Monthly water situation report

England

Summary – March 2014

Following three consecutive months of well above average rainfall across England, March marked a return to drier conditions with rainfall totals at 76% of the long term average (LTA). Soils moisture deficits increased during the month across most parts of England but decreased or remained at zero in a few areas, including the far north. Monthly mean river flows for March returned to *normal* for the time of year at most sites, although a number of groundwater-fed sites in southern and southeast England remain *notably high* and *exceptionally high*. Groundwater levels decreased at the majority of our indicator sites but ranged from *normal* to *exceptionally high* across the principal aquifers of England. Overall reservoir stocks decreased during March with storage in England as a whole at 96% of total capacity at the end of the month.

Rainfall

Rainfall totals for March were highest in North West Region at 90 mm and lowest in Anglian Region at 24 mm. Locally, the highest rainfall totals fell across parts of Cumbria (more than 130 mm), whilst the lowest rainfall totals (less than 20 mm) fell across parts of Norfolk, Suffolk, Essex and Cambridgeshire (Figure 1.1).

March rainfall totals were classed as *normal* for the time of year for the vast majority of hydrological areas across England. Rainfall totals for the hydrological areas in East Anglia, Essex and parts of Bedfordshire, Kent and Sussex were classed as *below normal* for the time of year. In contrast, the influence of the preceding three months of well above average rainfall means that cumulative totals over the past three and six months remain classed as *exceptionally high* across most of England (Figure 1.2).

Monthly rainfall totals as a percentage of the March LTA were below average in all six regions covering England, ranging from 98% in North West Region to 51% in Anglian Region. Overall, England received 76% of the LTA rainfall (Figure 1.3).

Soil moisture deficit

As a result of the mild weather and lower than average rainfall, soil moisture deficits (SMDs) increased by up to 26 mm across most parts of England during March. At the end of March, SMDs ranged from zero across parts of Cumbria and Northumberland, to approximately 25 – 30 mm across parts of East Anglia, Essex and Kent (Figure 2.1). End of March SMDs were 6 – 10 mm less than the LTA in the MORECS grid squares covering parts of north east England, Yorkshire, Greater London and West Sussex; in contrast, SMDs were 10 – 18 mm greater than the LTA in the MORECS grid squares covering East Anglia, Essex and parts of Kent (Figure 2.1).

At the beginning of March, SMDs were less than 6 mm across all regions covering England and close to zero in North West, South West and South East Regions. By the end of March, in response to the drier weather, SMDs had increased by between 5 and 15 mm in four regions, but changed little overall in North East and North West Regions. At the end of March, SMDs were 8 mm greater than the LTA in Anglian Region and within 4 mm of the LTA elsewhere (Figure 2.2).

River flows

Monthly mean river flows decreased, compared to February, at all our indicator sites across England. Whilst flows returned to their *normal* range for the time of year at most sites, flows at ten sites in groundwater-fed catchments in southern and southeast England remained *notably high* or *exceptionally high* for the time of year Monthly mean flows on the rivers Coln and Itchen were the highest on record for March and for the third consecutive month (Figure 3.1).

River flows at the regional index sites in central, northern and southwest England were *normal* for the time of year. Flows at the three index sites in eastern and southeast England were *above normal* or *notably high* (Figure 3.2).

Groundwater levels

Groundwater levels decreased at the majority of indicator sites across England during March and by the end of the month, levels were *normal* or *above normal* at just over half the sites. However, levels at the majority of indicator sites in chalk aquifers in southern and southeast England remained *notably high* or *exceptionally high* for the time of year as a result of the exceptional winter rainfall (Figures 4.1 and 4.2).

At the end of March, four indicator sites had the highest recorded groundwater levels for the time of year. This included Little Bucket (East Kent Chalk), Woodleys (Otter Valley Sandstone), Skirwith (Carlisle Basin and Eden Valley Sandstone) and Priors Heyes (West Cheshire Sandstone). However, please note that levels at Priors Heyes remain high compared to historic levels as the aquifer is recovering from the effects of abstraction. Groundwater levels in the sandstone at Woodleys were the highest recorded for any month on record (which started in 1966).

Groundwater levels at the index sites fell during March at three sites, were stable at another three and were rising slowly at the remaining two (Dalton Holme in the Hull & East Riding Chalk, and Heathlanes in the Shropshire Middle Severn /East Shropshire Sandstone) (Figures 4.2).

Reservoir storage

During March, reservoir stocks increased or remained unchanged at three quarters of the reported reservoirs and reservoir groups. Stocks at three reservoir groups decreased by more than 5% of full capacity, including Kielder in North East Region, Derwent Valley in Midlands Region and the NCZ Regional Group in North West Region. Nine reservoirs or reservoir groups are full. Reservoir stocks are classed as *normal* or higher for the time of year at all but one of the reported sites (Figure 5.1). The capacity of Abberton Reservoir in Anglian Region has been increased. Consequently, reservoir stocks are classed as *exceptionally high* for the time of year against historic percentage full values.

At a regional scale, reservoir stocks decreased in all areas. The largest decreases were less than 5% of full capacity and seen North West and North East Regions. At the end of March, regional reservoir stocks were lowest in North East Region, with stocks at 95% of full capacity, and highest in South West Region, with stocks at 99% of full capacity. Overall reservoir storage for England decreased during March to 96% of total capacity (Figure 5.2).

Forward look

High pressure is likely to bring plenty of dry weather through April, but with an interlude of more unsettled conditions mid-month. Daytime temperatures are likely to be near average to above average through to early May. Further ahead, there is a slightly higher than expected probability of above average precipitation for the period April to June[1].

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

September 2014: With average (100% of the LTA) rainfall between April and the end of September 2014, cumulative river flows are likely to be *normal* at two thirds of our modelled sites. With 120% of the LTA rainfall, river flows are likely to be *above normal* or higher at three quarters of the modelled sites. With 80% of the LTA rainfall river flows are likely to be *below normal* or lower at a third of the modelled sites (see Figure 6.1).

March 2015: With average rainfall between April 2014 and the end of March 2015, cumulative river flows are likely to be *normal* at over three quarters of the modelled sites. With above average rainfall (120% of the LTA), flows are likely to be *above normal* or higher at four fifths of our modelled sites. With below average rainfall (80% of the LTA), river flows are likely to be *notably low* or lower at over half of the modelled sites (see Figure 6.2).

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

September 2014: More than three quarters of modelled sites have a greater than expected chance of *above normal* or higher cumulative flows from April to September. Nearly half of the sites have a greater than expected chance of *normal* flows (see Figure 6.3).

March 2015: Nearly half of all modelled sites have a greater than expected chance of *normal* cumulative flows from April 2014 to March 2015. One fifth of the modelled sites have a greater than expected chance of *below normal* or lower flows, whilst more than two thirds of modelled sites have a greater than expected chance of *above normal* or higher flows between April 2014 and March 2015 (see Figure 6.4).

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

[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.

September 2014: With average rainfall (100% of the LTA) from April to September 2014, groundwater levels are likely to be *normal* or higher for the time of year at all except two of the modelled sites, and *above normal* or higher at nearly half of modelled sites. With above average rainfall (120% of the LTA) all sites will be *normal* or higher. With 80% of the LTA rainfall, all except three modelled sites are likely to have *normal* or higher groundwater levels for the time of year (see Figure 6.5).
March 2015: With average rainfall (100% of the LTA) from April 2014 to March 2015, groundwater levels are likely to be *normal* or higher for the time of year at all but two 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 four fifths of the modelled sites. With below average rainfall (80% of the LTA), groundwater levels are likely to be *below normal* or lower at over a third of our modelled sites (see Figure 6.6).

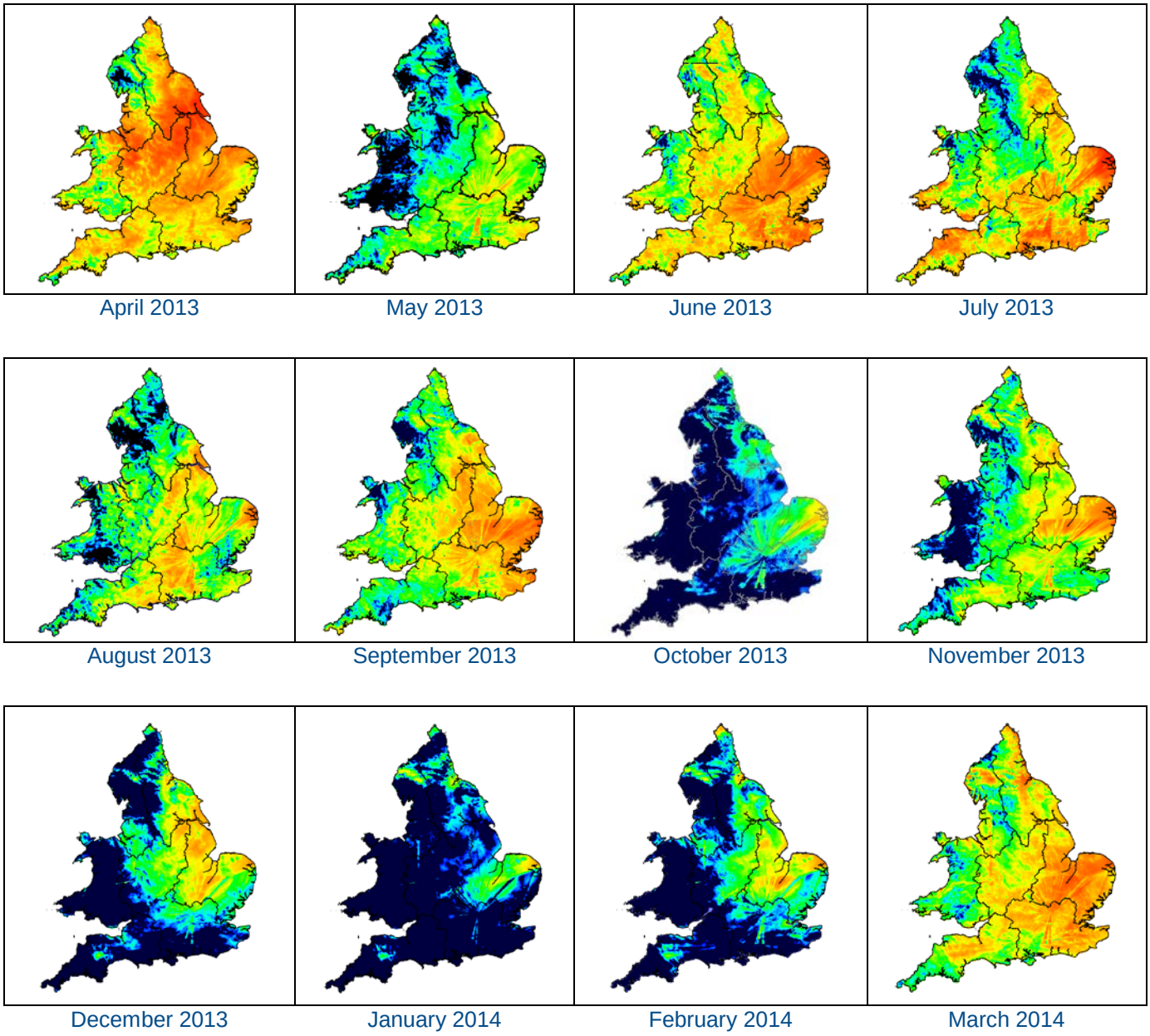
Probabilistic ensemble projections for groundwater levels in key aquifers [3]
September 2014: Nearly three quarters of modelled sites have a greater than expected chance of *above normal* or higher groundwater levels for the time of year. A third of the sites have a greater than expected chance of *normal* levels. Only three sites have a greater than expected chance of *below normal* levels for the time of year (see Figure 6.7).
March 2015: A third of the modelled sites have a greater than expected chance of levels being *normal* for the time of year. Over two thirds of the modelled sites have a greater than expected chance of *exceptionally high* groundwater levels for the time of year. Nearly a fifth of the modelled sites have a greater than expected chance of *exceptionally low* groundwater levels by the end of March 2015 (see Figure 6.8).

Authors: Karen James and Tom Schnetler (Hydrology – Water Resources Technical Services)

From April 2014 we are implementing a new two tier structure at a national and area level across the organisation. Over the period of implementation we will be making changes to how we report the water situation across the organisation. We will continue to report the water situation at a Regional level and using Regional boundaries until we fully complete these changes.

[3] Information produced by the Water Situation Forward Look group lead by Environment Agency in partnership with the Centre for Ecology and Hydrology, British Geological Survey, Met Office.

Rainfall



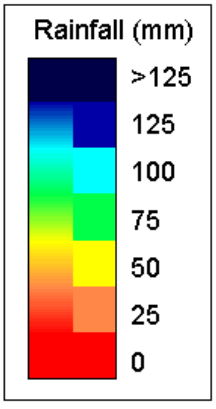


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2013). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

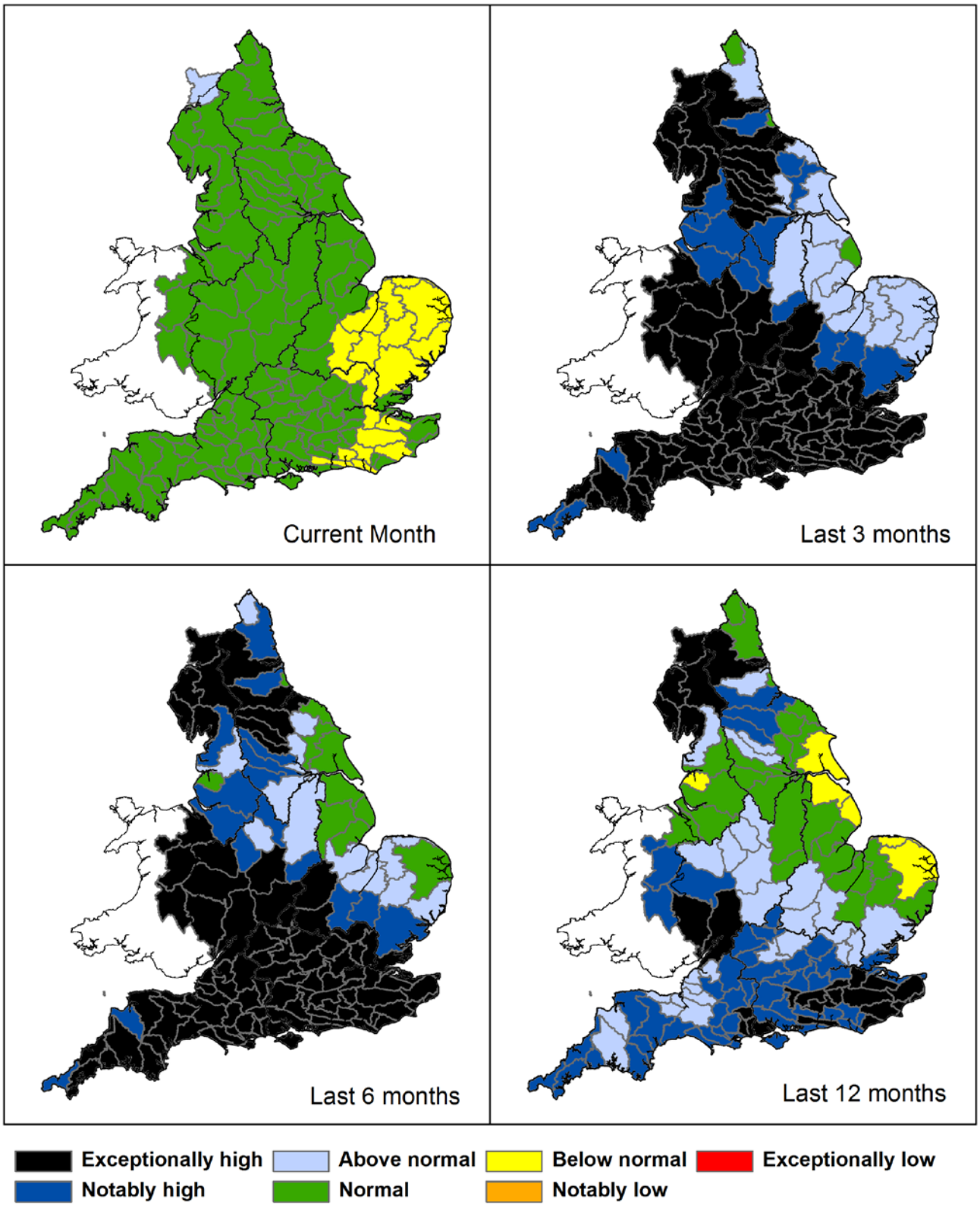


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 March), the last three months, the last six months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) 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.

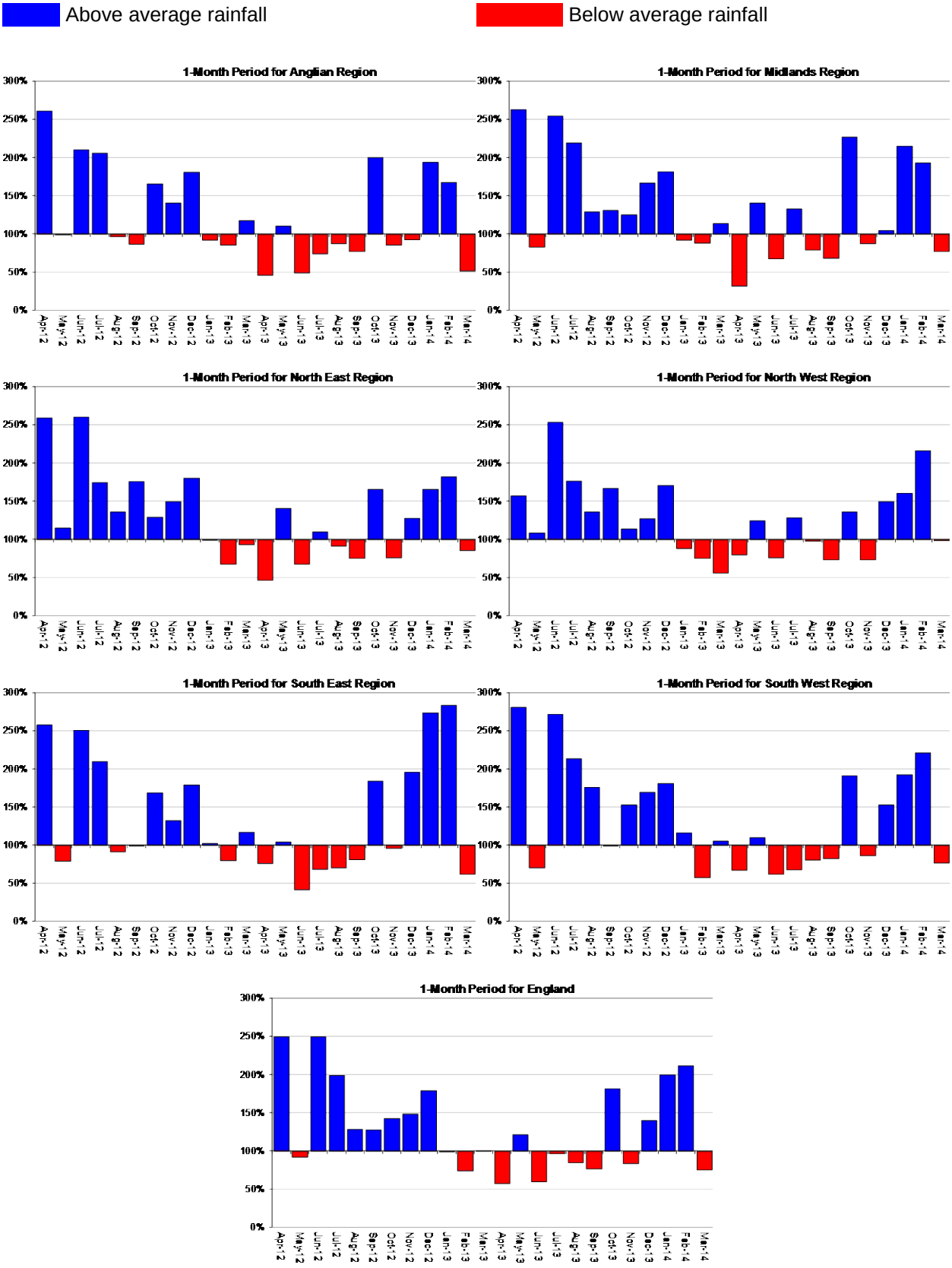


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each Environment Agency Region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2014).

Soil moisture deficit

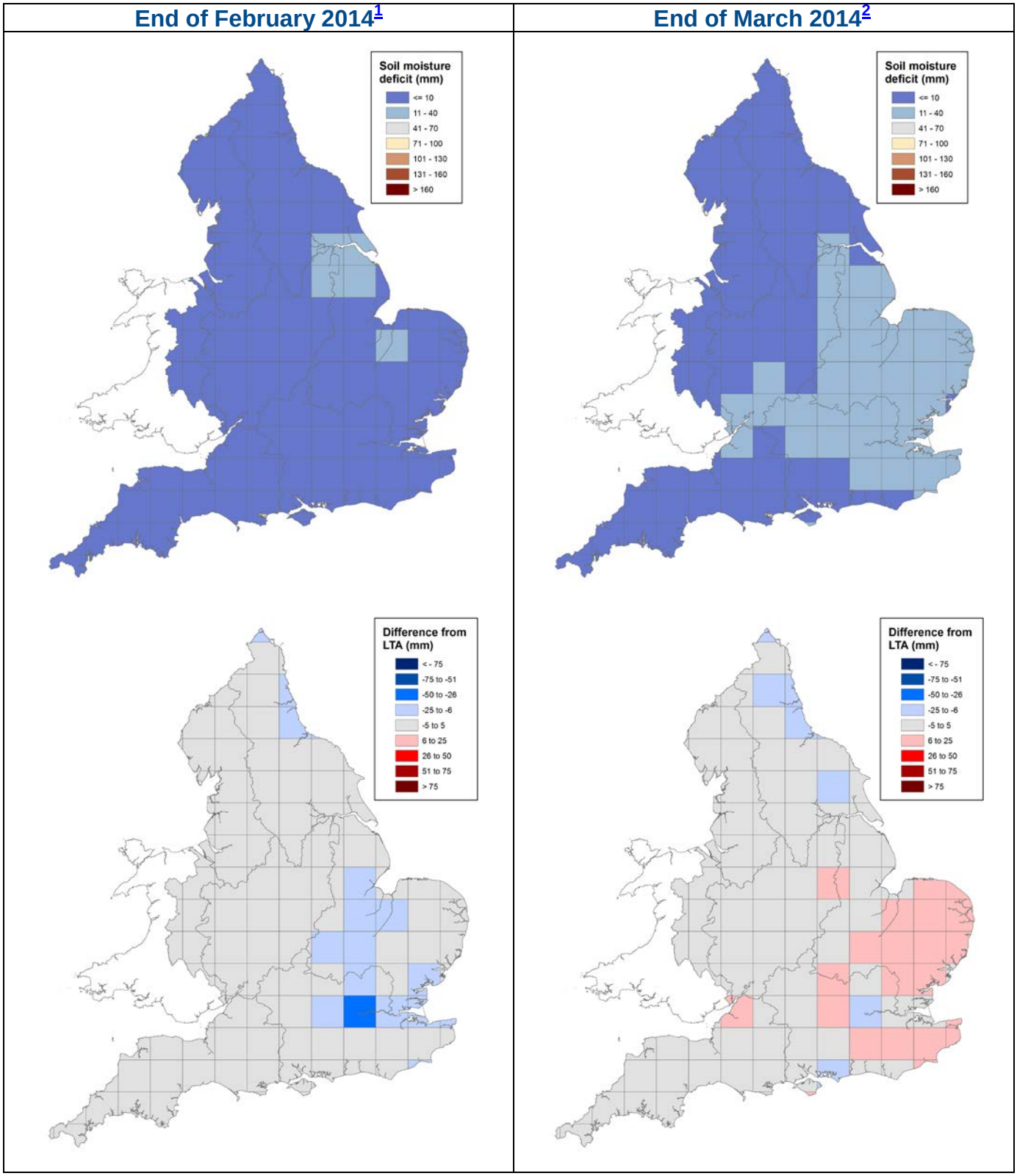


Figure 2.1: Soil moisture deficits for weeks ending 26 February 2014 [1] (left panel) and 01 April 2014 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2014). Crown copyright. All rights reserved. Environment Agency, 100026380, 2014

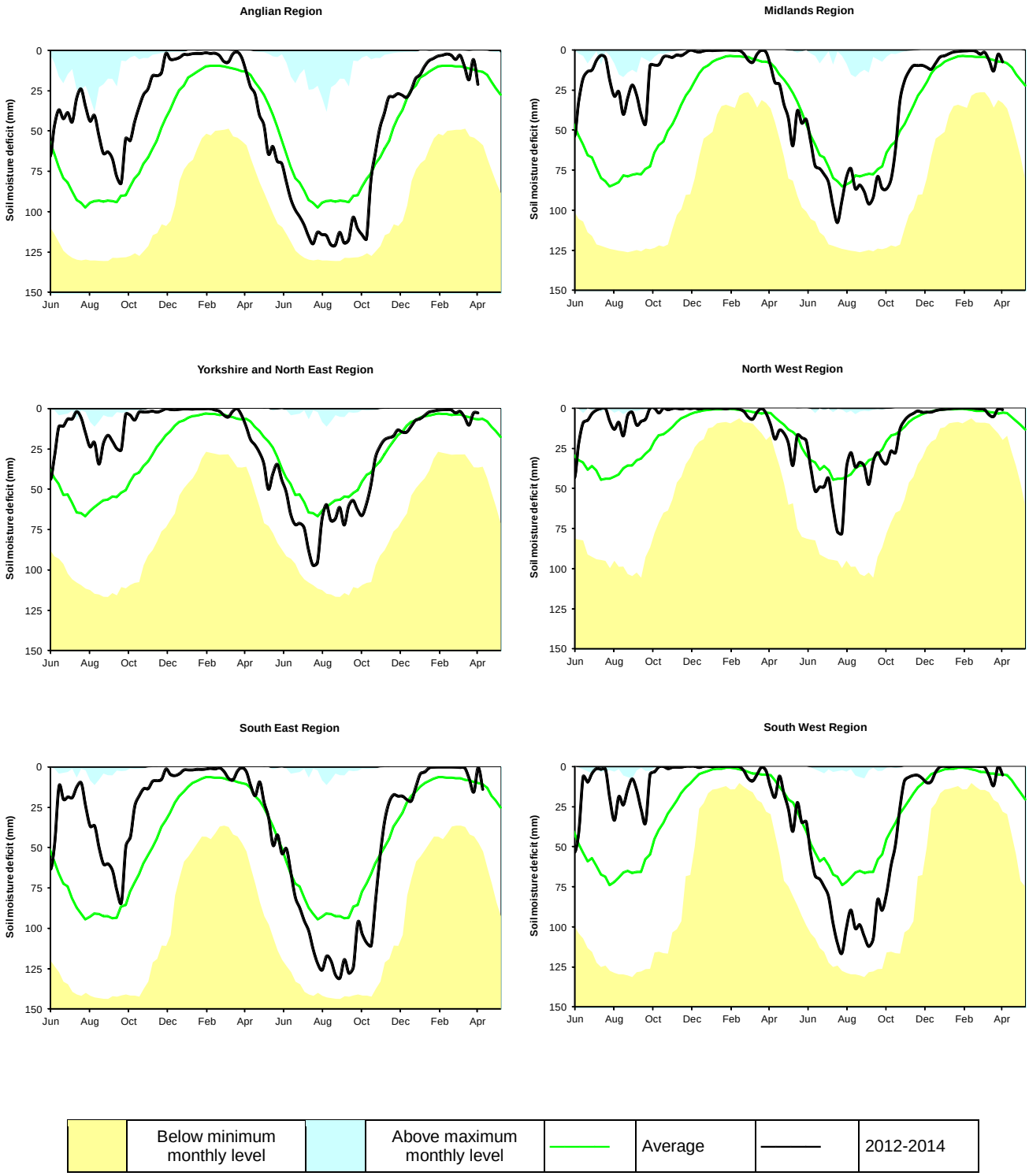
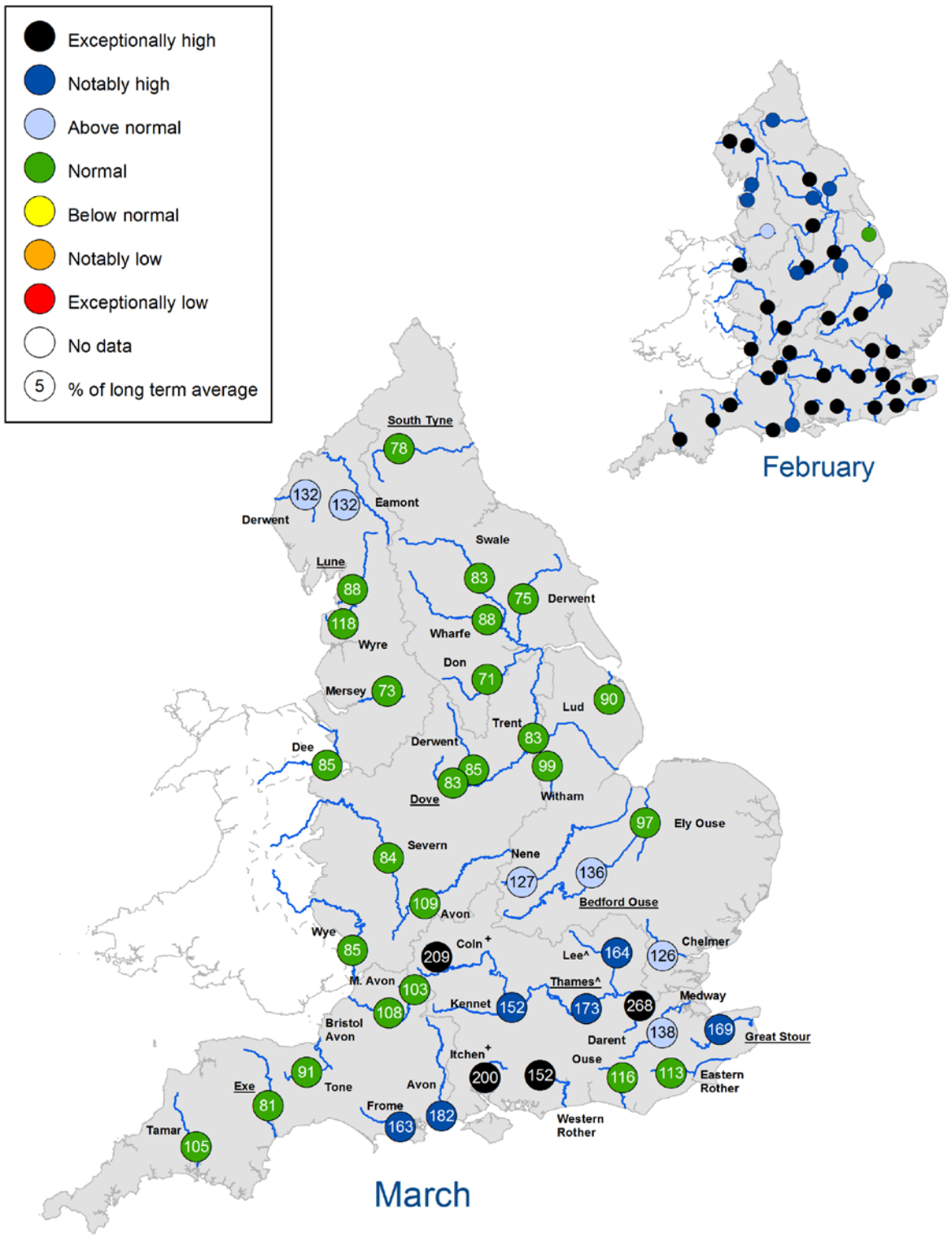


Figure 2.2: Latest soil moisture deficits for all Environment Agency Regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2014).

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 February 2014 and March 2014, 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, 2014.

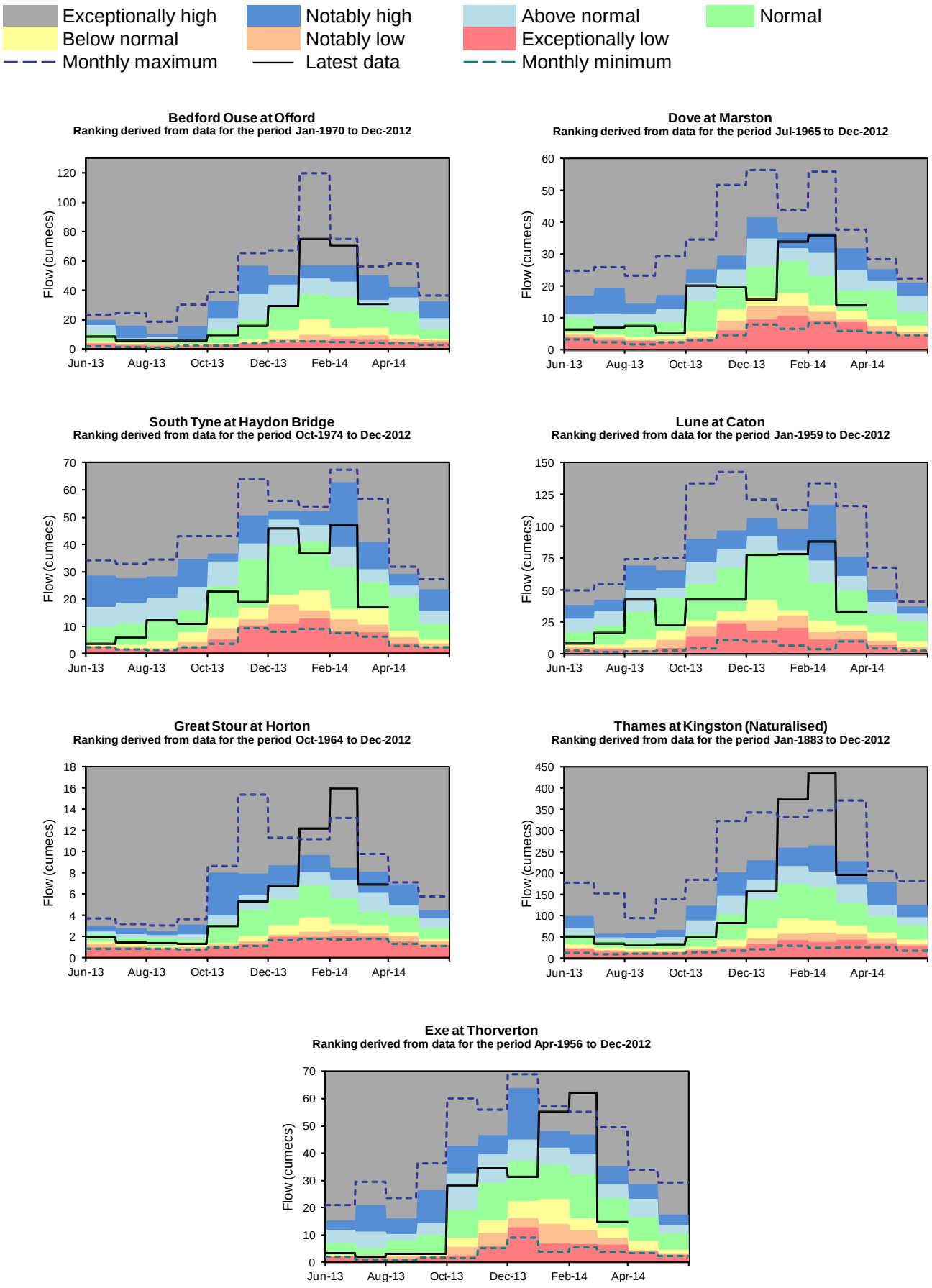
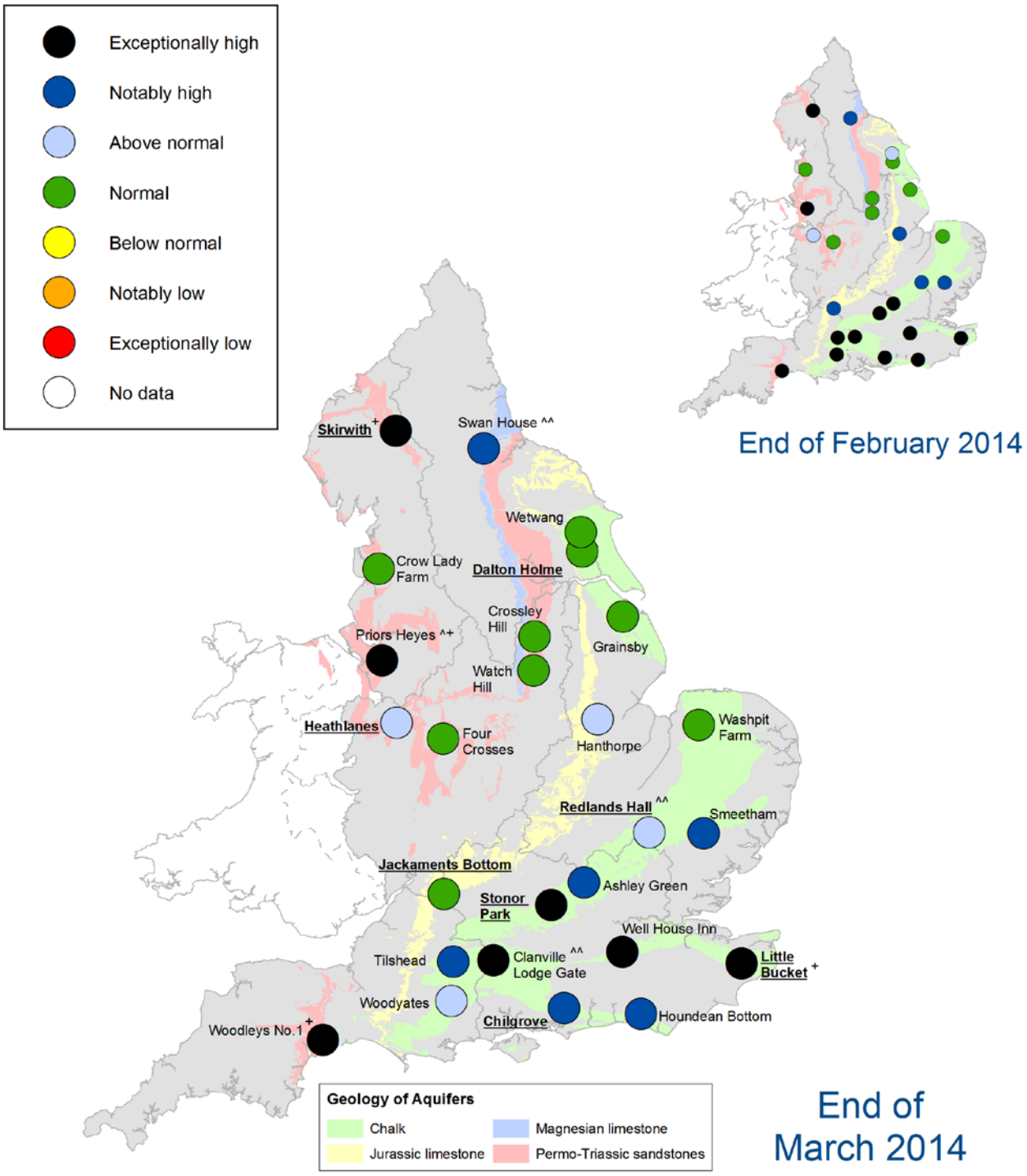


Figure 3.2: Index river flow sites for each Environment Agency Region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 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 February 2014 and March 2014, 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. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

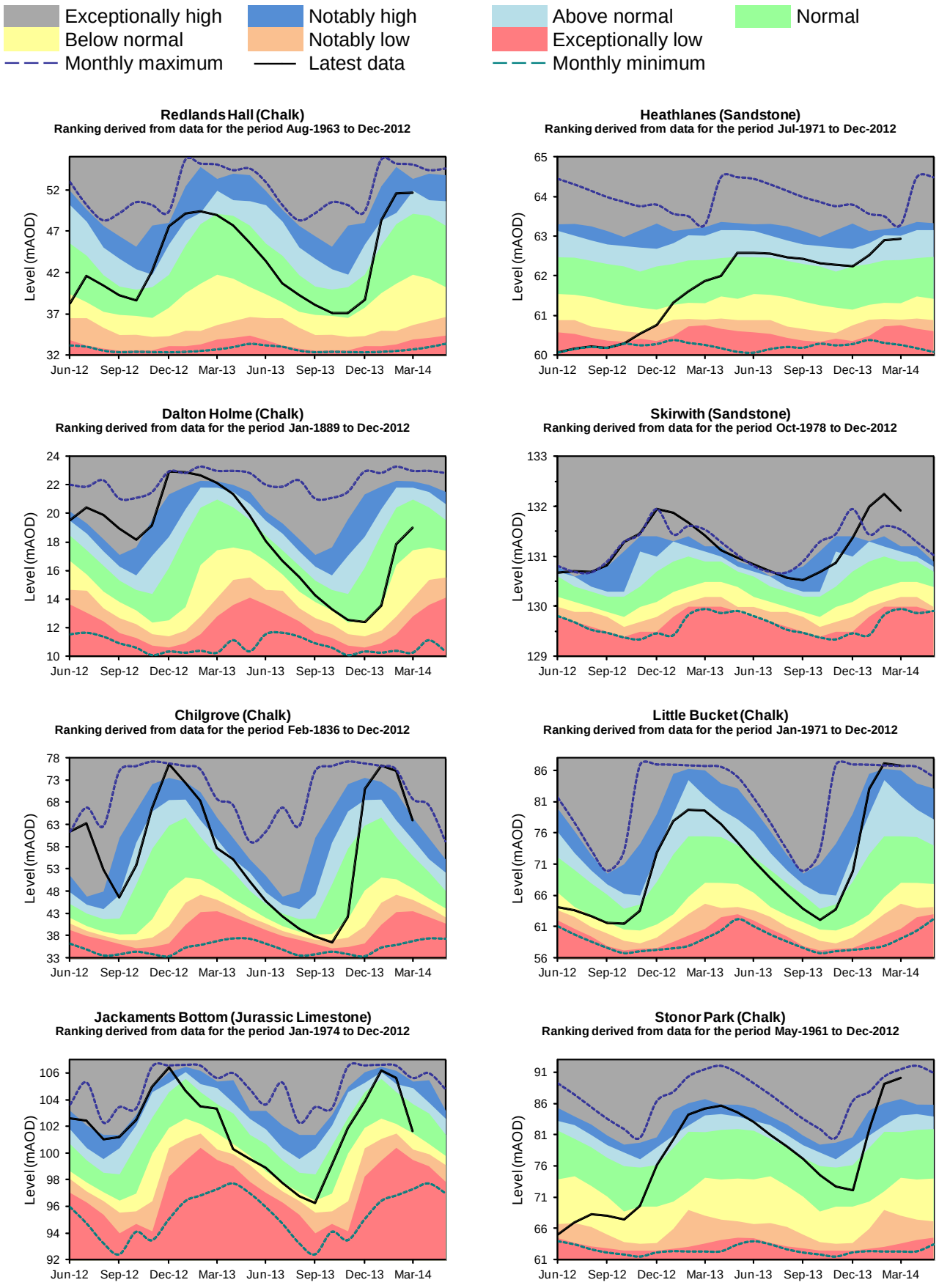
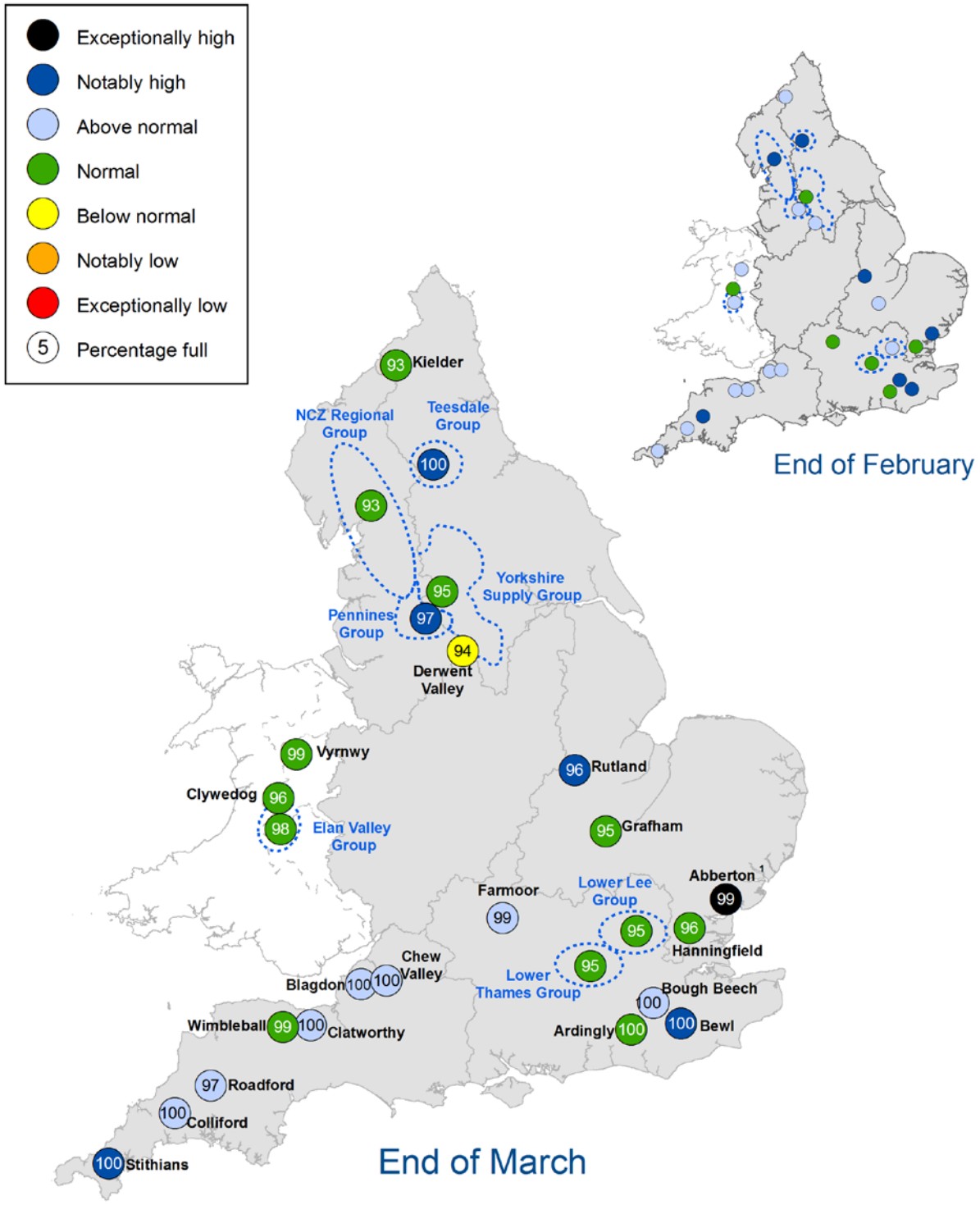


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2014).

Reservoir storage



1. Engineering work at Abberton Reservoir in Anglian Region to increase capacity has been completed.
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to our Midlands and North West regions

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of February 2014 and March 2014 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. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

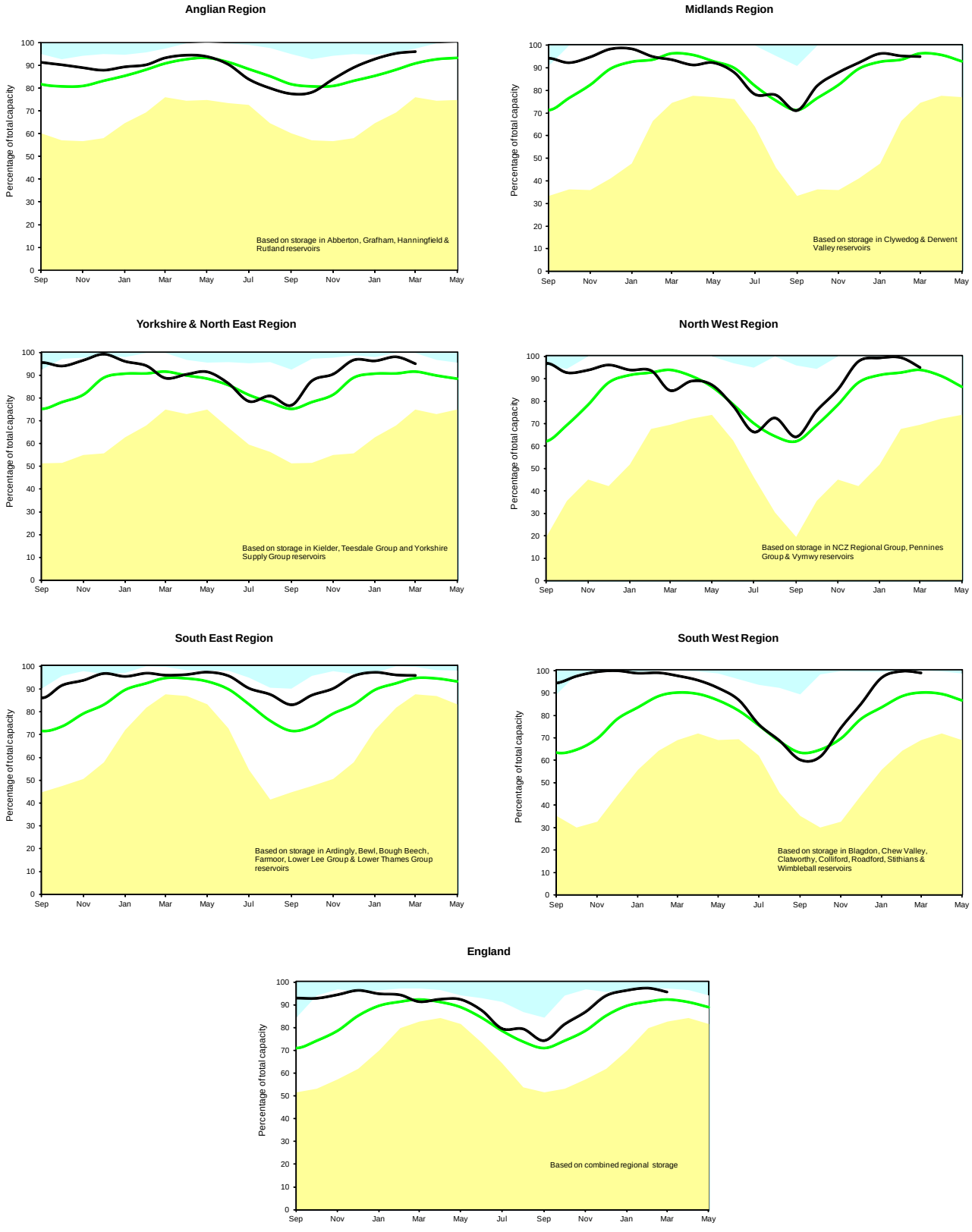


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

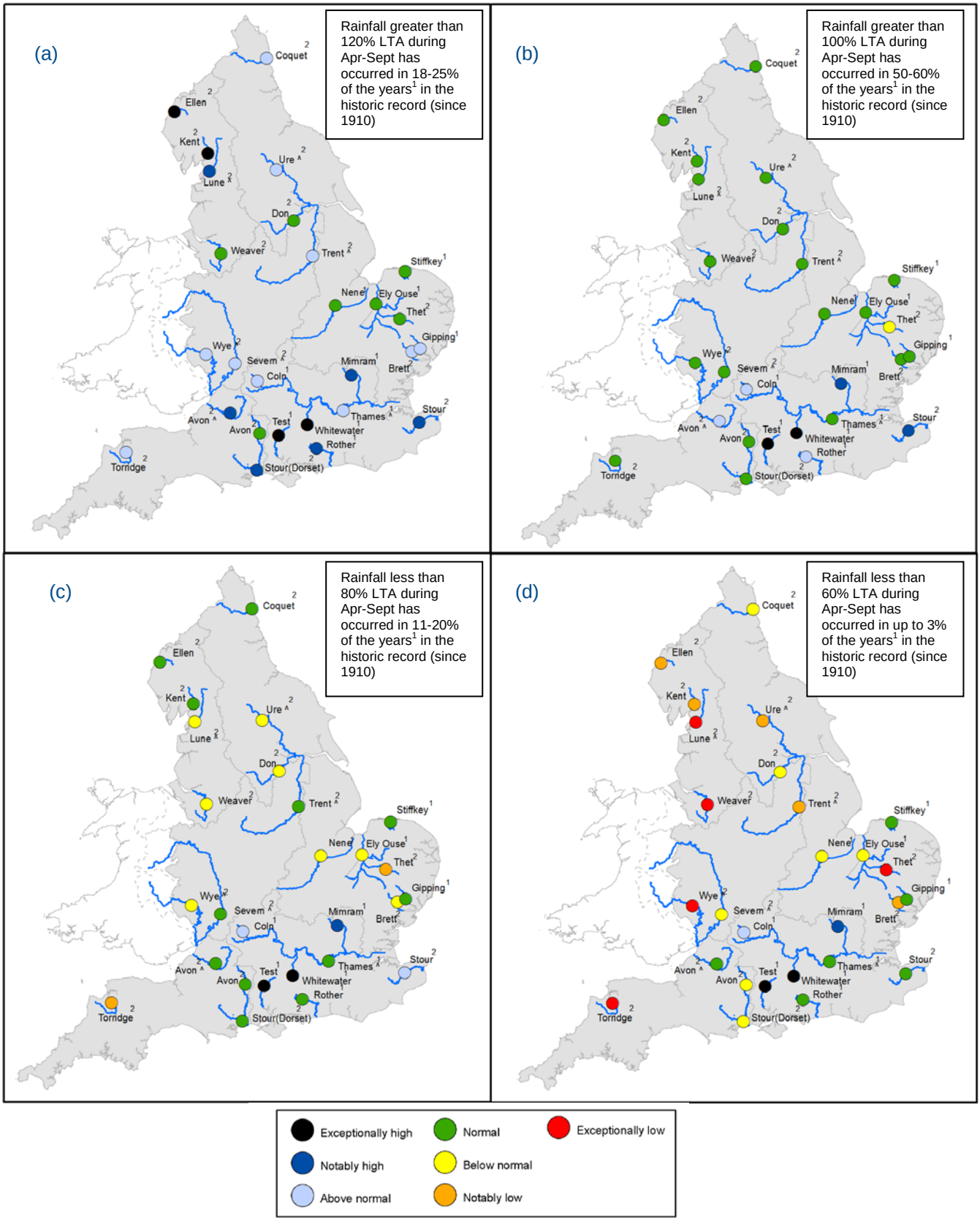
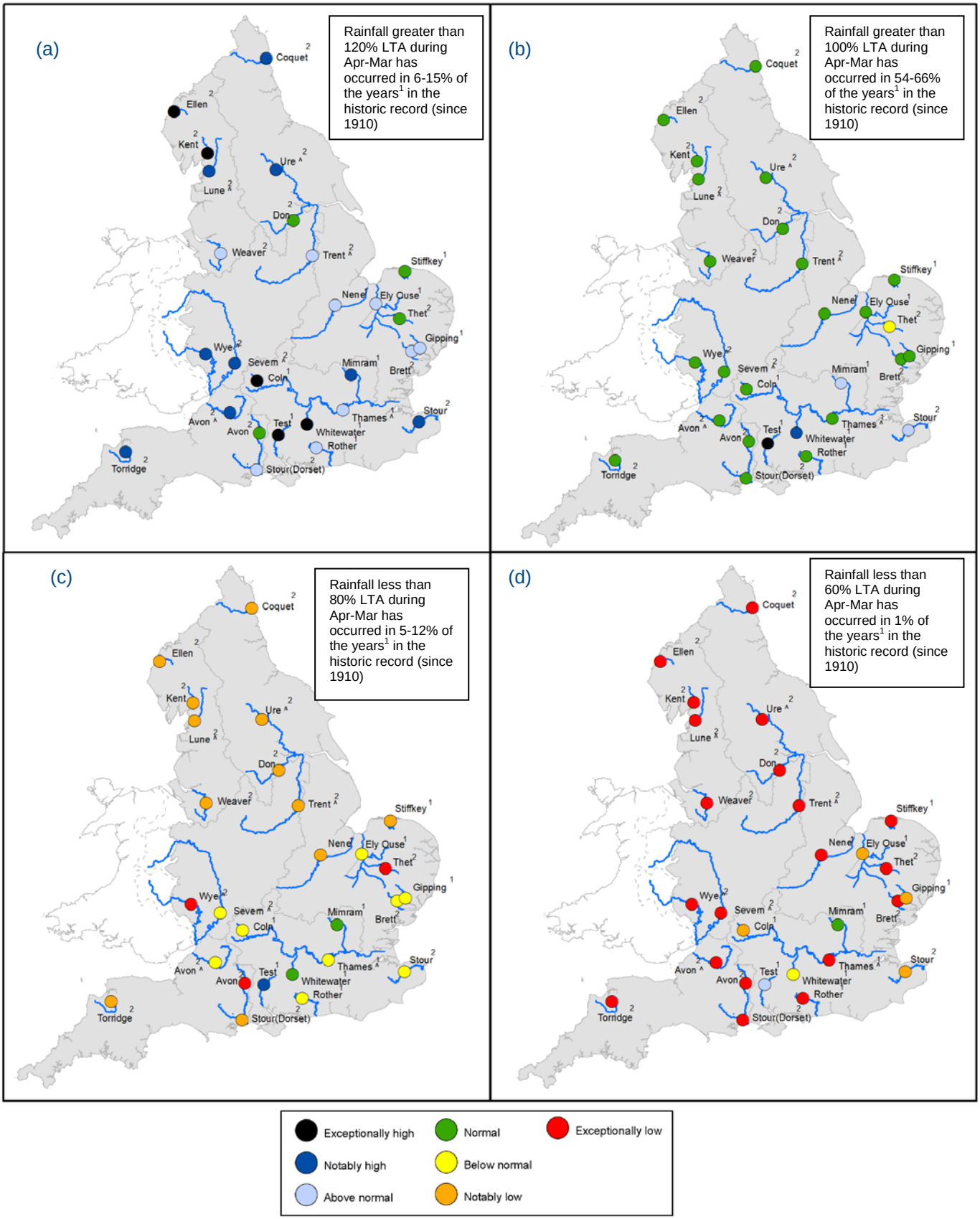


Figure 6.1: Projected river flows at key indicator sites up until the end of September 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2014 and September 2014 (Source: Centre for Ecology and Hydrology, Environment Agency)

[1] Projections for these sites are produced by the Environment Agency
[2] Projections for these sites are produced by CEH,
[3] This range of probabilities is a regional analysis
^ *"Naturalised" flows are projected for these sites*



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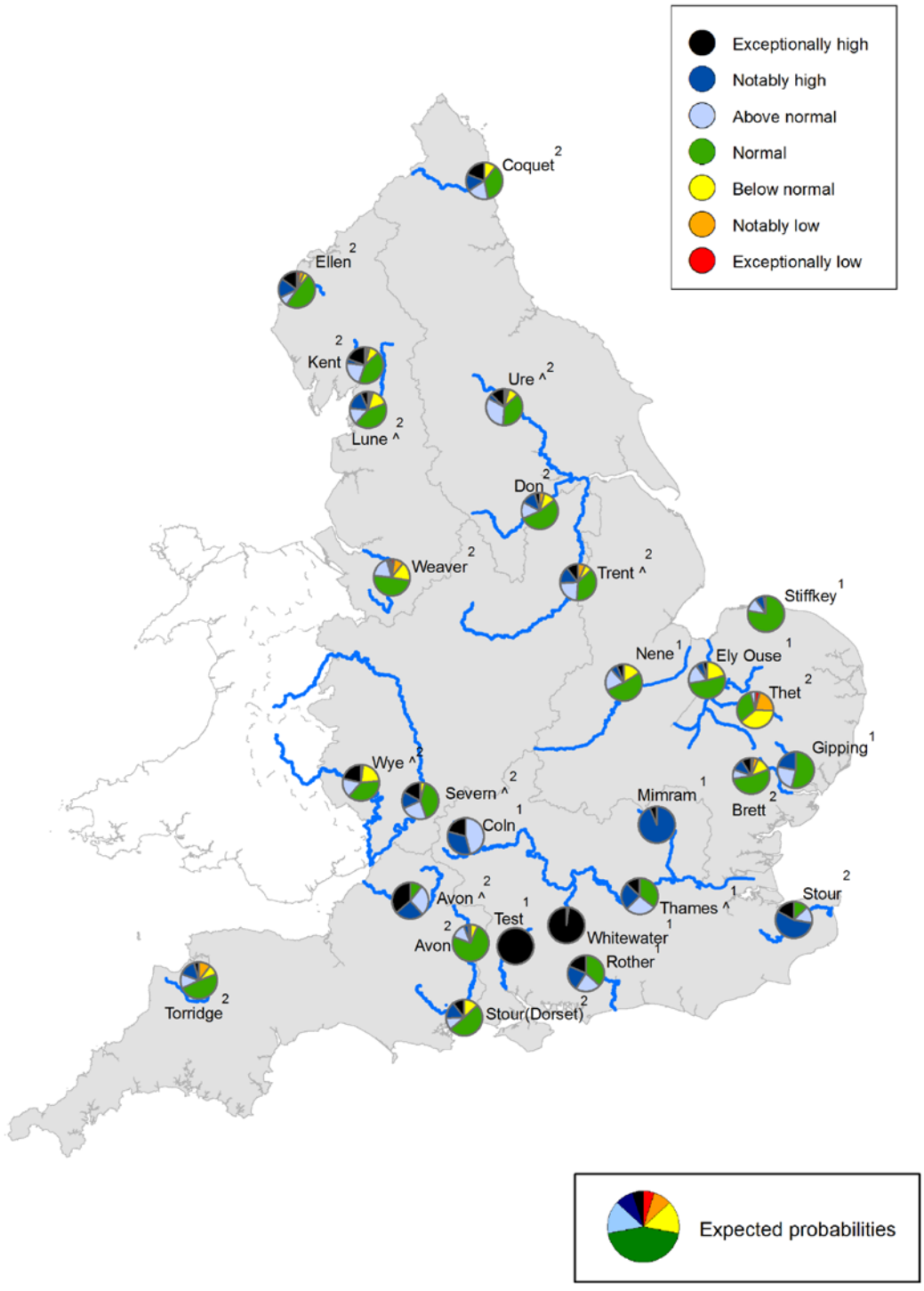

Figure 6.3: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2014. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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.

^ *"Naturalised" flows are projected for these sites'*

[1]*Projections for these sites are produced by the Environment Agency,*[2] *Projections for these sites are produced by CEH*

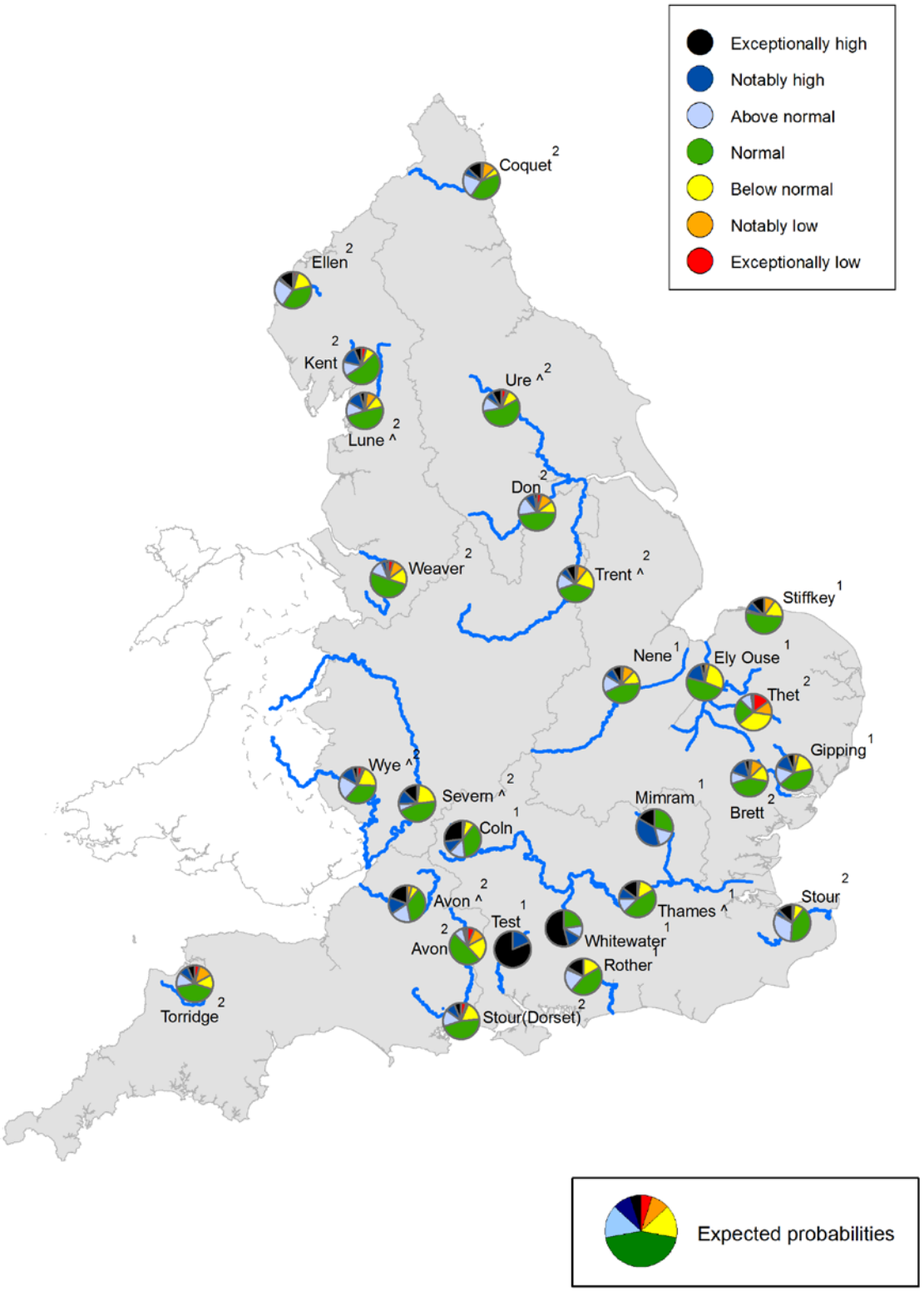

Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of March 2015. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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.

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Forward look - groundwater

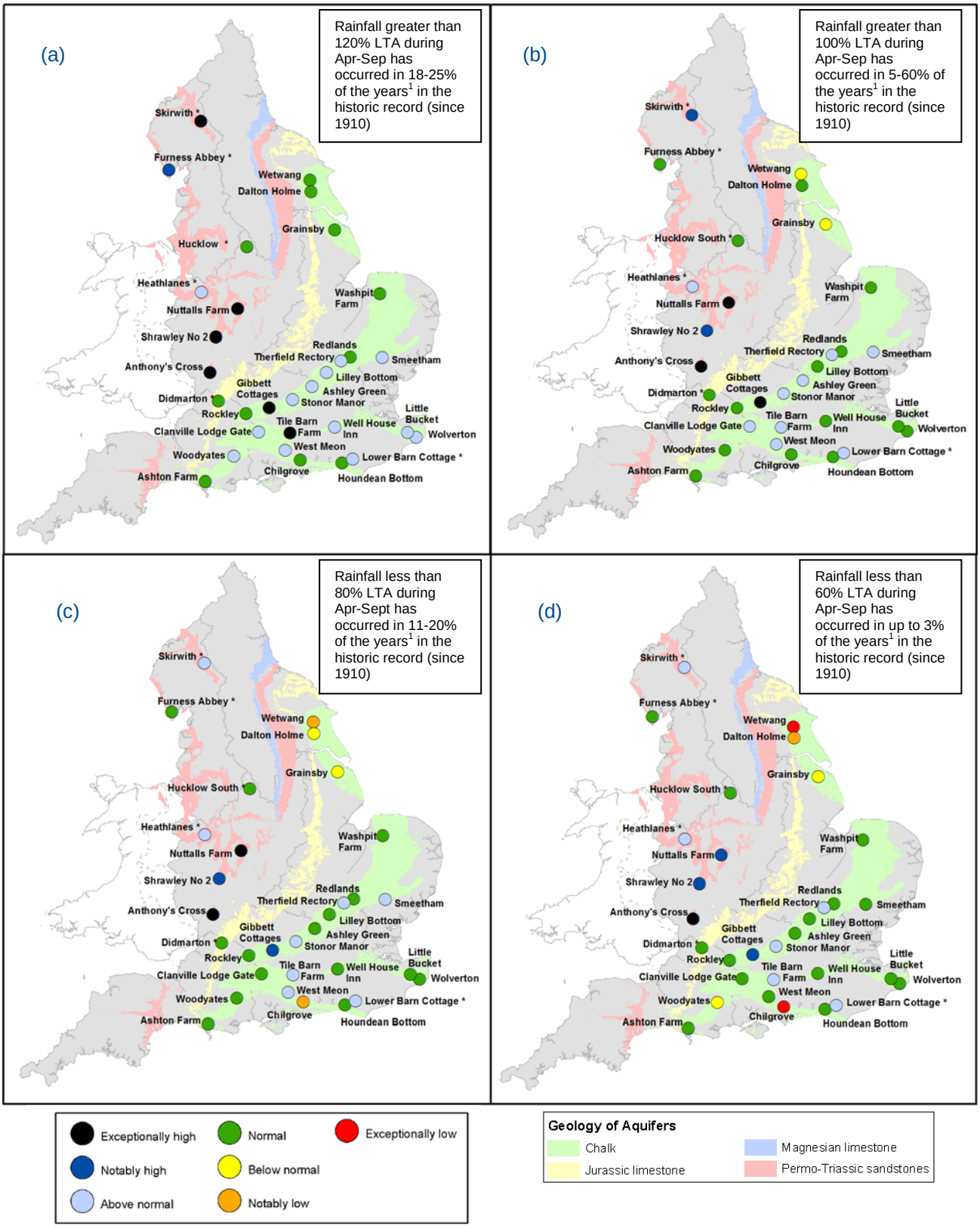

Figure 6.5: Projected groundwater levels at key indicator sites at the end of September 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2014 and September 2014 (Source: Environment Agency) Geological map reproduced with kind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

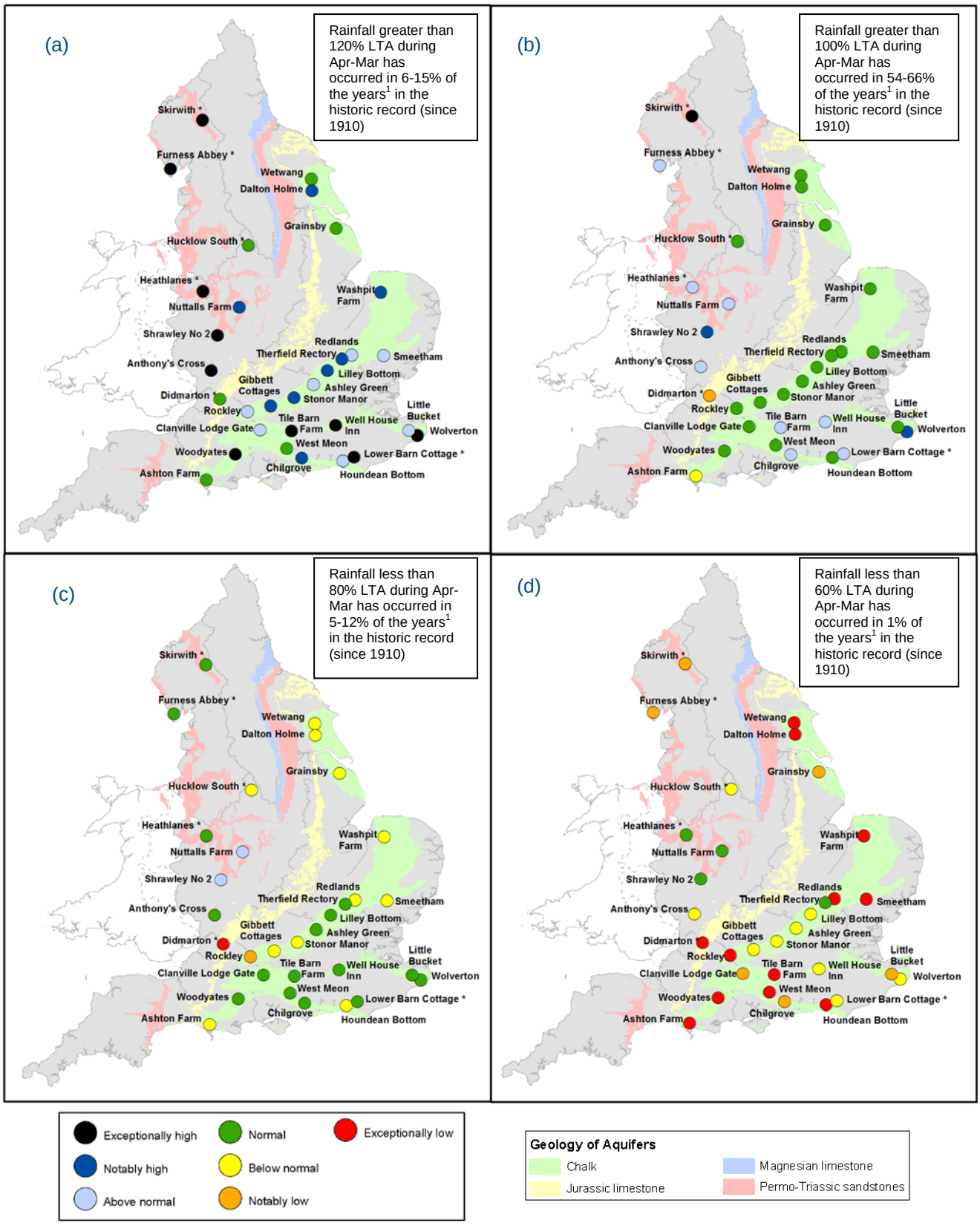

Figure 6.6: Projected groundwater levels at key indicator sites at the end of March 2015. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2014 and March 2015 (Source: Environment Agency) Geological map reproduced with kind permission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

* Projections for these sites are produced by BGS

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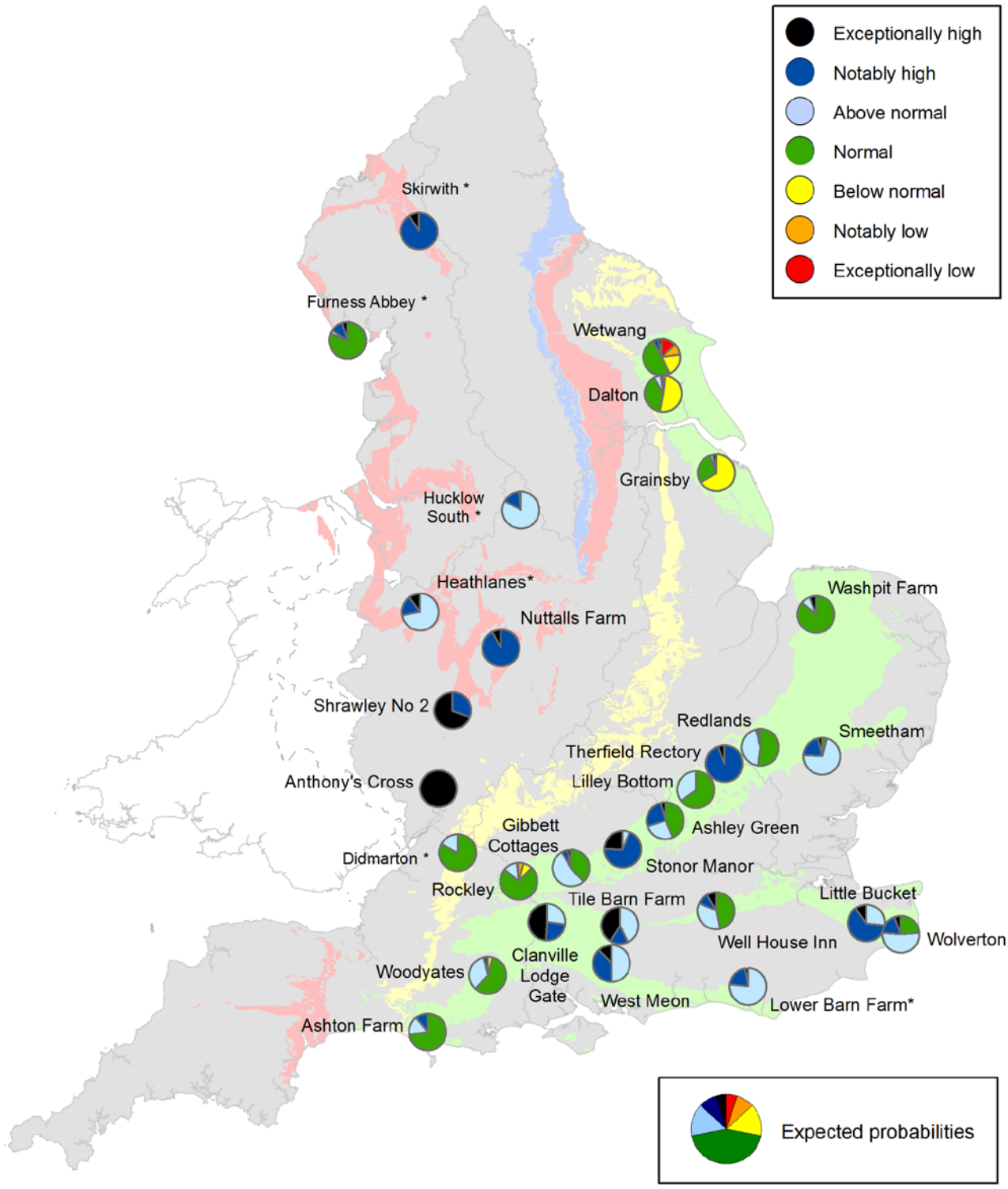
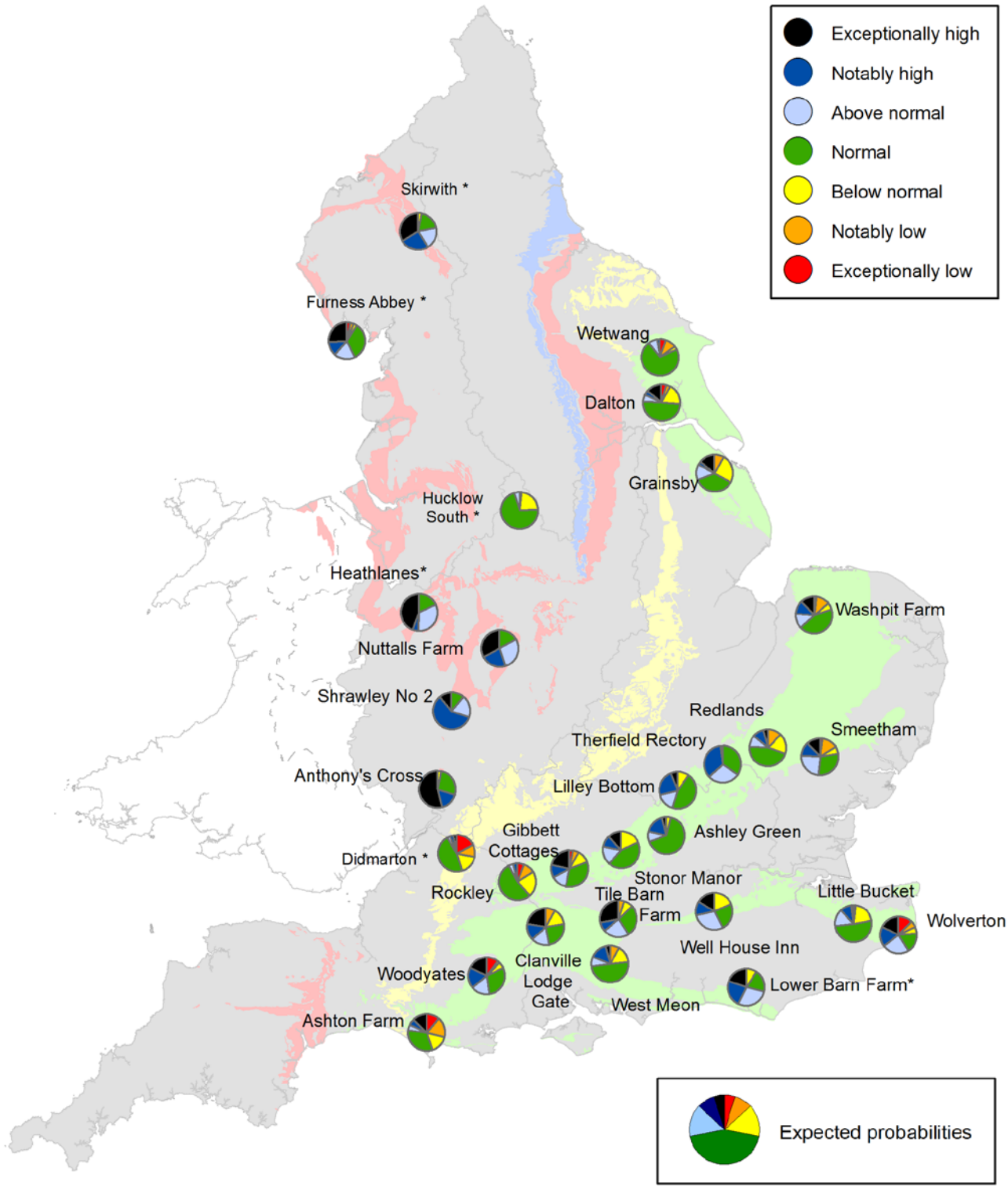


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

Figure 6.7: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of September 2014. 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 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

Figure 7.1: Environment Agency Region Location Map (see note on page 3)

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).
Effective rainfall	The rainfall available to percolate into the soil or produce river flow. Expressed in depth of water (mm).
Groundwater	The water found in an aquifer
Recharge	The process of increasing the water stored in the saturated zone of an aquifer. Expressed in depth of water (mm).
Reservoir live capacity	The reservoir capacity normally usable for storage to meet established reservoir operating requirements. It is the total capacity less that not available because of operating agreements or physical restrictions. Only under abnormal conditions, such as a severe water shortage might this additional water be extracted.
Soil moisture deficit (SMD)	The difference between the amount of water actually in the soil and the amount of water that 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

Units

cumecs	Cubic metres per second ($m^3 s^{-1}$)
mAOD	Metres Above Ordnance Datum (mean sea level at Newlyn Cornwall).