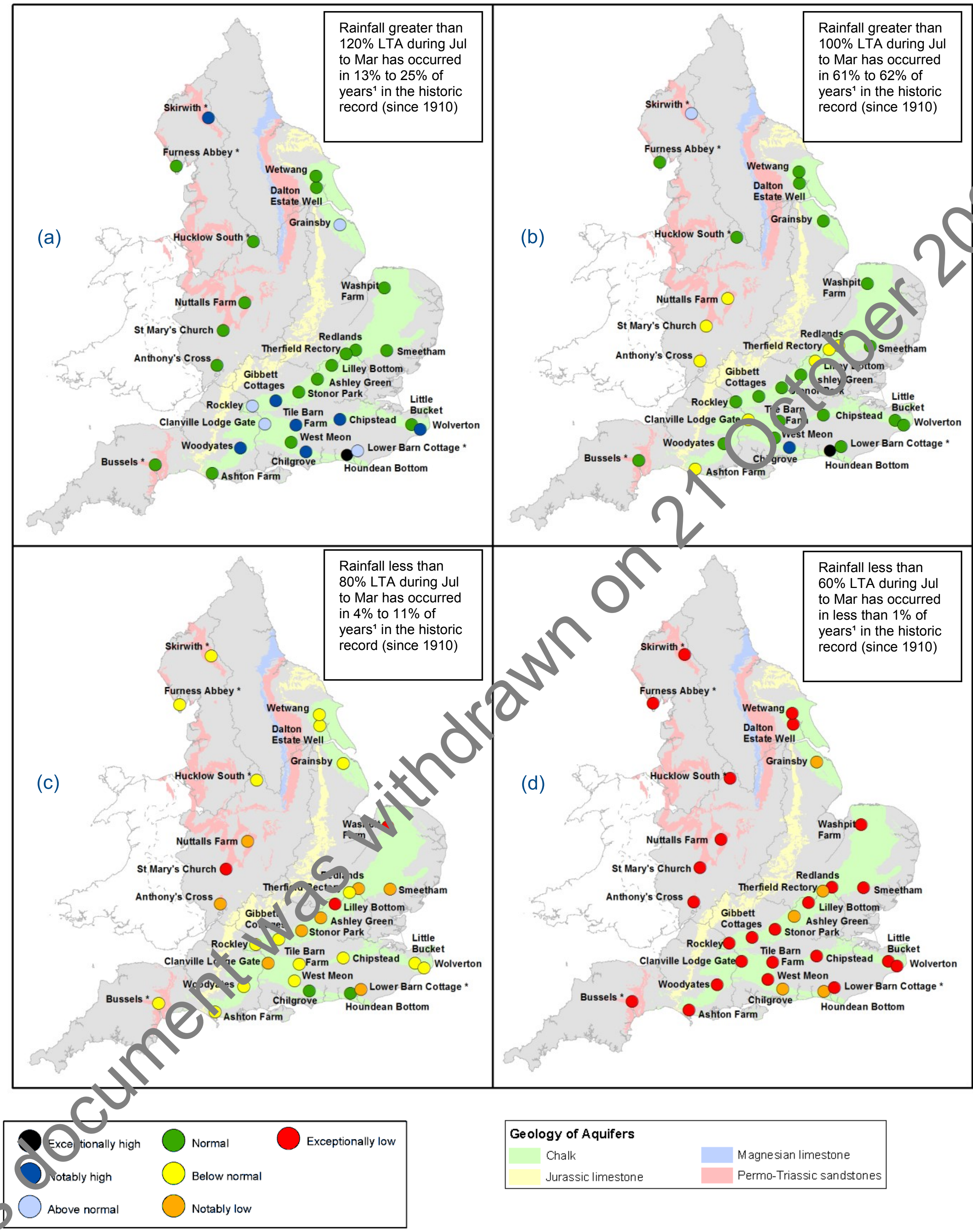

Figure 6.6: Projected groundwater levels at key indicator sites at the end of March 2020. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between July and March (Source: Environment Agency). Geological map reproduced with kind permission from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

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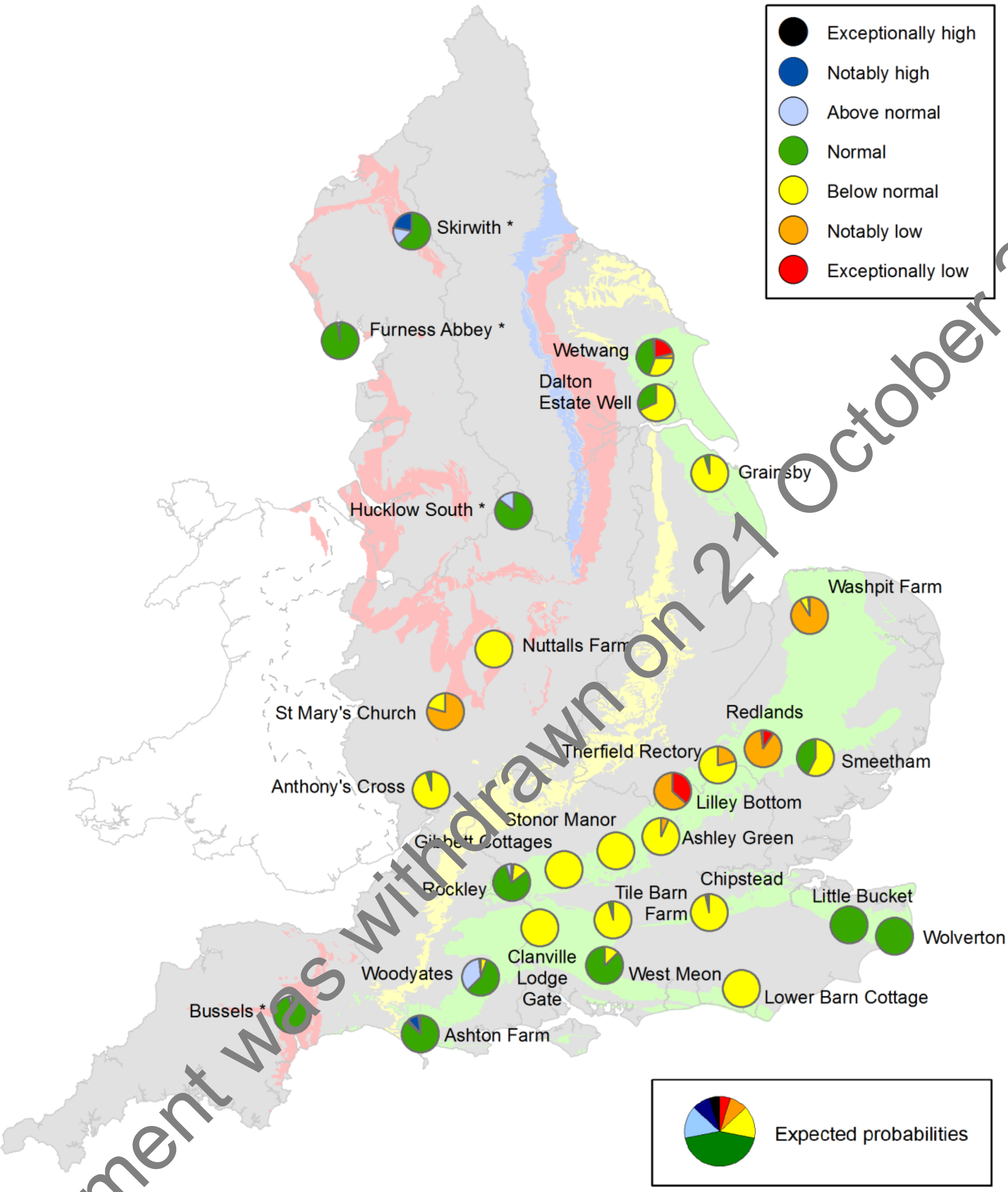

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

Figure 6.7: 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.

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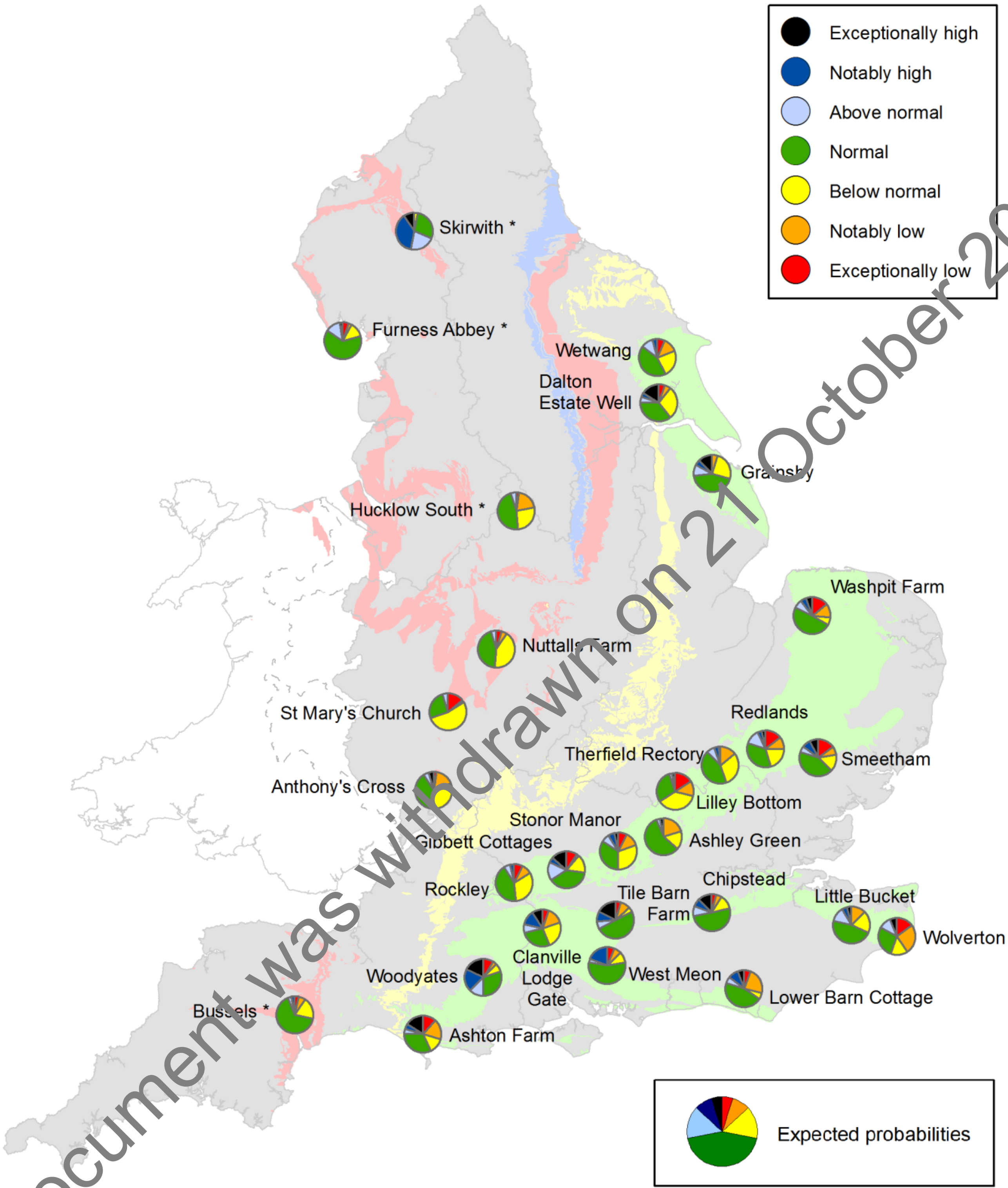

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

Figure 6.8: 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.

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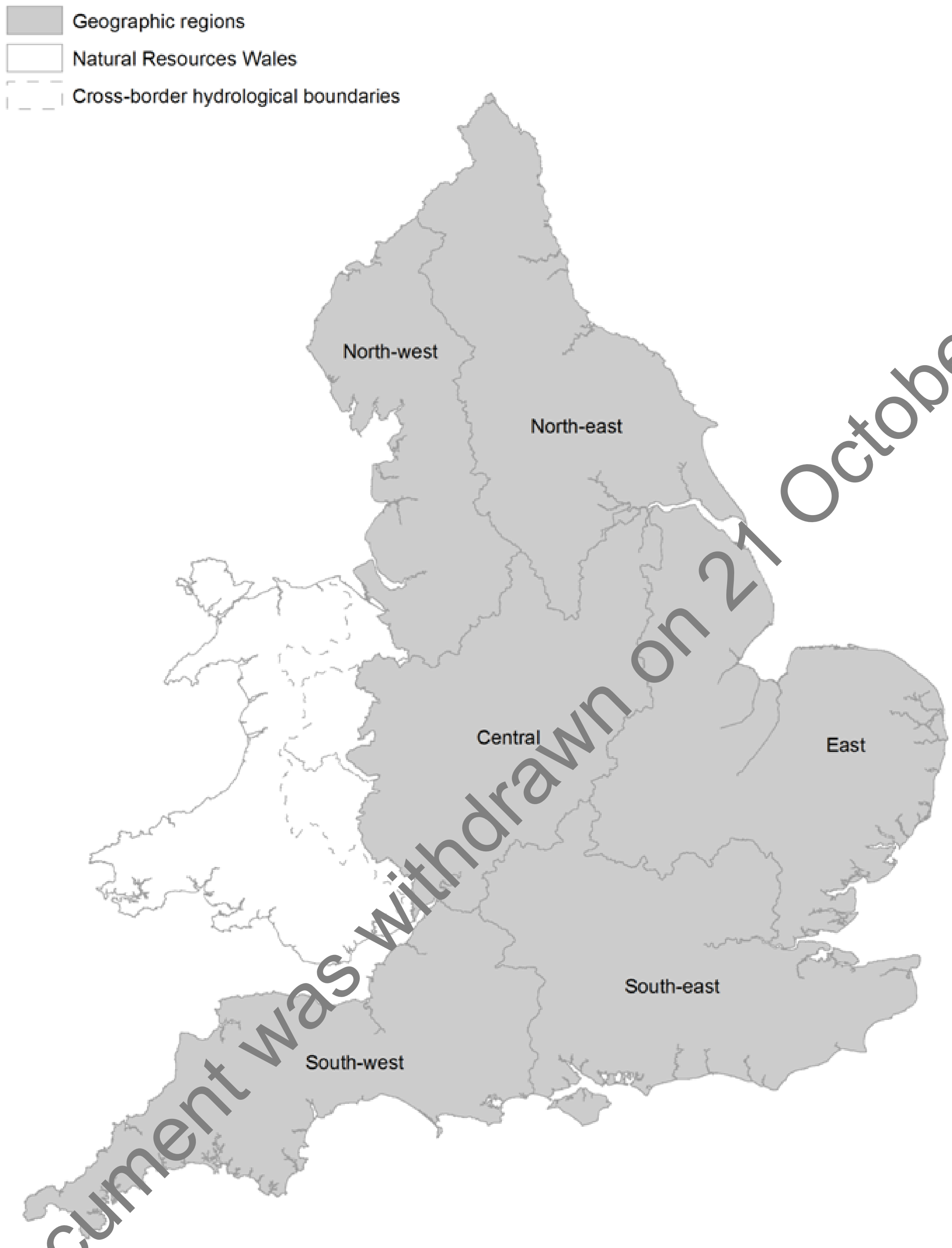

Figure 7.1: Geographic regions

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