Monthly water situation report

England

Summary – December 2018

December rainfall was above average across England. It was driest in parts of north-east England and wettest in parts of the north-west and south-west. Soils continued to get wetter during the first part of the month and soil moisture deficits are now close to average for the time of year. River flows increased at all sites and were normal or higher for the time of year at most sites. Groundwater levels increased at just over half of sites but are yet to start rising in some aquifers in east and south-east England. Stocks increased at most reservoirs during the month, with total stocks for England increasing from 70% of total capacity to 84%.

Rainfall

December rainfall totals were highest in parts of Devon and Cornwall in south-west England and parts of Cumbria and Lancashire in north-west England. The Avon, Dart and Erme catchment in south Devon received nearly 250mm of rainfall (149% of the LTA). Rainfall totals were lowest in parts of Northumbria in north-east England and parts of Kent and Essex around the Thames Estuary. The Tweed catchment in the far north-east of England received 41mm (62% of the LTA) (Figure 1.1).

December rainfall totals were classed as normal or above normal for the time of year in all but 7 catchments, located in the north of England, which were below normal or notably low. The six-month cumulative rainfall totals were classed as below normal across most of the country. However, it was the 6th and 7th wettest November-December 2-month period on record (since 1910) and the wettest since 2012 in the catchments of West Cornwall and Avon, Dart and Erme respectively (Figure 1.2).

The December rainfall total for England was 100mm, which was 118% of the 1961-1990 LTA (115% of the 1981-2010 LTA). At a regional scale, December rainfall totals ranged from 101% of the LTA in north-east England to 134% in south-west England (Figure 1.3).

Soil moisture deficit

Soils generally continued to get wetter during the first part of December, with significant reductions in soil moisture deficit (SMD) occurring across parts of the east Midlands and East Anglia. At the end of December, the wettest soils (smallest SMDs) were generally in western England and the driest soils (largest SMDs) were around the Wash in East Anglia (where significant deficits still persist) and the Thames Estuary in south-east England. At the end of December, SMDs were close to or smaller than average across most of England (Figure 2.1). At a regional scale, end of December SMDs were close to average for the time of year in all regions (Figure 2.2).

River flows

Monthly mean river flows increased at all indicator sites in December, compared to November. Flows were classed as normal or higher for the time of year at four-fifths of sites; however 9 sites across central, south-east and east England were classed as below normal, with the River Cam in east England remaining notably low for the fourth consecutive month (Figure 3.1).

At the regional index sites, monthly mean flows were classed as above normal for the time of year on the River Stour in south-east England and the River Exe in south-west England, below normal on the Bedford Ouse in east England and normal elsewhere (Figure 3.2).

Groundwater levels

Groundwater levels rose during December at just over half of the indicator sites. However, levels continued to recede at a number of key chalk aquifer sites, including Stonor Park and Ashley Green in the South West and East Chilterns Chalk respectively and Grainsby (Northern Chalk), Redlands (Cam and Ely Ouse Chalk) and Washpit Farm (NW Norfolk Chalk) in east England. At the end of December, groundwater levels were normal or higher for the time of year at just over half of the indicator sites, with 9 sites (including 2 in sandstone aquifers) classed as below normal and Crossley Hill and Ashley Green classed as notably low.

At the major aquifer index sites, groundwater levels were classed as below normal for the time of year at Redlands (Cam and Ely Ouse Chalk aquifer) and Stonor Park (South West Chilterns Chalk aquifer), but were normal elsewhere (Figures 4.1 and 4.2).

Reservoir storage

Stocks increased in all but 2 reservoirs and reservoir groups in England during December. The largest increases as a percentage of total capacity were at Clatworthy reservoir in south-west England (60%), Stithians reservoir and the Pennines reservoir group (both 35%) and Derwent Valley (32%). Stocks decreased at Clywedog and Farmoor reservoirs by 2 and 5% respectively.

End of December stocks were classed as normal or above normal for the time of year at three-fifths of sites, with the remaining sites ranging from below normal to exceptionally low. Stocks were classed as notably low in the Derwent Valley group and Carsington and Ogston combined and Grafham reservoirs, whilst the Dove Group remained exceptionally low for the time of year for the sixth consecutive month (compared to historical conditions) (Figure 5.1).

Regional reservoir stocks increased in all regions, with increases ranging from 5% in east England to 24% in south-east England. End of December stocks ranged from 74% in east England to 91% in north-west England. Total reservoir stocks for England increased from 70% of total capacity to 84% during December (Figure 5.2).

Forward look

January is expected to be dominated by cold, dry weather for the first part of the month, with occasional showers and spells of rain in places from mid-month, particularly in the north and west. There is an increased risk of snow falling towards the end of the month. For the 3-month period January-February-March, below-average precipitation is more likely than above-average precipitation[1].

Projections for river flows at key sites[2]

All but two modelled sites have a greater than expected chance of cumulative river flows being below normal or lower for the time of year by the end of both March and September 2019.

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

Projections for groundwater levels in key aquifers[2]

Just over half of the modelled sites have a greater than expected chance of groundwater levels being normal or higher for the time of year by the end of March 2019. However, by September 2019, nearly two-thirds of modelled sites have a greater than expected chance of levels being below normal or lower.

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

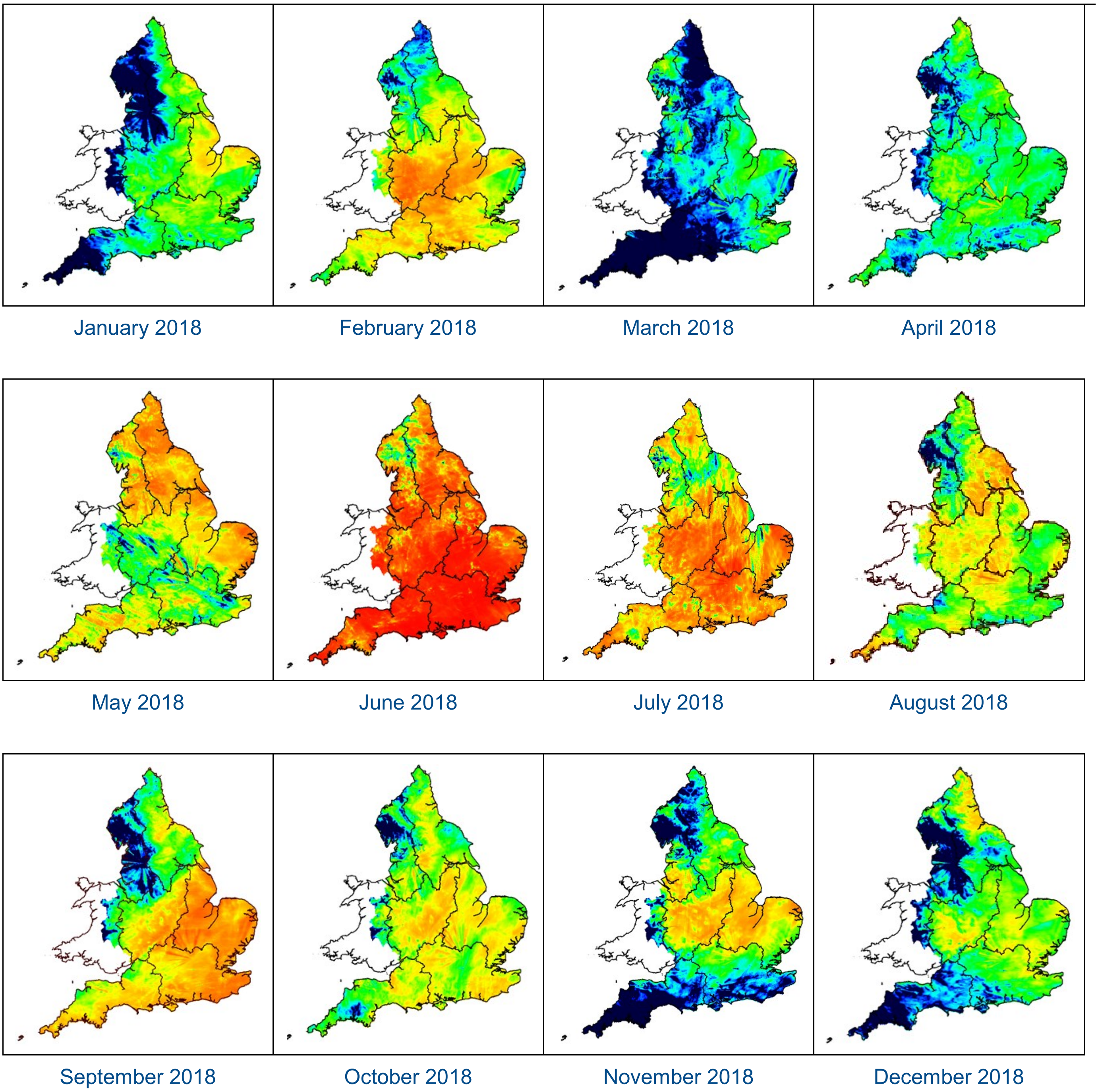
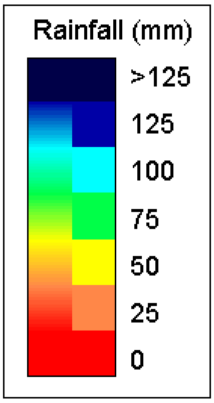


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2019). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.



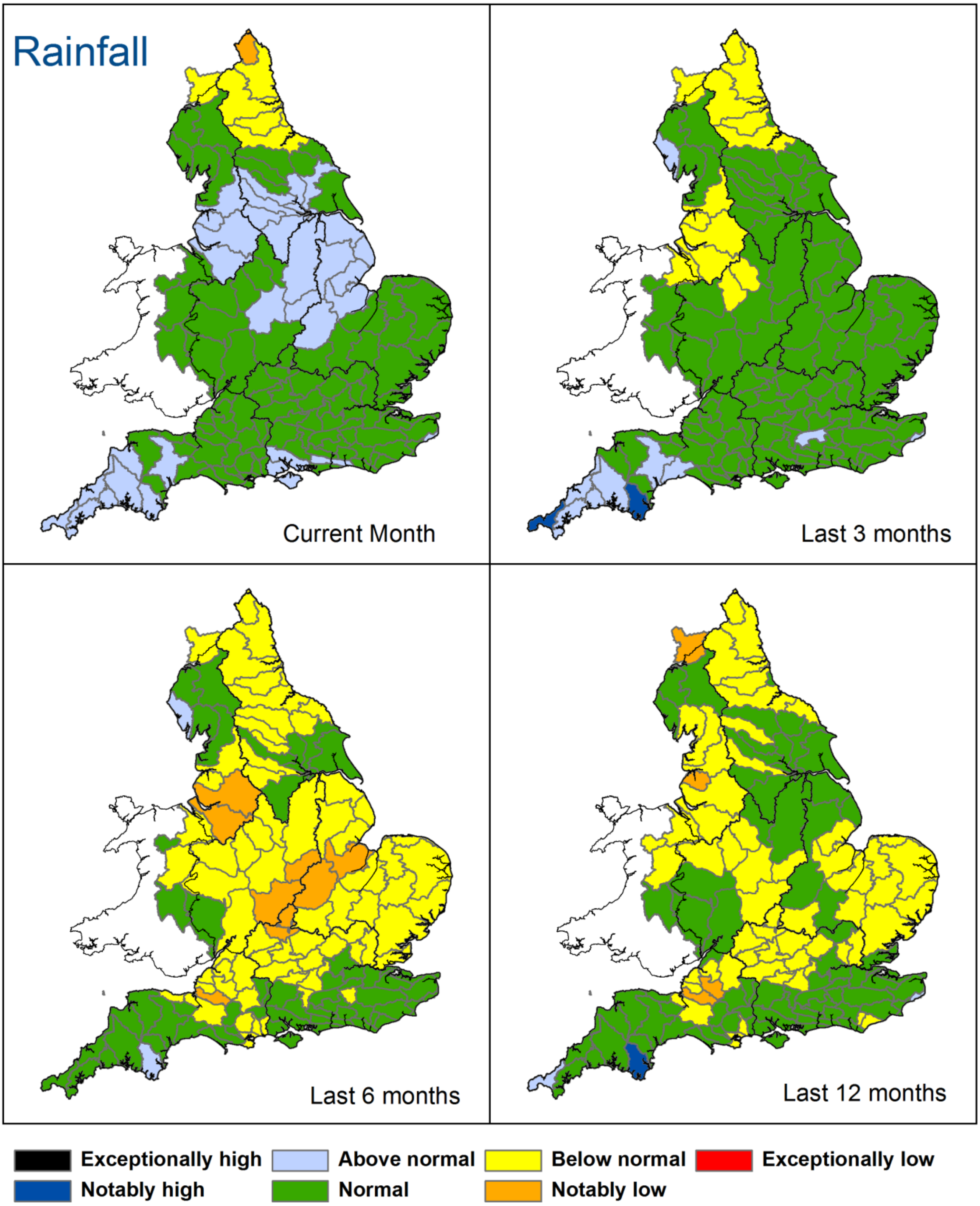


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 December), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met 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 (blue) Below average rainfall (red)

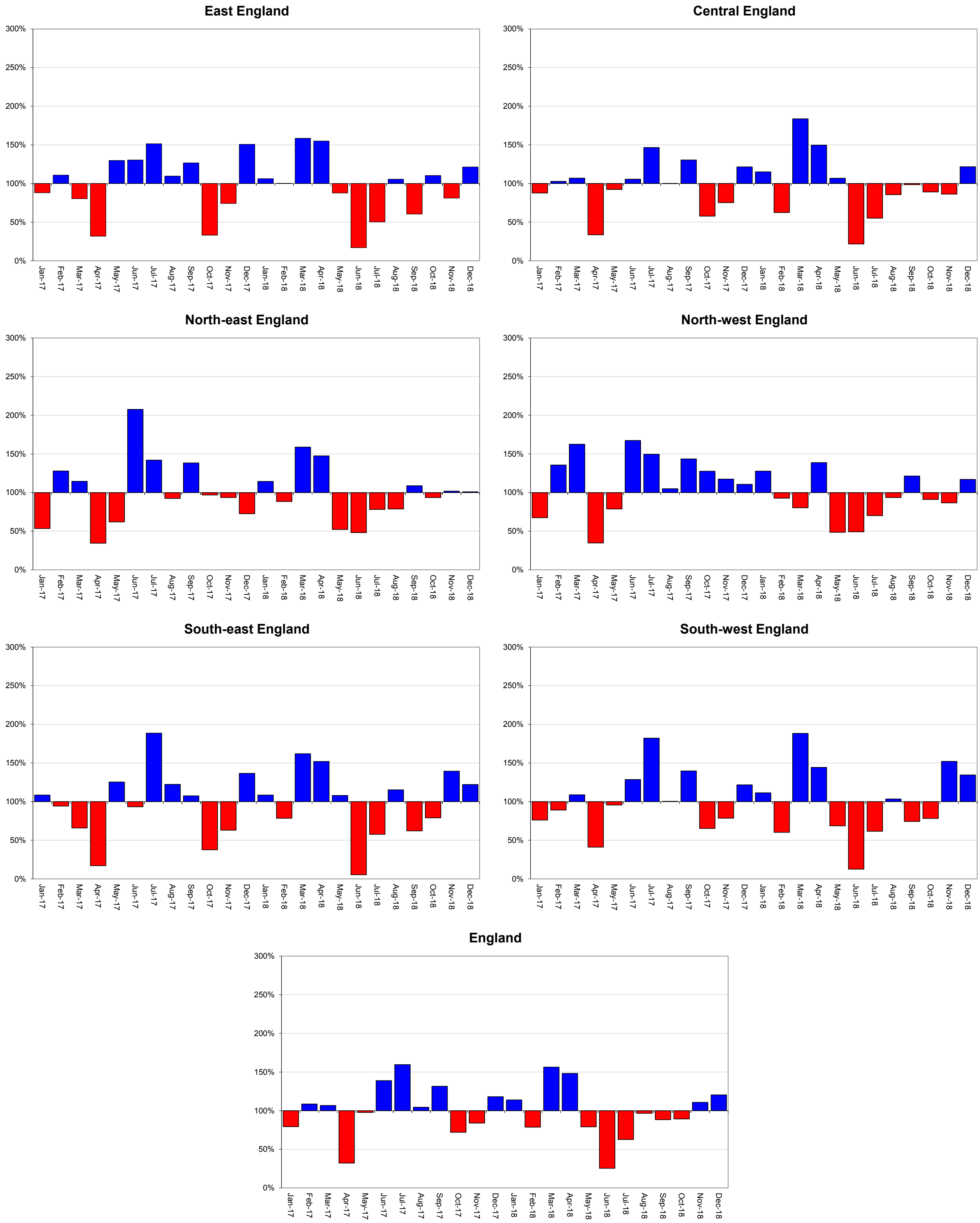


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2019).

Soil moisture deficit

End of November 2018[1]	End of December 2018[2]

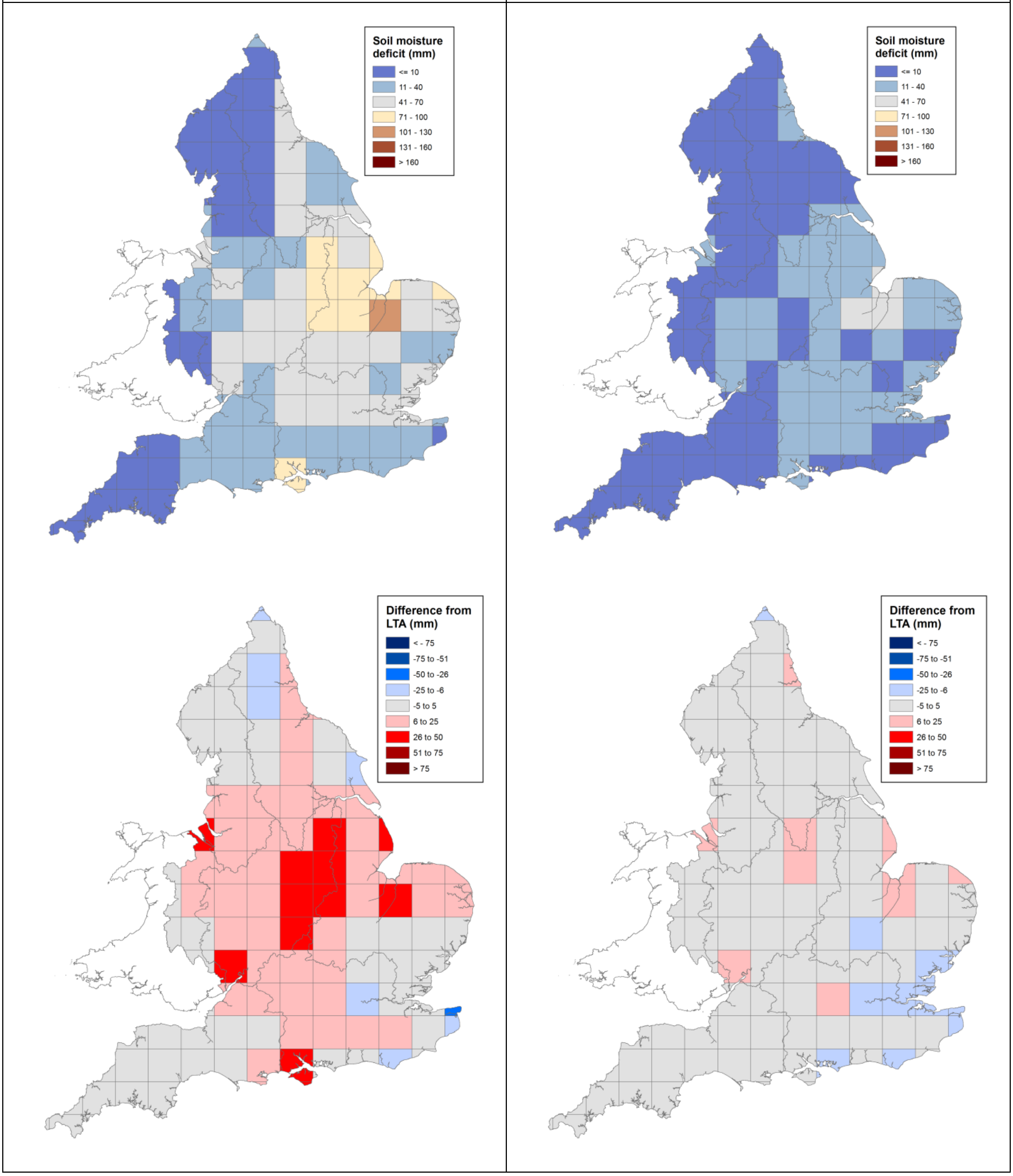


Figure 2.1: Soil moisture deficits for weeks ending 28 November 2018 [1] (left panel) and 1 January 2019 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2019). Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.

Soil moisture deficit charts

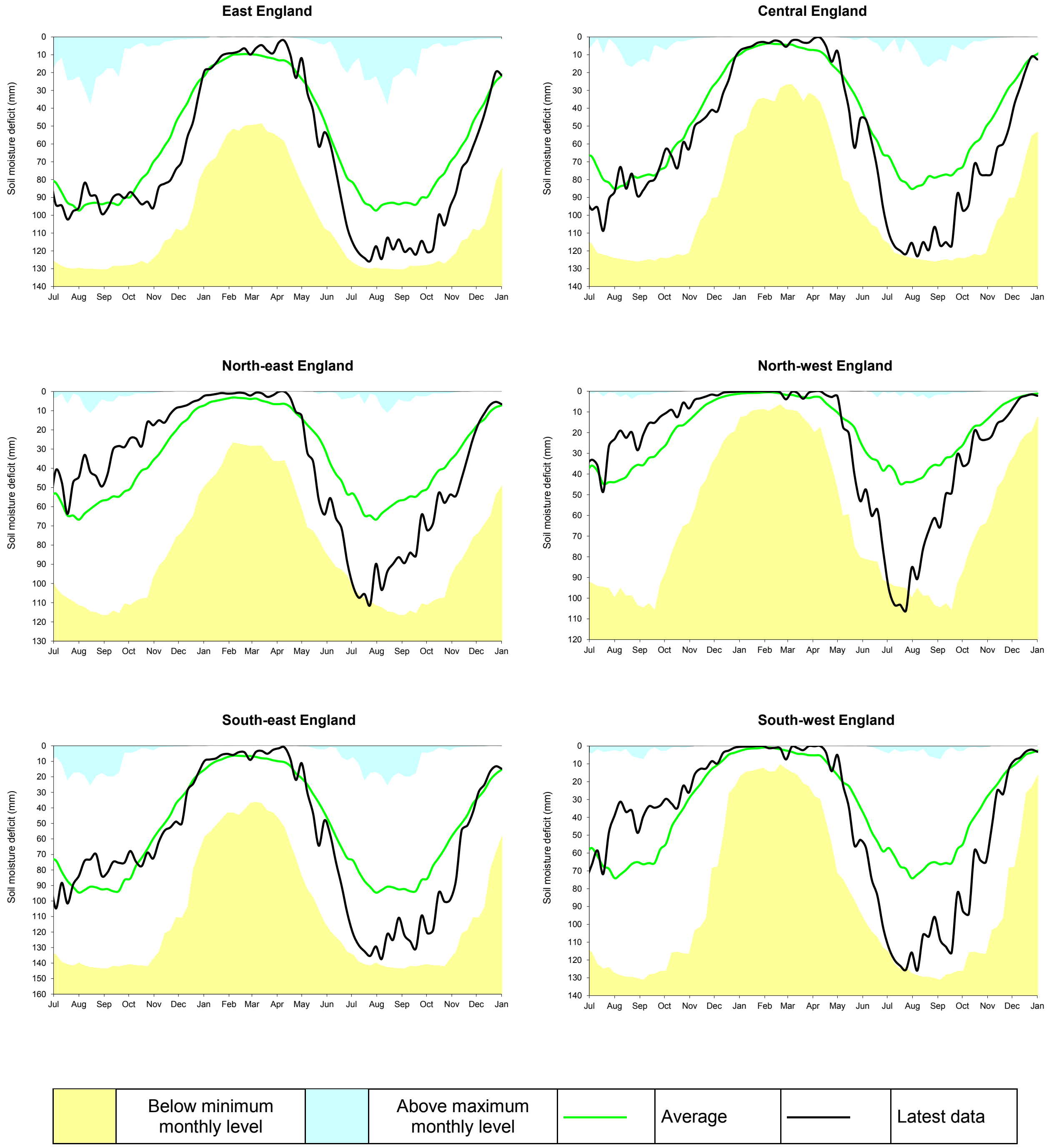
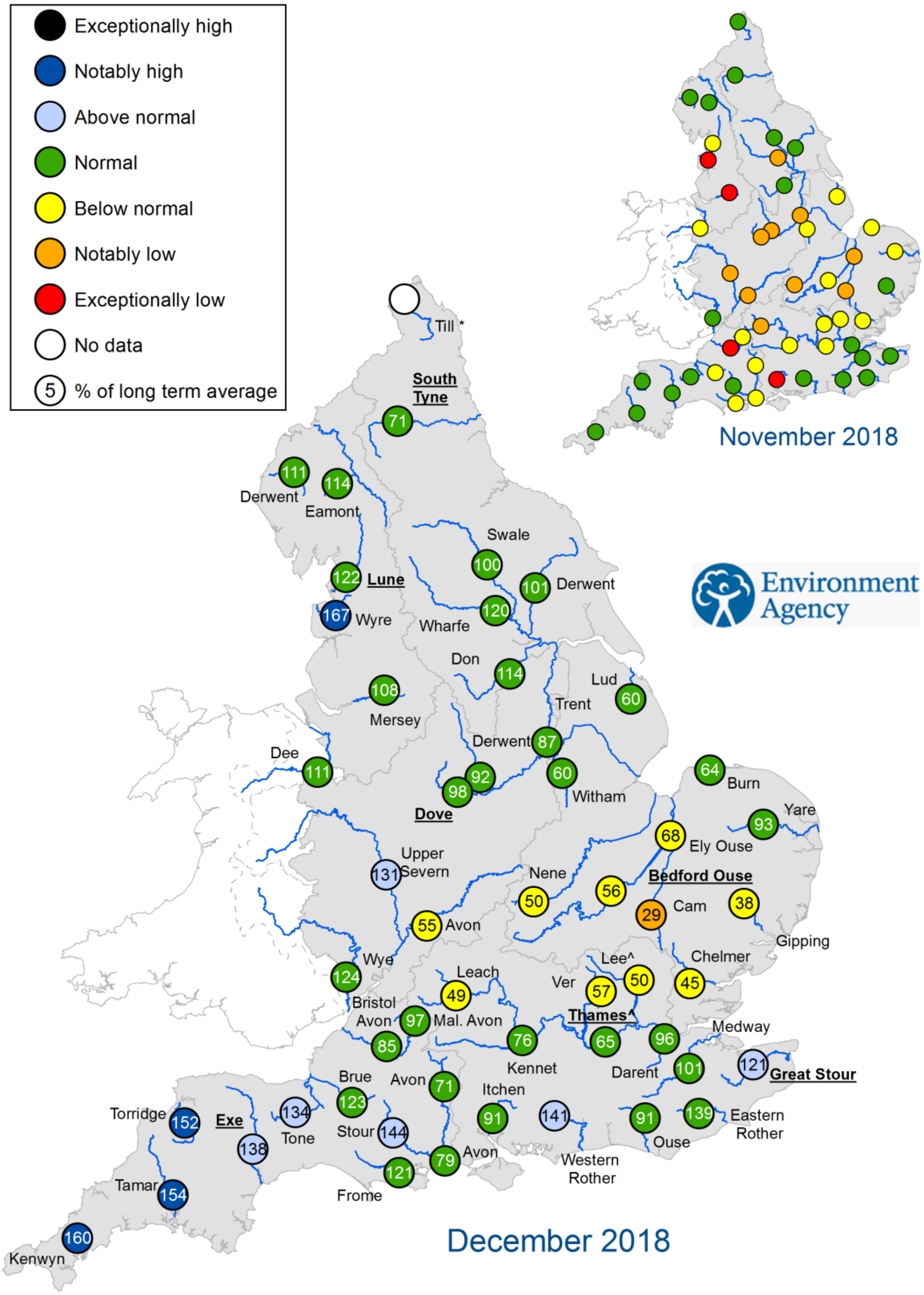


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2019).

River flows



^ "Naturalised" flows are provided for the River Thames at Kingston and the River Lee at Feildes Weir

* Data unavailable for the River Till at Heaton Mill due to technical difficulties at site.

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 2018 and December 2018, expressed as a percentage of the respective long term average and classed relative to an analysis of historic November and December monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2019.

River flow charts

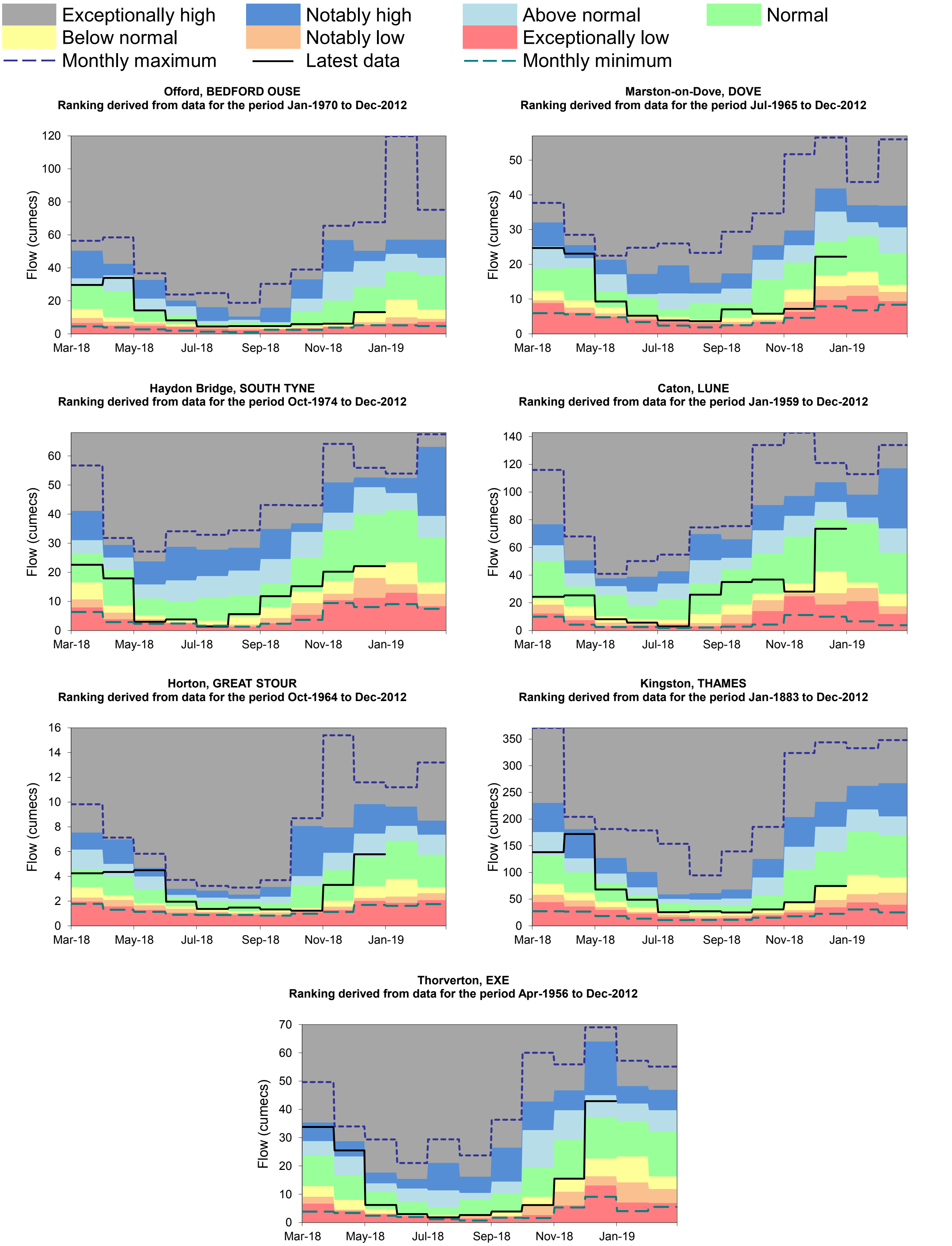
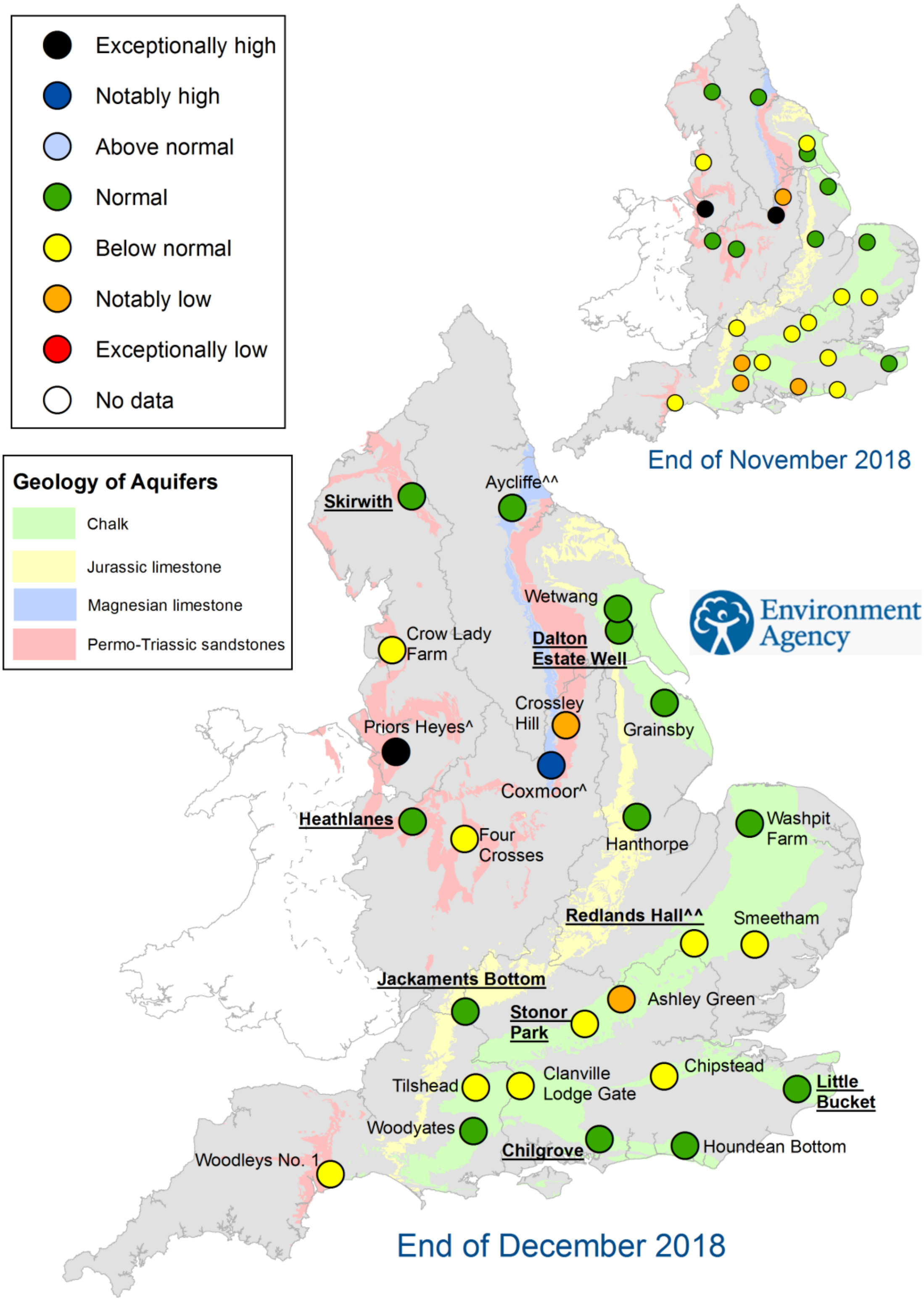


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 November 2018 and December 2018, 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, 2019.

Groundwater level charts

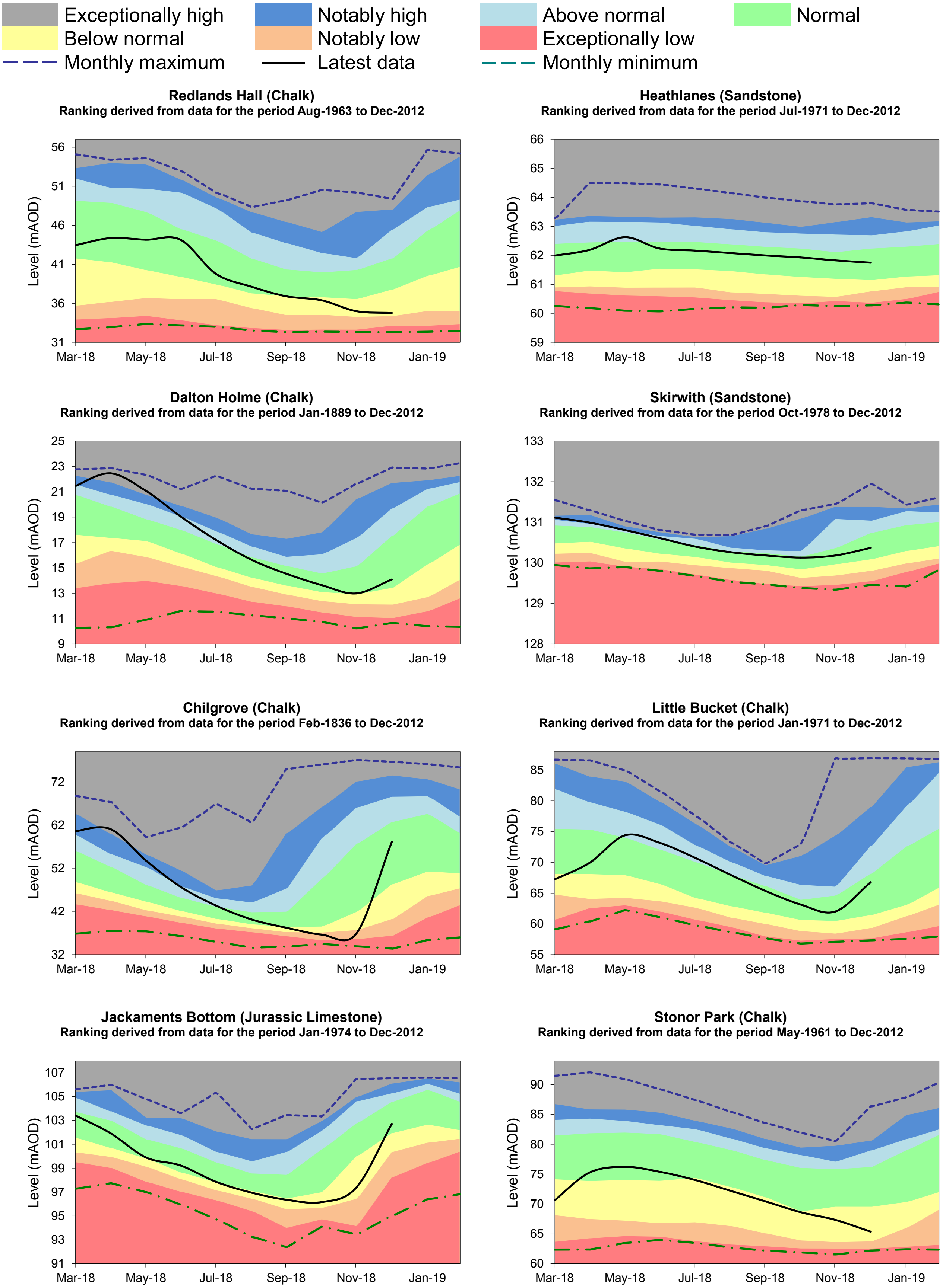
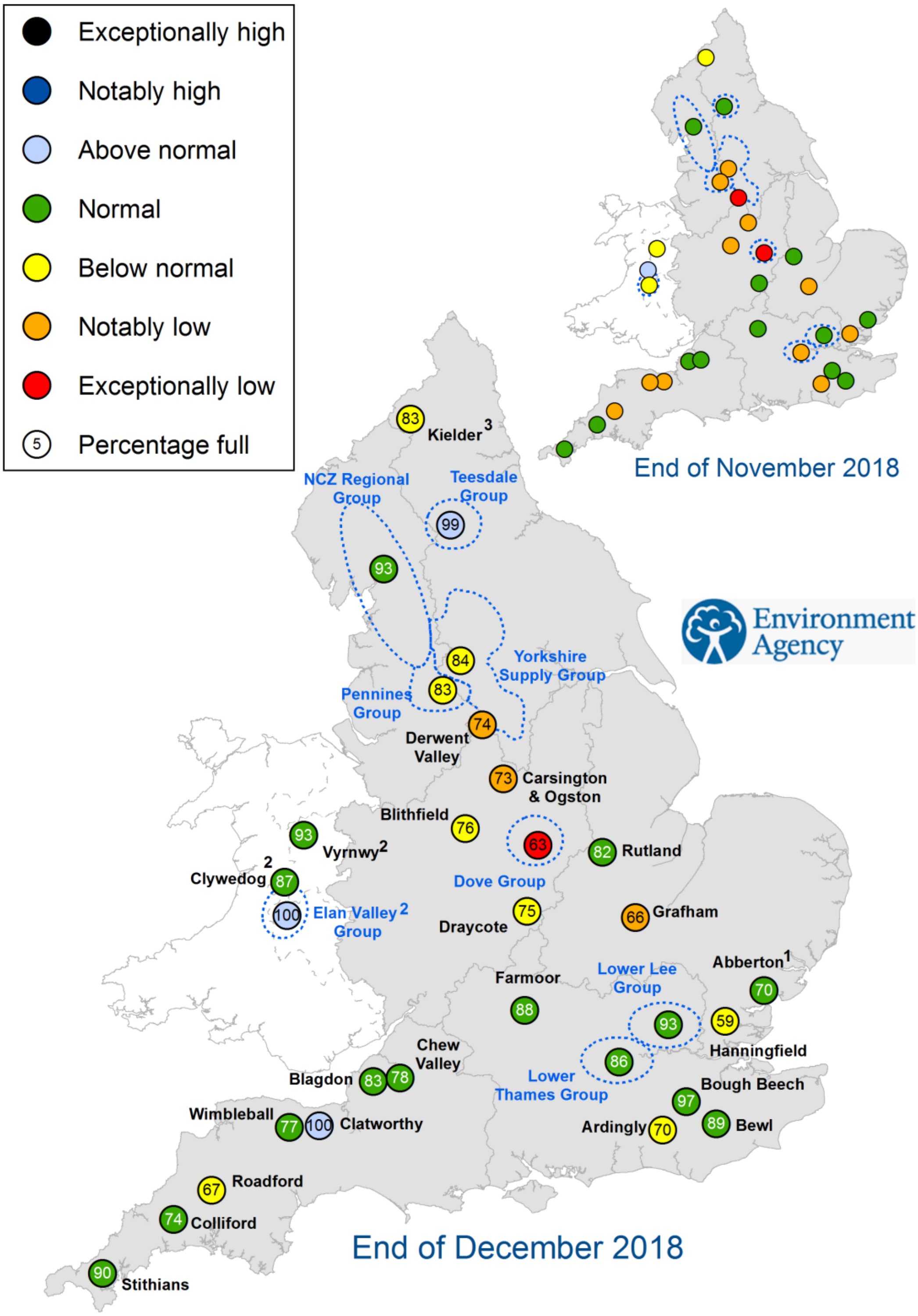


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2019).

Reservoir storage

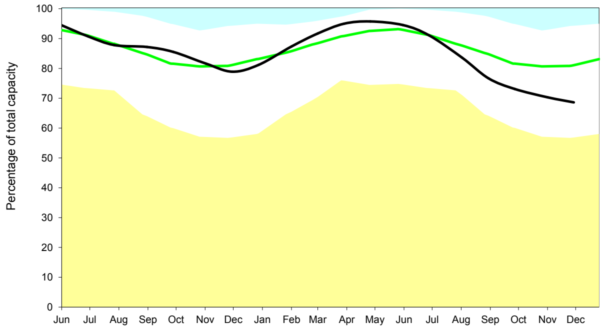


1. Current levels at Abberton Reservoir in east England are relative to increased capacity
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England
3. Current levels at Kielder are lower than historical levels due to the implementation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

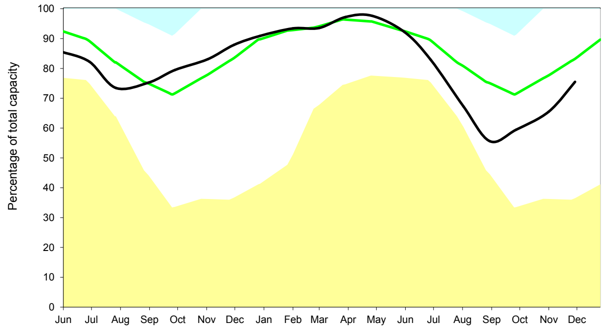
Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of November 2018 and December 2018 as a percentage of total capacity and classed relative to an analysis of historic November and December values respectively (Source: Water Companies). Note: Classes shown may not necessarily 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.

Reservoir storage charts

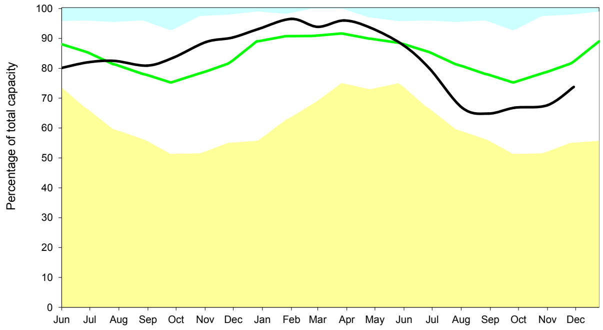
East England
Based on storage in Abberton, Grafham, Hanningfield, Rutland reservoirs



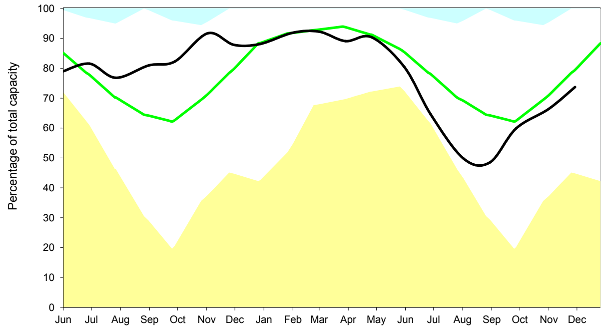
Central England
Based on storage in Clywedog, Carsington and Ogston, Derwent Valley, Dove (Foremark & Staunton), Draycote, Elan Valley Group reservoirs



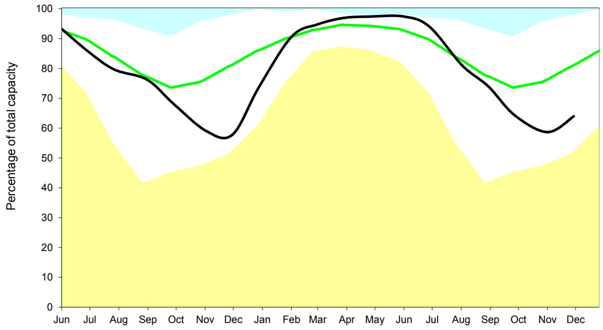
North-east England
Based on storage in Kielder, Teesdale Group, Yorkshire Supply Group reservoirs



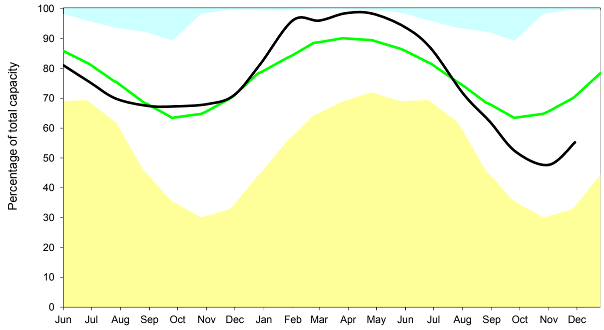
North-west England
Based on storage in NCZ Regional Group, Pennines Group, Vyrnwy reservoirs



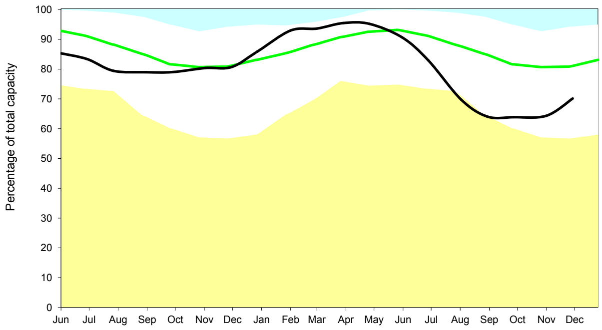
South-east England
Based on storage in Ardingly, Bewl, Bough Beech, Farmoor, Lower Lee Group, Lower Thames Group reservoirs



South-west England
Based on storage in Blagdon, Chew Valley, Clatworthy, Colliford, Roadford, Stithians, Wimbleball reservoirs



England
Based on combined regional storage



	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

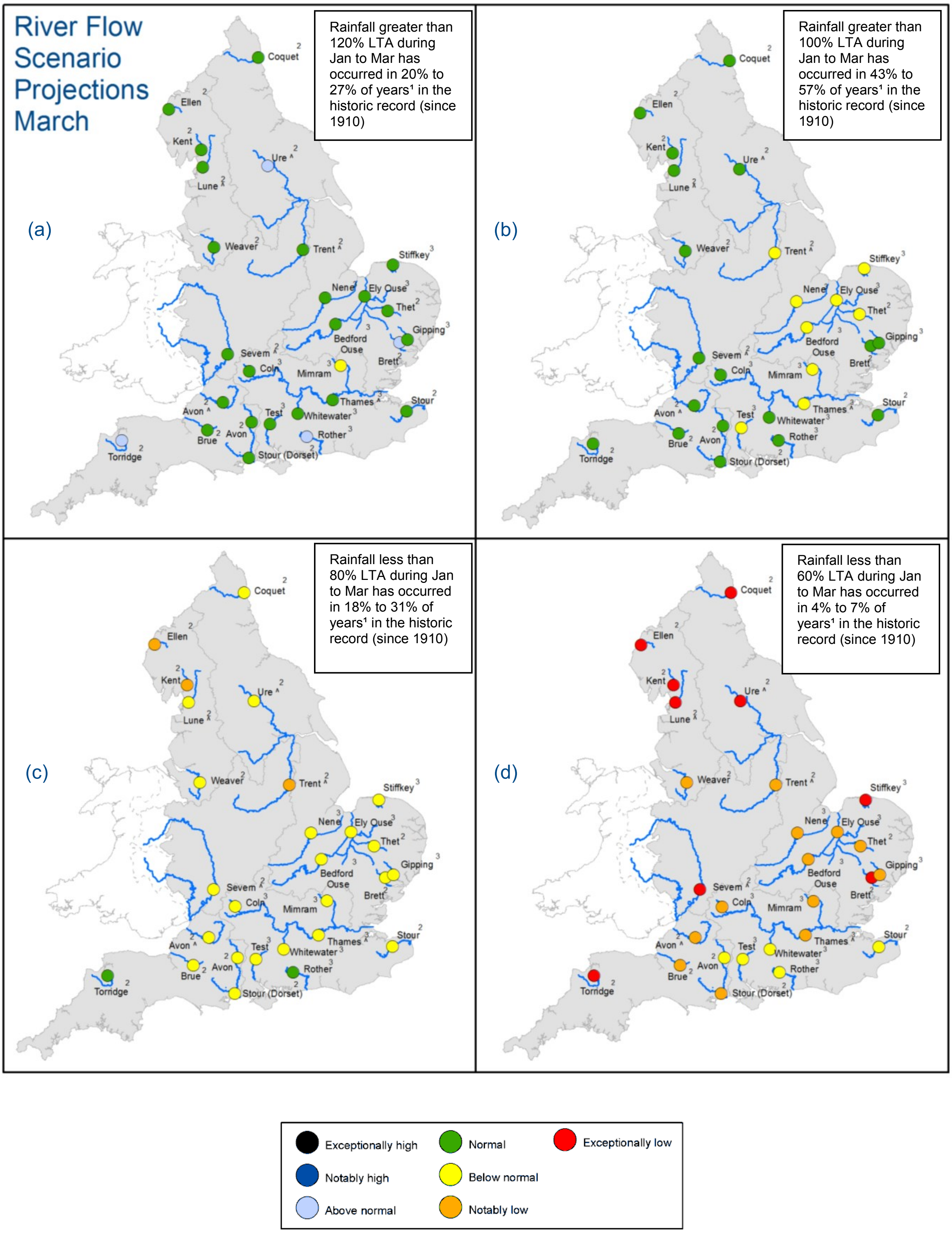


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2019 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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*

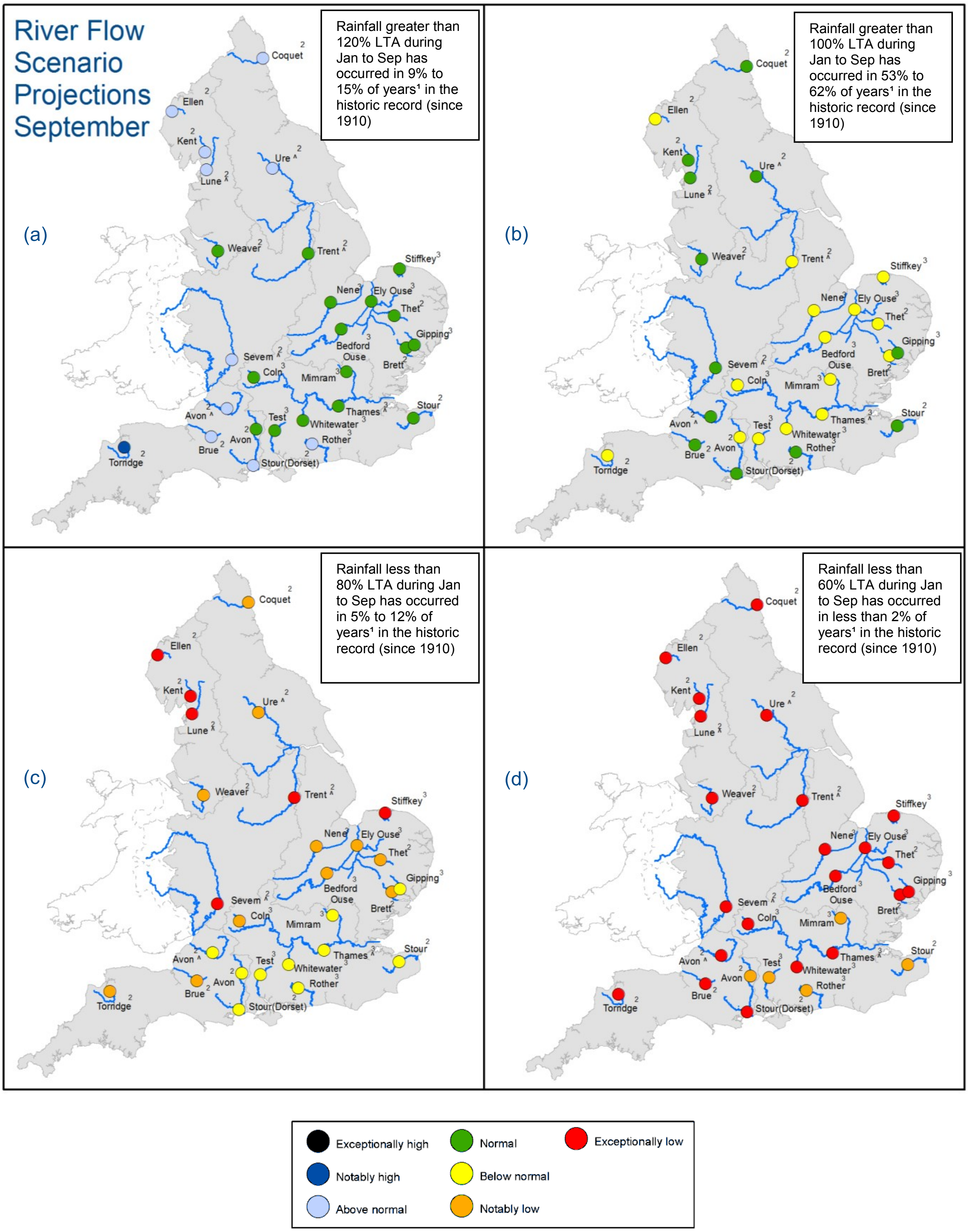


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and September 2019 (Source: Centre for Ecology and Hydrology, Environment Agency).

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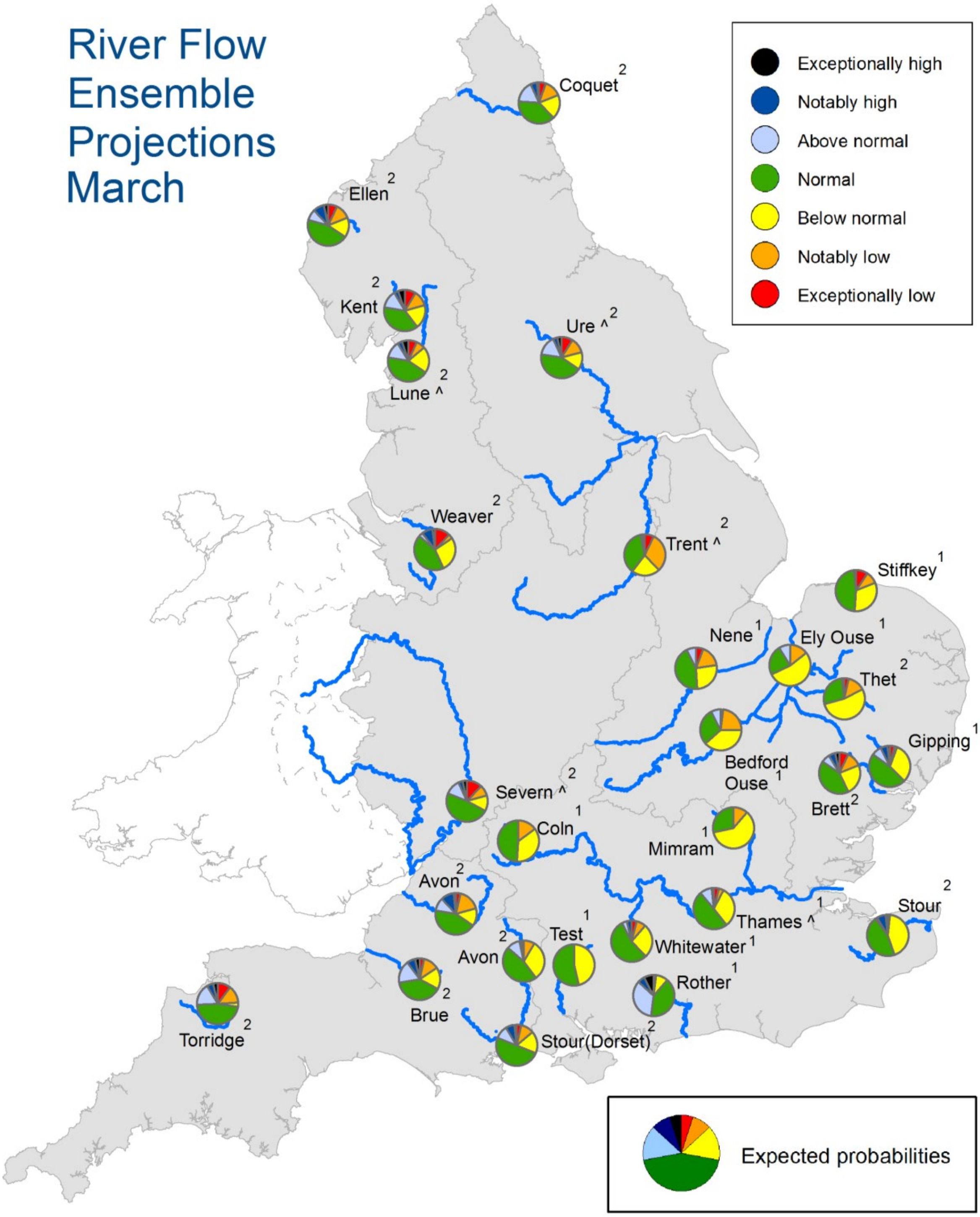

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 March 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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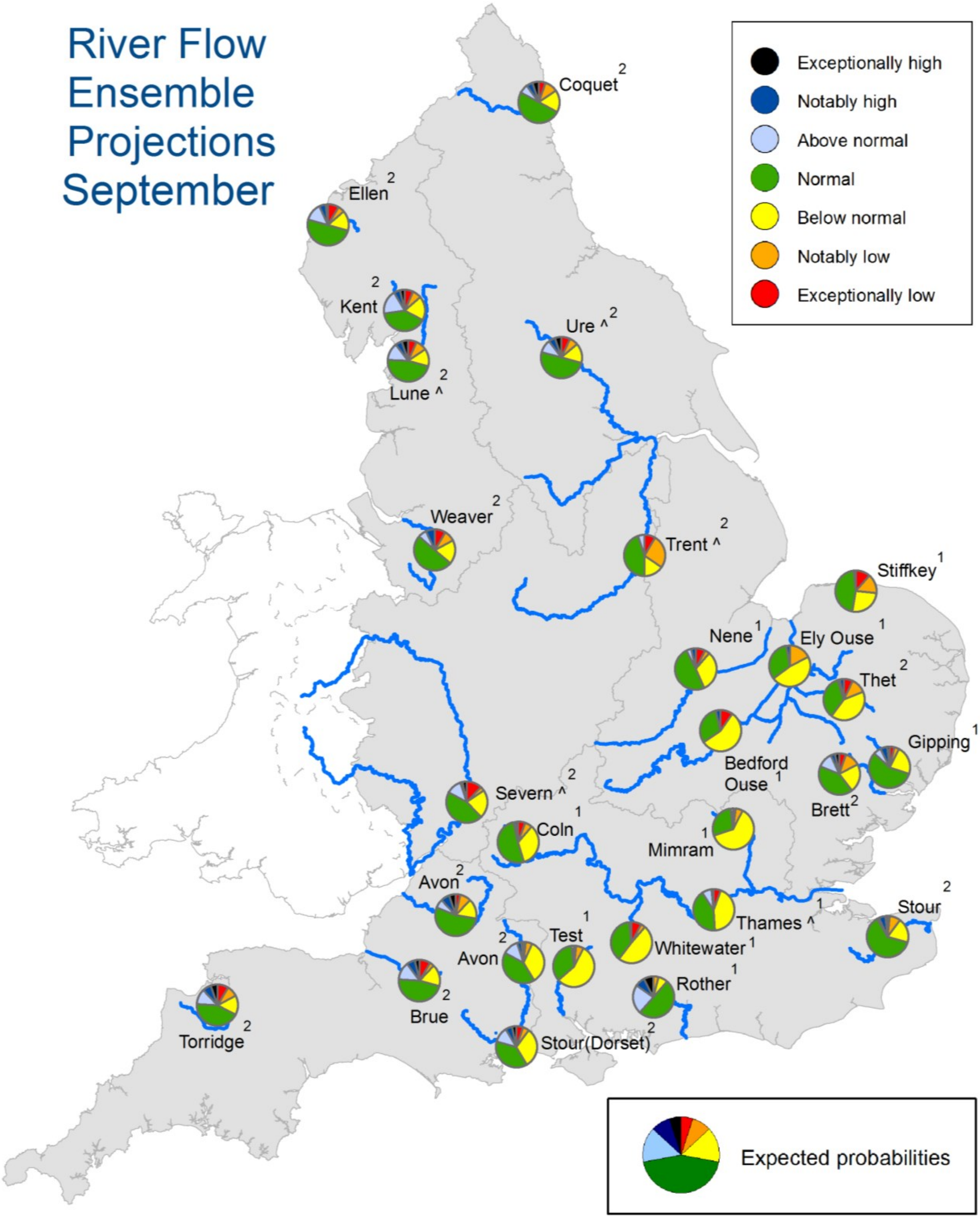
^"Naturalised" flows are projected for these sites



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 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).

[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

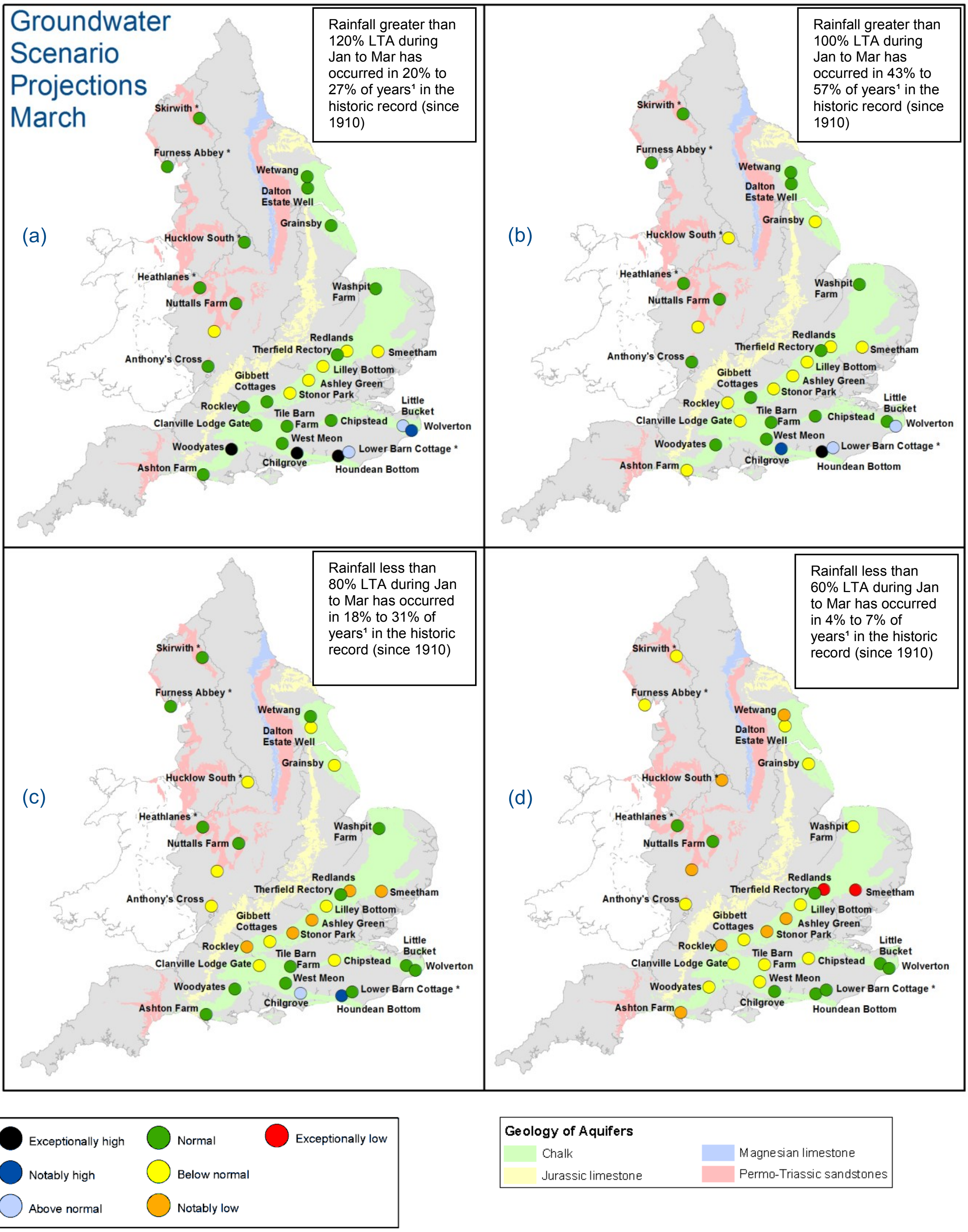


Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2019 (Source: Environment Agency). Geological map reproduced with kind permission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

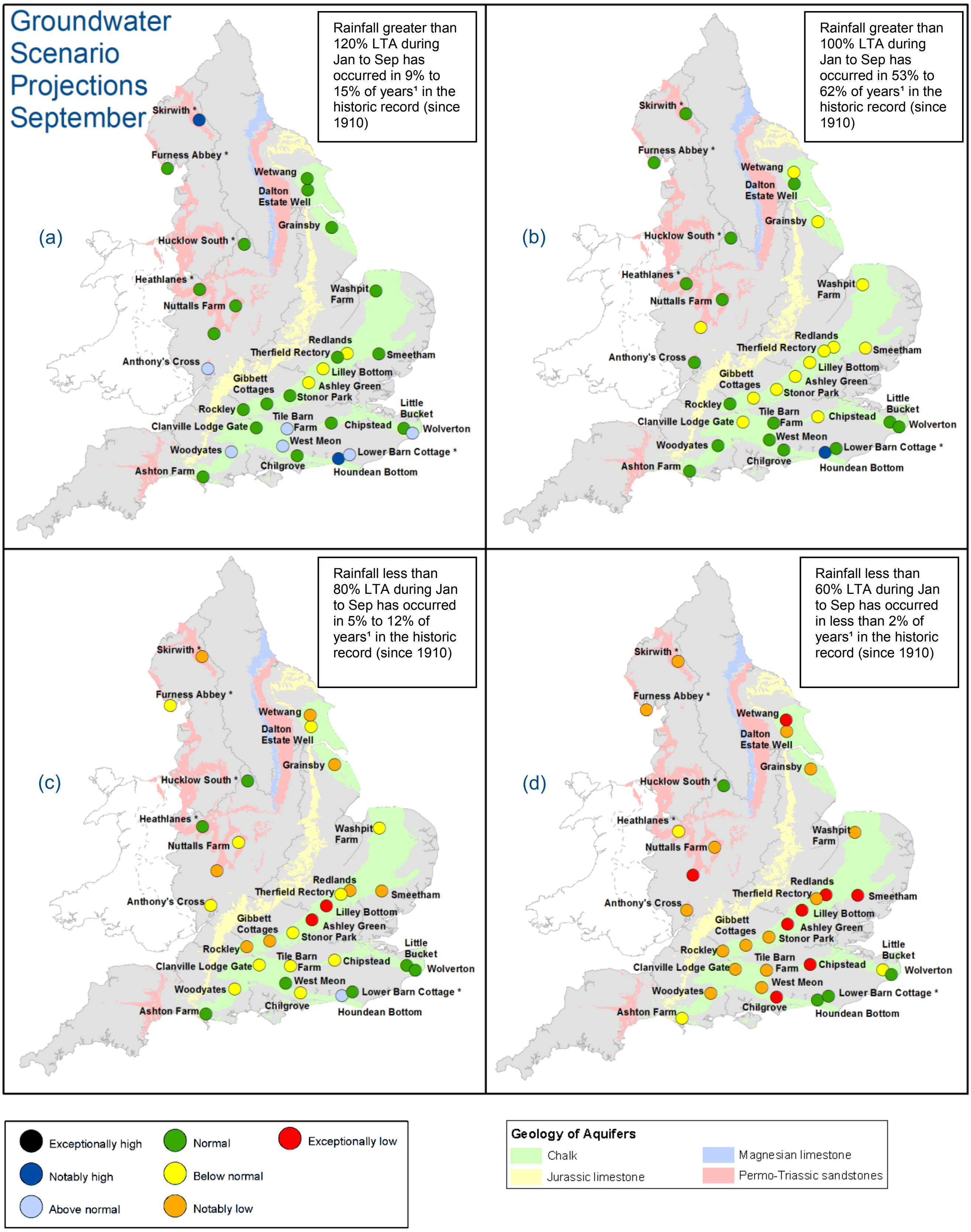
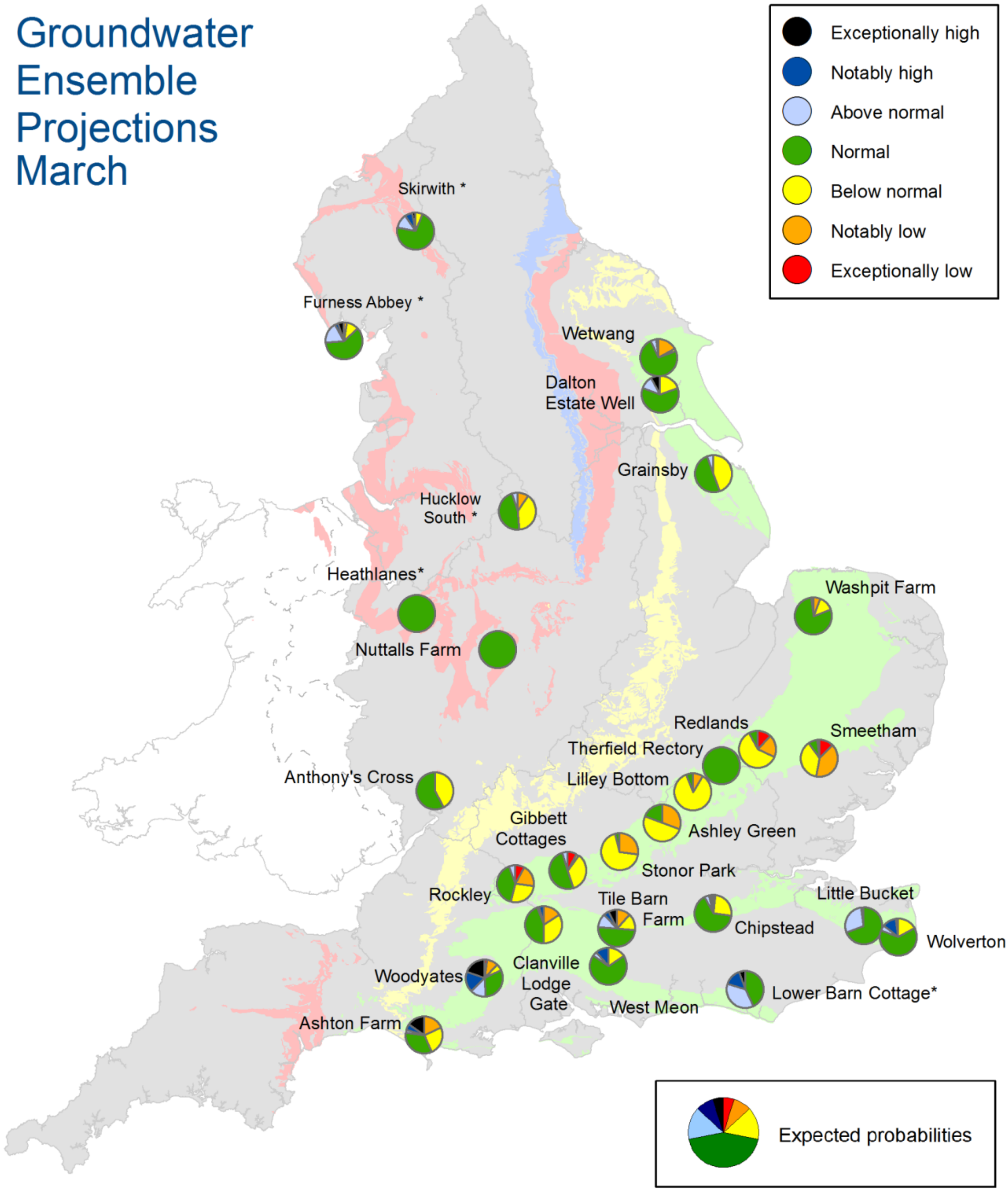


Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and September 2019 (Source: Environment Agency). Geological map reproduced with kind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

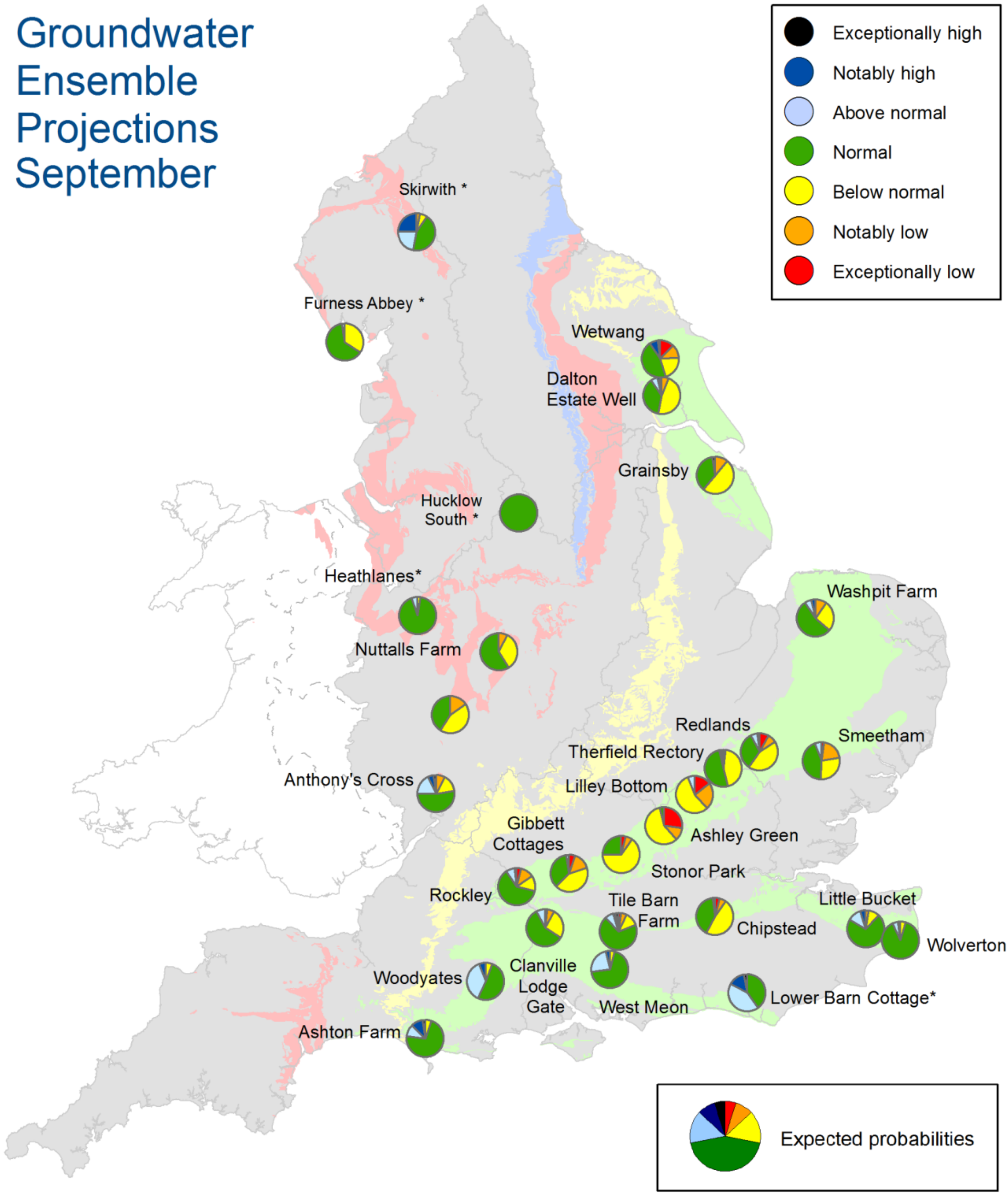
* Projections for these sites are produced by BGS
¹ This range of probabilities is a regional analysis



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 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*



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 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*

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