Environment Agency

Monthly water situation report

England

Summary – September 2014

Following the wettest August across England for 10 years, September was the second driest on record with only 22% of the long term average rainfall recorded. Soil moisture deficits increased across England in response to the low rainfall and monthly mean river flows decreased at all but one indicator site. Despite the low rainfall, river flows were **normal** or higher for the time of year at the majority of sites; however, flows at approximately two-fifths of sites across northern and parts of central and southwest England were **below normal** or **notably low**. Groundwater levels decreased at all indicator sites during September but remain **normal** or higher for the time of year at all sites. Reservoir stocks decreased at all but one of the reservoirs and reservoir groups during September, but remain **normal** or higher for the time of year at the majority of sites. Overall reservoir storage for England was 73% of total capacity at the end of the month.

Rainfall

September rainfall totals were highest across parts of Wiltshire, West Berkshire, Norfolk and Suffolk at nearly 30 mm and lowest across the east of Kent at less than 5 mm. The month's rainfall was less than 50% of the September long term average (LTA) in all but one hydrological area across England and less than 25% of the LTA in nearly two-thirds of the hydrological areas (Figure 1.1).

September rainfall totals were lower than **normal** for the time of year in all hydrological areas across England, with nearly two thirds being classed as **exceptionally low**. In the cumulative 3 month period ending in September, the dry September was offset by the wet August, with just over half of the hydrological areas being **normal** or higher for the time of year. The exceptional winter rainfall is still evident in the 12 month cumulative rainfall totals, with most of England classed as **above normal** to **exceptionally high** for the time of year (Figure 1.2)

At a regional scale, September rainfall totals were **exceptionally low** for the time of year across England and ranged from 14% of the LTA in northwest England to 32% in the east. Overall, England received 22% of the September LTA, making it the second driest September on record (which started in 1910) and the driest since 1959 (Figure 1.3). September was also the second driest on record in northwest and central England and the third driest in southwest England. In contrast, the cumulative 9-month period ending in September was the third wettest on record in southeast and southwest England and it was the second wettest 12-month period (ending in September) in southeast England.

Soil moisture deficit

The below average September rainfall resulted in soil moisture deficits (SMDs) increasing by up to almost 45 mm across England; by the end of the month, SMDs ranged from 20 to 40 mm across Cumbria and surrounding areas to 130 to 150 mm in parts of Norfolk, Hampshire and the Isle of Wight. Broadly, SMDs were largest across parts of southern and eastern England and smallest across northwest and parts of southwest England. End of September SMDs were generally up to 50 mm larger than the LTA in the majority of MORECS grid squares covering England (Figure 2.1).

At the end of August, regional-scale SMDs ranged from 31 mm in northwest England to 86 mm in the east. By the end of September SMDs ranged from 52 mm in northwest England to 107 mm in the southeast, with the largest increase of 29 mm occurring in southwest England (Figure 2.2).

River flows

Monthly mean river flows for September decreased compared to August at all but one of our updated indicator sites (the River Avon at Bathford), in response to the below average rainfall. Despite the low rainfall, September river flows were **normal** or higher for the time of year at the majority of indicator sites and the groundwater-fed River Darent at Hawley remained **exceptionally high** for the time of year. However flows at nearly two-fifths of sites, located across northern England and parts of central and southwest England, were **below normal** or **notably low** (Figure 3.1).

River flows at the regional index sites in east and southeast England were **normal** for the time of year. Flows at the index sites in central and southwest England were **below normal**, whilst the sites in the northeast and northwest were **notably low** (Figure 3.2).

Groundwater levels

Groundwater levels declined at all indicator sites during September. At the end of the month, levels were **normal** for the time of year at nearly two thirds of sites; of the remaining sites, six were **above normal** and three were **notably high** for the time of year. The level at Priors Heyes (West Cheshire Sandstone) remains **exceptionally high** compared to historic levels as it is recovering from the effects of historic abstraction (Figure 4.1).

Groundwater levels at the major aquifer index sites were **normal** at three sites (two in chalk aquifers of the Chichester chalk and Cam and Ely Ouse chalk and one in the Burford Jurassic limestone aquifer), **above normal** at three sites (two in chalk aquifers of the East Kent Stour and Hull and East Riding chalk and one in the Shropshire Middle Severn Sandstone aquifer) and **notably high** at two sites (one in the South West Chilterns chalk aquifer and the other in the Carlisle Basin and Eden Valley sandstone aquifer) (Figure 4.2).

Reservoir storage

Reservoir stocks decreased at all reported reservoirs and reservoir groups during September, with the exception of Grafham Water in east England which increased by 1%. The largest decrease in storage of 18% of total capacity was at Abberton Reservoir in east England. Stocks in a further 9 reservoirs and reservoir groups decreased by between 10 and 14%. In spite of the decreases, stocks at the end of September were classed as **normal** or **above normal** at all but 5 reservoirs and reservoir groups (Figure 5.1).

At a broader scale, reservoir stocks decreased in all regions during September, by between 3 and 11%. At the end of the month, regional stocks ranged from 54% of total capacity in northwest England to 84% in southeast England. Overall reservoir storage for England decreased by 8% during September to 73% of total capacity (Figure 5.2).

Forward look

October is expected to be unsettled to begin with, particularly in the north and west, while temperatures will be close to average. From mid-month, more settled conditions are likely to return and temperatures are expected to be above average. Longer term, there is an increased likelihood of above average rainfall and temperatures for the period October-November-December[1].

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

March 2015: With average (100% of the LTA) rainfall between October and the end of March 2015, cumulative river flows are likely to be **normal** at all except two of the modelled sites, and **below normal** at the others. With 120% of the LTA rainfall, river flows are likely to be **above normal** at half of the modelled sites, and **normal** at the other half. With 80% of the LTA rainfall river flows are likely to be **below normal** or **notably low** at more than four fifths of the modelled sites (see Figure 6.1).
September 2015: With average rainfall between October 2014 and the end of September 2015, cumulative river flows are likely to be **normal** at three quarters of the modelled sites and **below normal** at a quarter. With above average rainfall (120% of the LTA), flows are likely to be **above normal** at two thirds of our modelled sites. With below average rainfall (80% of the LTA), river flows are likely to be **notably low** or lower at four fifths of the modelled sites (see Figure 6.2).

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

March 2015: A third of the modelled sites have a greater than expected chance of **normal** cumulative flows from October 2014 to March 2015 (see Figure 6.3).
September 2015: More than half of the modelled sites have a greater than expected chance of **normal** cumulative flows from October 2014 to September 2015 (see Figure 6.4).

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.

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

March 2015: With average rainfall (100% of the LTA) from October 2014 to March 2015, groundwater levels are likely to be **normal** for the time of year at two thirds of the modelled sites. With above average rainfall (120% of the LTA) two thirds of the modelled sites are likely to have **above normal** or higher groundwater levels. With 80% of the LTA rainfall, a third of the modelled sites are likely to have **below normal** groundwater levels for the time of year (see Figure 6.5).

September 2015: With average rainfall (100% of the LTA) from October 2014 to September 2015, groundwater levels are likely to be **normal** for the time of year at four fifths of the modelled sites. With above average rainfall (120% of the LTA), levels are likely to be **above normal** or higher for the time of year at a third of the modelled sites. With below average rainfall (80% of the LTA), groundwater levels are likely to be **below normal** or lower at two thirds of the modelled sites (see Figure 6.6).

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

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

September 2015: Three quarters of the modelled sites have a greater than expected chance of levels being **normal** for the time of year. 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 Hydrology Team

[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.

Rainfall

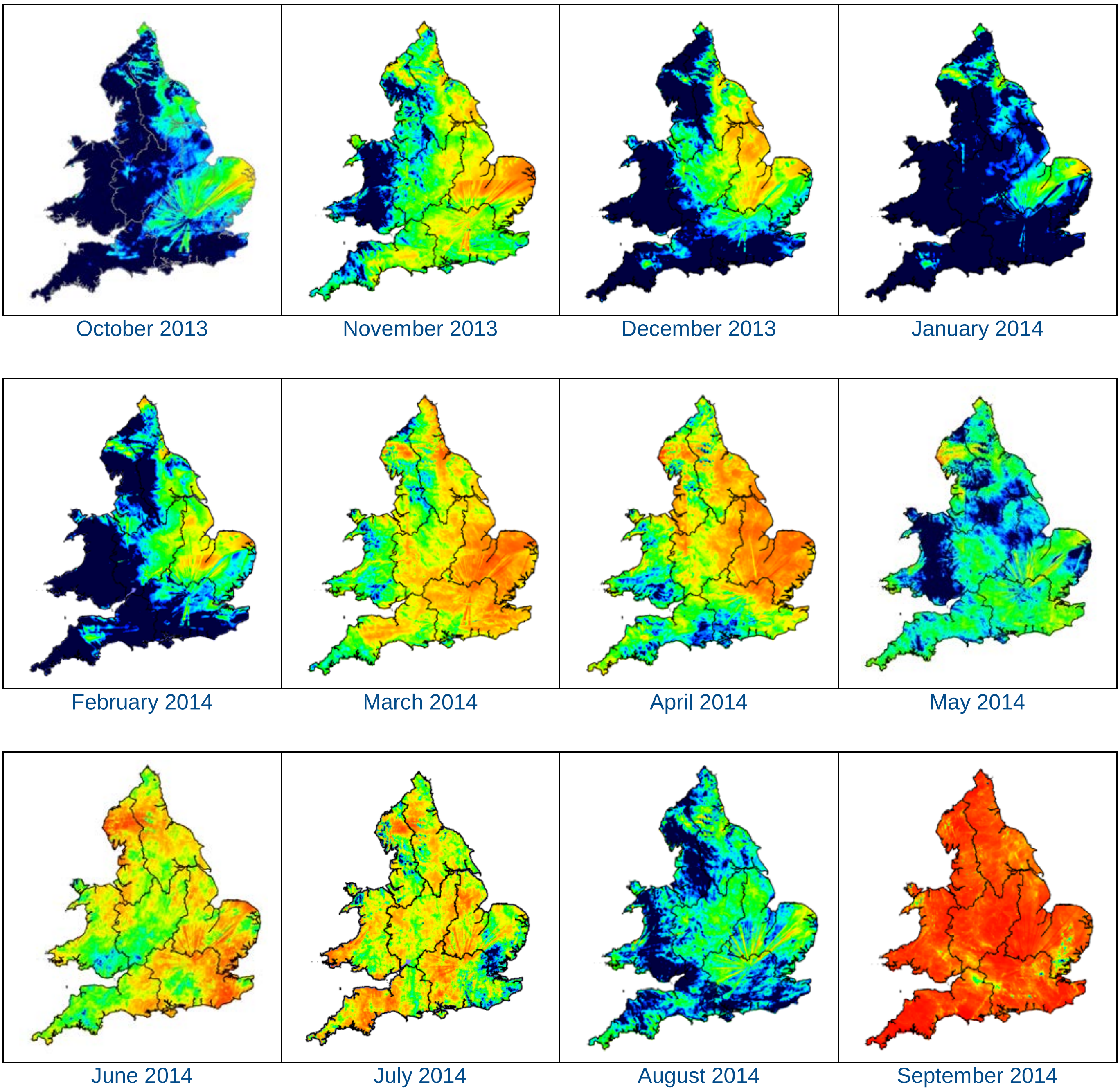
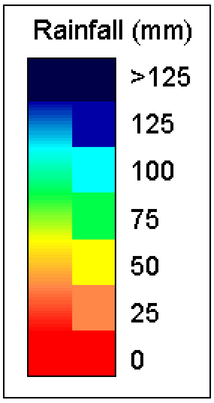


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2014). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.



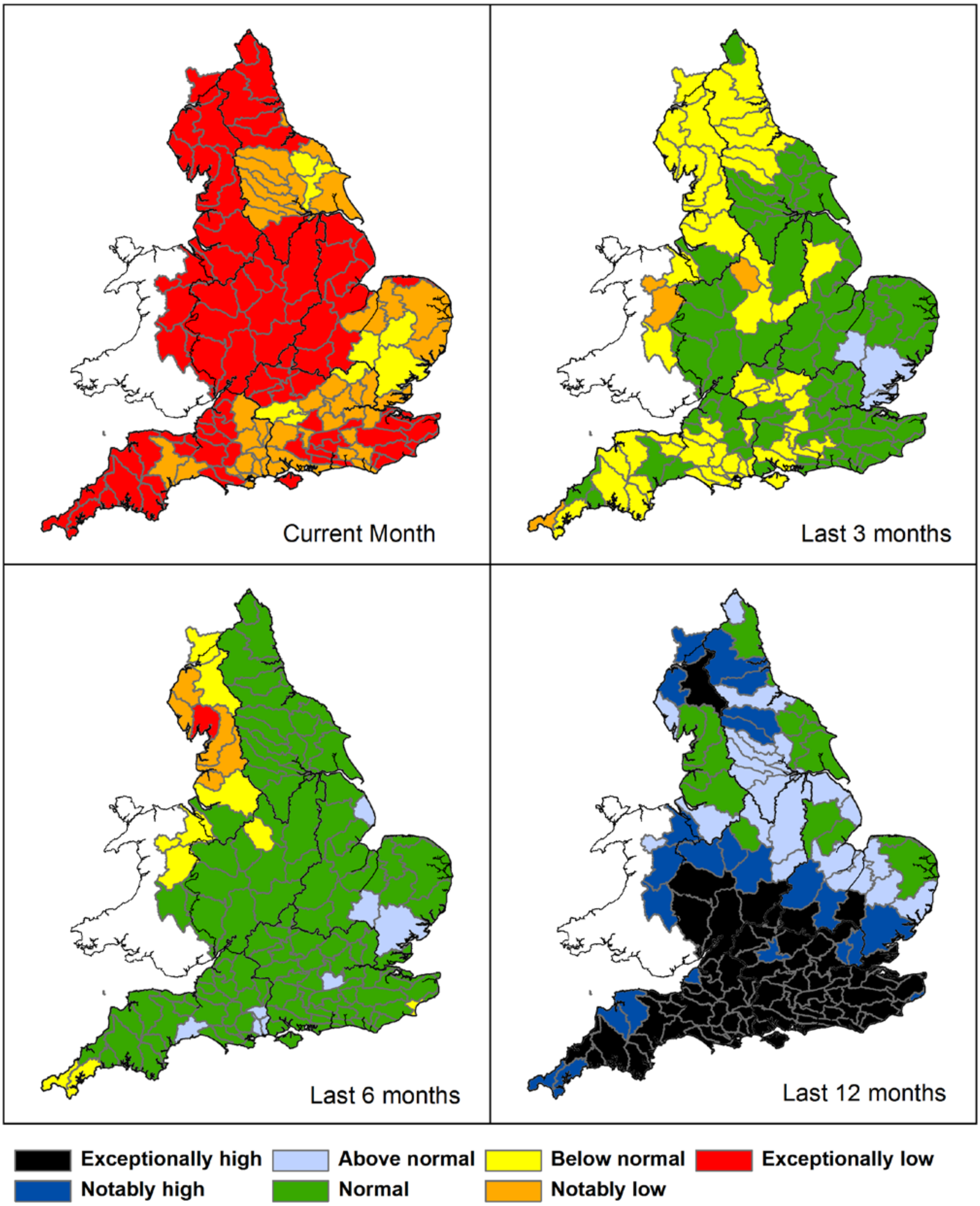


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30th September), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) 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.

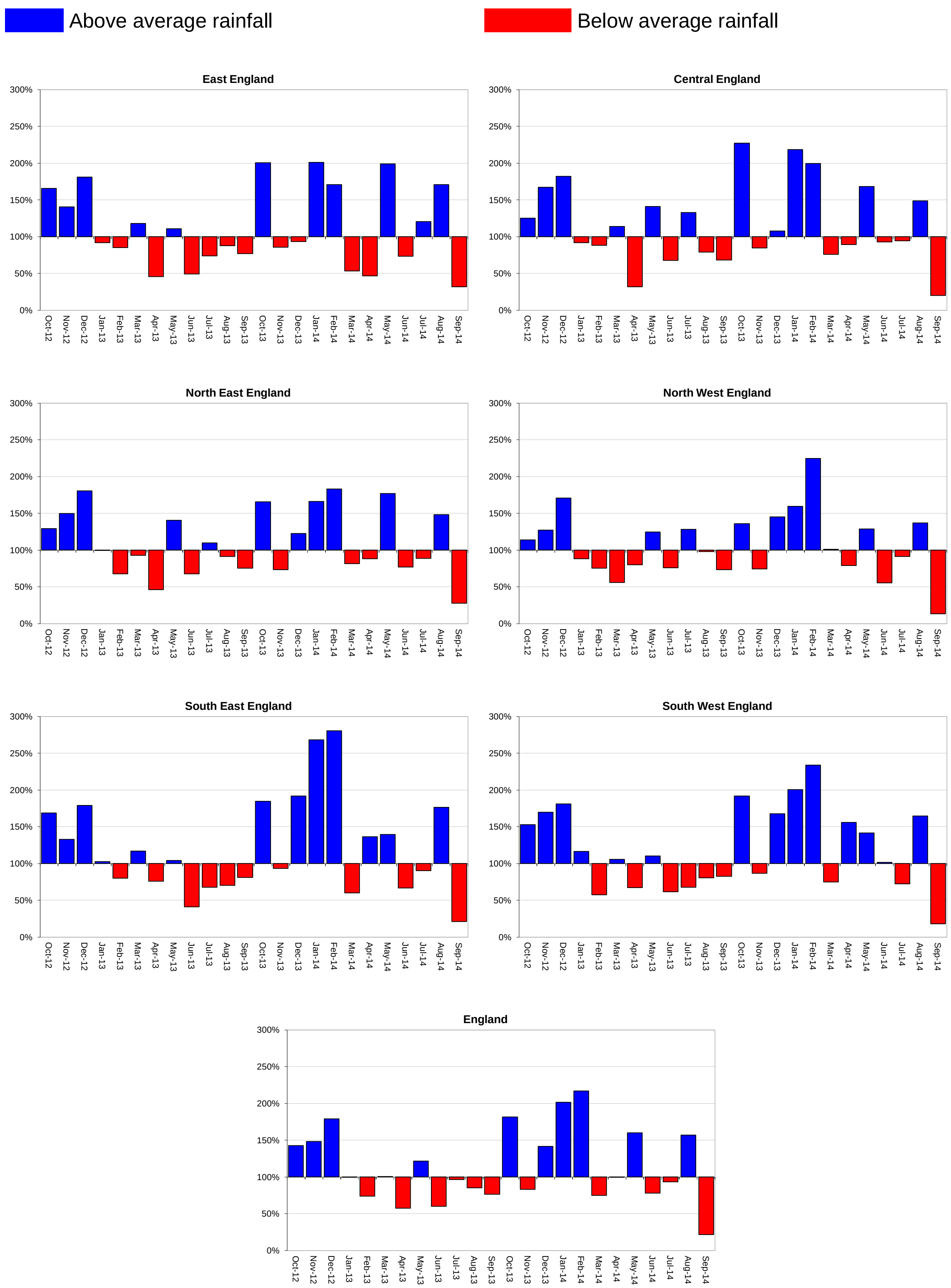


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each Environment Agency Region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2014).

Soil moisture deficit

End of August 2014 [1]	End of September 2014 [2]

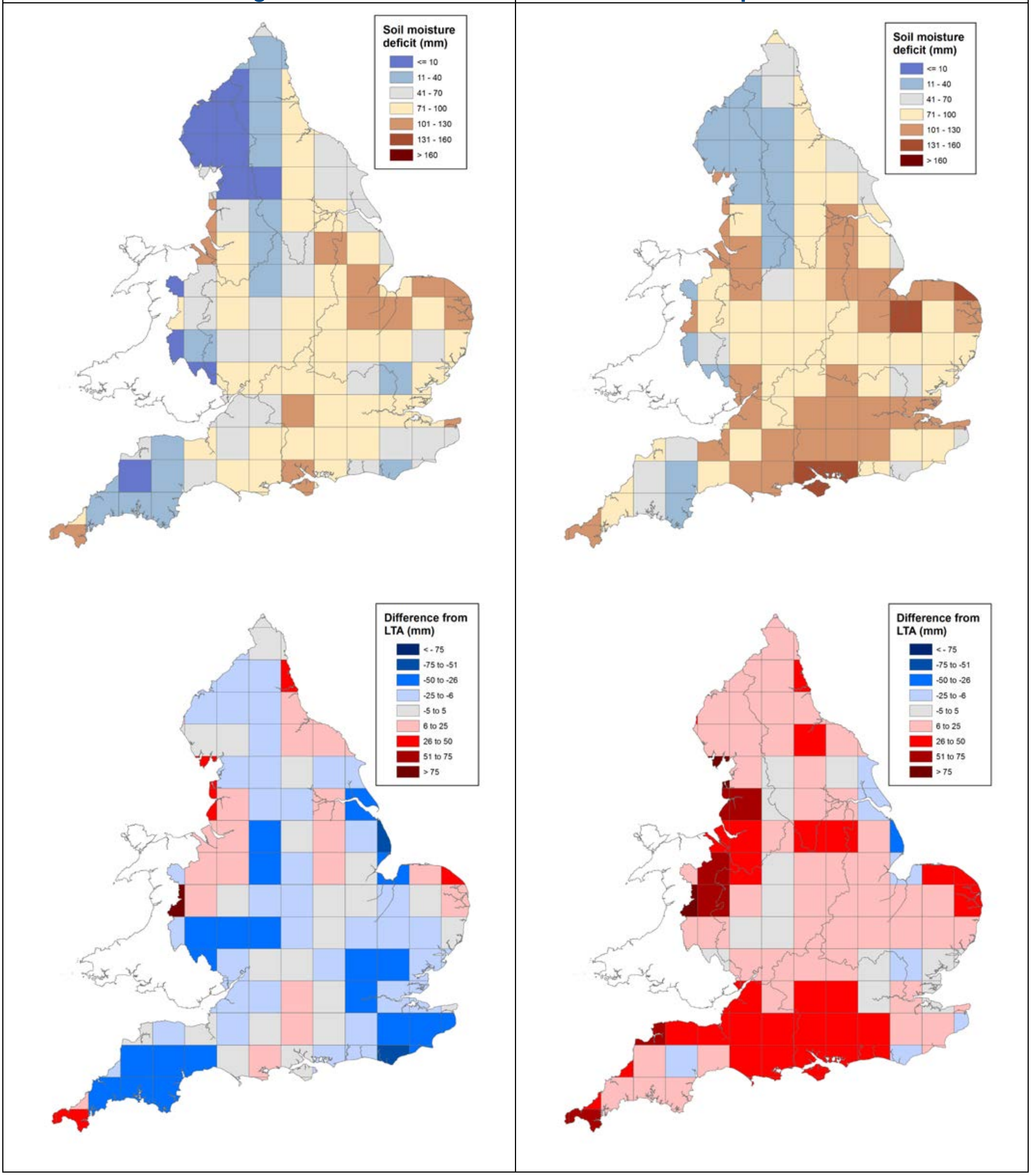


Figure 2.1: Soil moisture deficits for weeks ending 02 September 2014 [1] (left panel) and 30 September 2014 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2014). Crown copyright. All rights reserved. Environment Agency, 100026380, 2014

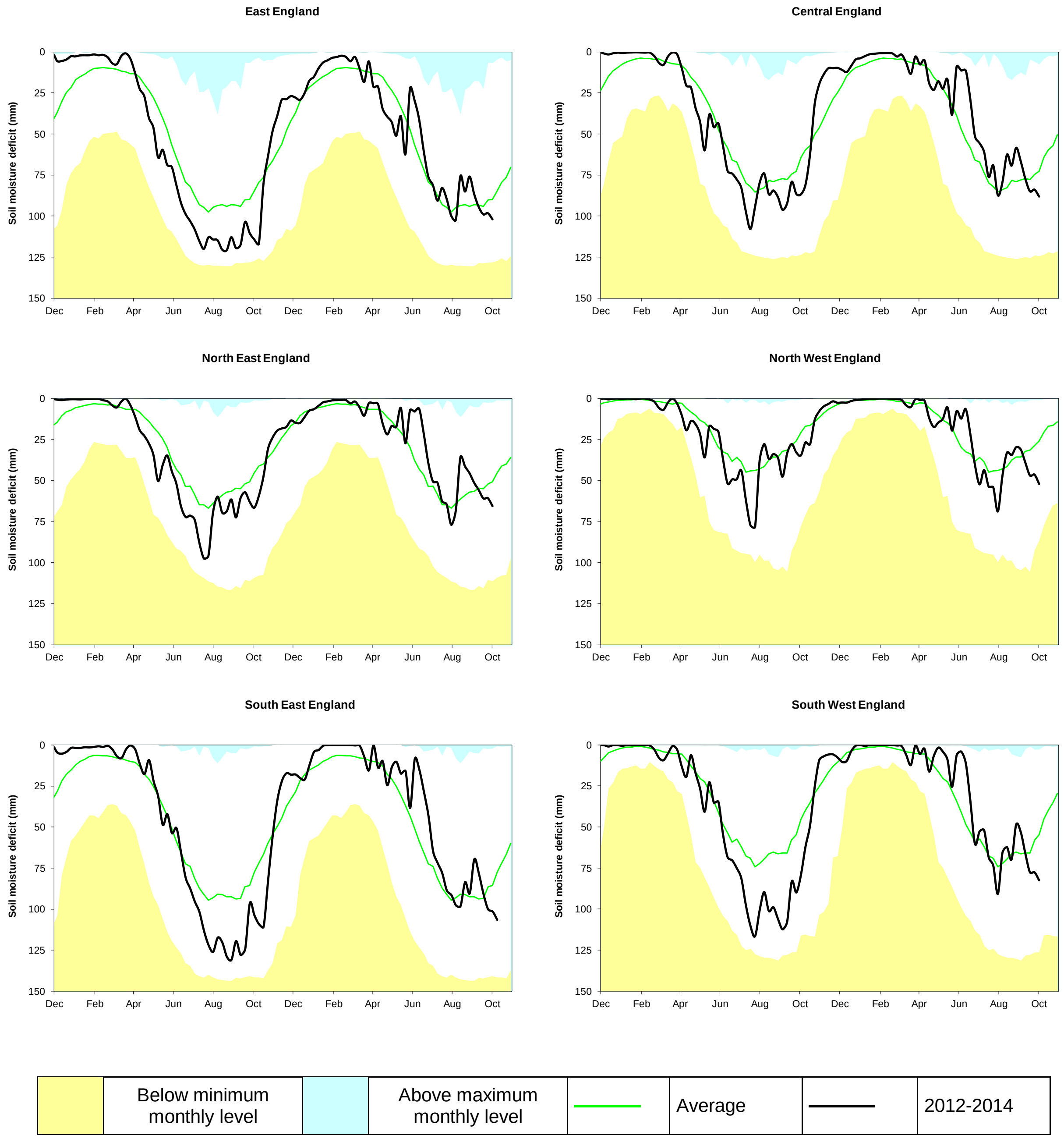
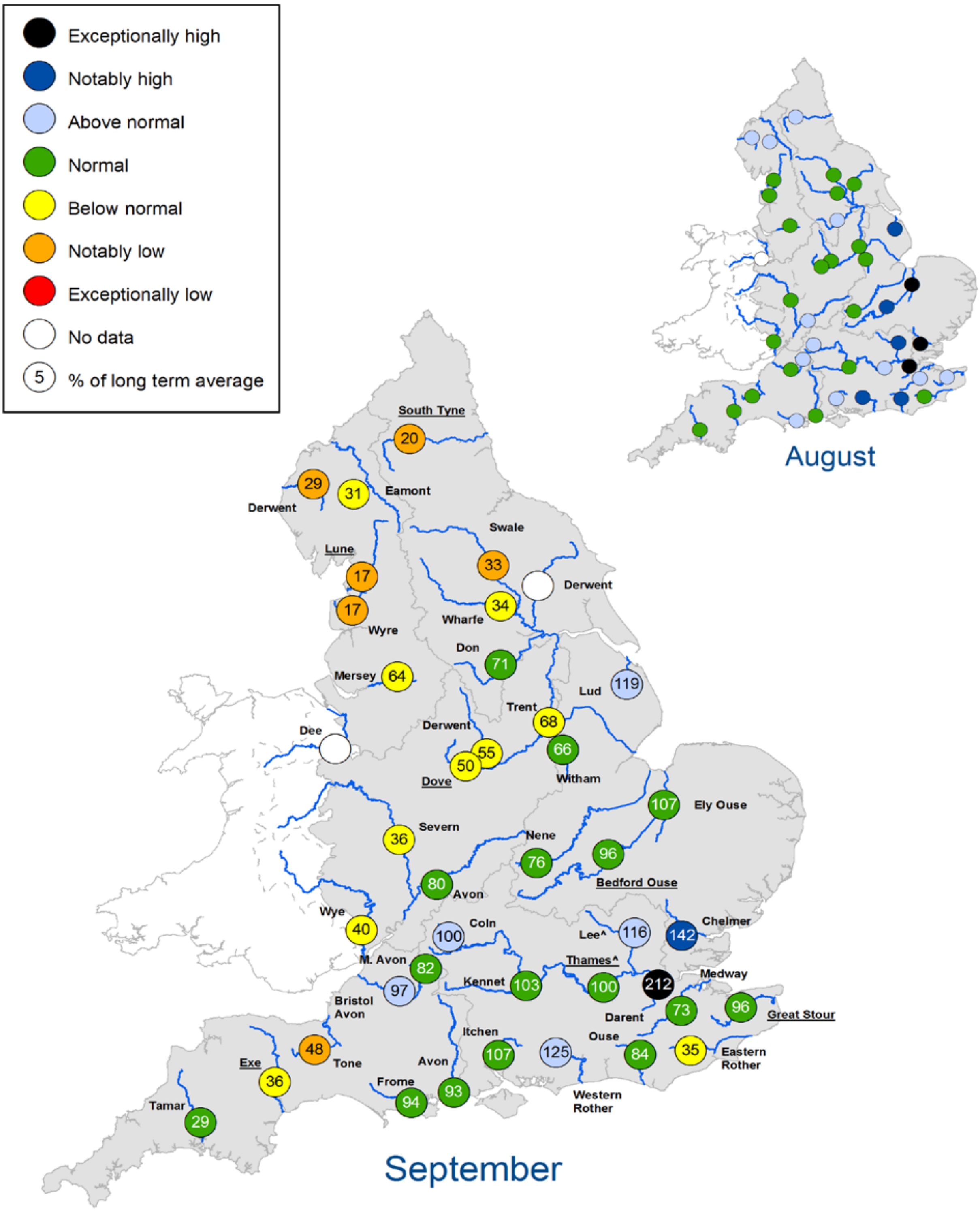


Figure 2.2: Latest soil moisture deficits for all Environment Agency Regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2014).

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 August and September 2014, expressed as a percentage of the respective long term average and classed relative to an analysis of historic August and September monthly means (Source: Environment Agency).

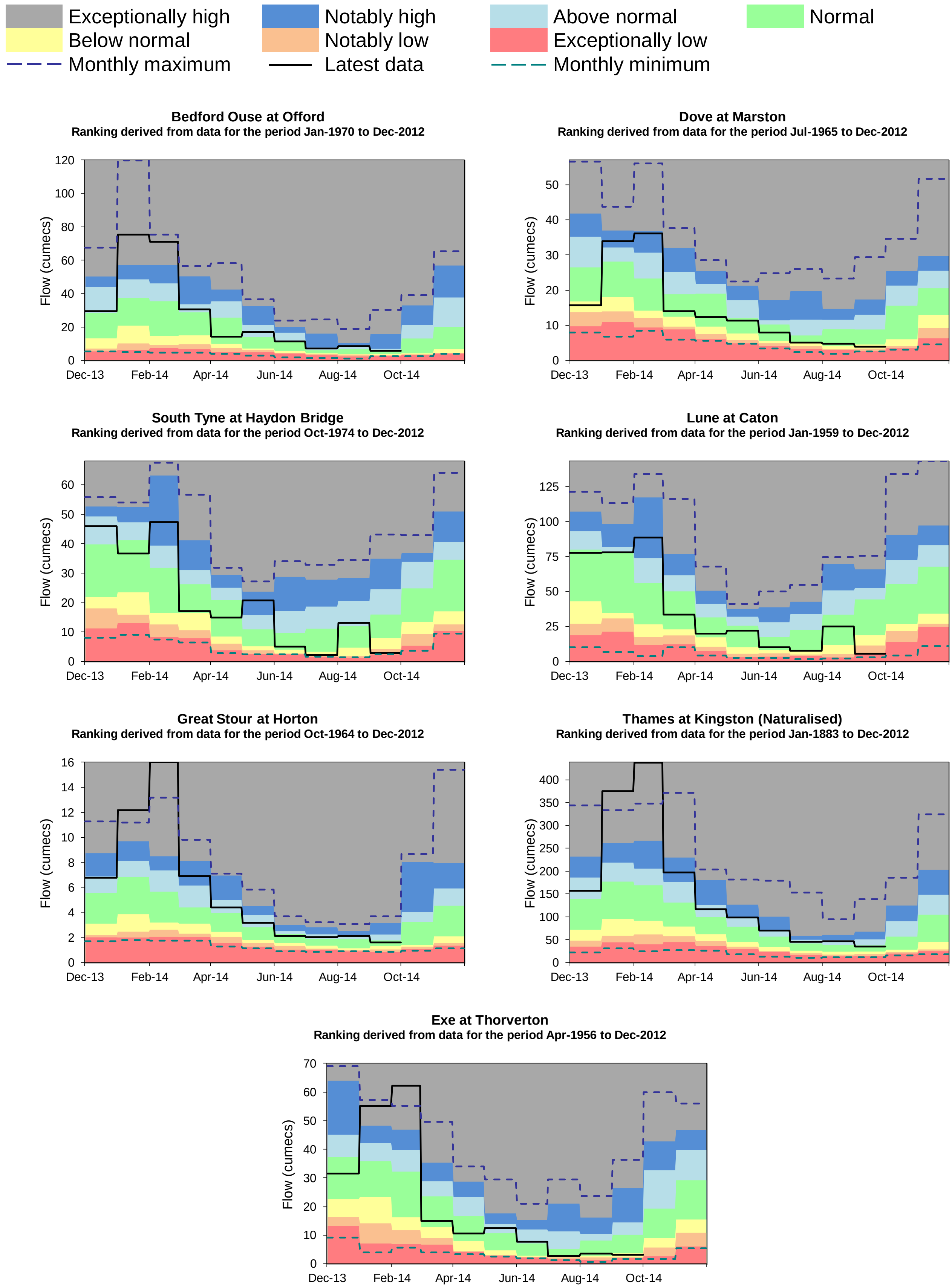
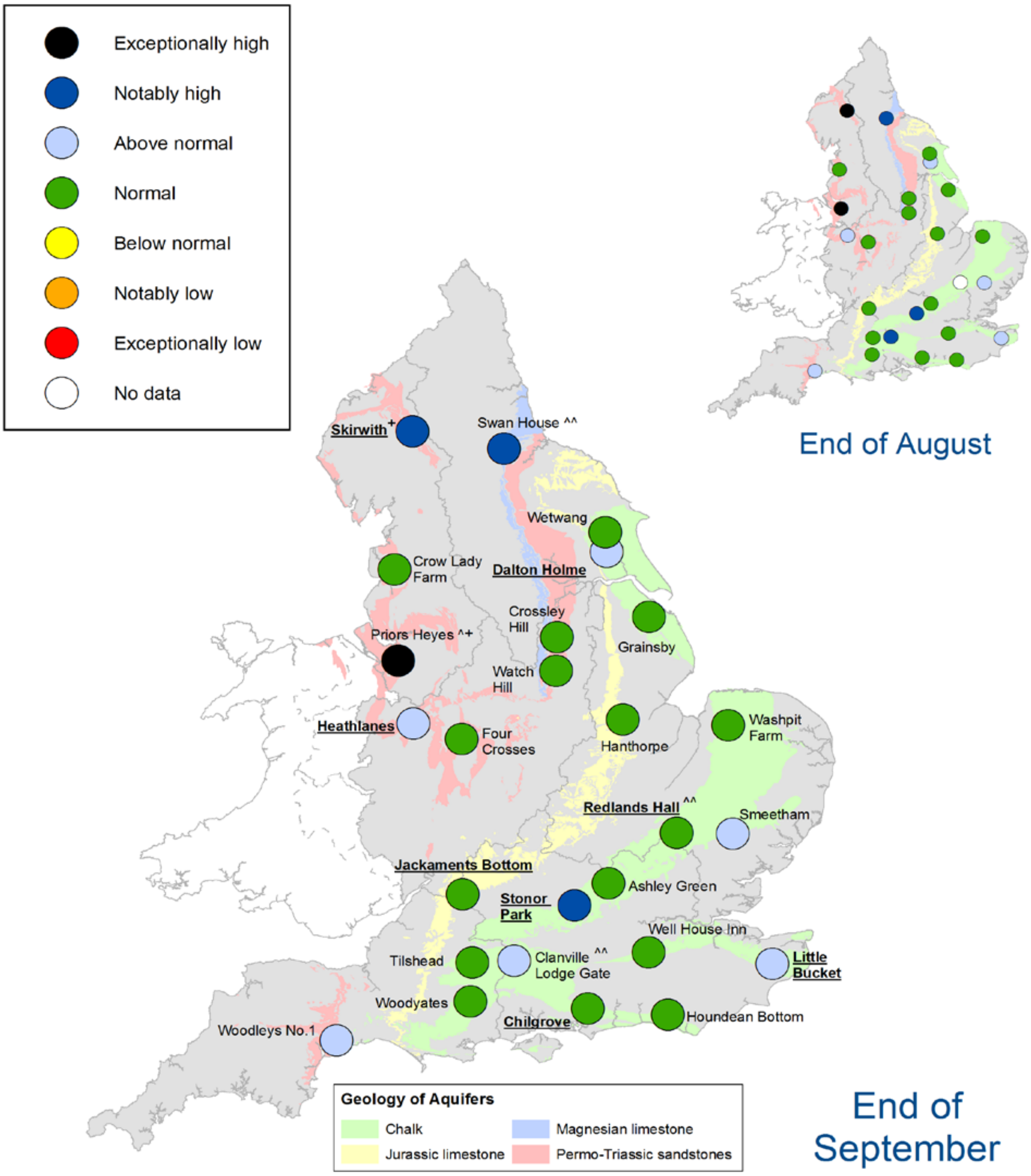


Figure 3.2: Index river flow sites for each Environment Agency Region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 August and September 2014, classed relative to an analysis of respective historic August and September 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.

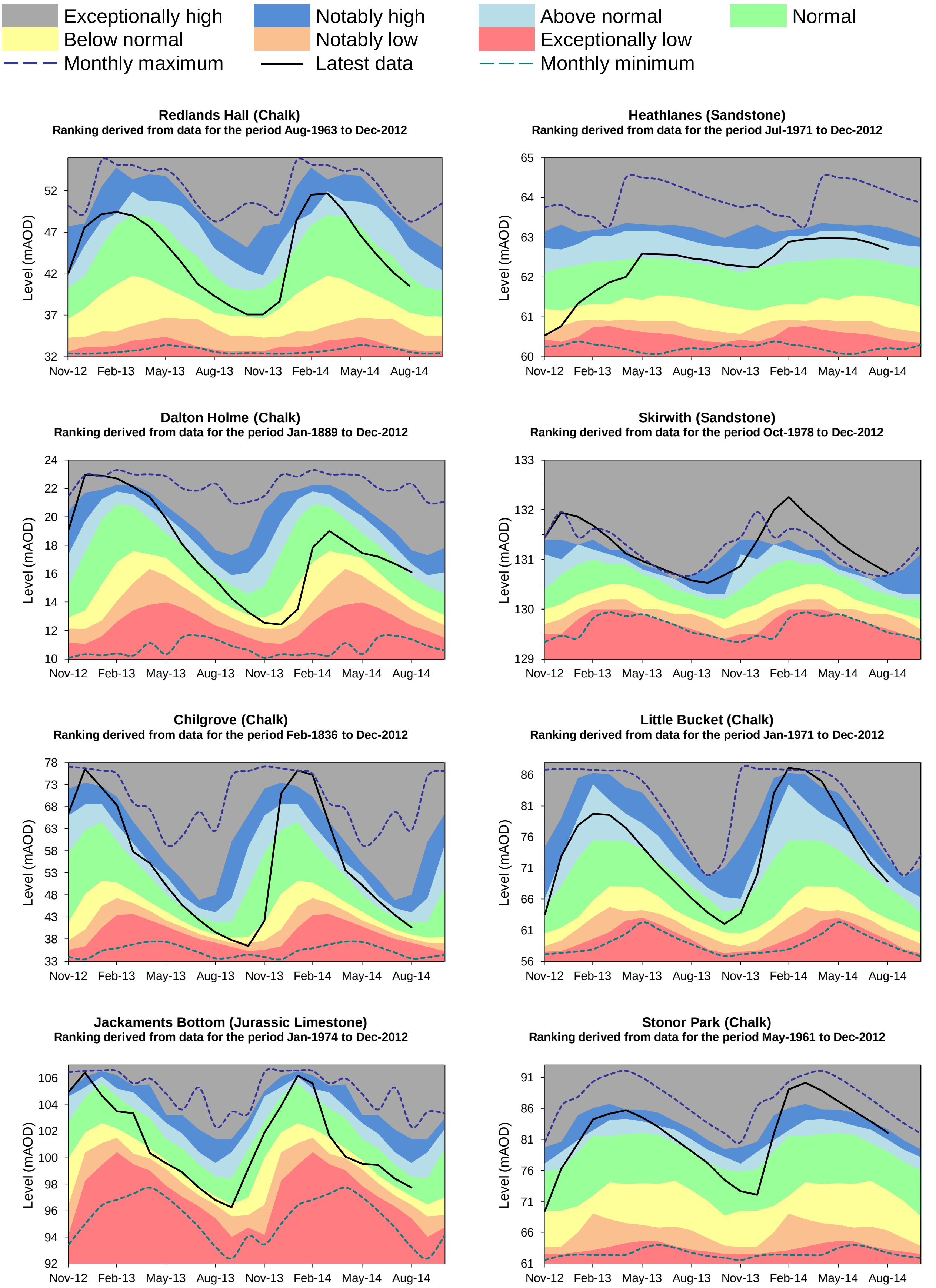
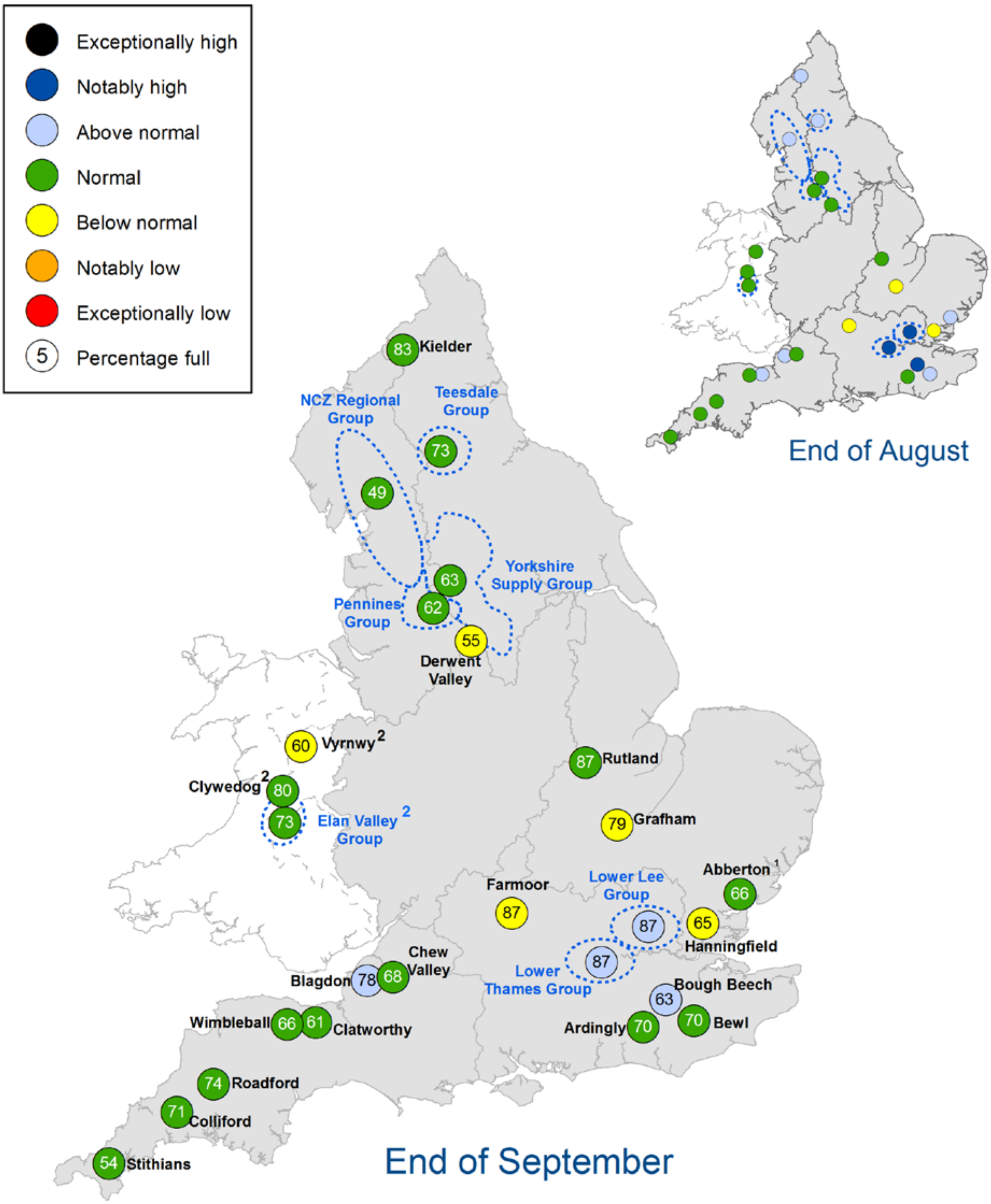


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2014).

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

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

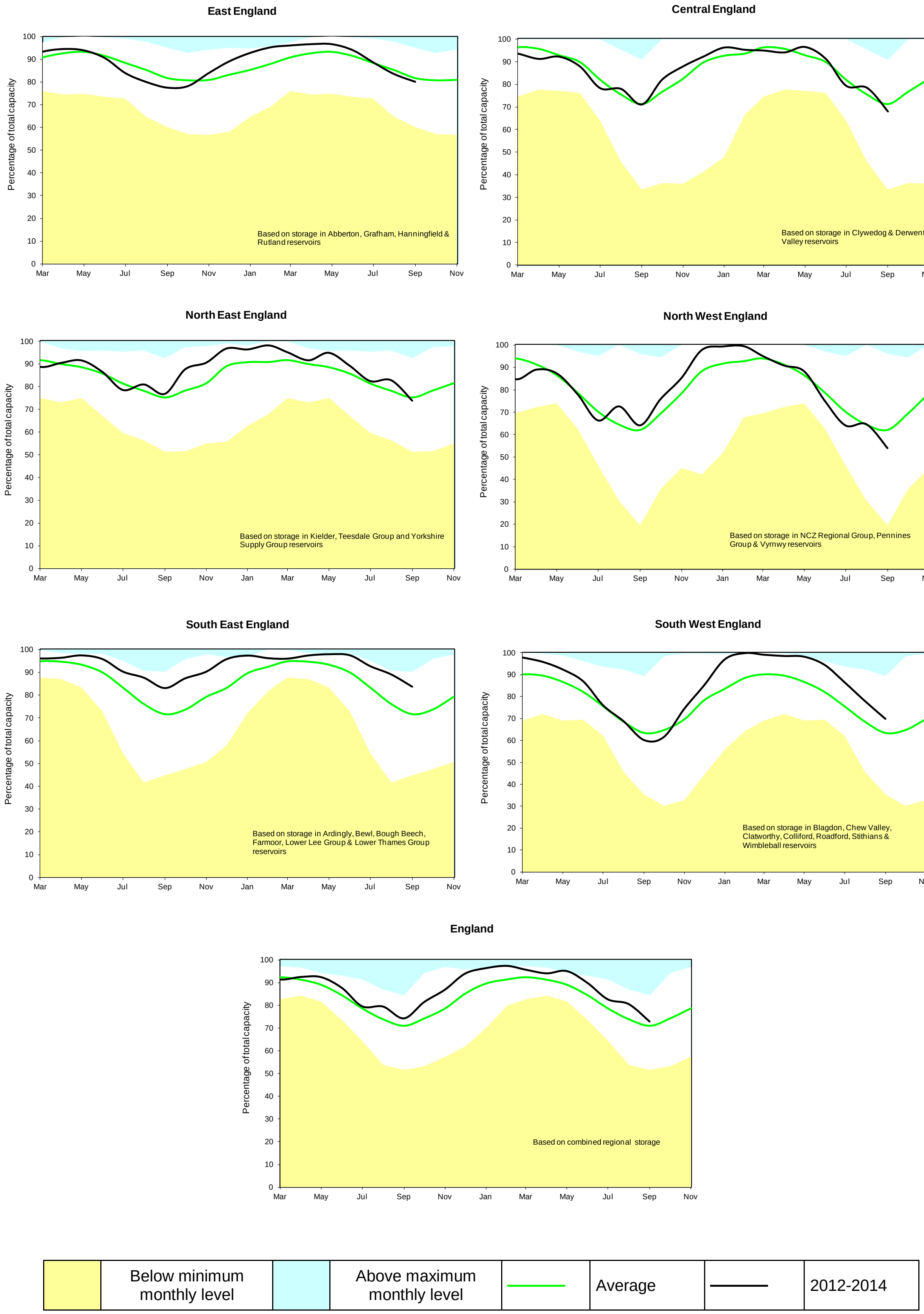


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

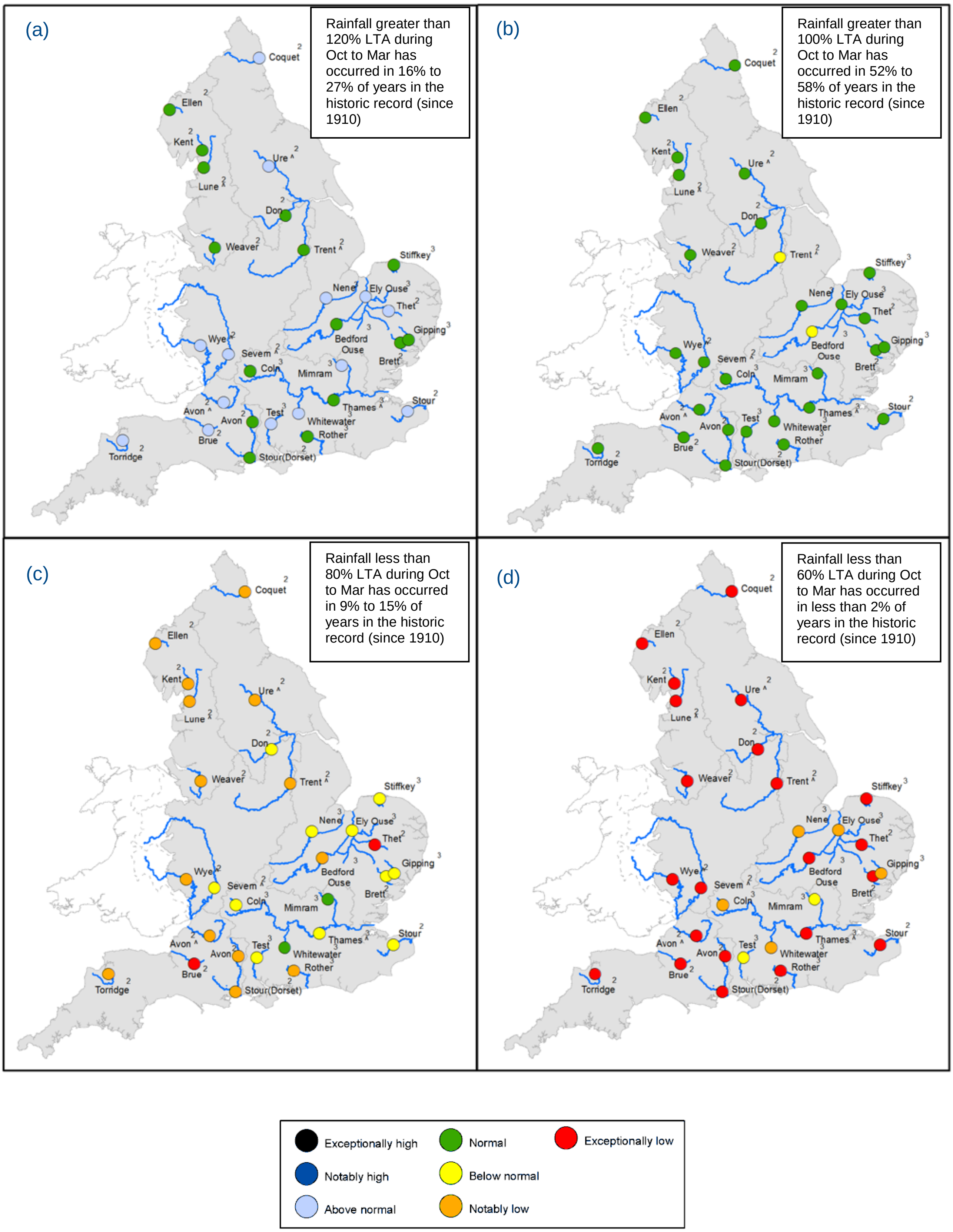


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2014 and March 2015 (Source: Centre for Ecology and Hydrology, Environment Agency)

[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

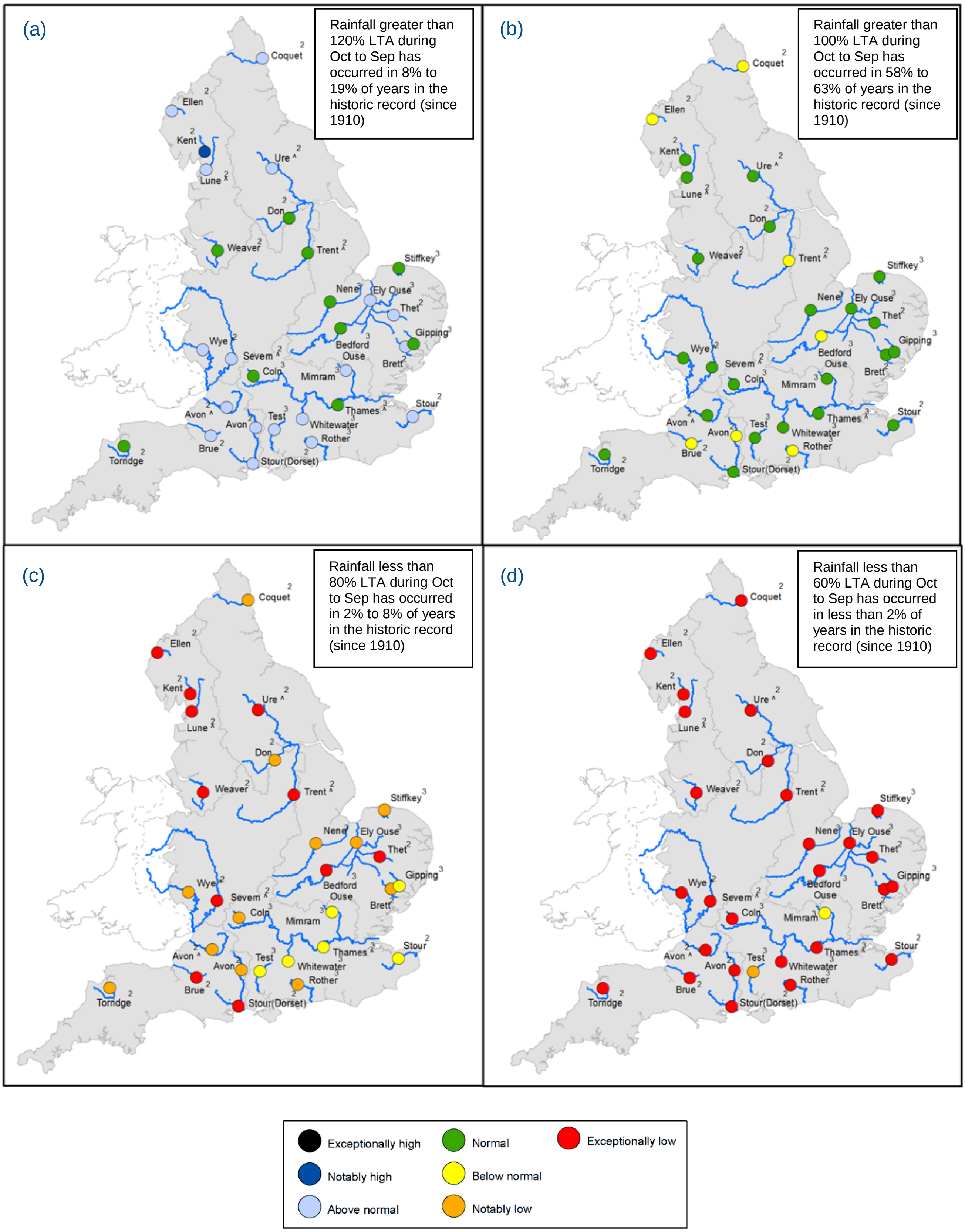


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2014 and September 2015 (Source: Centre for Ecology and Hydrology, Environment Agency)

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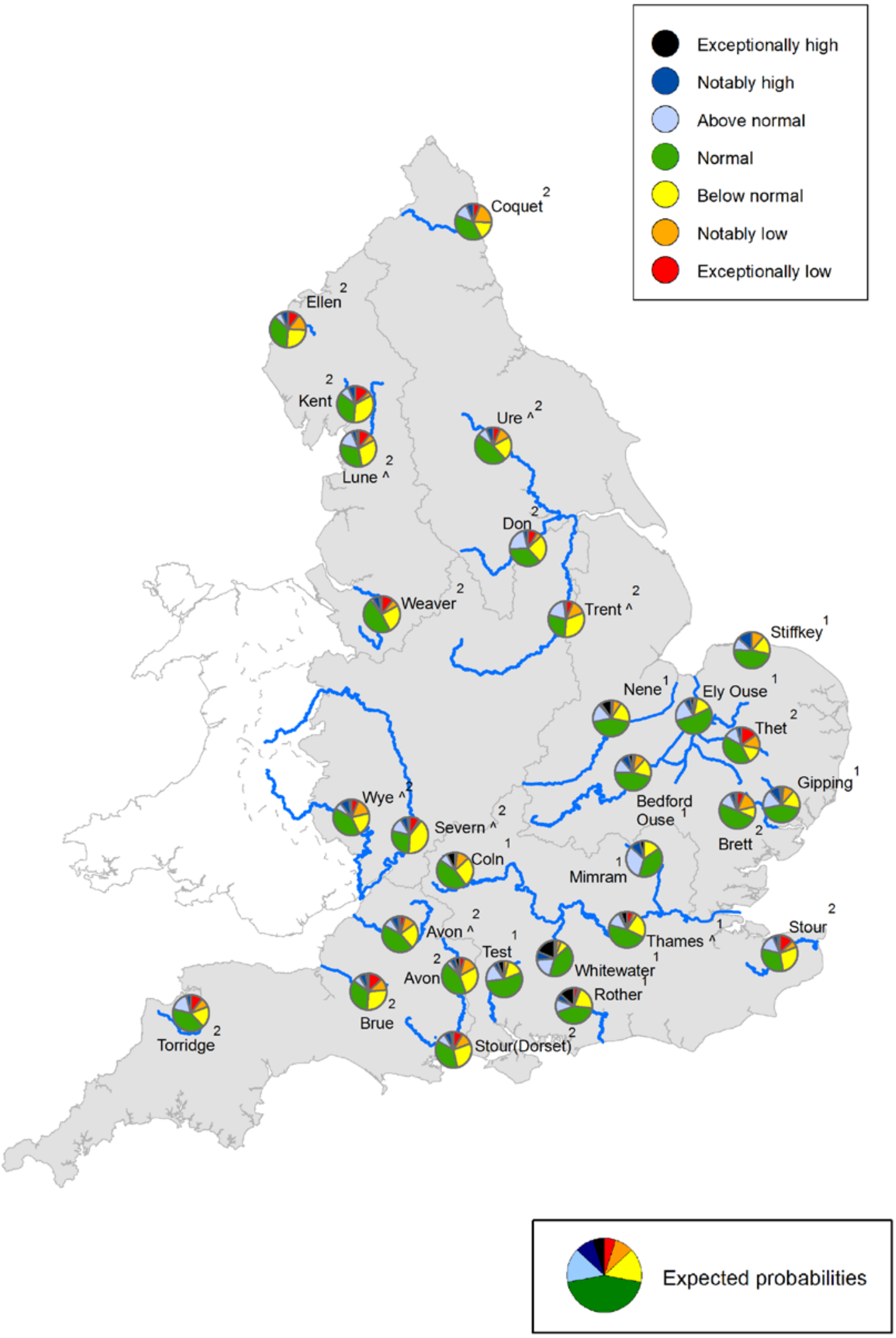
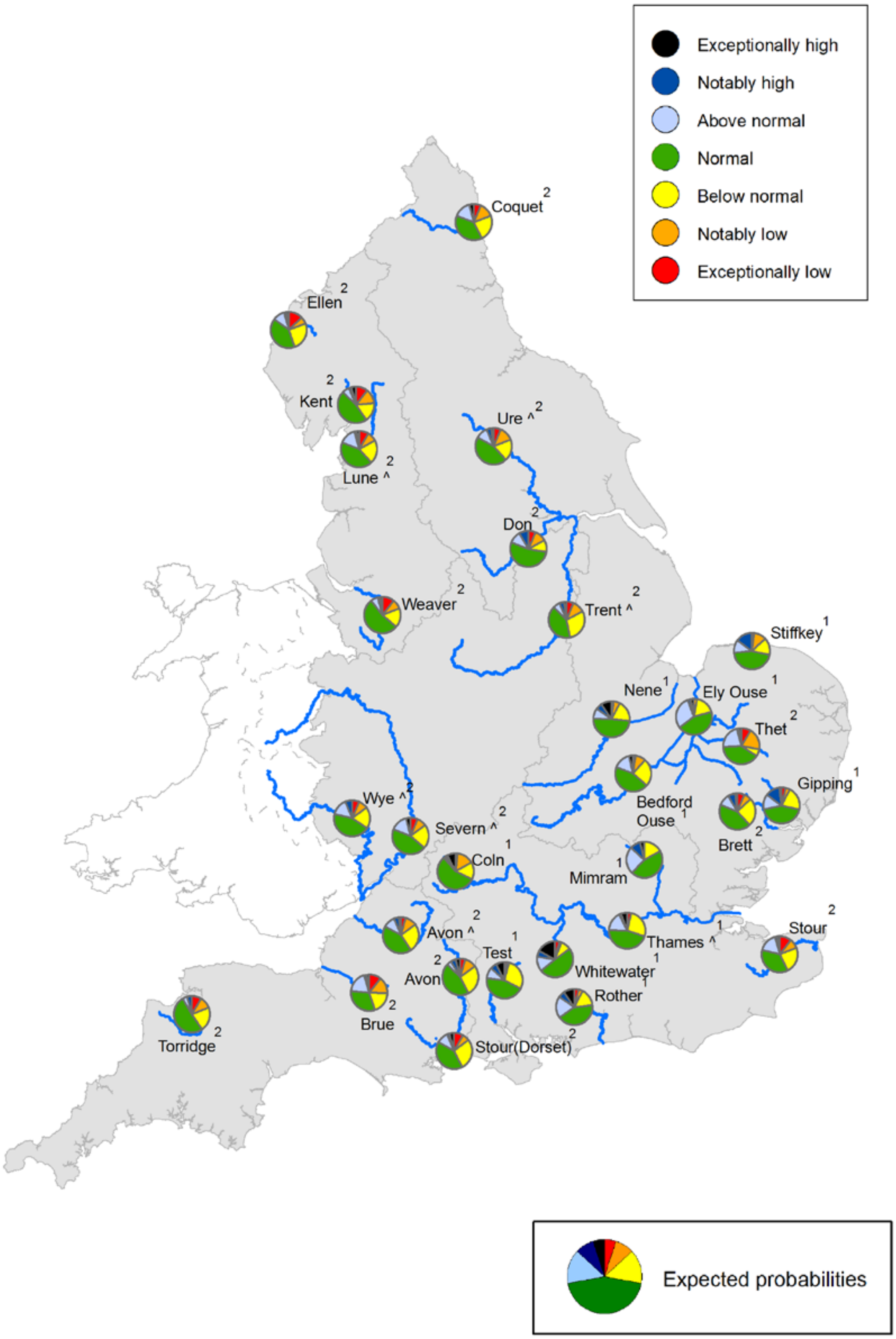


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

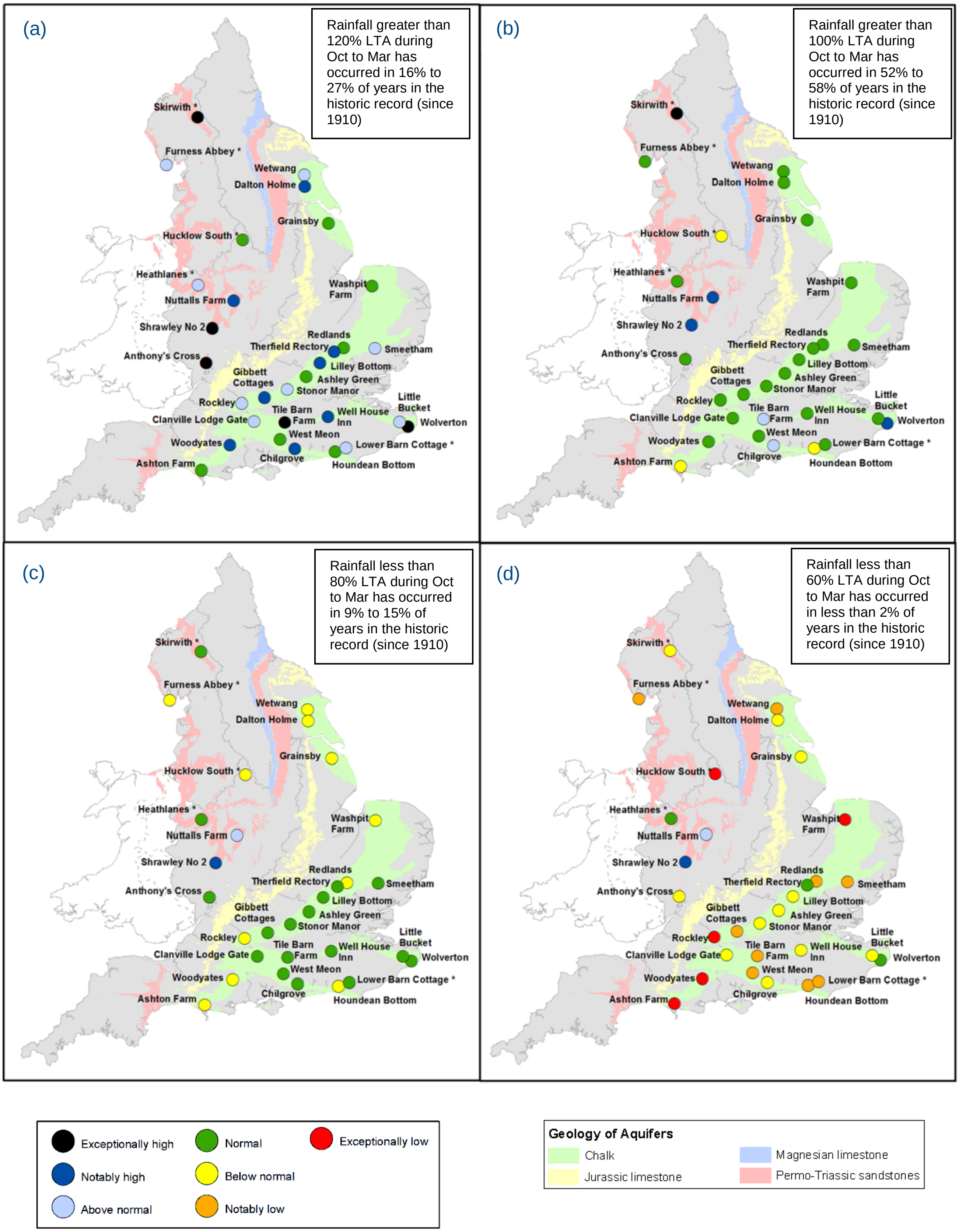


Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2014 and March 2015 (Source: Environment Agency). Geological map reproduced with kind permission 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

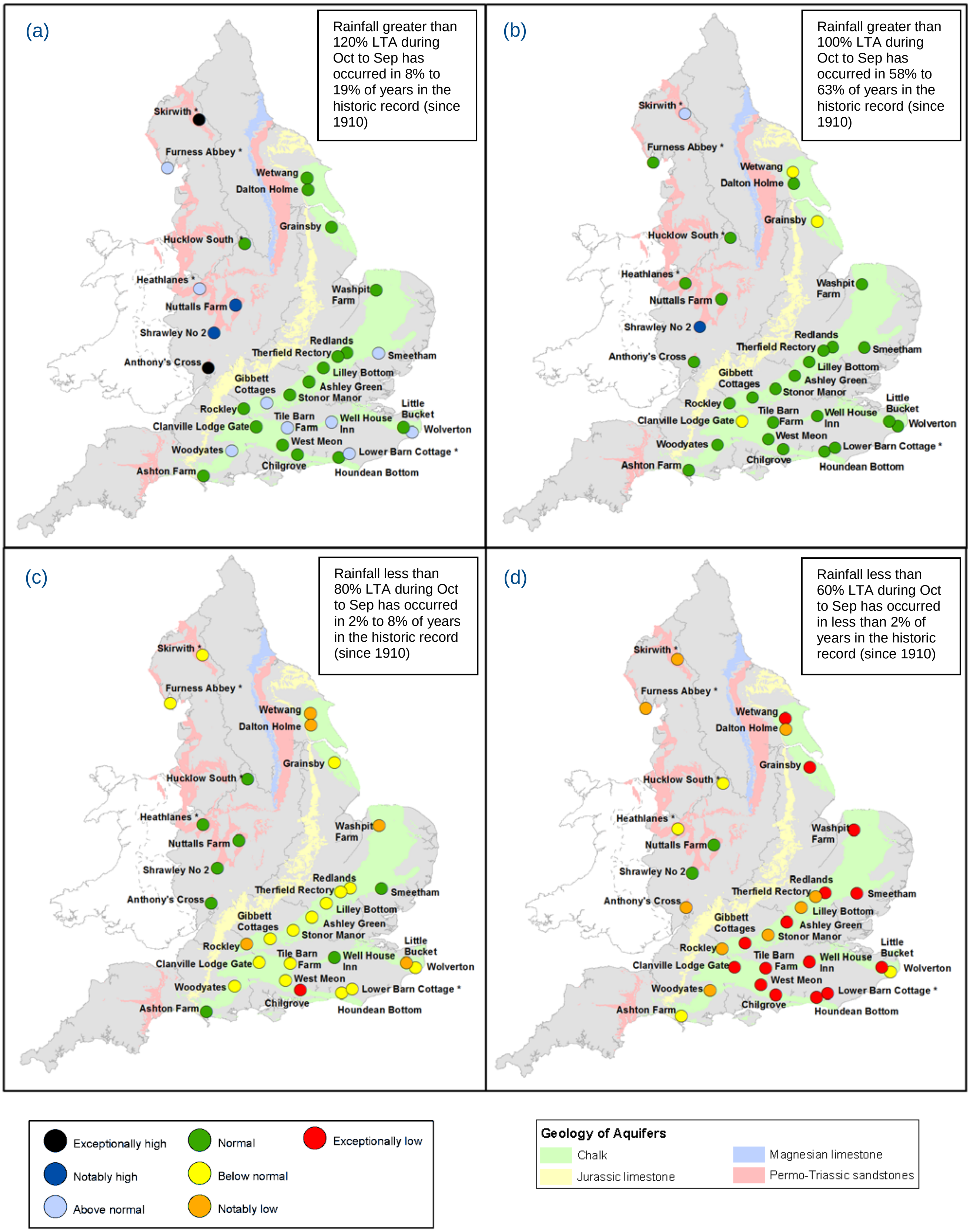
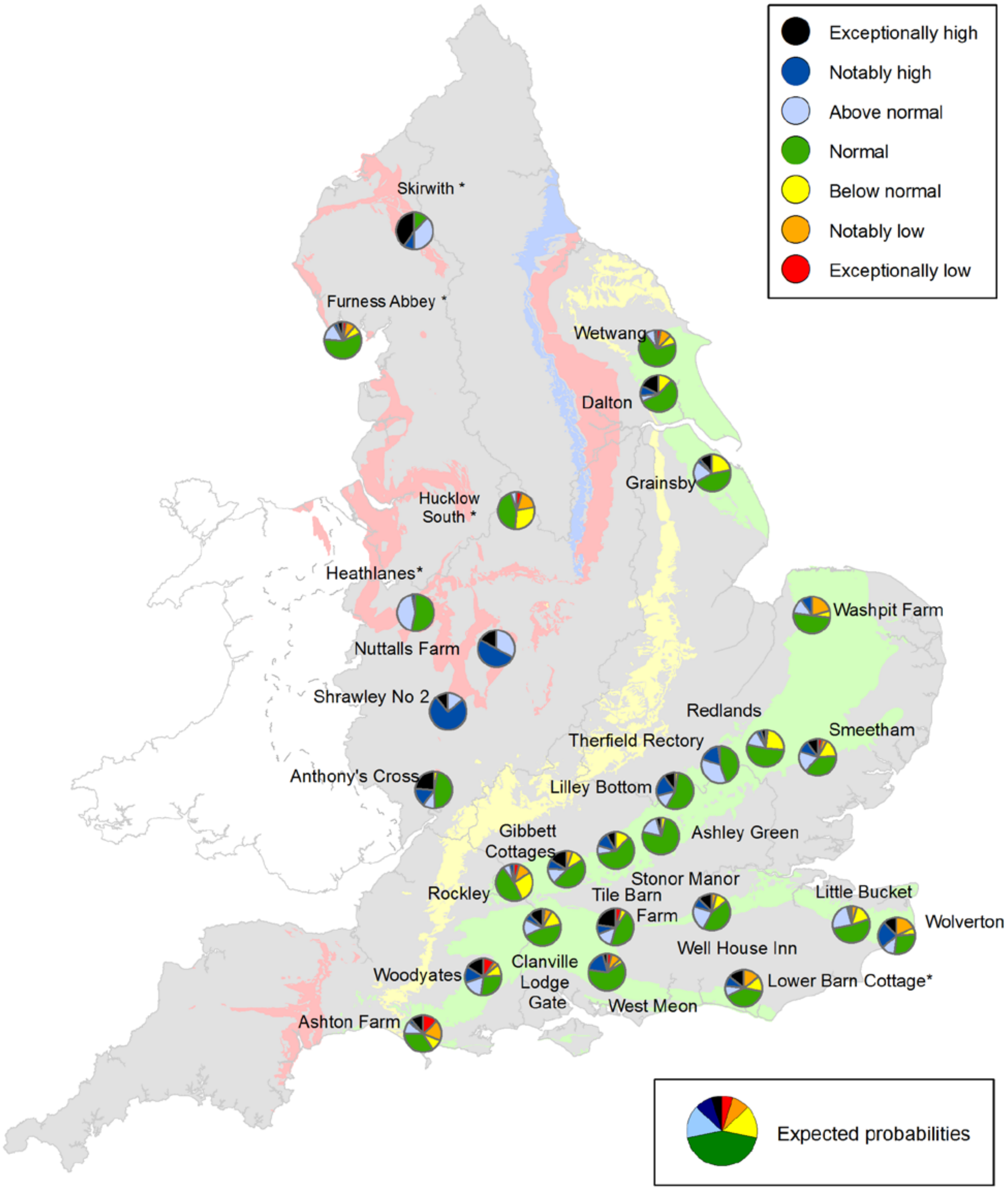


Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2014 and September 2015 (Source: Environment Agency). Geological map reproduced with kind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

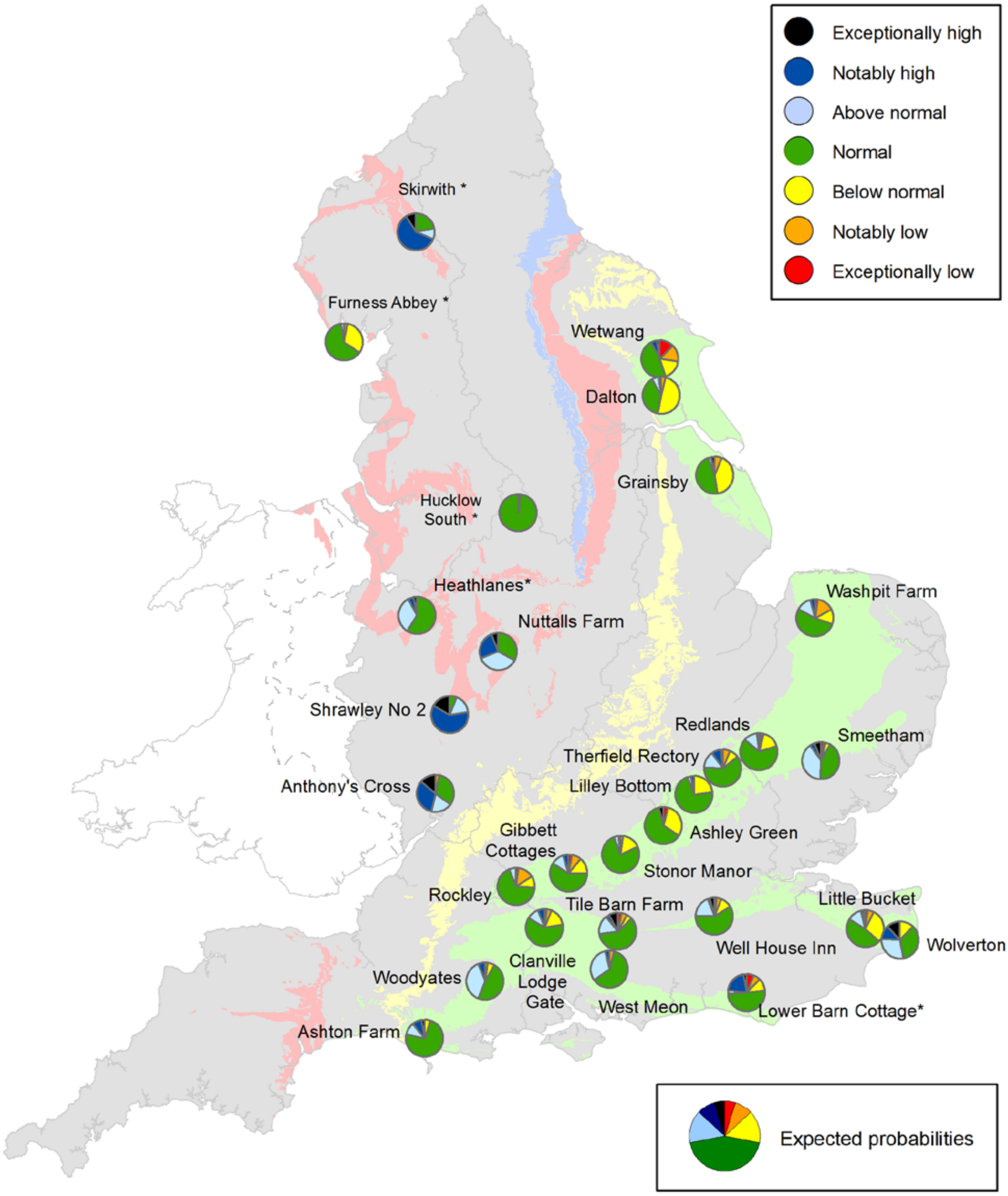
* Projections for these sites are produced by BGS
[1] This range of probabilities is a regional analysis



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