# Monthly water situation report

## England

## Summary – October 2014

October rainfall was above average across England at 140% of the long term average. Soil moisture deficits decreased during the month and were generally close to or smaller than average by the end of the month. Monthly mean river flows increased at all indicator sites but were within the **normal** range for the time of year at most sites. Groundwater levels decreased at two thirds of sites but remained **normal** or higher for the time of year at all but one site. Reservoir stocks increased or remained static at nearly two thirds of sites and stocks were **normal** for the time of year at all but four sites. Overall reservoir stocks for England were 76% of total capacity at the end of October.

### Rainfall

October rainfall totals were highest across Cumbria at more than 200 mm and lowest across parts of Durham, Yorkshire and Nottinghamshire at less than 70 mm. Rainfall totals were above the October long term average (LTA) in all but four hydrological areas and parts of Cumbria received more than 200% of the LTA (Figure 1.1).

In stark contrast to September, October rainfall totals were **normal** or higher for the time of year across all hydrological areas. Across nearly half of the hydrological areas rainfall totals were **above normal** or **notably high**, with 3 areas in Cumbria being **exceptionally high** for the time of year. Over the cumulative 3 and 6 month periods ending in October, rainfall totals were generally **normal** to **above normal** across England. The exceptional winter rainfall of 2013-14 remains evident in the 12 month cumulative rainfall totals, with the southern half of England and parts of the north classed as having received **above normal** to **exceptionally high** rainfall totals for the time of year (Figure 1.2)

At a regional scale, October rainfall totals were **normal** to **above normal** for the time of year and ranged from 125% of the October LTA in northeast England to 157% in east England. Overall, England received 140% of the October LTA (Figure 1.3). The 10 and 11 month cumulative periods ending in October were the wettest on record in southeast England and the third wettest on record in southwest England (and the wettest since 1960).

### Soil moisture deficit

In response to the above average October rainfall, soil moisture deficits (SMDs) decreased across England by up to approximately 100 mm. At the end of October, SMDs ranged from less than 10 mm across much of northwest and southwest England to more than 80 mm in parts of Yorkshire and Norfolk. End of month SMDs were either close to the LTA or up to 65 mm smaller than the LTA in the majority of MORECS grid squares covering England. In a few isolated parts of England, end of month SMDs were larger than the LTA, most notably in the far west of Cornwall and around Cheshire and Shropshire (Figure 2.1).

Regional-scale SMDs decreased during October and by the end of the month ranged from 17 mm in northwest England to 51 mm in east England. The largest decrease of 61 mm occurred in southeast England (Figure 2.2).

### River flows

October monthly mean river flows increased compared to September at all indicator sites across England, in response to the above average monthly rainfall. Flows were **normal** for the time of year at the majority of indicator sites, with 9 sites, located across northwest, southeast and east England, being higher than **normal**. The groundwater-fed rivers Darent and Lud in southeast and east England respectively, were **notably high** for the time of year (Figure 3.1).

Monthly mean river flows were classed as **normal** at all regional index sites, except the River Exe in southwest England which was **below normal** for the time of year (Figure 3.2).

## Groundwater levels

Despite the above average monthly rainfall, groundwater levels continued to decline at approximately two thirds of indicator sites during October. However, at the end of the month, levels remained classed as **normal** or higher at all but one site (Chilgrove in the Chichester Chalk aquifer in southeast England was **below normal**).

Groundwater levels at the major aquifer index sites were **normal** at 2 sites (one in the Cam and Ely Ouse chalk aquifer and one in the Burford Jurassic limestone aquifer), **above normal** at 3 sites (located in the Shropshire Middle Severn sandstone, Hull and East Riding chalk and East Kent Stour chalk aquifers) and **notably high** at 2 sites (located in the Carlisle Basin and Eden Valley sandstone and South West Chilterns chalk aquifers) (Figures 4.1 and 4.2).

## Reservoir storage

Reservoir stocks increased at two-fifths of all reported reservoirs and reservoir groups during October, including all those in northeast and northwest England and all but one in central England (which remained static). Stocks decreased at just over a third of reported sites, including all those in eastern England, and remained static at the remaining quarter of sites. Changes in reservoir stocks ranged from -9% at Abberton, Farmoor and Blagdon reservoirs to +17% at the Elan Valley Group. At the end of October, stocks were classed as **normal** or **above normal** for the time of year at all but four reservoirs (Figure 5.1).

Regional-scale reservoir stocks increased during October by between 3 and 11% in central, northeast and northwest England and decreased by up to 5% in eastern, southeast and southwest England. At the end of October, regional stocks ranged from 65% of total capacity in northwest England to 84% in southeast England. Overall reservoir storage for England increased by 3% to 76% of total capacity (Figure 5.2).

## Forward look

Rainfall during November and the period November-December-January is likely to be average to above average across all areas. Temperatures are likely to be milder than average[1].

### Scenario based projections for river flows at key sites[2]

**March 2015**: With average (100% of the LTA) rainfall between November 2014 and the end of March 2015, cumulative river flows are likely to be **normal** at all but 3 of the modelled sites and **above normal** at the remainder. With 120% of the LTA rainfall, river flows are likely to be **above normal** at just over two thirds of the modelled sites and **normal or notably high** at the remainder. With 80% of the LTA rainfall river flows are likely to be **below normal** or **notably low** at nearly four fifths of the modelled sites (see Figure 6.1).
**September 2015**: With average rainfall between November 2014 and the end of September 2015, cumulative river flows are likely to be **normal** at more than four fifths of the modelled sites. With above average rainfall (120% of the LTA), flows are likely to be **above normal** or higher at three quarters of our modelled sites. With below average rainfall (80% of the LTA), river flows are likely to be **below normal** or **notably low** at just over four fifths of the modelled sites (see Figure 6.2).

### Probabilistic ensemble projections for river flows at key sites[2]

**March 2015:** Just over half of the modelled sites have a greater than expected chance of **normal** cumulative flows from November 2014 to March 2015. A third of the modelled sites have a greater than expected chance of **above normal** or higher cumulative flows (see Figure 6.3).
**September 2015:** Just over half of the modelled sites have a greater than expected chance of **normal** cumulative flows from November 2014 to September 2015. Just under half of the modelled sites have a greater than expected chance of **above normal** or higher cumulative flows (see Figure 6.4).

### Scenario based projections for groundwater levels in key aquifers[3]

**March 2015**: With average rainfall (100% of the LTA) from November 2014 to March 2015, groundwater levels are likely to be **normal** for the time of year at just over two fifths of the modelled sites. With above average rainfall (120% of the LTA) four fifths of the modelled sites are likely to have **above normal** or higher groundwater levels. With 80% of the LTA rainfall, more than four fifths of the modelled sites are likely to have **normal** or higher groundwater levels for the time of year (see Figure 6.5).
**September 2015**: With average rainfall (100% of the LTA) from November 2014 to September 2015, groundwater levels are likely to be **normal** or higher for the time of year at all but one modelled site. With above

[1] Source: Met Office
[2] 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, 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, Met Office.

average rainfall (120% of the LTA), levels are likely to be **above normal** or higher for the time of year at just under half of the modelled sites. With below average rainfall (80% of the LTA), groundwater levels are likely to be **below normal** or lower at just under two thirds of the modelled sites (see Figure 6.6).

**Probabilistic ensemble projections for groundwater levels in key aquifers**[3]

**March 2015:** Just over two thirds of the modelled sites have a greater than expected chance of **above normal** or higher groundwater levels for the time of year. Half of the sites also have a greater than expected chance of **normal** levels (see Figure 6.7).

**September 2015:** Just under three quarters of the modelled sites have a greater than expected chance of levels being **normal** for the time of year. Just over a third of the modelled sites have a greater than expected chance of **above normal** or higher groundwater levels by the end of September 2015 (see Figure 6.8).

Authors: E & B Assessment Team (Hydrology)

# Rainfall

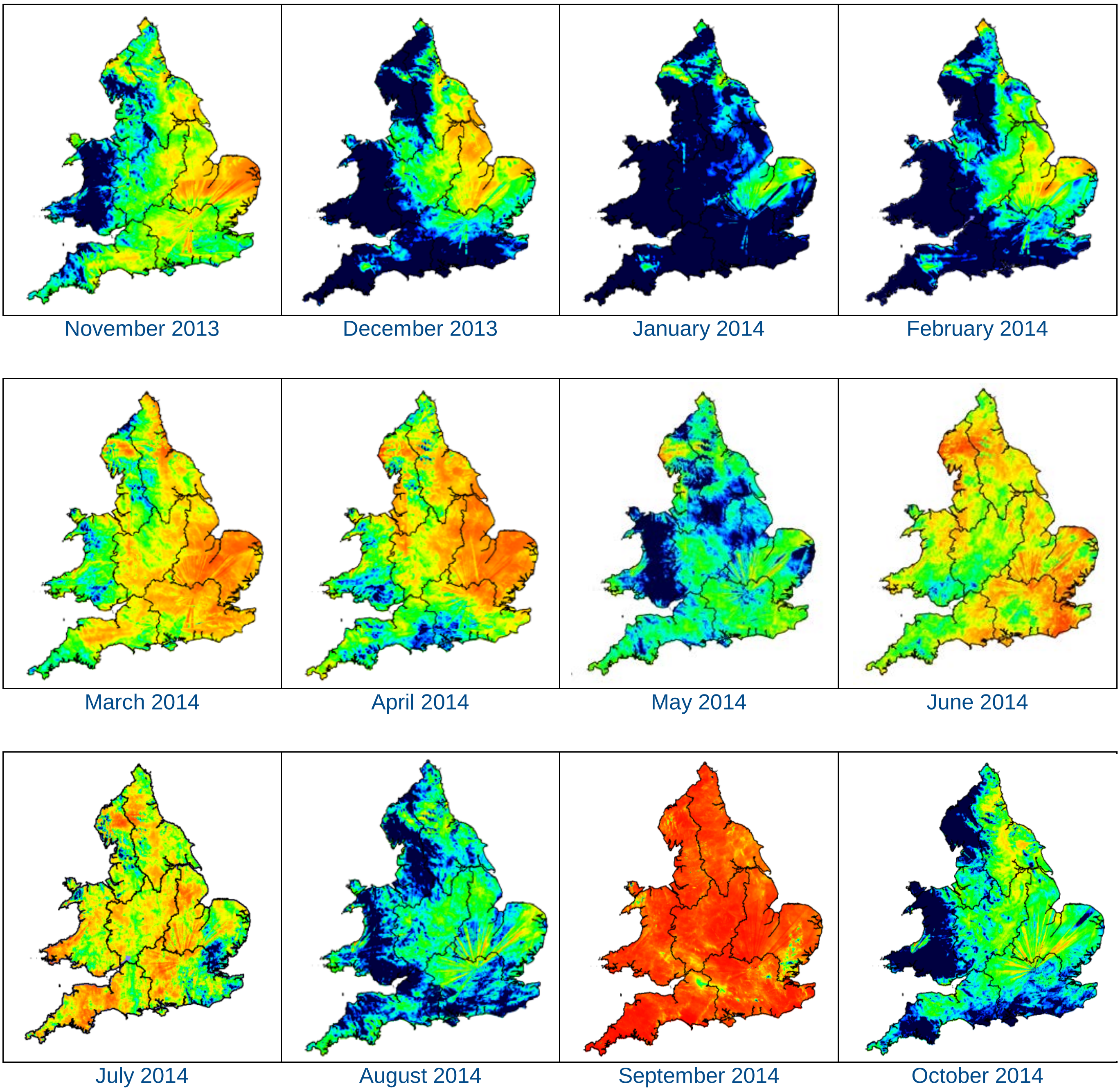
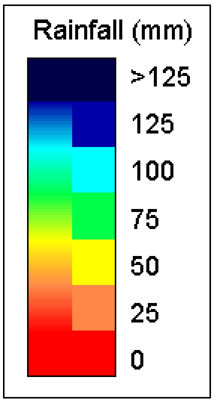



**Figure 1.1**: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2014). Note: Radar beam blockages in some regions may give anomalous totals in some areas. 



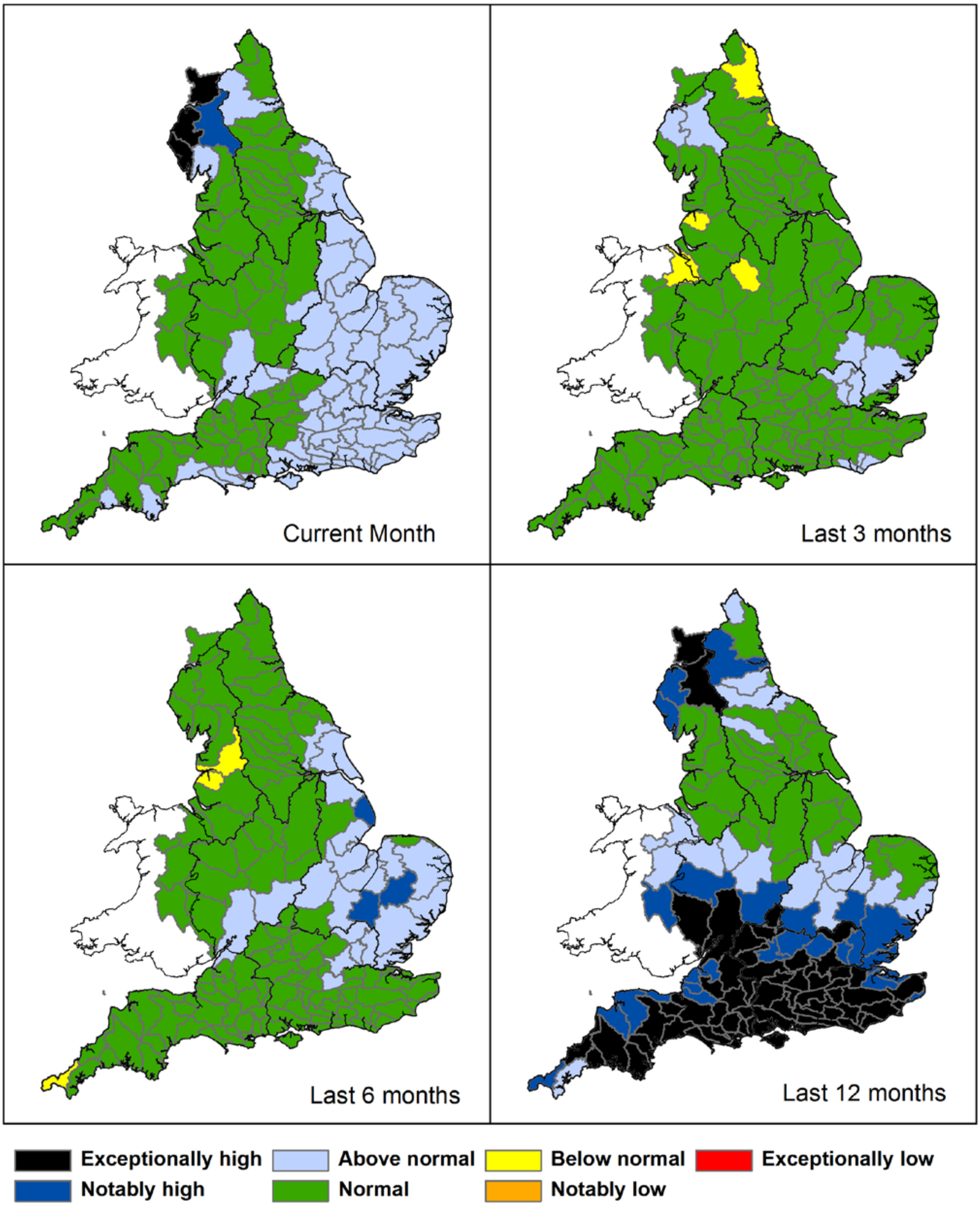



**Figure 1.2**: Total rainfall for hydrological areas across England for the current month (up to 31 October), the last three months, the last six months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2014).* Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

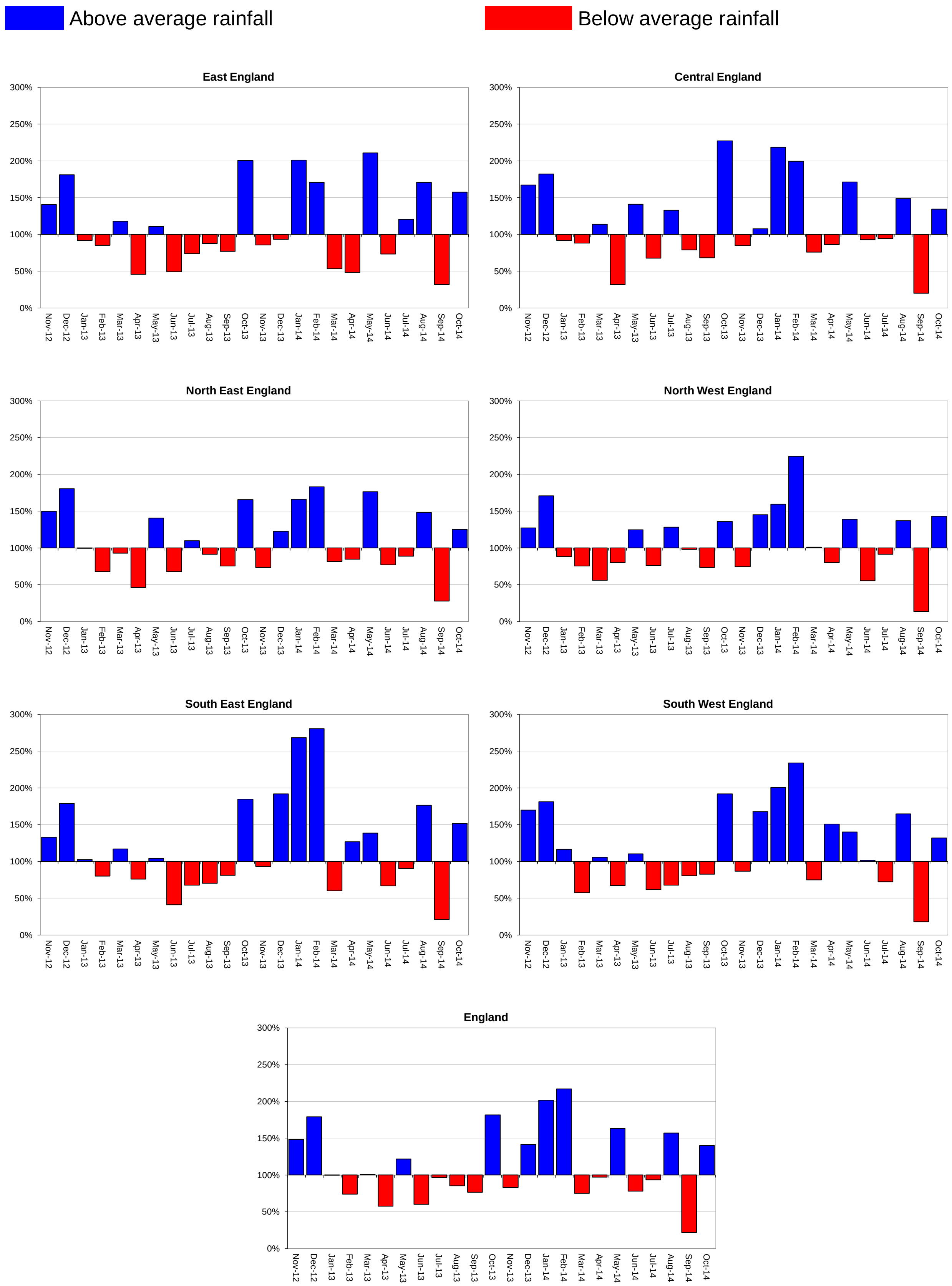



**Figure 1.3**: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2014).

# Soil moisture deficit

| End of September 2014 [1] | End of October 2014 [2] |
|---|---|

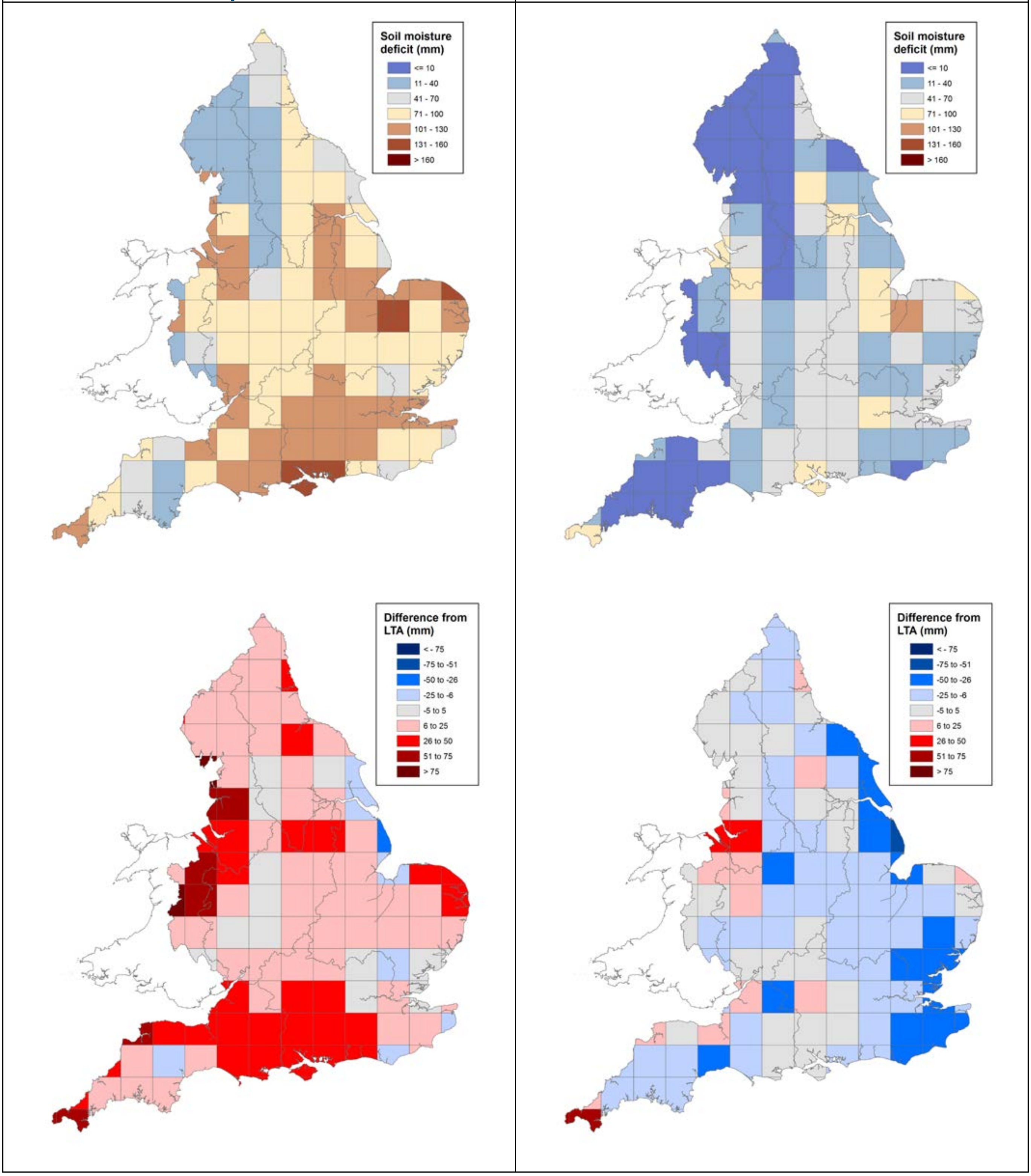



**Figure 2.1**: Soil moisture deficits for weeks ending 30 September 2014 [1] (left panel) and 28 October 2014 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2014). Crown copyright. All rights reserved. Environment Agency, 100026380, 2014

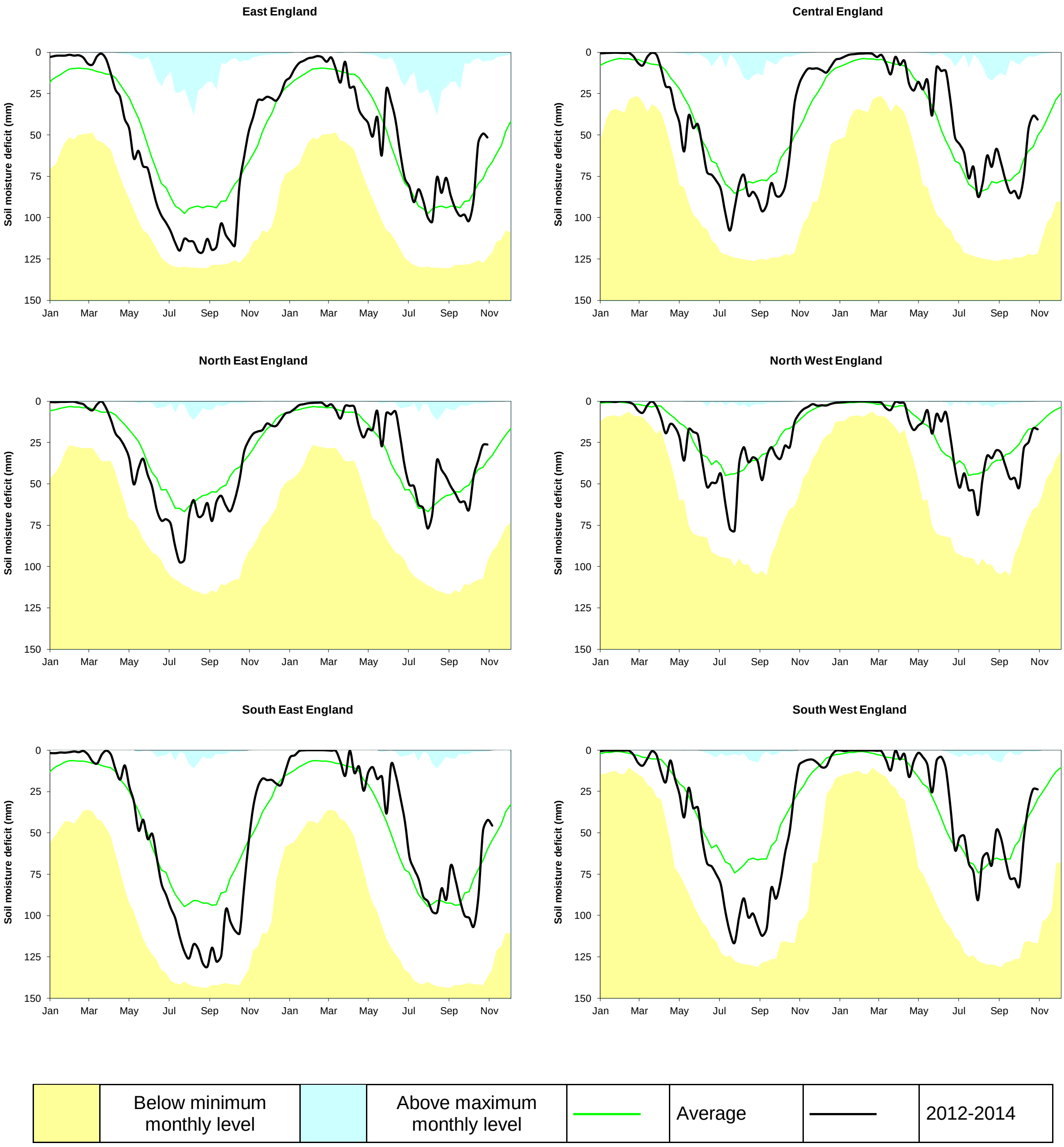
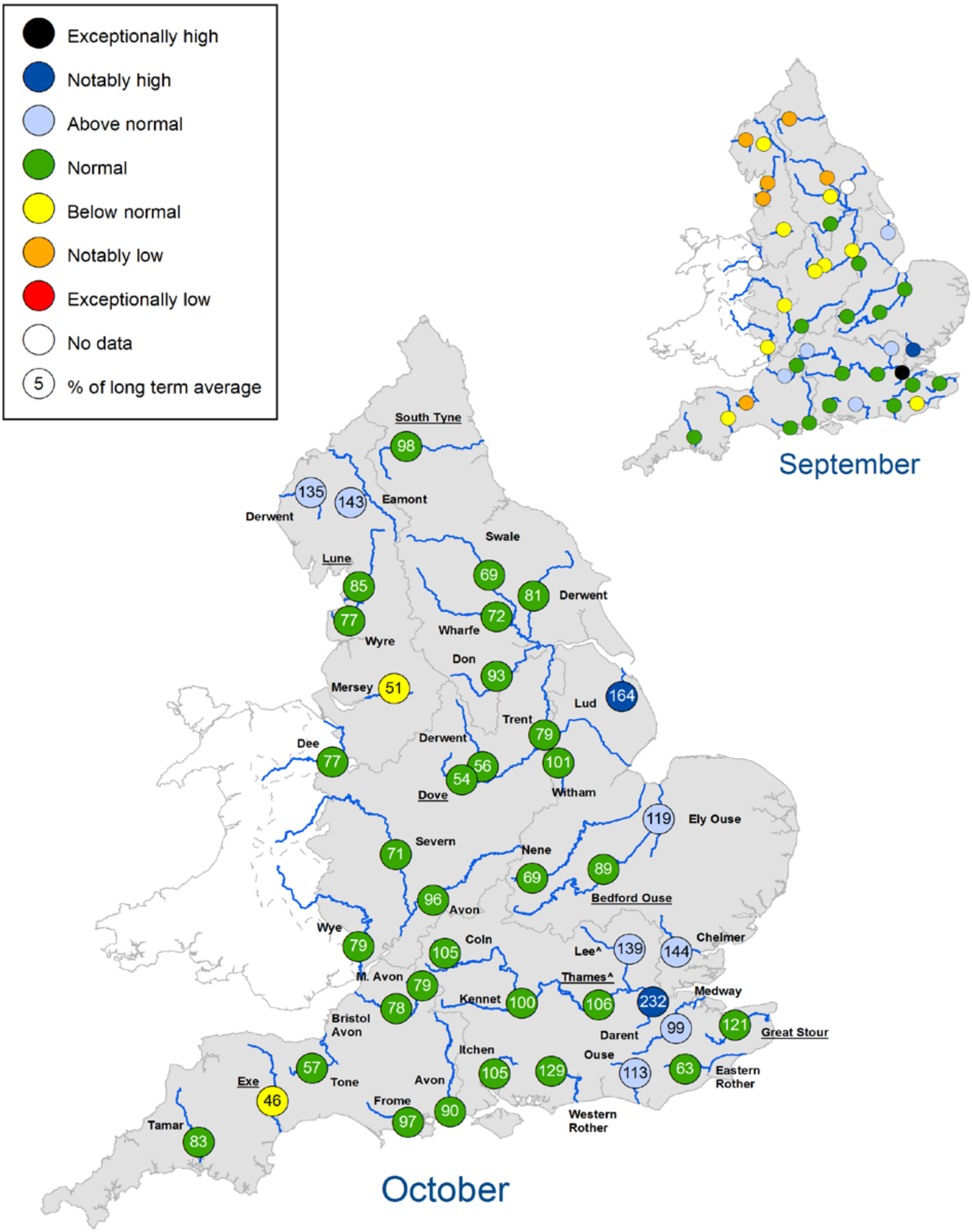



**Figure 2.2**: Latest soil moisture deficits for all regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2014).

# River flows




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

+/- Monthly mean flow is the highest/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 September and October 2014, expressed as a percentage of the respective long term average and classed relative to an analysis of historic September and October monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

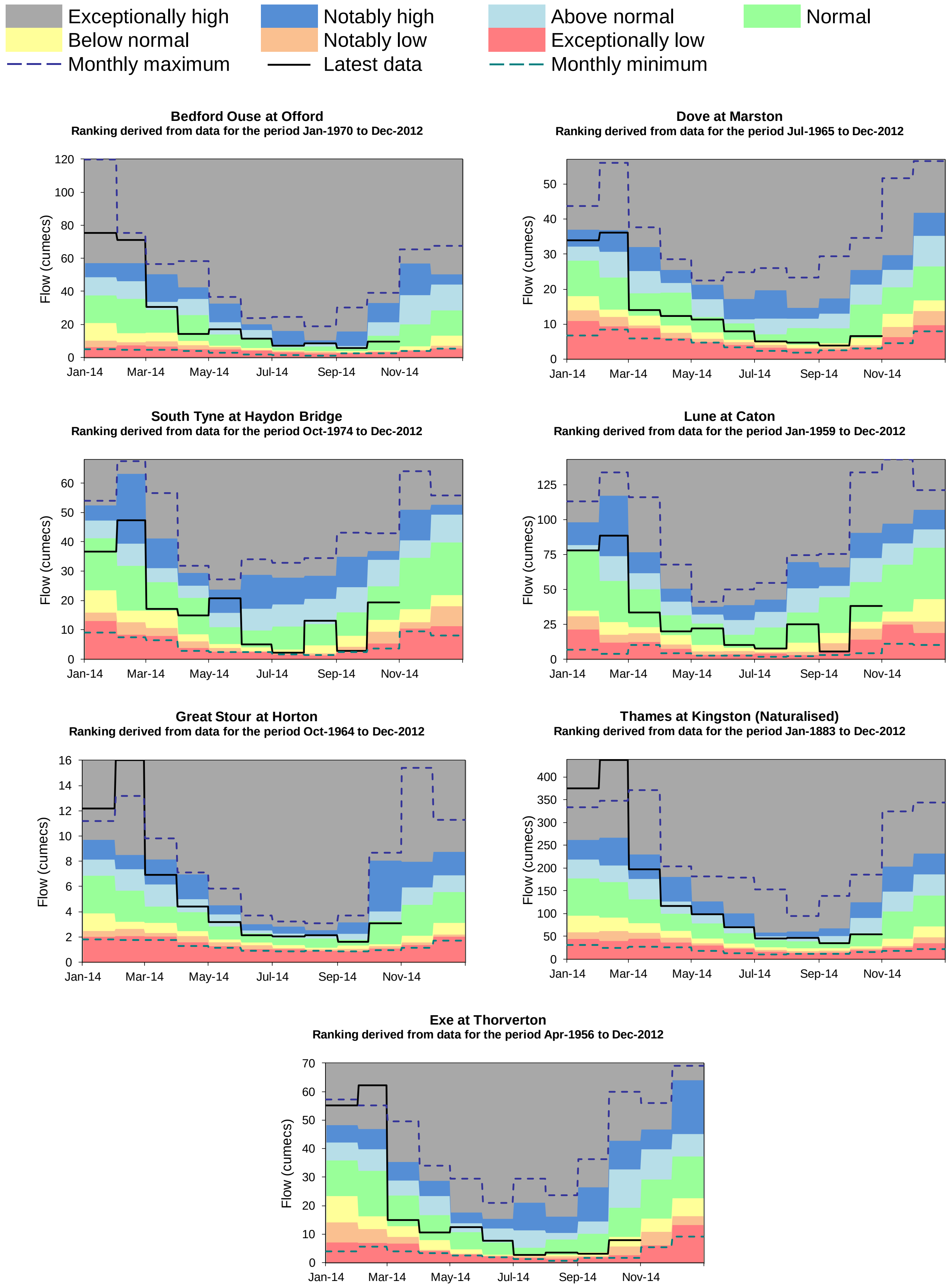
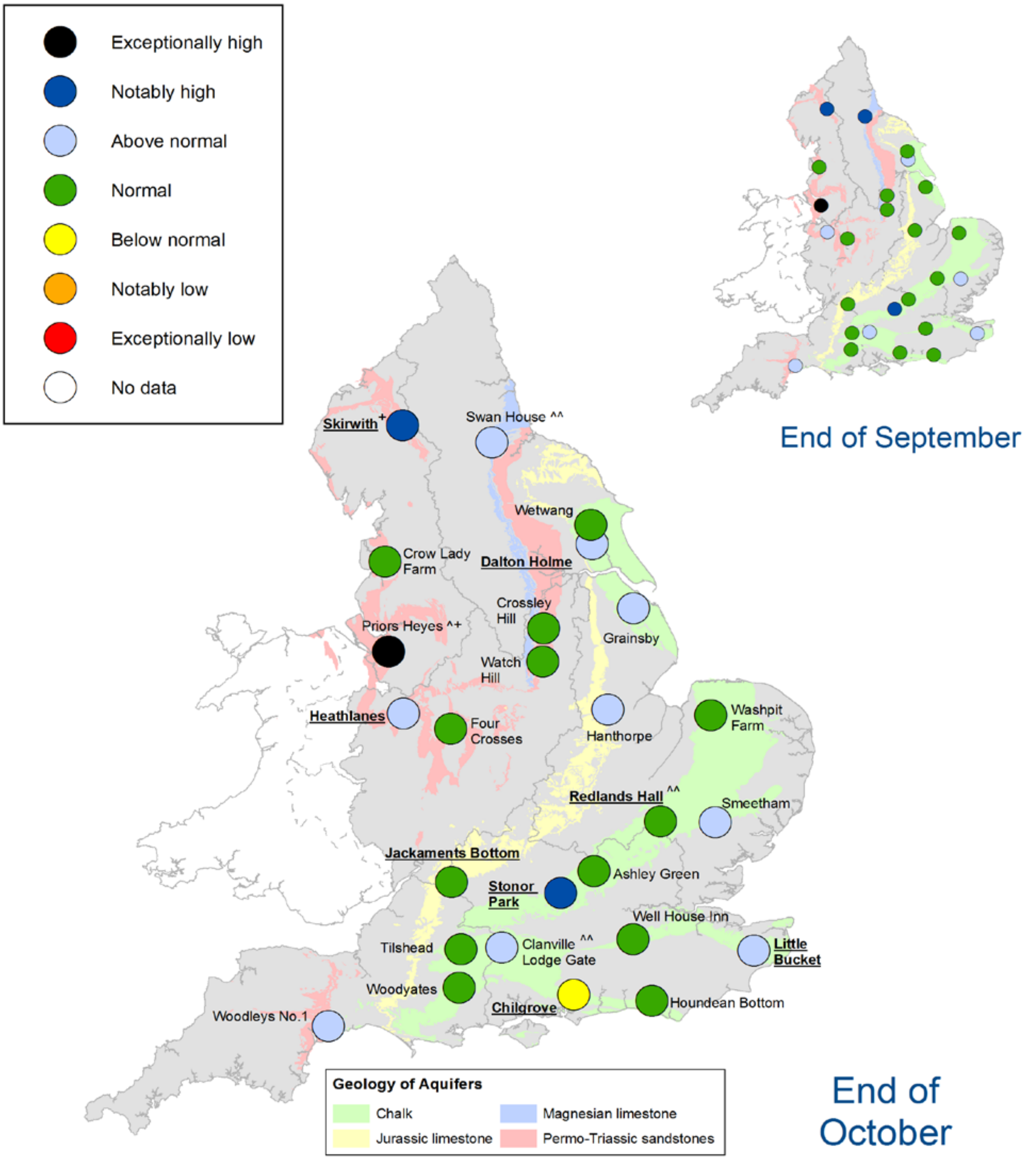



**Figure 3.2**: Index river flow sites for each region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

# 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).
Highlighted 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 September and October 2014, classed relative to an analysis of respective historic September and October levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

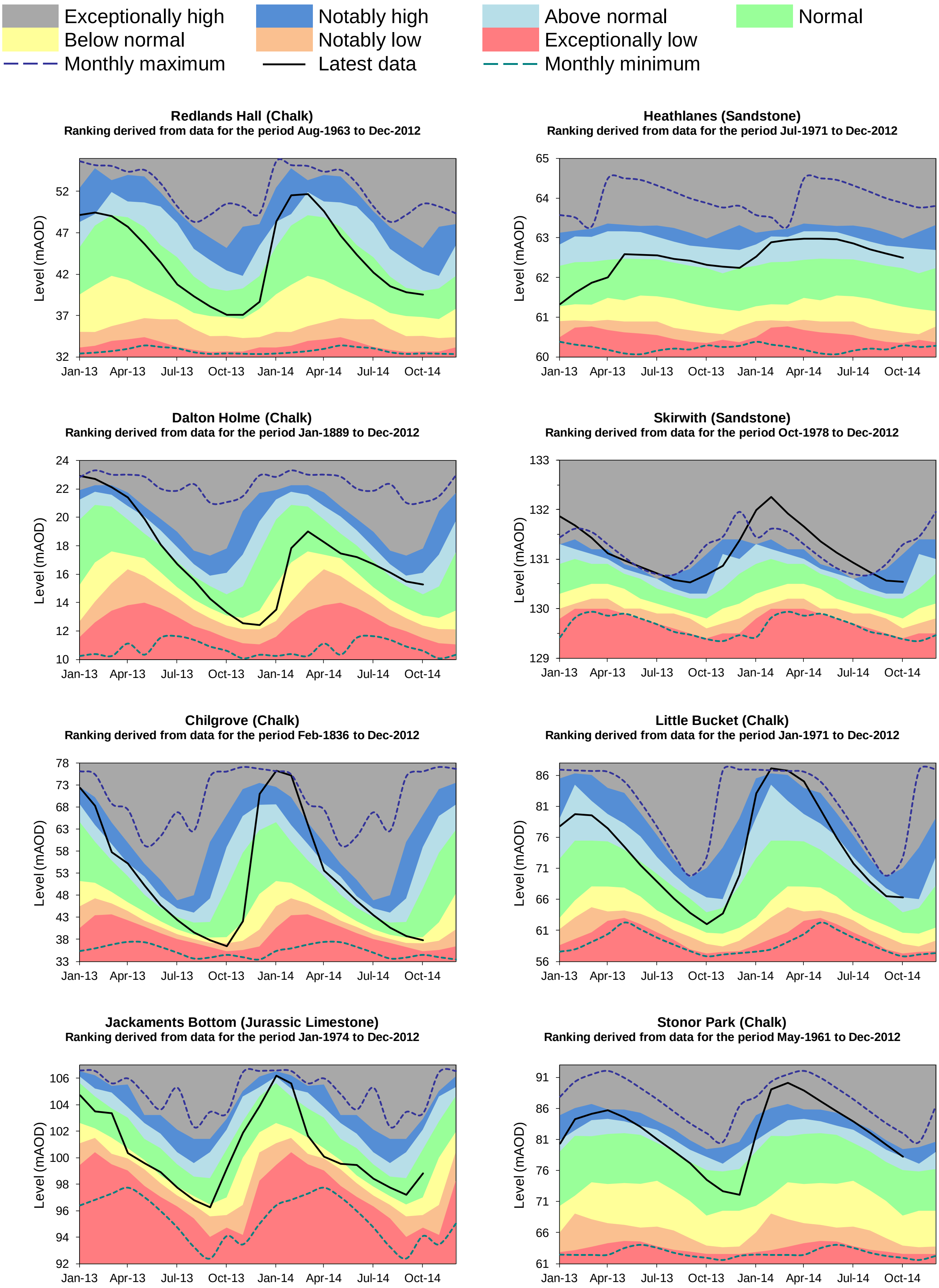
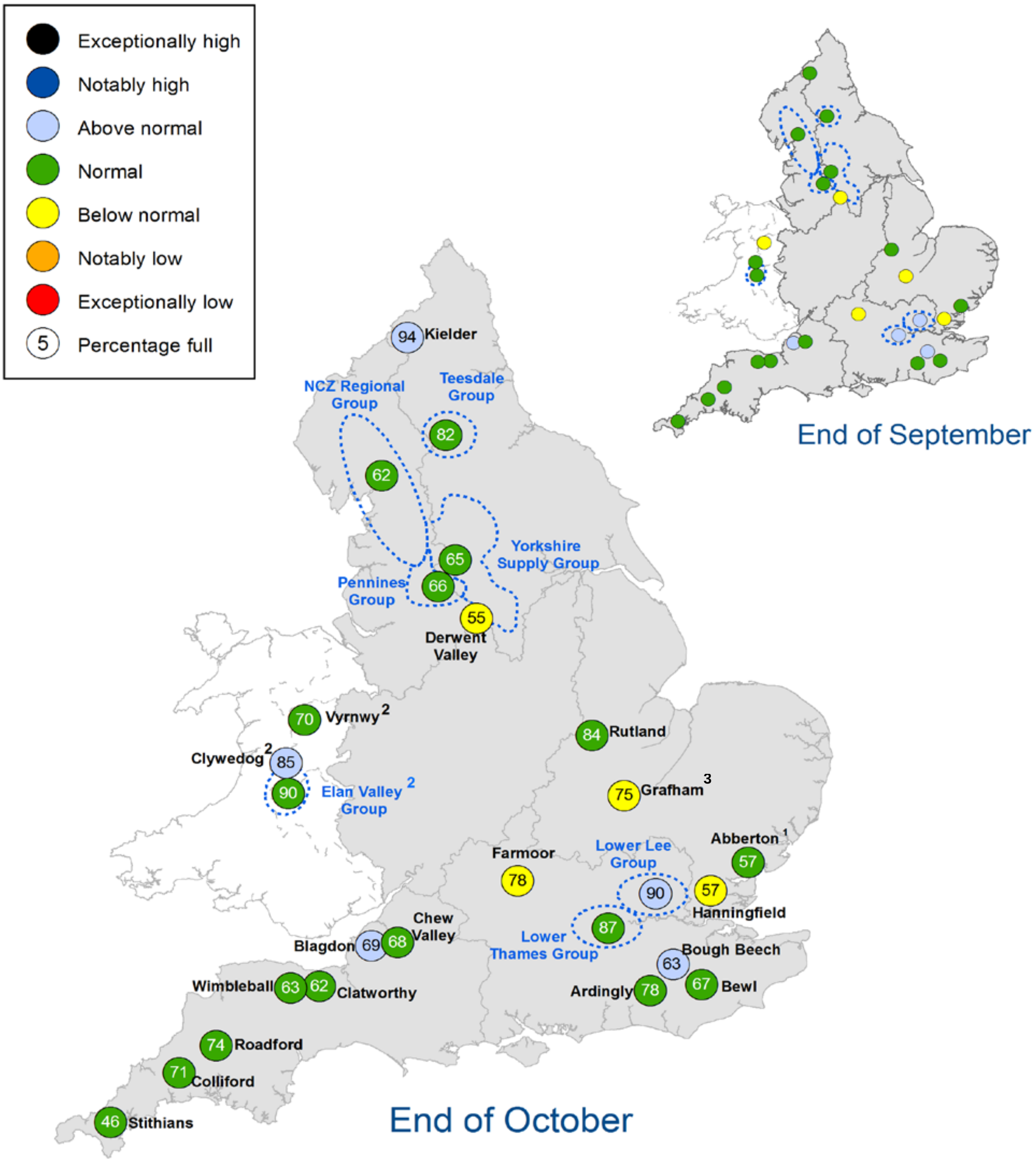


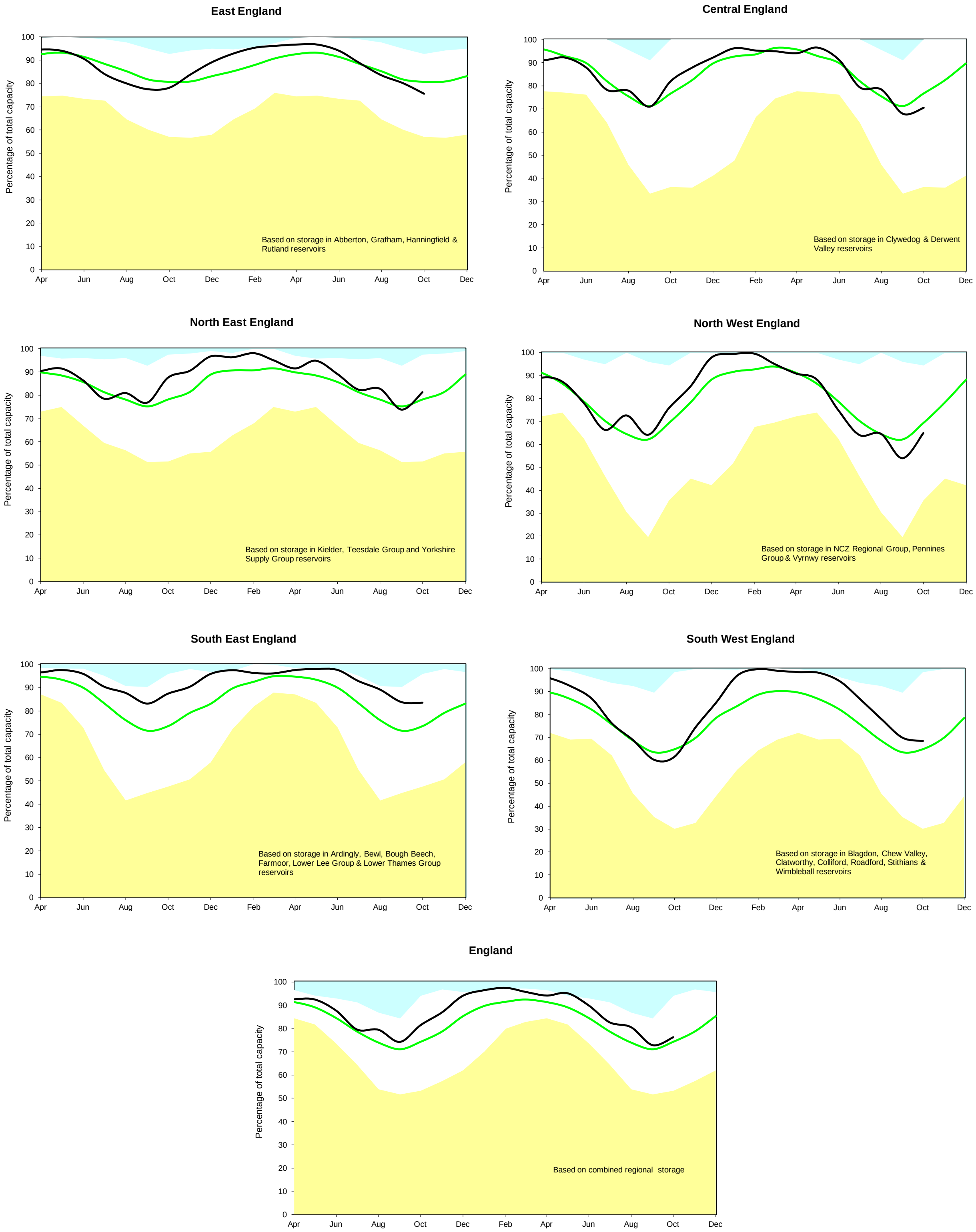

**Figure 4.2**: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2014).

# Reservoir storage




1. Water levels have been affected by engineering work at Abberton Reservoir in Essex to increase capacity
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to central and northwest England
3. Water levels at Grafham are affected by engineering work until December 2014

**Figure 5.1**: Reservoir stocks at key individual and groups of reservoirs at the end of September and October 2014 as a percentage of total capacity and classed relative to an analysis of historic September and October 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, 2014.




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Below minimum monthly level | | Above maximum monthly level | | Average | | 2012-2014 |

**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

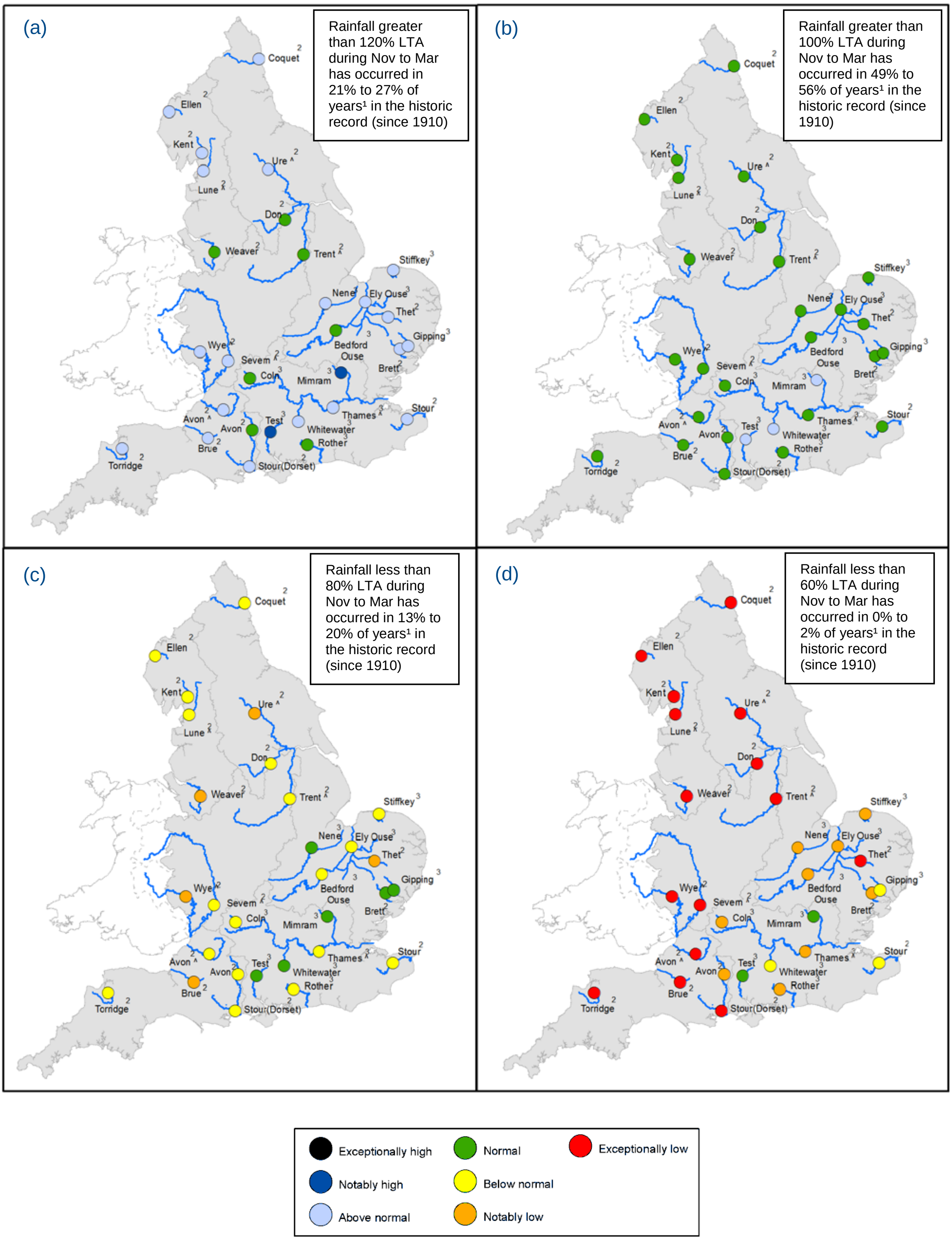



**Figure 6.1**: Projected river flows at key indicator sites up until the end of March 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between November 2014 and March 2015 (Source: Centre for Ecology and Hydrology, Environment Agency).

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

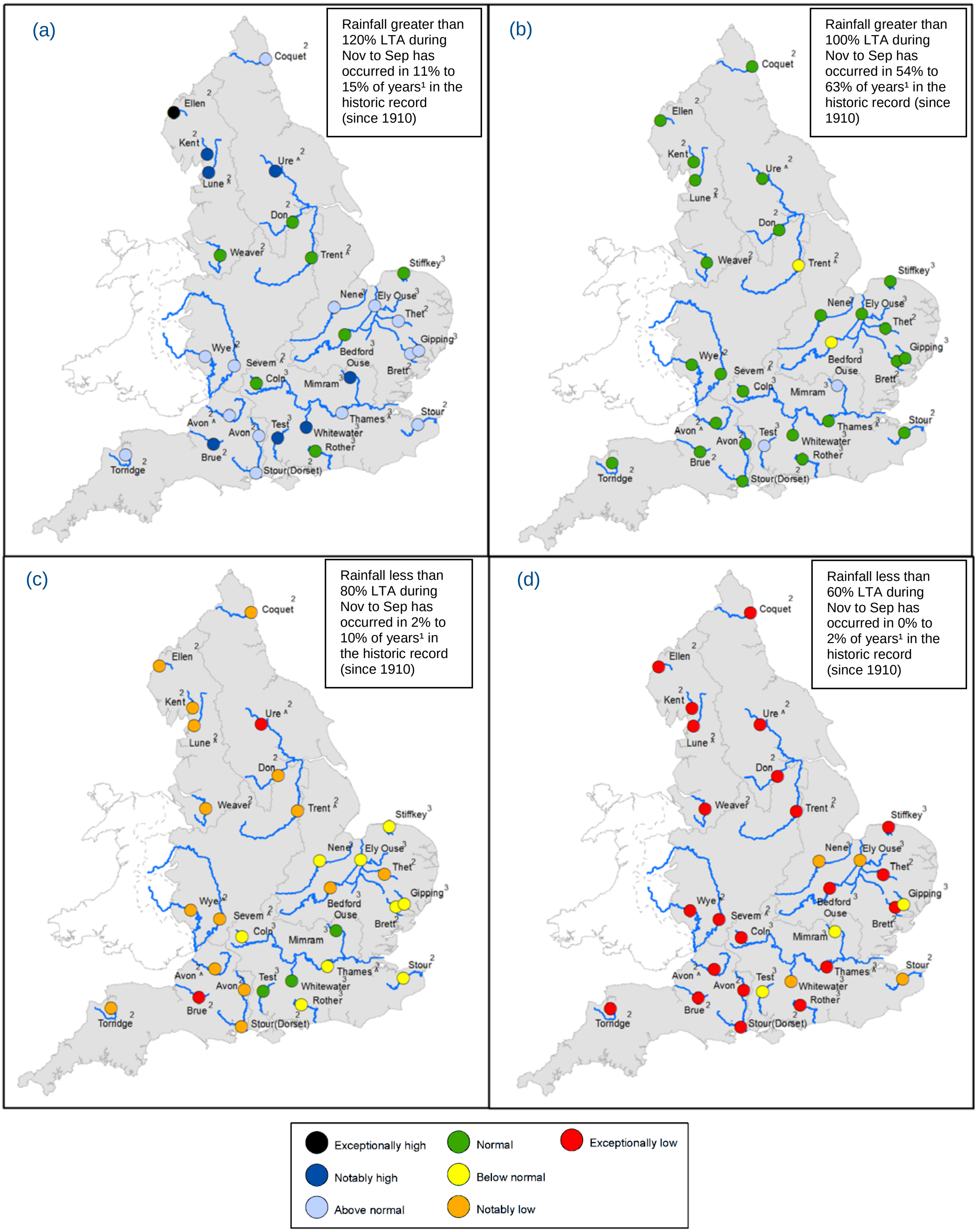



**Figure 6.2**: Projected river flows at key indicator sites up until the end of September 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between November 2014 and September 2015 (Source: Centre for Ecology and Hydrology, Environment Agency).

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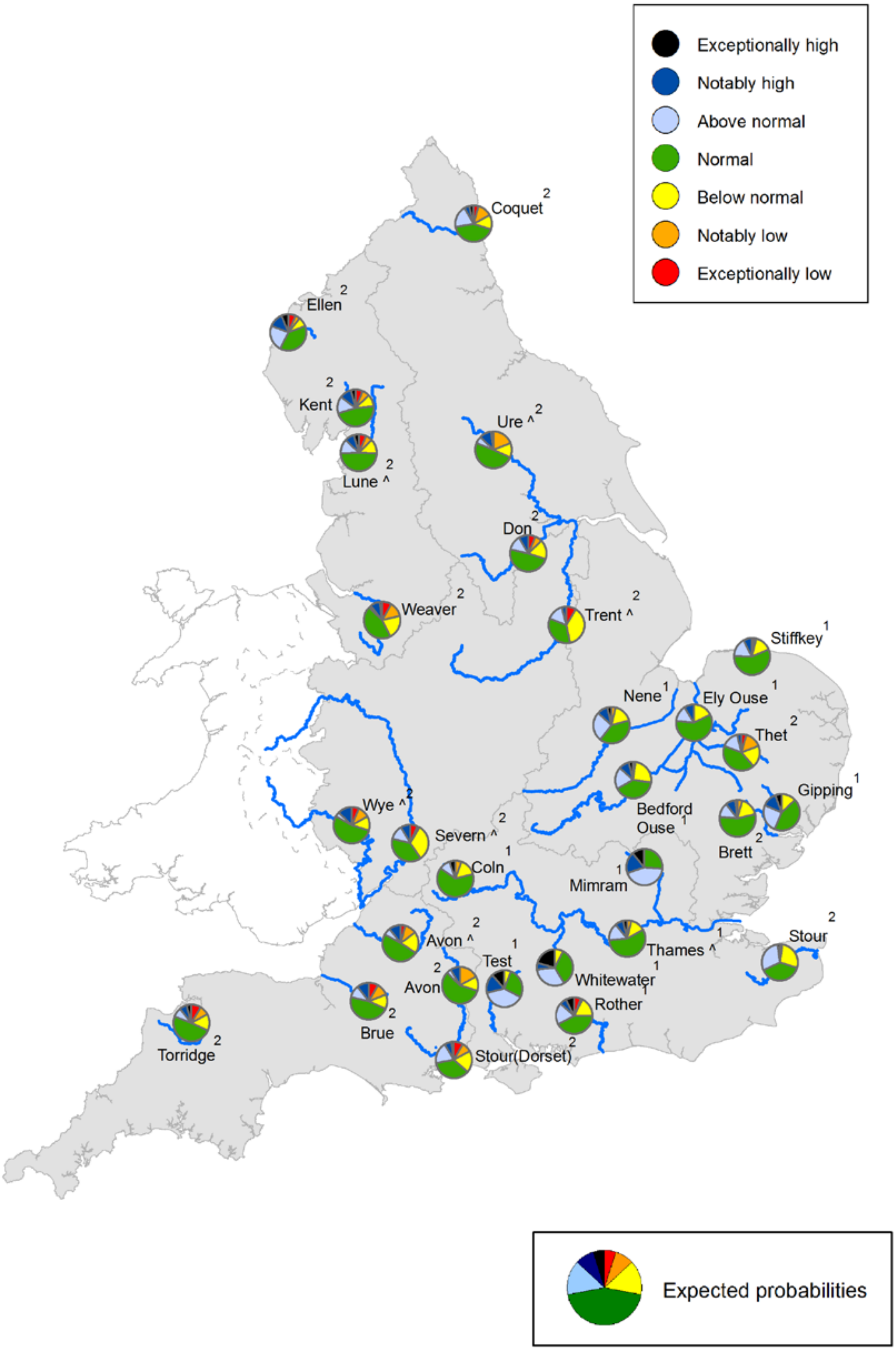
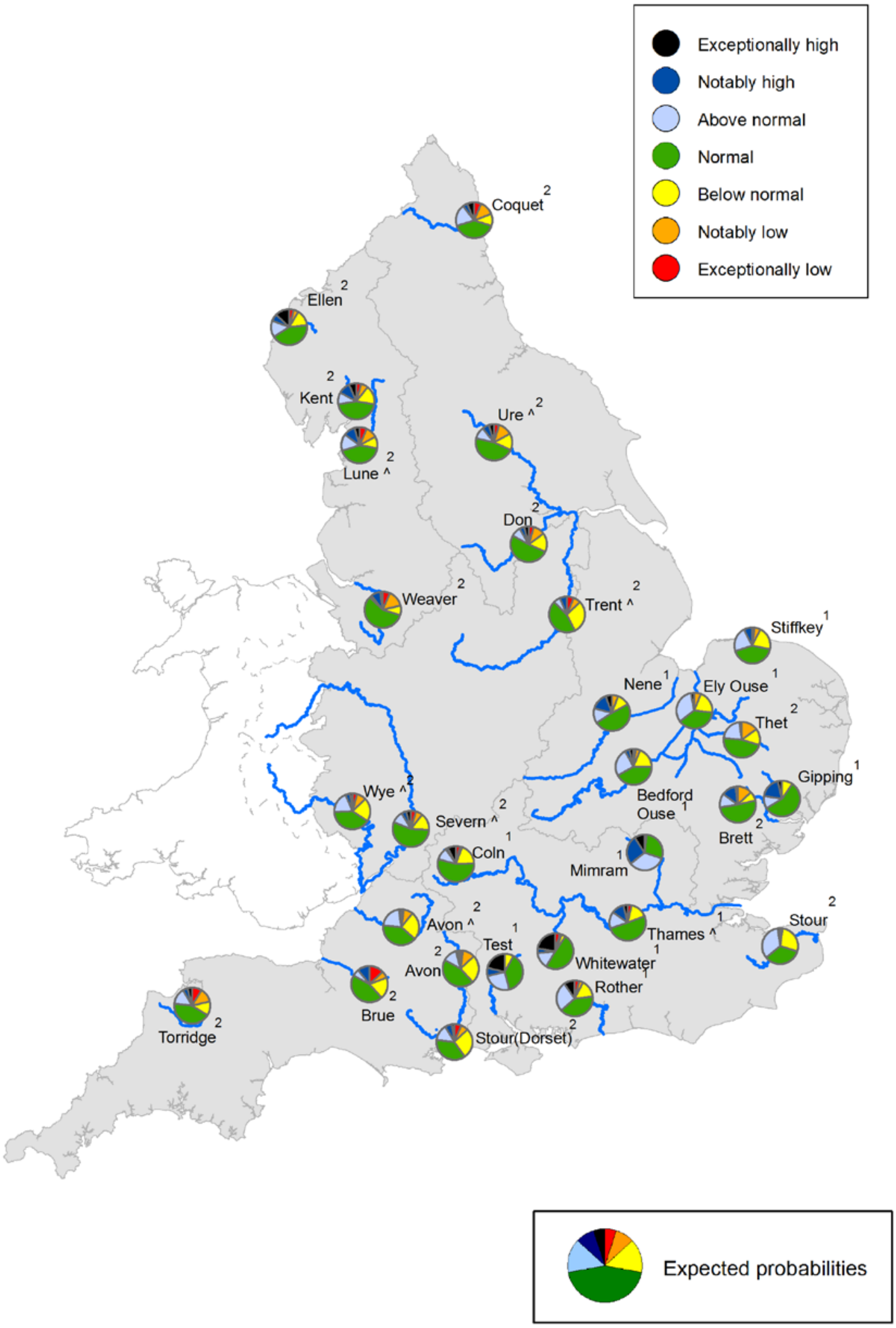



*Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels 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 2015. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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




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

**Figure 6.4**: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2015. 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

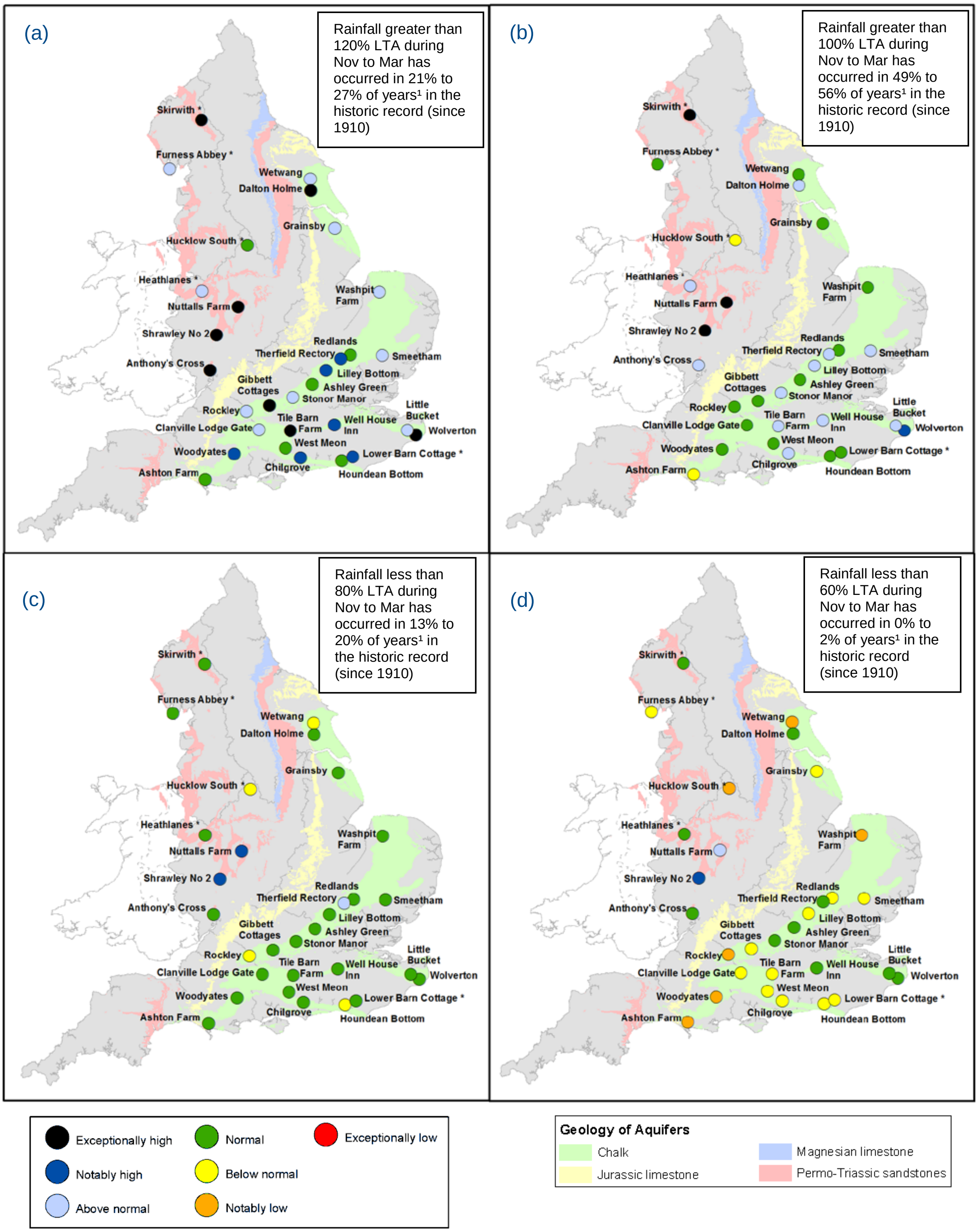



**Figure 6.5**: Projected groundwater levels at key indicator sites at the end of March 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between November 2014 and March 2015 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2014.

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

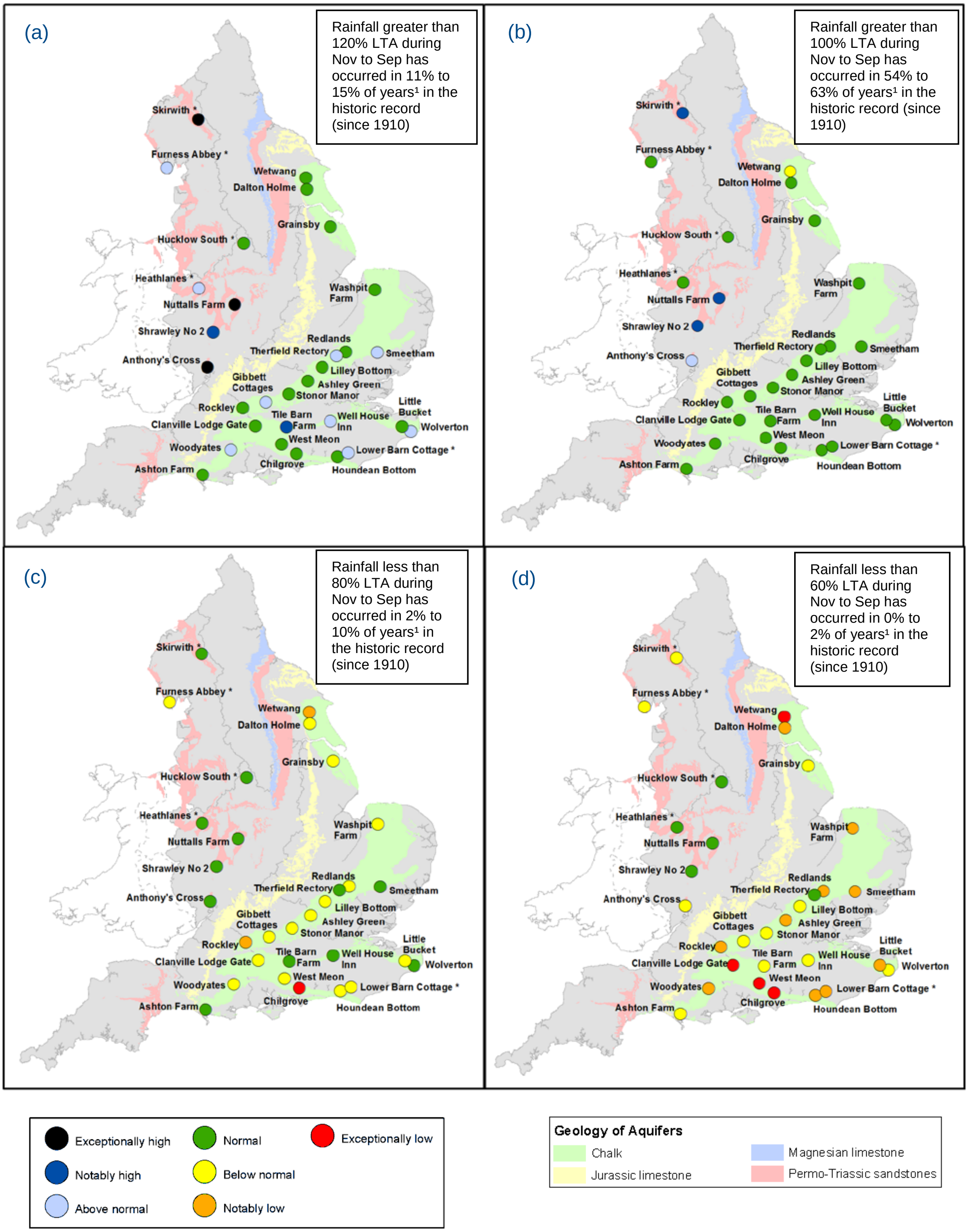
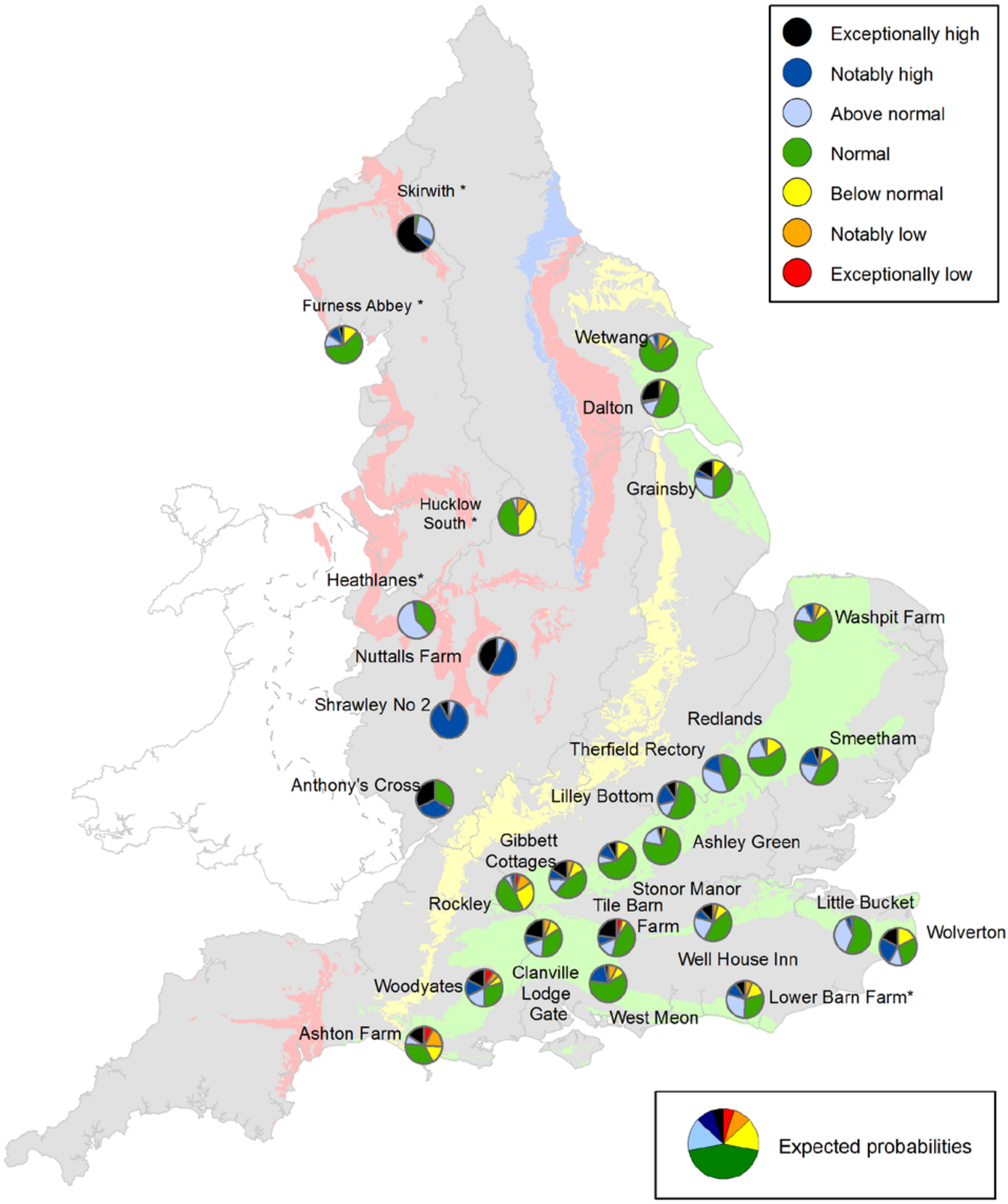



**Figure 6.6**: Projected groundwater levels at key indicator sites at the end of September 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between November 2014 and September 2015 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2014.

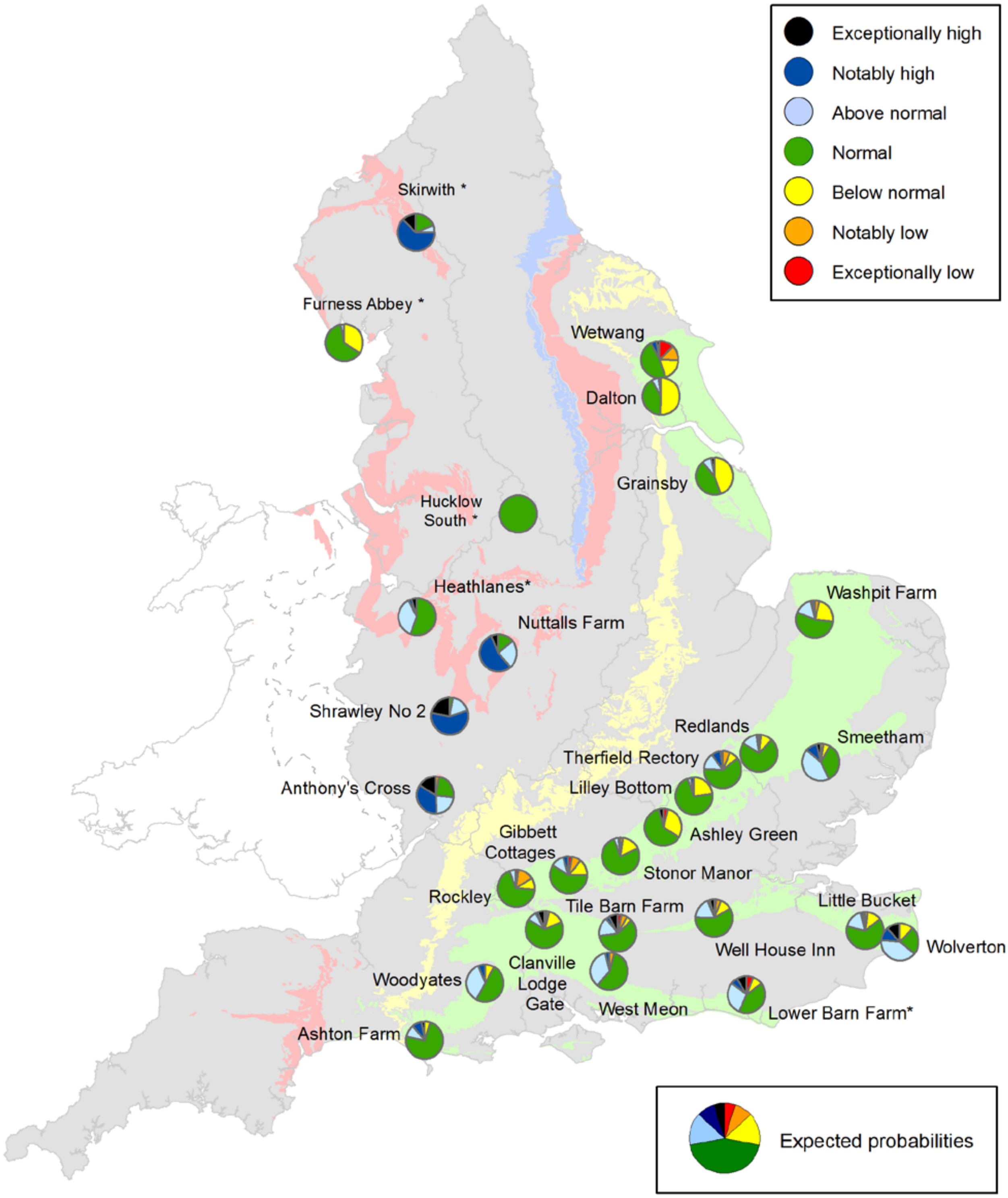
* Projections for these sites are produced by BGS
[1] This range of probabilities is a regional analysis




*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 2015. 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, 2014.

* 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 2015. 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, 2014.

* 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, usually based on the period 1961-1990. However, the period used may vary by parameter being reported on (see figure captions for details). |
| 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 |