# Monthly water situation report

## England

## Summary – March 2018

March rainfall was well above average across England at 153% of the monthly long term average and totals were higher than normal for the time of year across the majority of hydrological areas. Soil moisture deficits were largely eliminated across England and soils were close to, or wetter, than average at the end of the month. Mean monthly river flows were higher in March than in February at most indicator sites and were normal or higher for the time of year at all but three sites. Groundwater recharge continued at the majority of sites during March, with end of month levels being normal or higher for the time of year just over three quarters of sites. Reservoir stocks increased or remained at full capacity at the majority of reported reservoirs and reservoir groups and were mainly normal or higher for the time of year at the end of March. Overall reservoir storage for England was 95% of total capacity at the end of March.

### Rainfall

Precipitation during March fell as both snow and rainfall, with two notable snow events occurring at the start and in the middle of the month, affecting much of the country. March rainfall[1] totals were highest across parts of the south coast in Devon and Cornwall at 200 to 250mm and lowest across parts of Cumbria, Hertfordshire, Cambridgeshire and Essex at 50 to 65mm. Rainfall totals were above the March long term average (LTA) across almost all hydrological areas, with several across Devon, Dorset, Somerset and the lower Wye and Severn catchments receiving 200 to 240% of the March LTA. In contrast, the hydrological areas in Cumbria and Lancashire received below average rainfall with the Derwent catchment in Cumbria receiving only 45% of the LTA (Figure 1.1).

March rainfall totals were classed as above normal to exceptionally high for the time of year across the majority of hydrological areas. Rainfall totals were normal in north-west England, with the parts of Cumbria being below normal. The 3, 6 and 12 month cumulative rainfall totals were largely normal to above normal across all hydrological areas (Figure 1.2). It was provisionally the wettest March on record (since records began in 1910) in the Exe and West Somerset Streams hydrological areas in south-west England. It was also provisionally within the top 5 wettest Marchs on record in all but one of the remaining hydrological areas covering Devon and Cornwall, and several across parts of south-west, central and north-east England.

At a regional scale, March rainfall totals were well above average across 5 of the 6 regions, ranging from 159% in east and north-east England to 188% in south-west England. In contrast, north-west England received 80% of the LTA. It was provisionally the 5th wettest March on record and the wettest since 1981 in south-west, central and north-east England, while in south-east England it was the wettest March since 2001. The monthly rainfall total for England was 102mm which was 153% of the 1961-90 LTA (160% of the 1981-10 LTA) (Figure 1.3).

### Soil moisture deficit

The above average rainfall during March largely eliminated any soil moisture deficits (SMDs) remaining at the end of February, although there were some slight increases across parts of north-west England. At the end of March, SMDs were at or close to zero across most of the country, with slightly larger deficits of between 11 and 22mm across parts of east and south-east England (Figure 2.1). End of month SMDs were close to average across much of England, with soils across a swathe of central southern England being wetter than average. At a regional scale, end of month SMDs ranged from zero in south-west England to 9mm in east England. Soils were wetter than average across all regions at the end of March (Figure 2.2).

### River flows

March monthly mean flows increased compared to February at most indicator sites across England. Sites where March flows were lower than for February included all those in north-west England, together with the naturalised flows on the River Lee in south-east England and the gauged flows on the River Dee whose catchment spans the border between England and Wales.

[1] Hereafter, rainfall refers to the combination of snow and rain that fell during the month. Note that recorded rainfall is likely to be underestimated during snow events.



River flows were classed as normal or higher for the time of year at all but 3 indicator sites and were in the range above normal to exceptionally high at nearly two-thirds of sites. Flows in the rivers Tone in Somerset and Kenwyn in Cornwall were the highest March monthly mean flows on record. In contrast, flows were below normal for the time of year in the rivers Derwent and Eamont in Cumbria and the groundwater-fed River Ver in Hertfordshire (Figure 3.1). Flows at the regional index sites in east (Bedford Ouse) and central England (River Dove) were above normal for the time of year, whilst the other sites were all normal (Figure 3.2).

## Groundwater levels

Groundwater recharge continued during March, with levels rising at the majority of indicator sites in response to the above average rainfall. Levels decreased at 2 sites in the slower-responding sandstone aquifers in the north-east and north-west of England, together with Chilgrove and Houndean Bottom located in the Chichester chalk and Brighton chalk aquifers respectively.

End of month groundwater levels were normal or higher for the time of year at the majority of indicator sites. Levels at Little Bucket (East Kent Stour chalk aquifer), Ashley Green (East Chilterns chalk aquifer) and Stonor Park (South West Chilterns chalk aquifer) in south-east England were below normal for the time of year, together with Woodleys No. 1 (Otter Valley sandstone aquifer) in south-west England and Crow Lady Farm (Fylde and Preston sandstone aquifer) in north-west England. Crossley Hill (Idle Torne sandstone aquifer) remained exceptionally low for the time of year (Figures 4.1 and 4.2). End of month levels at the major aquifer index sites were all normal or higher for the time of year except at Stonor and Little Bucket (highlighted above).

## Reservoir storage

Reservoir stocks increased or remained at full capacity at all but 5 reported reservoirs or reservoir groups during March. The largest increases occurred at Abberton (12%), Draycote (11%) and Bewl (10%) reservoirs, whilst the largest decreases occurred at the NCZ Regional Group (6%) in north-west England and Stithians Reservoir (5%) in south-west England. End of month stocks were classed as normal or higher for the time of year at the majority of sites, whilst Carsington and Ogston, Draycote and the Dove Group reservoirs in central England and Abberton reservoir in east England were classed as below normal. The NCZ Regional Group in north-west England was classed as notably low for the time of year at the end of March, but levels have risen in early April (Figure 5.1).

Regional reservoir stocks increased during March by 2 to 4% in all regions except north-west where stocks decreased by 3%. End of March stocks ranged from 89% of total capacity in north-west England to 98% in south-west England. Overall storage for England increased slightly to 95% of total capacity (Figure 5.2).

## Forward look

The weather for April is expected to be mixed, with showers and spells of heavy rain, particularly across south-east England, interspersed with drier and more settled conditions, particularly in the north of England. For the 3-month period April-May-June, above average precipitation is slightly more likely than below average precipitation[2].

### Projections for river flows at key sites[3]

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 2018. Nearly three-quarters of the modelled sites have a greater than expected chance of cumulative flows being normal or higher by the end of March 2019.

For scenario based projections of cumulative river flows at key sites by September 2018 see Figure 6.1.
For scenario based projections of cumulative river flows at key sites by March 2019 see Figure 6.2.
For probabilistic ensemble projections of cumulative river flows at key sites by September 2018 see Figure 6.3.
For probabilistic ensemble projections of cumulative river flows at key sites by March 2019 see Figure 6.4.

### Projections for groundwater levels in key aquifers[2]

Just over two-thirds of the modelled sites have a greater than expected chance of groundwater levels being normal or higher for the time of year at the end of September 2018. Three-fifths of the modelled sites have a greater than expected chance of levels being normal or higher at the end of March 2019.

For scenario based projections of groundwater levels in key aquifers in September 2018 see Figure 6.5.
For scenario based projections of groundwater levels in key aquifers in March 2019 see Figure 6.6.
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2018 see Figure 6.7.
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2019 see Figure 6.8.

Authors: National Water Resources Hydrology Team

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

# Rainfall

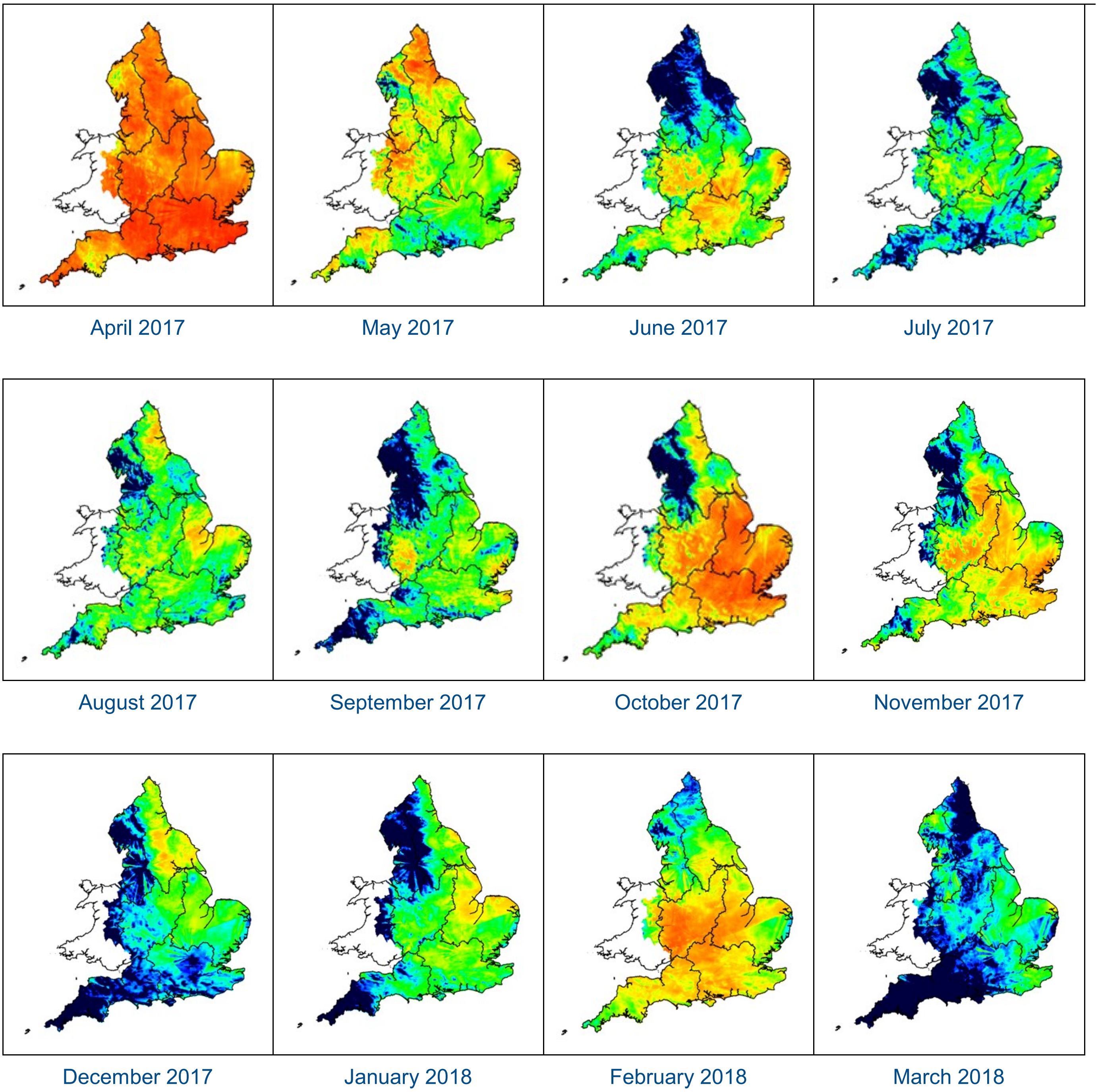
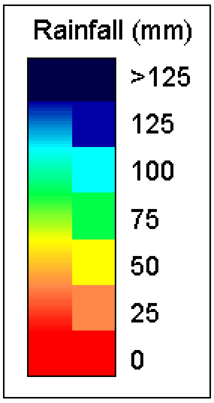



**Figure 1.1**: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2018). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2018.



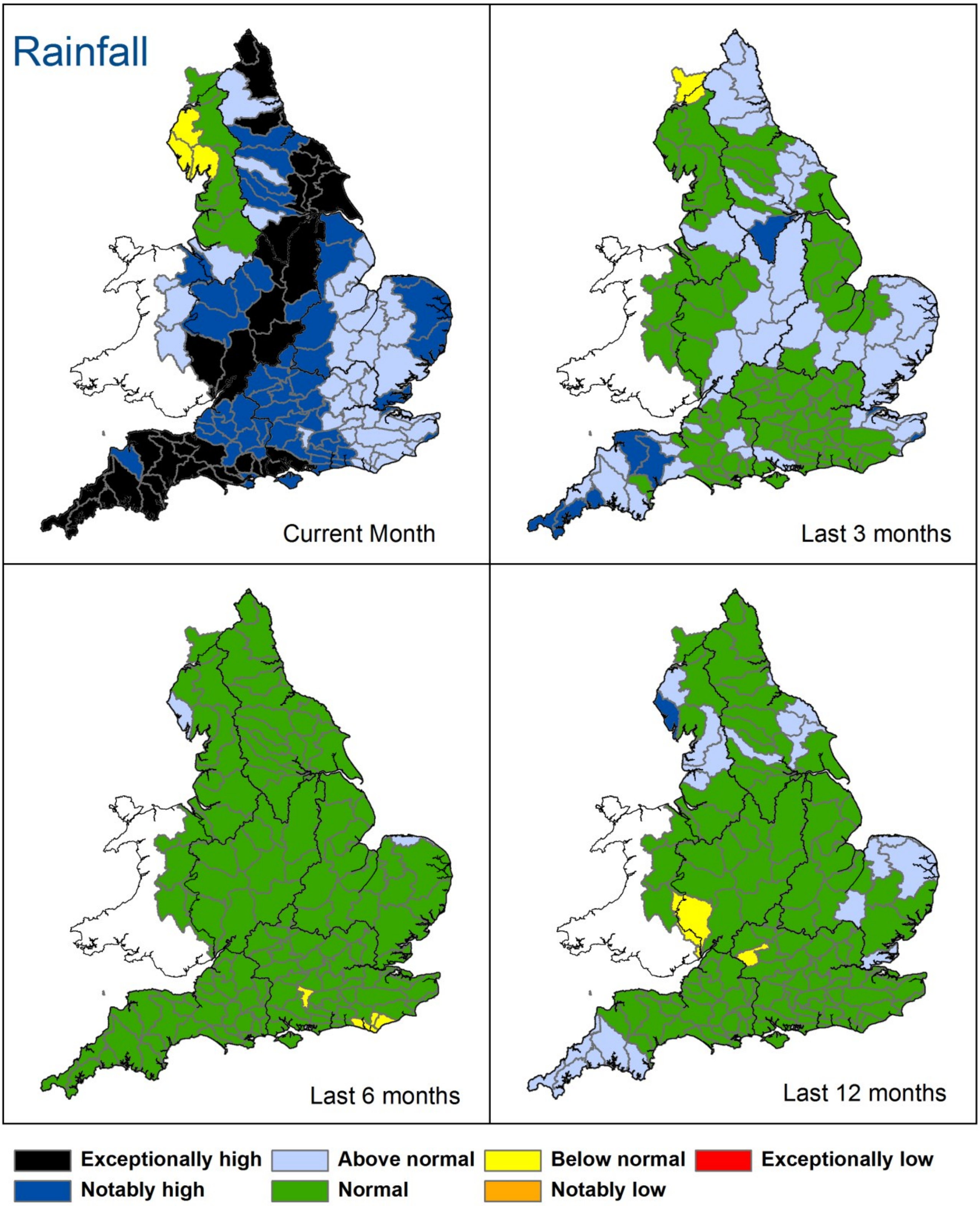



**Figure 1.2**: Total rainfall for hydrological areas across England for the current month (up to 31 March), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2018).* 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, 2018.

## Rainfall charts

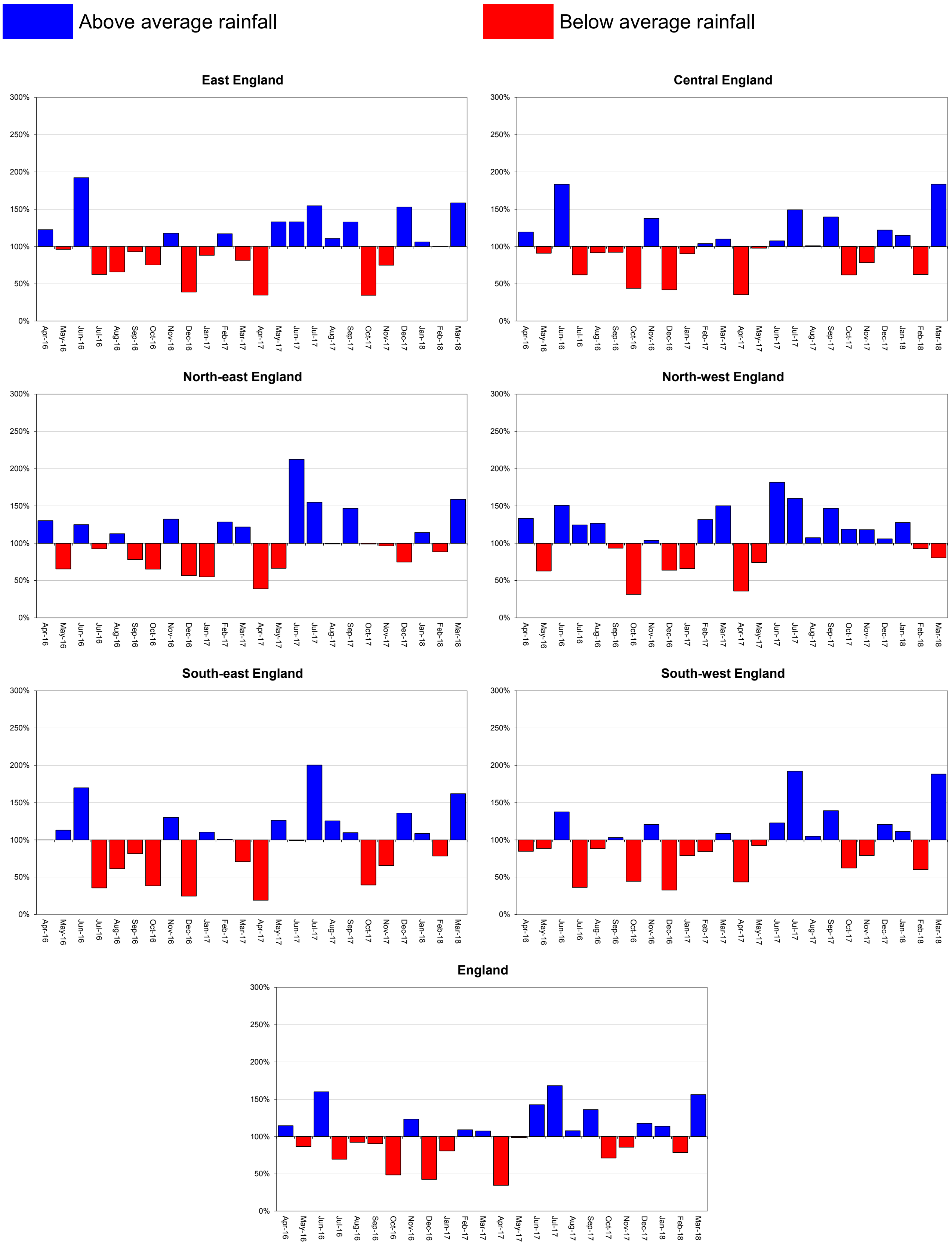



**Figure 1.3**: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2018).

# Soil moisture deficit

| End of February 2018[1] | End of March 2018[2] |
| --- | --- |

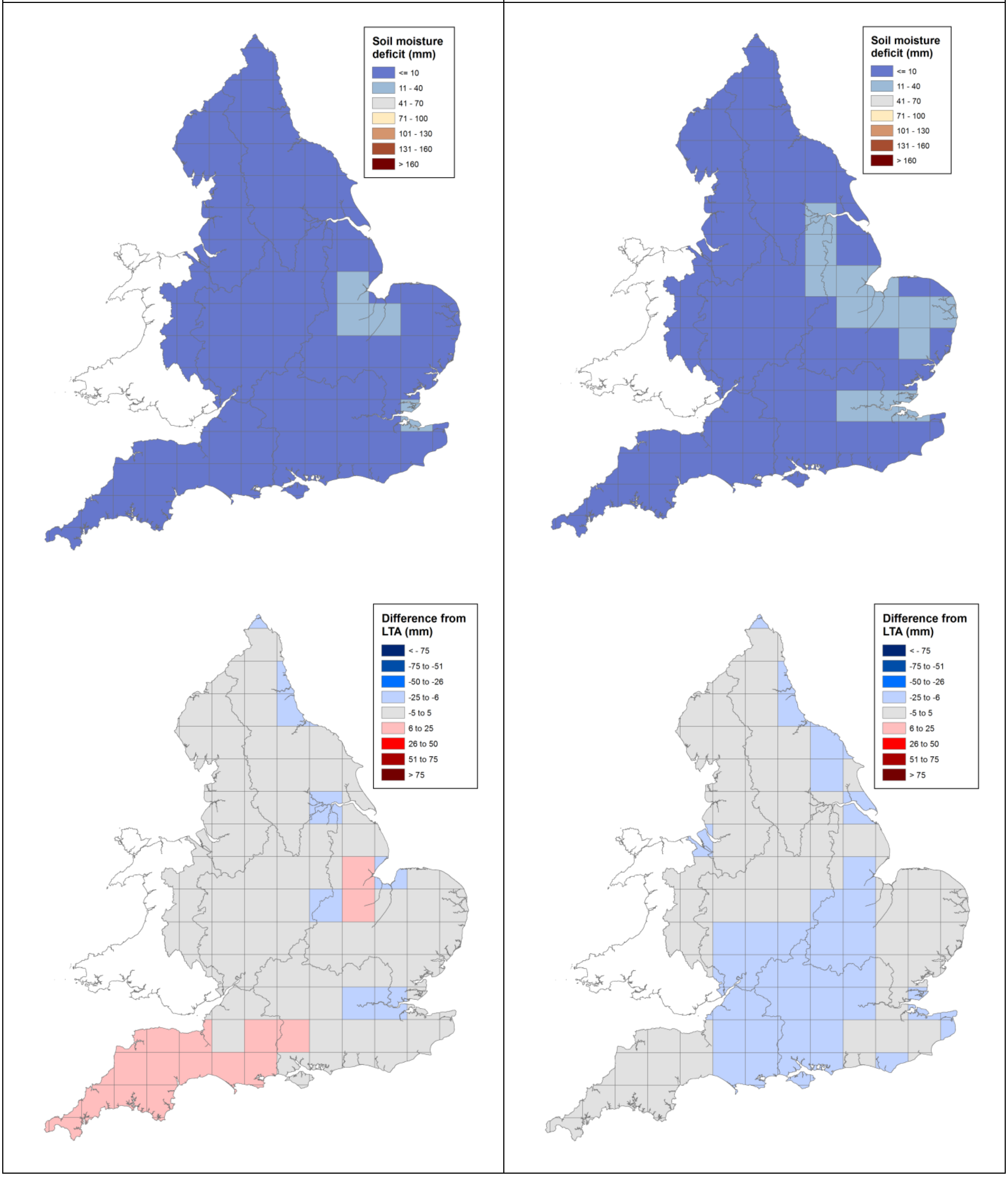



**Figure 2.1**: Soil moisture deficits for weeks ending 27 February 2018[1] (left panel) and 27 March 2018[2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2018). Crown copyright. All rights reserved. Environment Agency, 100026380, 2018.

## Soil moisture deficit charts

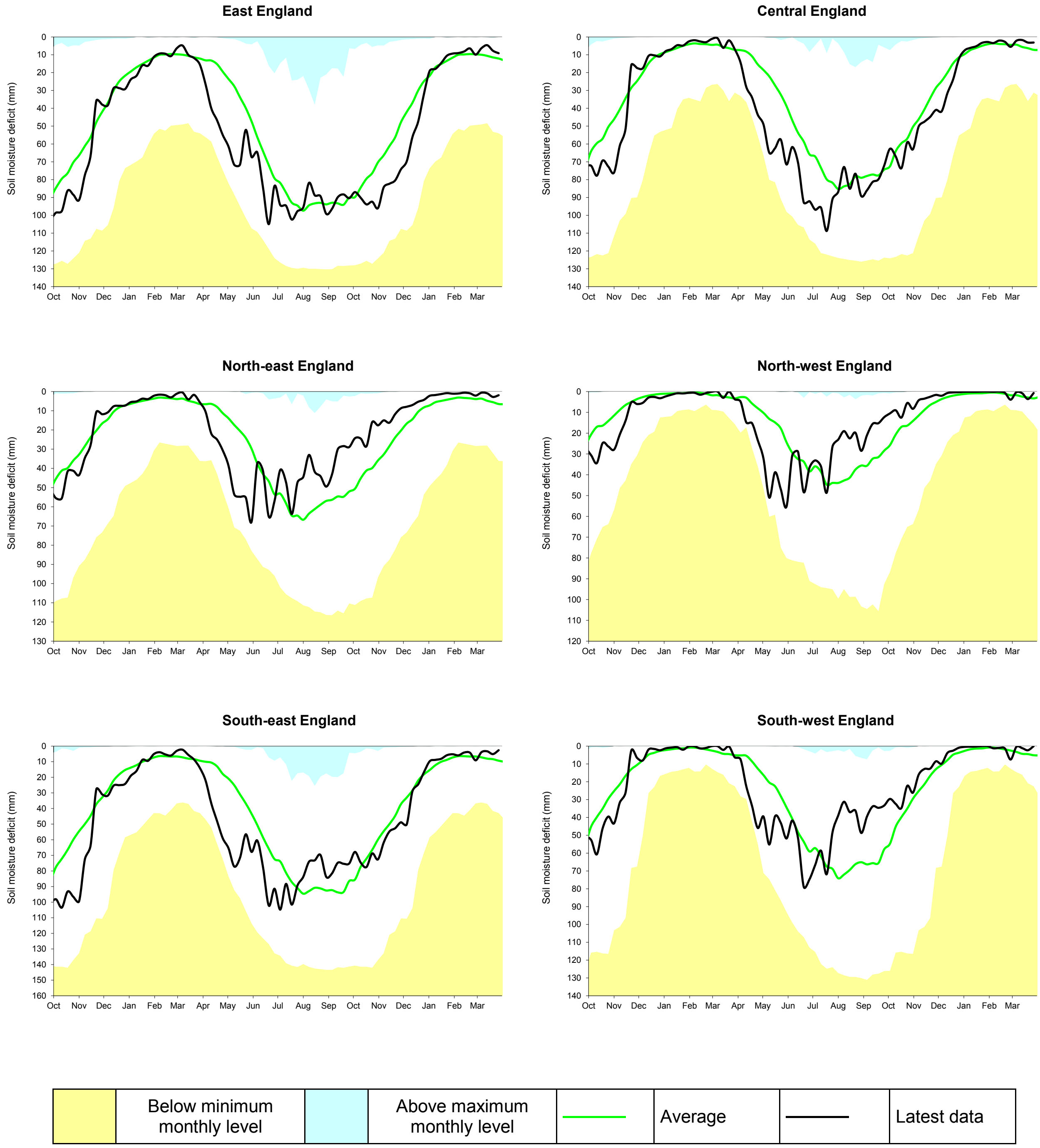
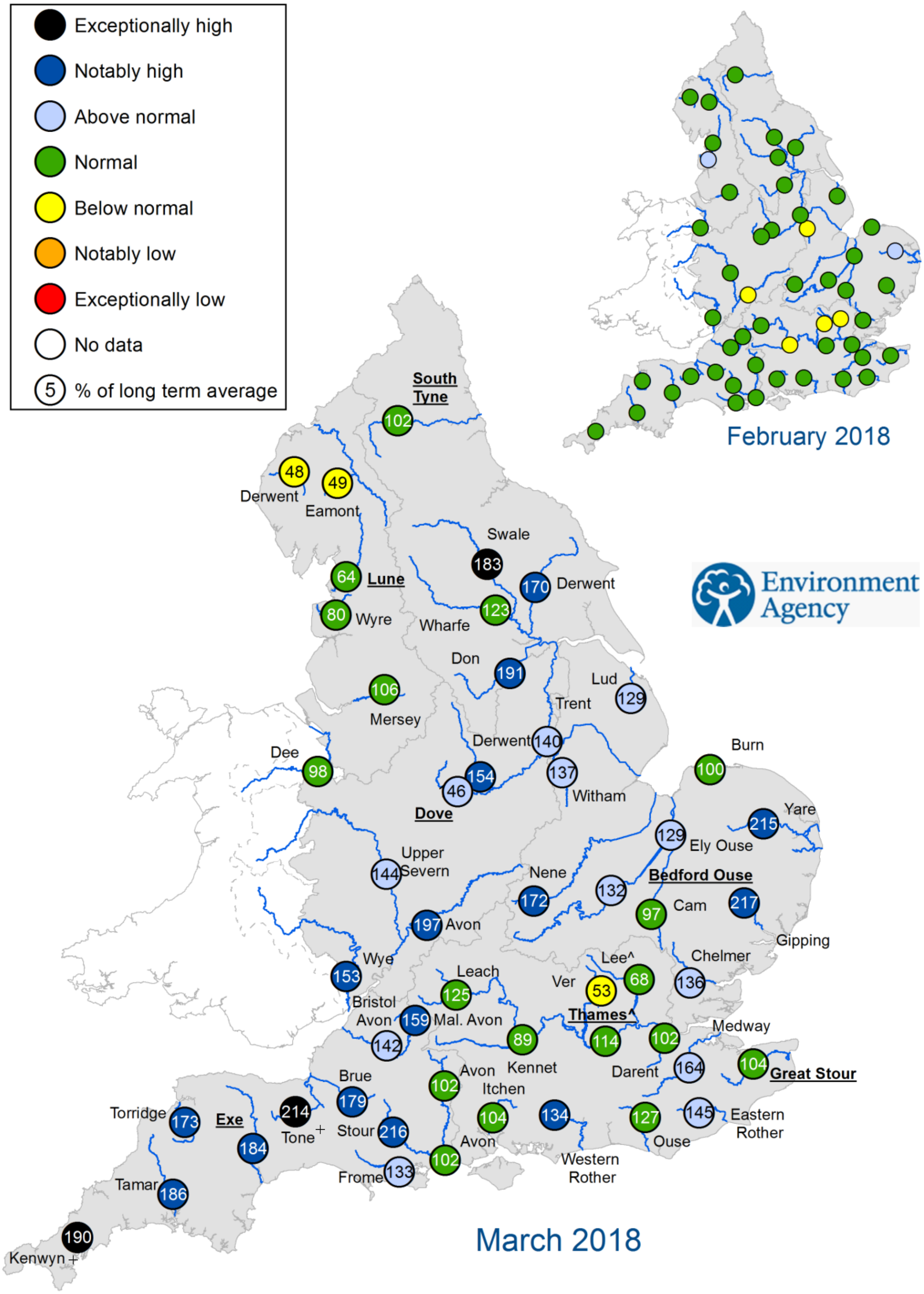



**Figure 2.2**: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2018).

# 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 2018, 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, 2018.

# River flow charts

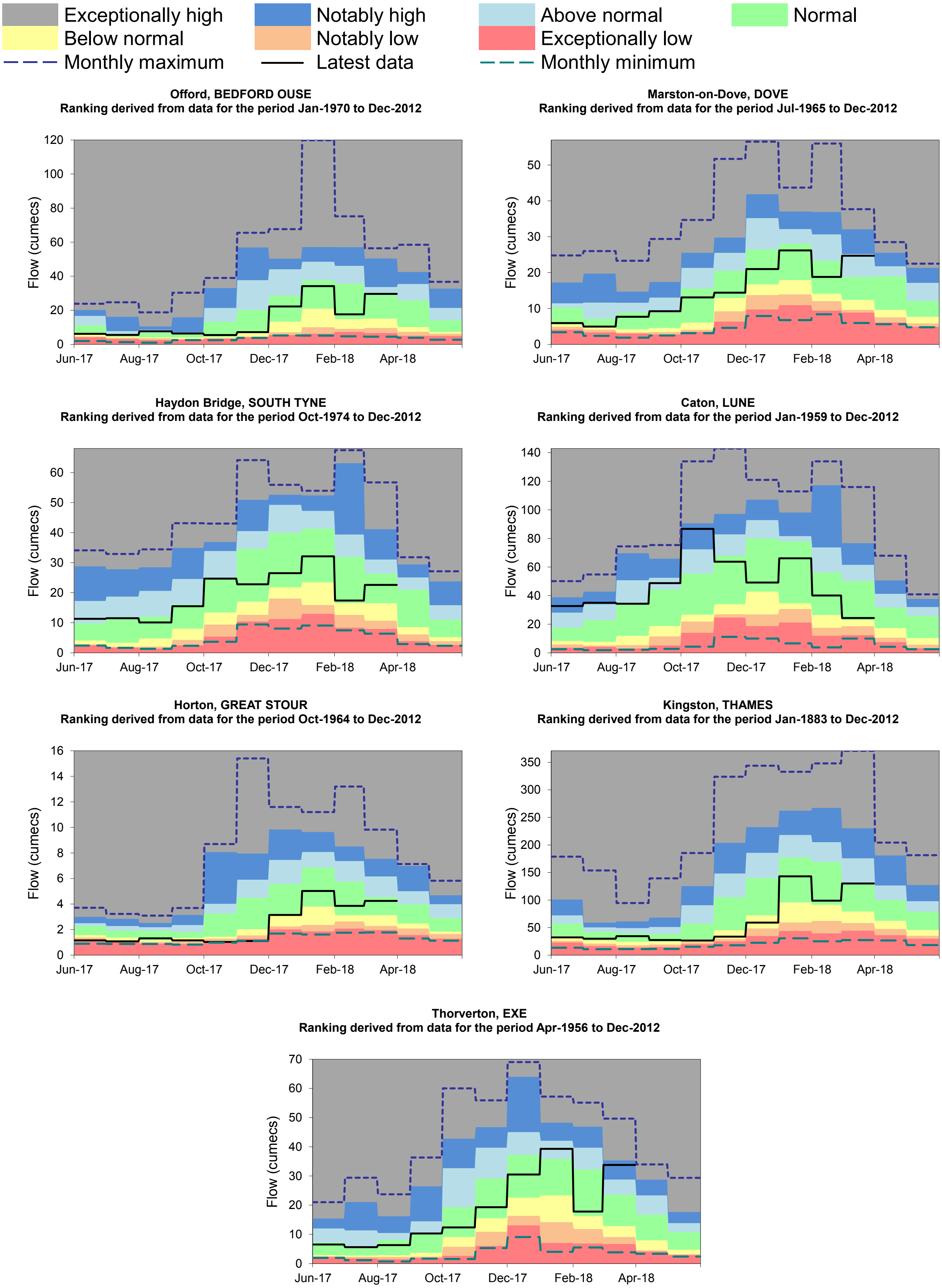
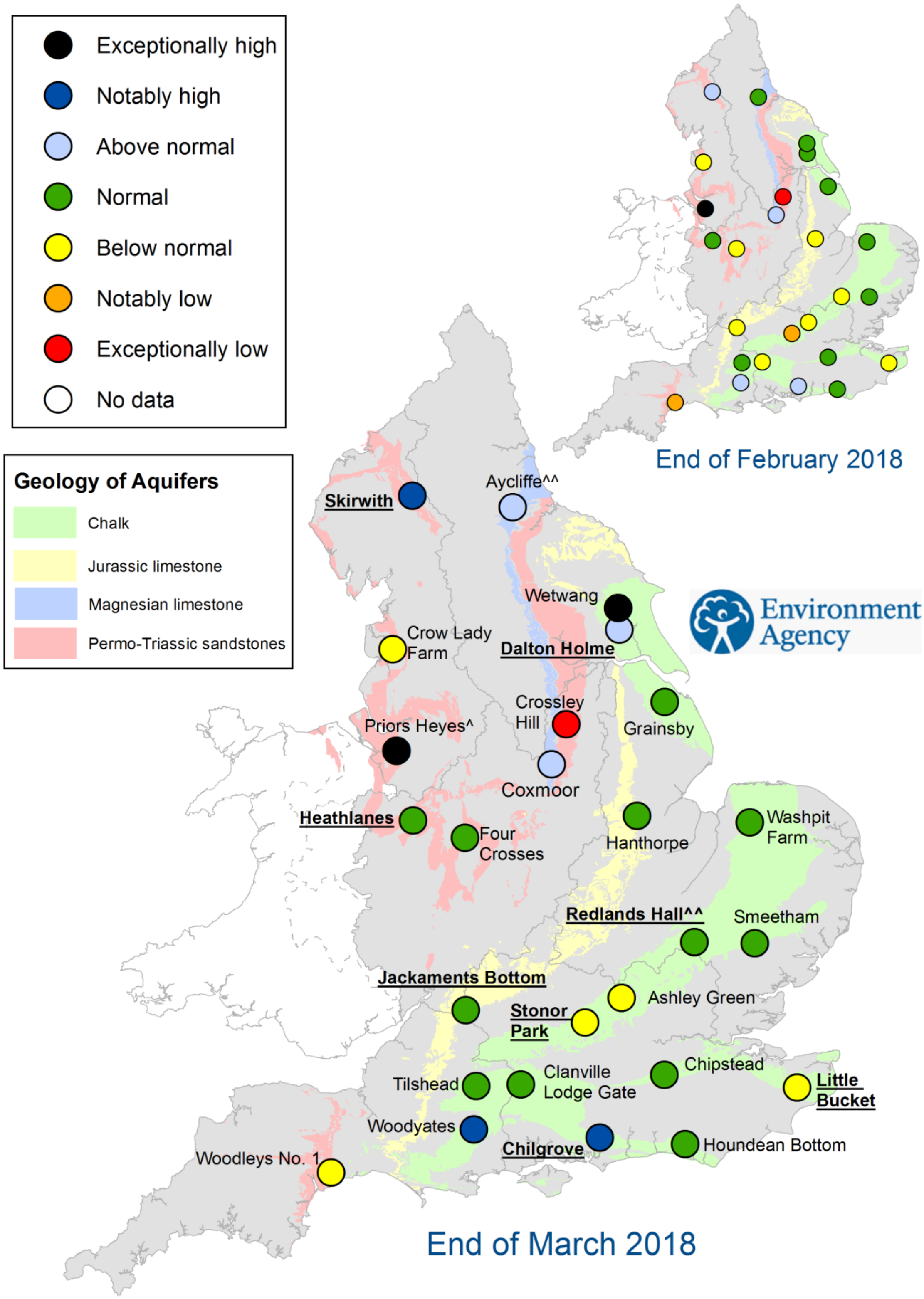



**Figure 3.2**: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

## 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 2018, 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. 

## Groundwater level charts

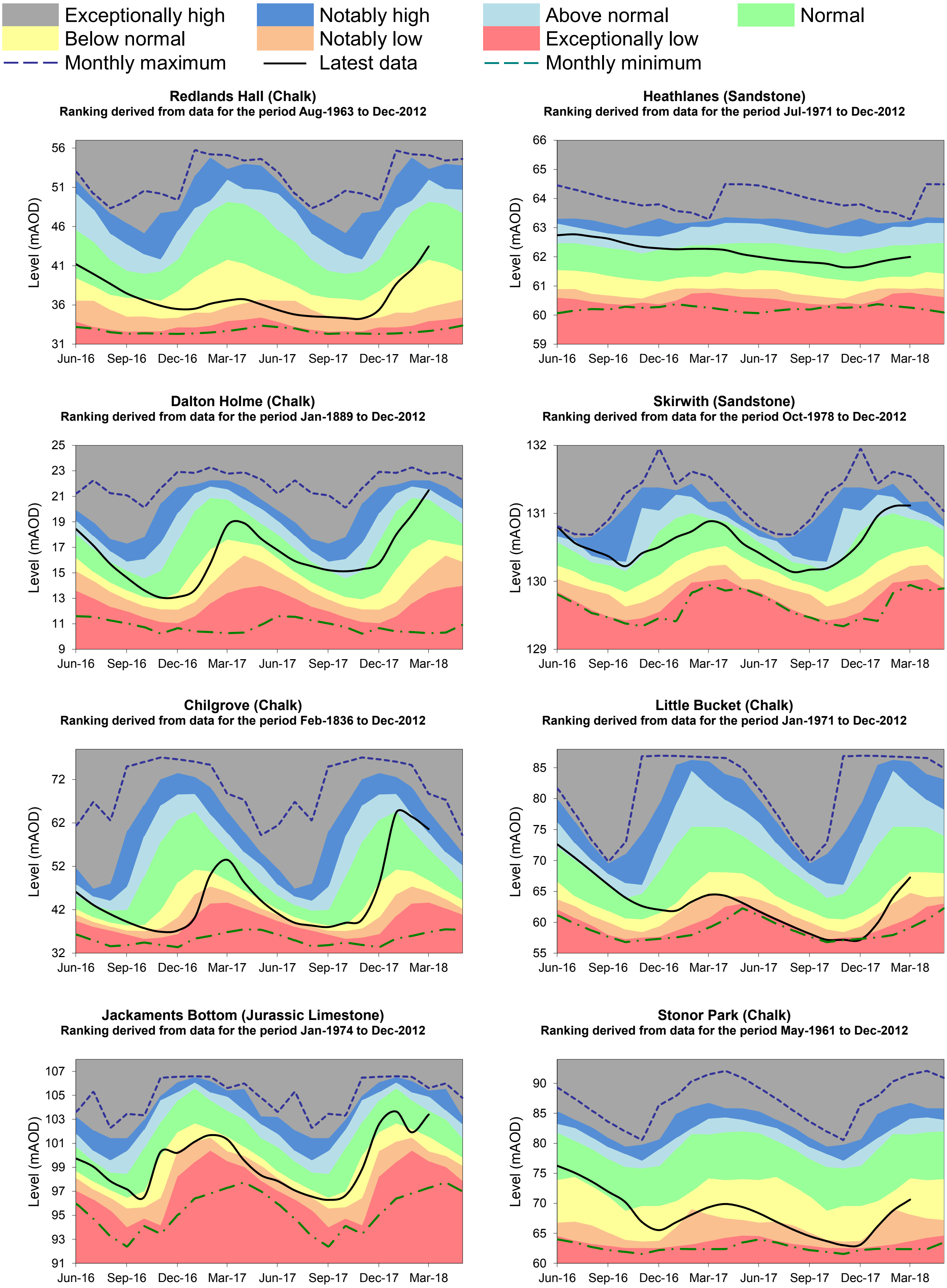
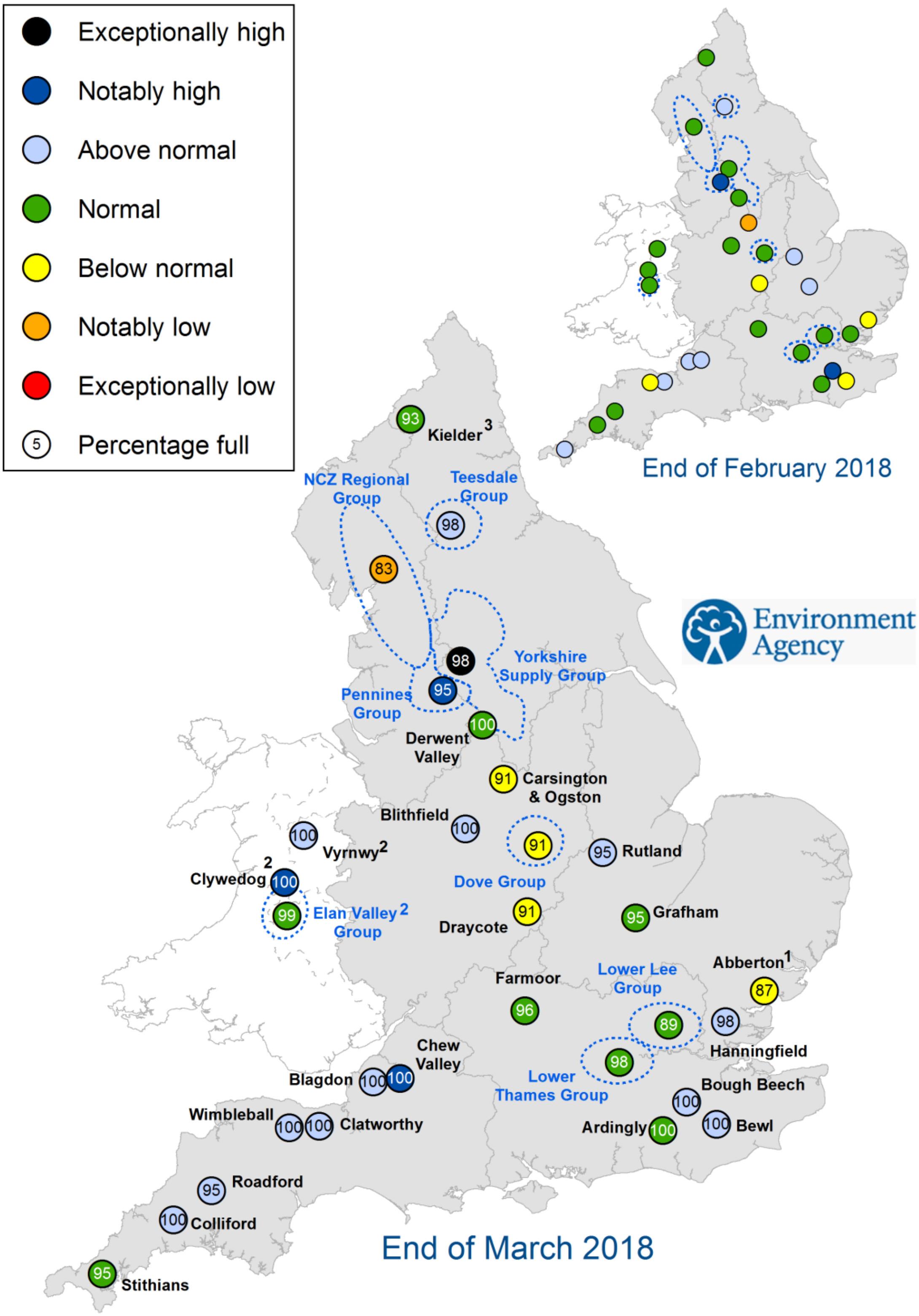



**Figure 4.2**: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2018).

# 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 February and March 2018 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. 

# Reservoir storage charts

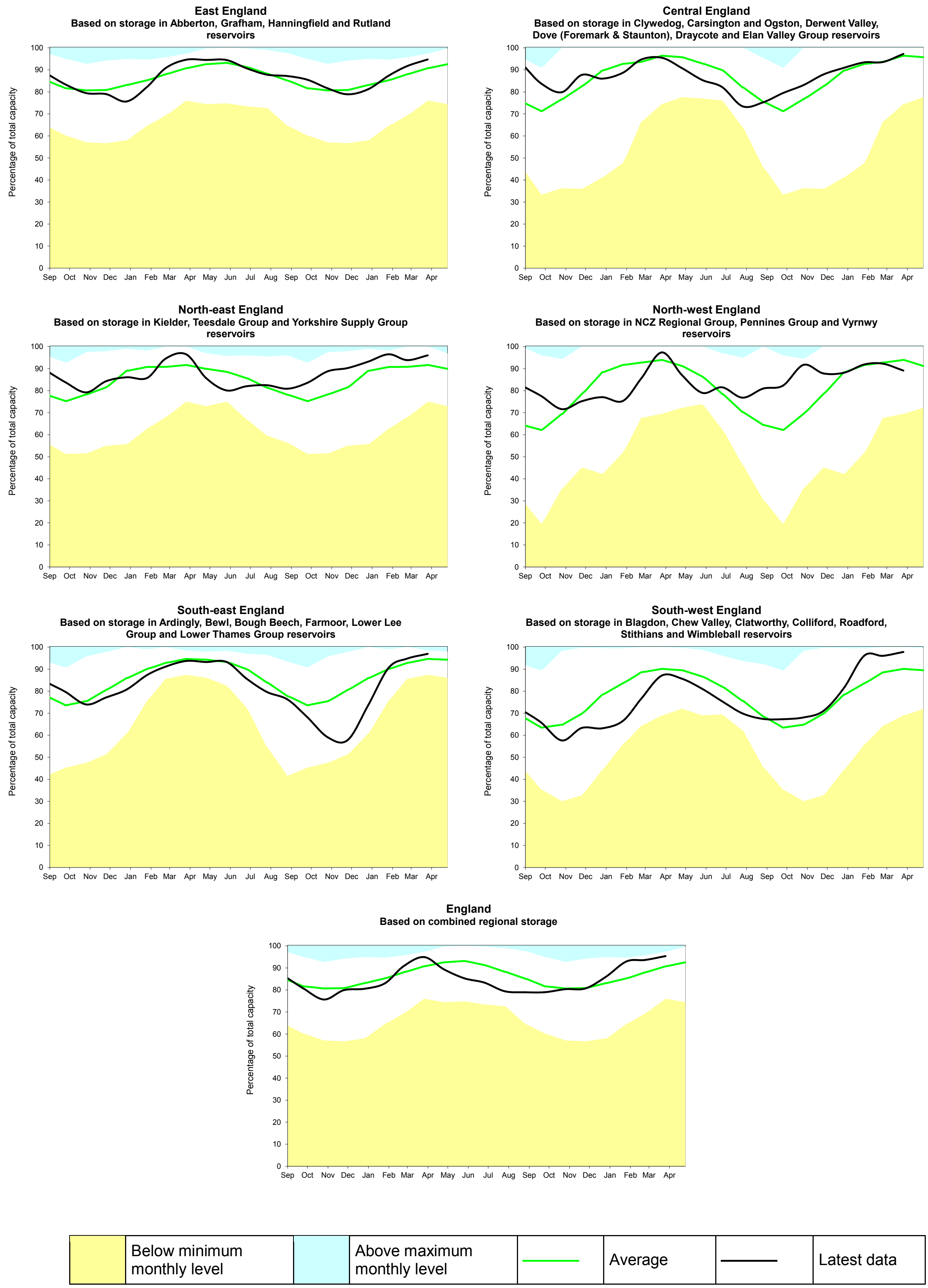



**Figure 5.2**: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

# Forward look – river flow

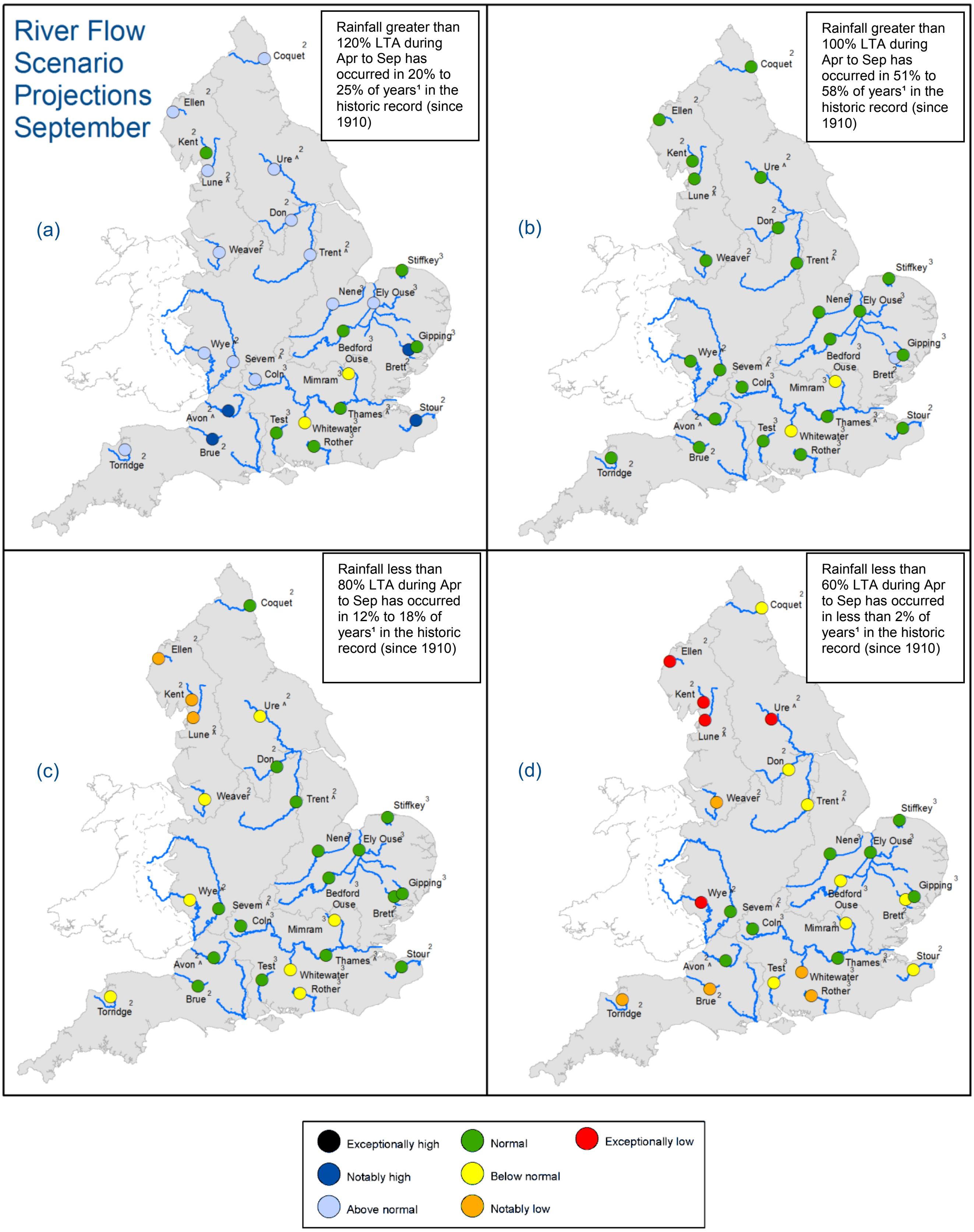



**Figure 6.1**: Projected river flows at key indicator sites up until the end of September 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April and September 2018 (Source: Centre for Ecology and Hydrology, Environment Agency).

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*

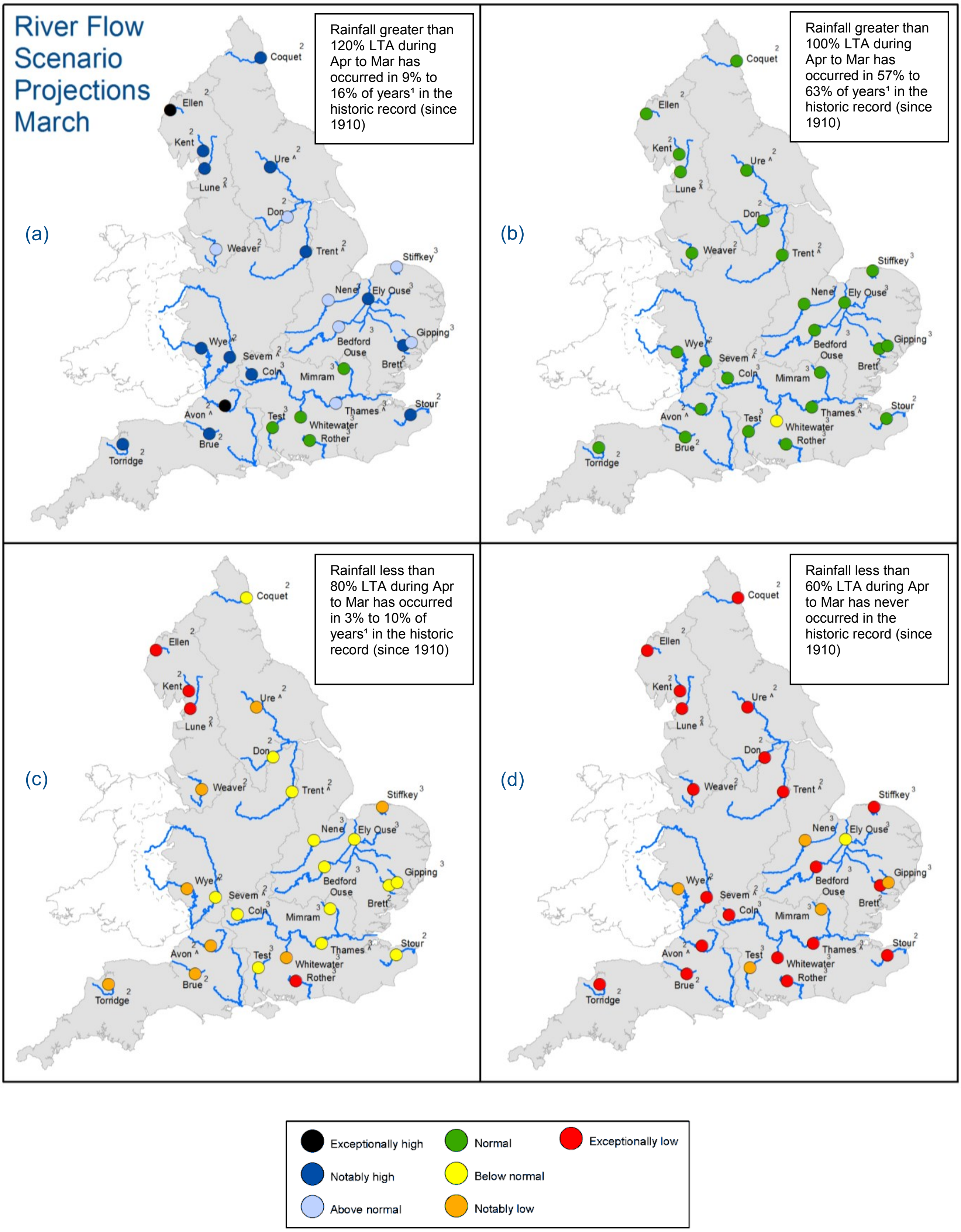



**Figure 6.2**: Projected river flows at key indicator sites up until the end of March 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2018 and March 2019 (Source: Centre for Ecology and Hydrology, Environment Agency).

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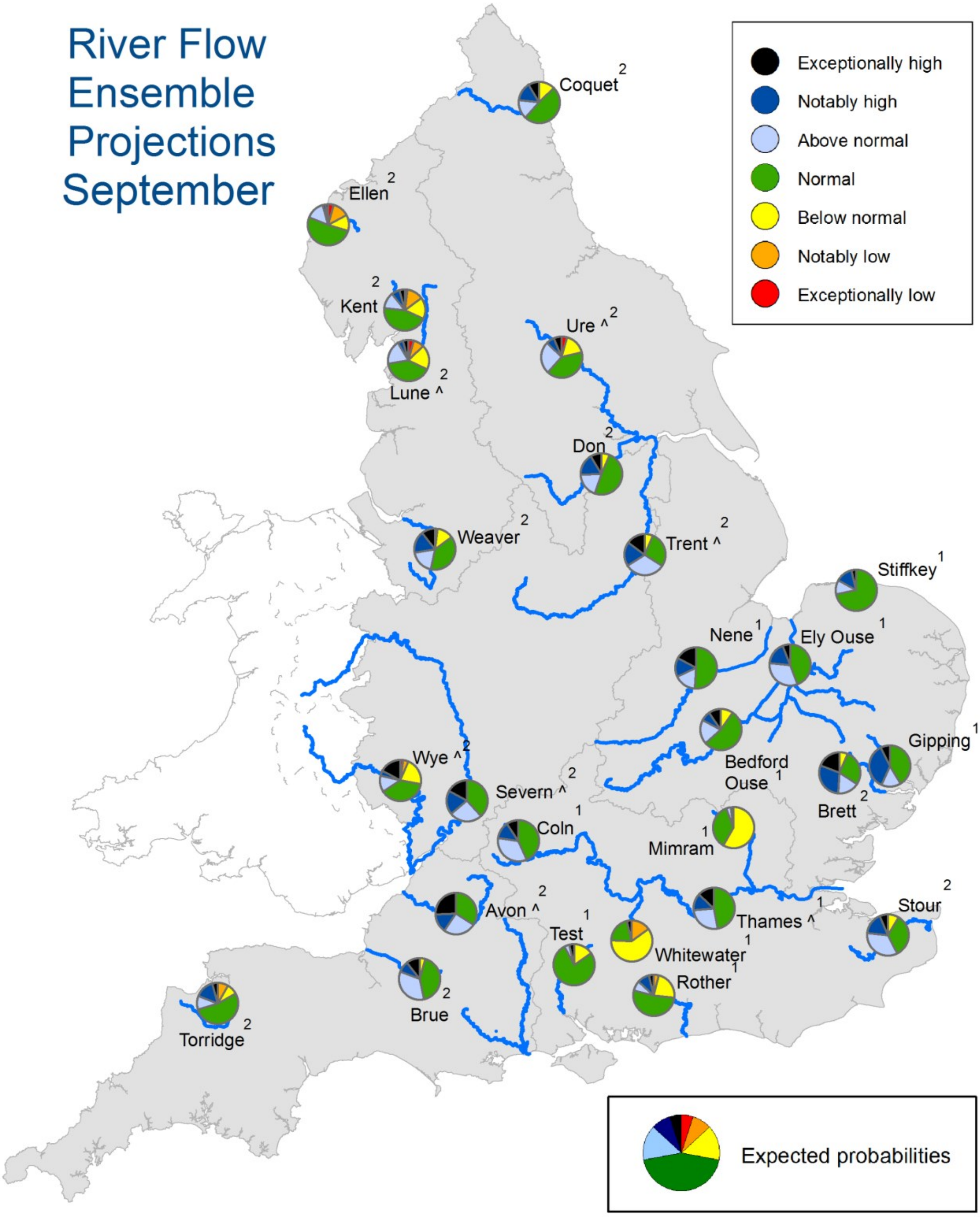
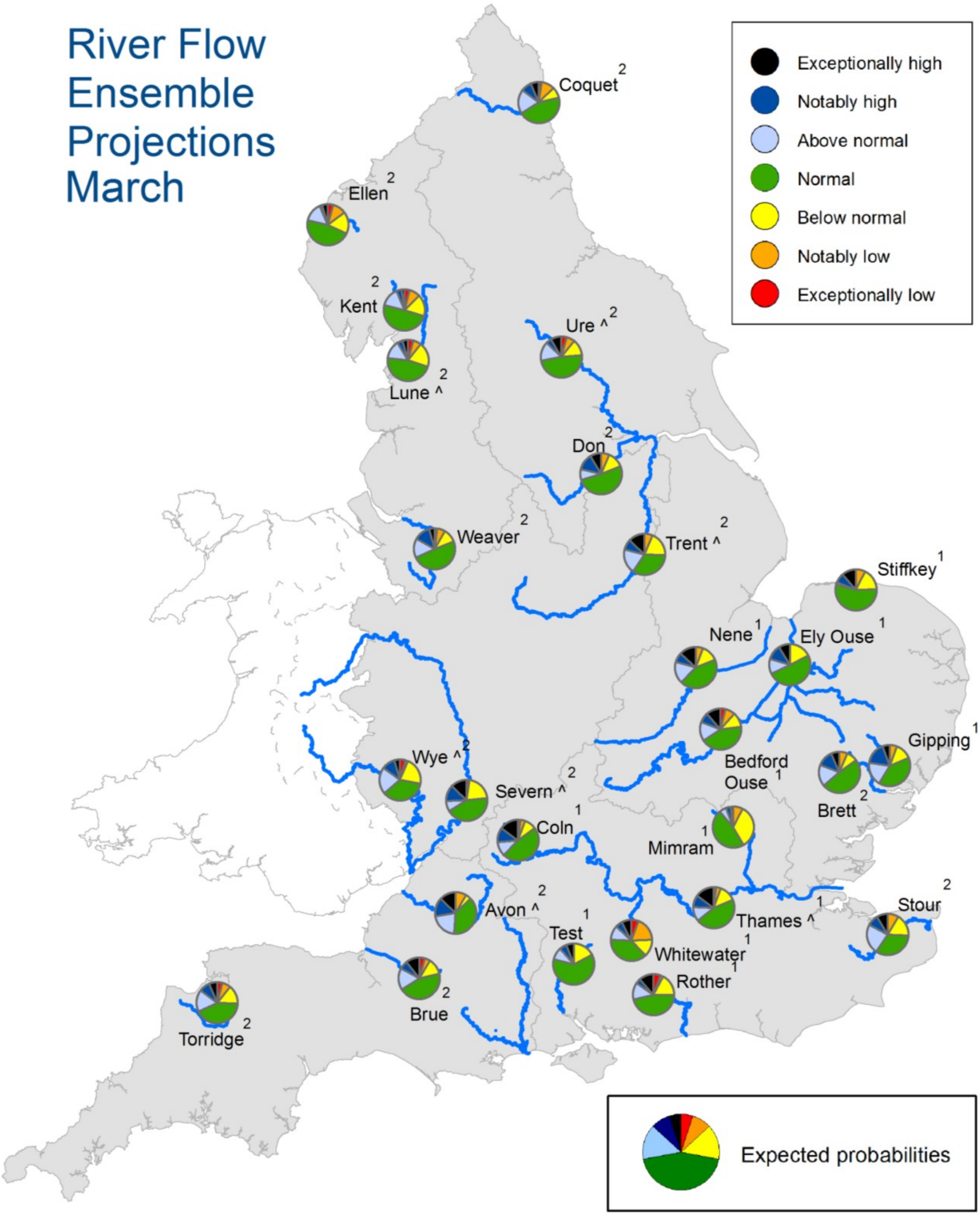



*Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels 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 September 2018. 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 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).

[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

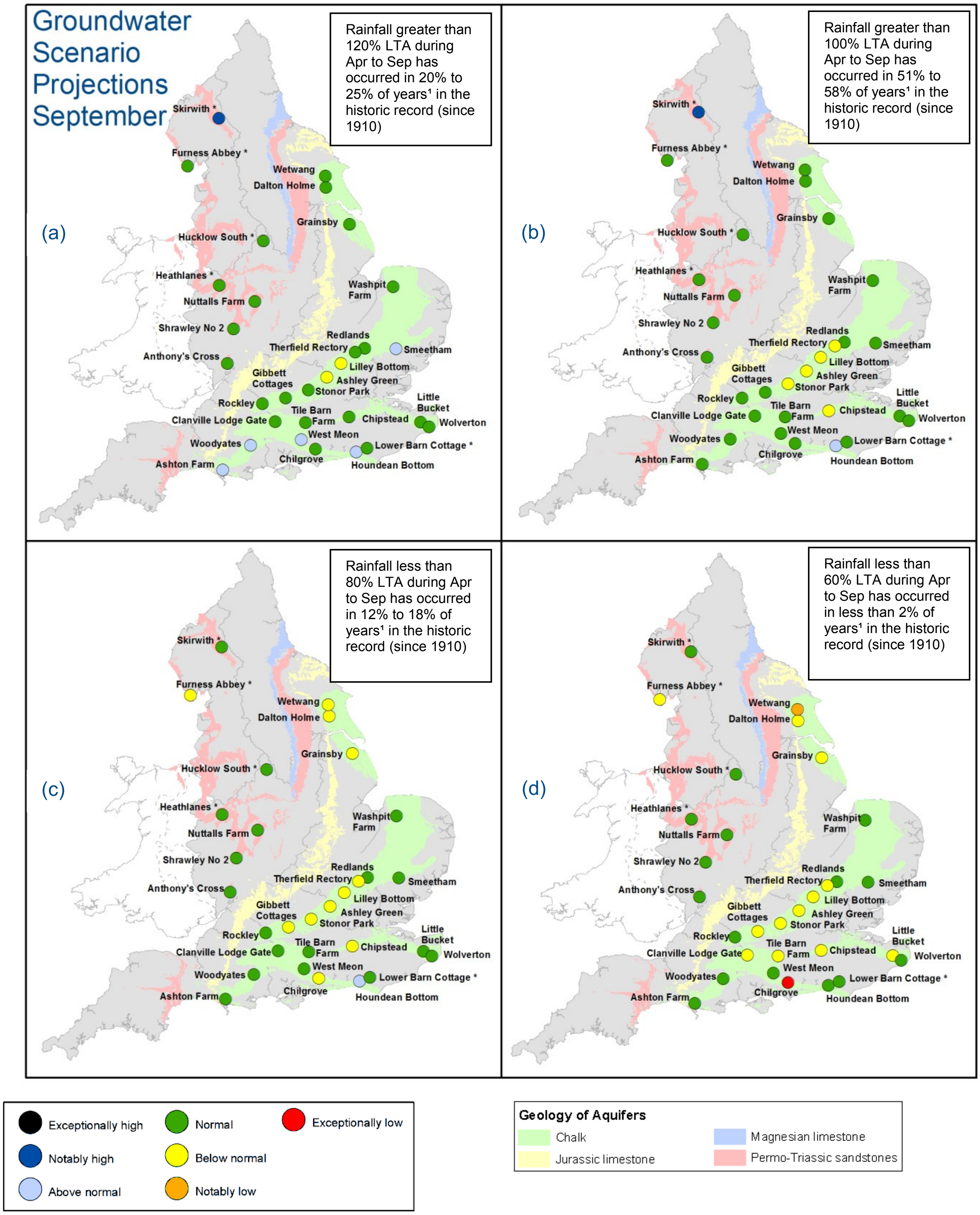



**Figure 6.5**: Projected groundwater levels at key indicator sites at the end of September 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April and September 2018 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2018.

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

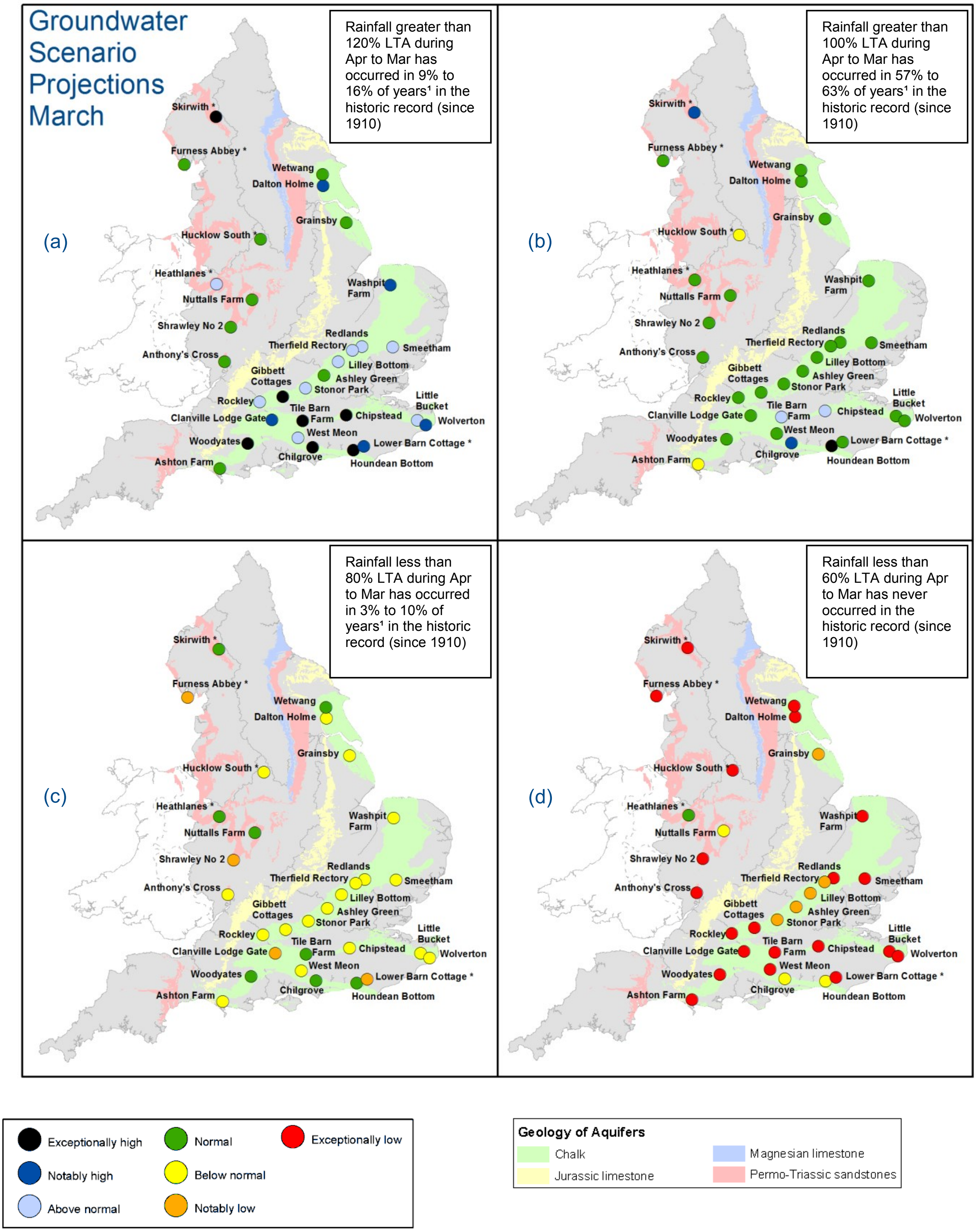
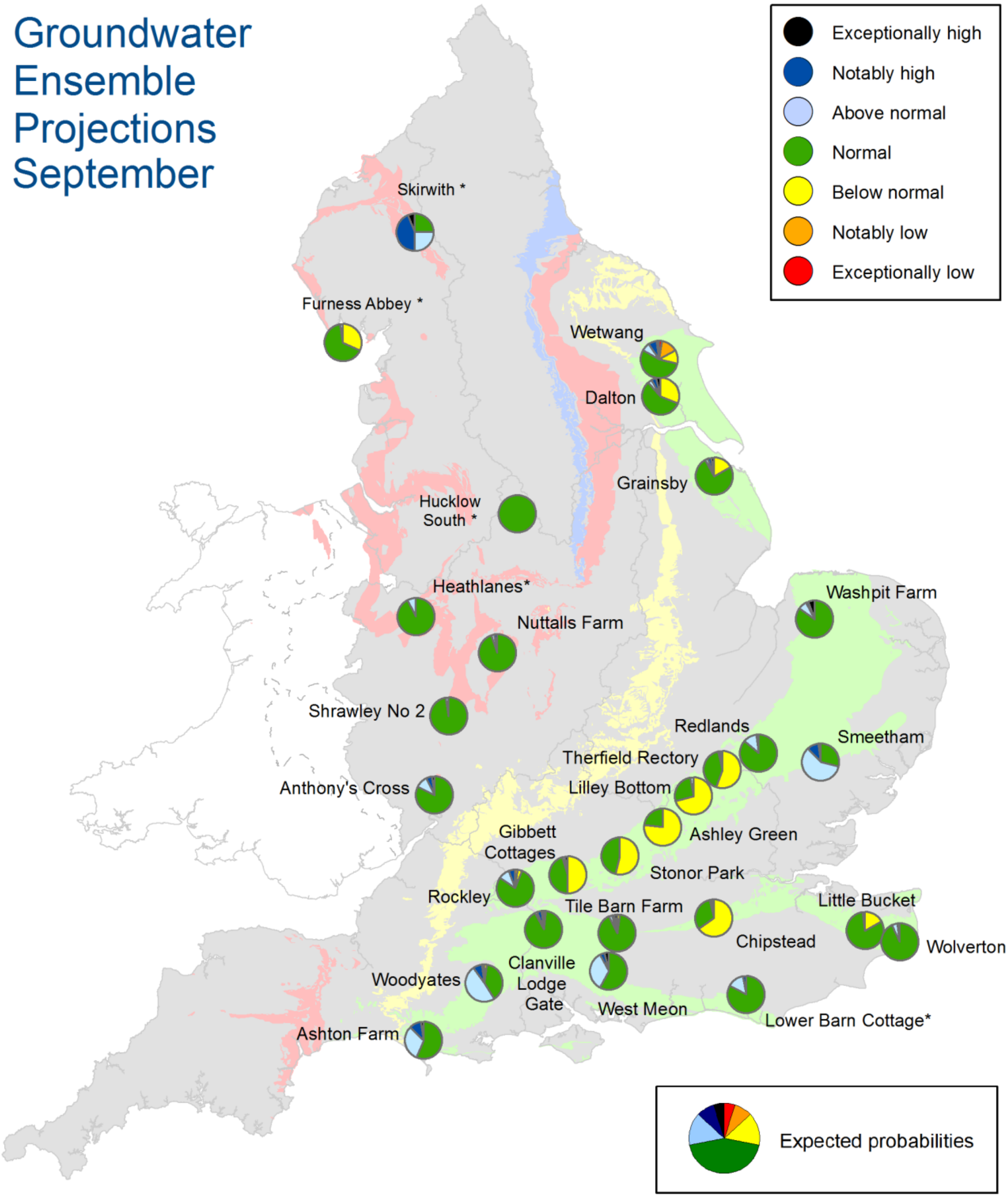



**Figure 6.6**: Projected groundwater levels at key indicator sites at the end of March 2019. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2018 and March 2019 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2018.

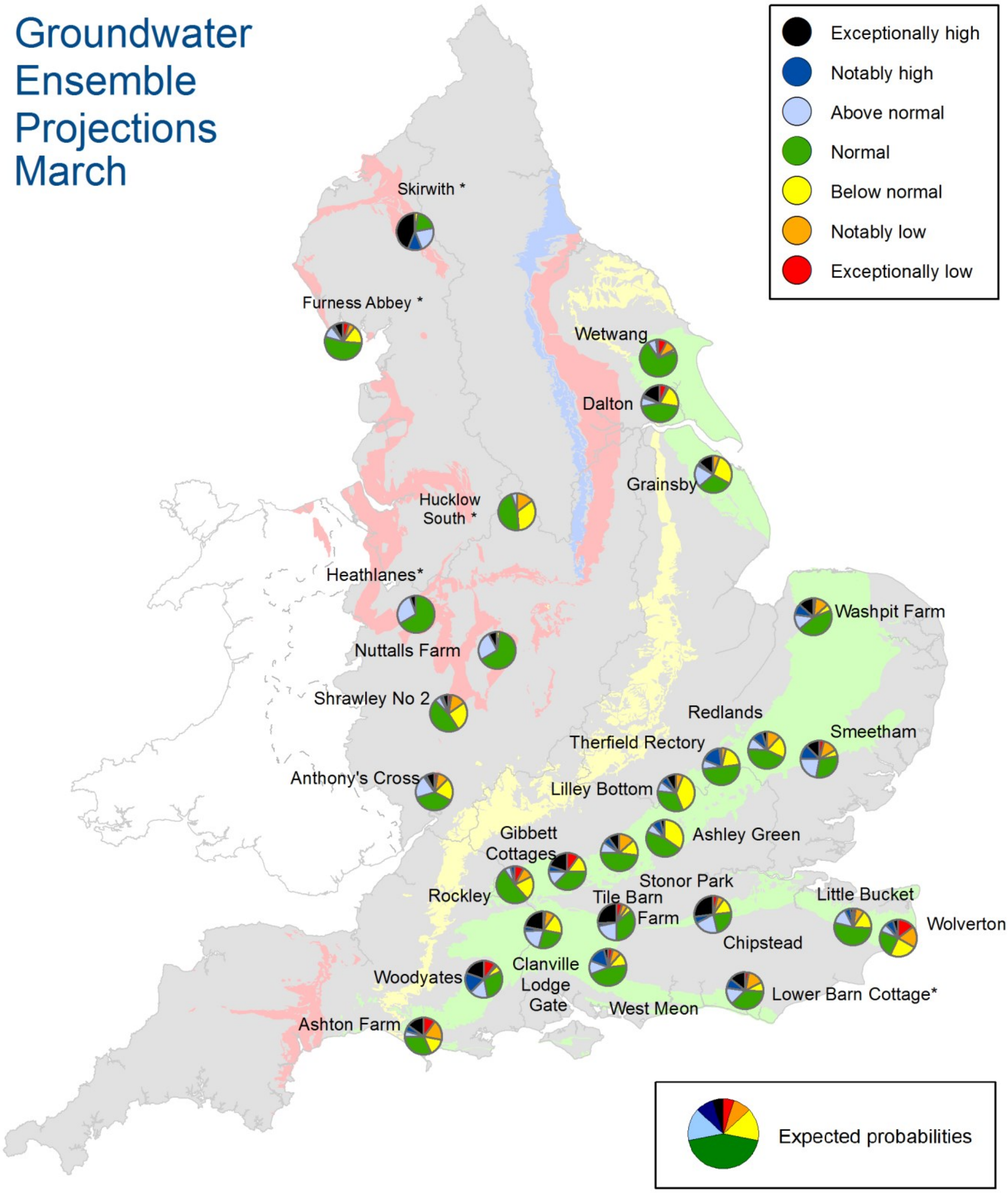
* Projections for these sites are produced by BGS
¹ This range of probabilities is a regional analysis




*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 2018. 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, 2018.

** 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 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, 2018.

* 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 |