Monthly water situation report

England

Summary – November 2013

In contrast to October, November has seen a return to below average monthly rainfall, with England receiving 84% of the November long term average (LTA). Rainfall totals were classed as *normal* for the time of year except in some catchments along the Irish and North Sea coasts where they were *below normal* or lower. Soil moisture deficits (SMDs) decreased in all areas during November. Monthly mean river flows for November were *normal* for the time of year in most areas and *above normal* in parts of southern and southwest England. Groundwater levels continued to decline in many areas, but are *normal* or higher at half of our indicator sites. Overall reservoir stocks increased during November with storage in England as a whole at 87% of total capacity at the end of the month.

Rainfall

November rainfall totals were highest in our South West Region at 90 mm. In our remaining regions, totals ranged from 49 mm (Anglian Region) to 88 mm (North West Region) (Figure 1.1). Locally, the highest rainfall totals (more than 110 mm) fell in western areas of Cumbria, the southeast coast of Cornwall, north Devon and the southeast Kent coast. The lowest rainfall totals (less than 40 mm) fell in parts of East Yorkshire, Lincolnshire and Northamptonshire. The majority of the month's rainfall fell in the first two weeks of the month, with the latter part of the month being notably drier in the majority of our regions.

Rainfall totals for the whole of November were classed as *normal* or lower for the time of year in all hydrological areas across England. All hydrological areas in our Midlands, South East and South West Regions had rainfall totals that were classed as *normal* for the time of year. Rainfall totals for the majority of hydrological areas in our Anglian, Yorkshire and North East and North West Regions were also classed as *normal.* The exception to this is a number of hydrological areas lying on the east coast of England, in our Anglian and Yorkshire and North East Regions and half of the hydrological areas within our North West Region, which had *below normal* or *notably low* rainfall totals for November. Cumulative rainfall totals over the past three to twelve months were also classed as *normal* for the majority of hydrological areas across England (Figure 1.2).

Monthly rainfall totals as a percentage of the November long term average (LTA) were below average in all of our six regions, ranging from 73% in our North West Region to 96% in our South East Region (Figure 1.3). England as a whole received 84% of the LTA rainfall.

Soil moisture deficit

Soil moisture deficits (SMDs) decreased in all six of our regions during November 2013. At the end of November, SMDs ranged from less than 10 mm across much of northwest, central and southwest England, parts of southeast England and the Welsh borders, to between 41 and 70 mm in parts of East Yorkshire, Lincolnshire and Norfolk (Figure 2.1). The month end SMDs were 6-50 mm less than the LTA in around half of the MORECS squares reported on, covering much of central, eastern and southeast England, and parts of northwest and southwest England. SMDs were 6-25 mm greater than the LTA in just six MORECS grid squares covering parts of our Yorkshire and North East, North West and South East Regions (Figure 2.1).

At the beginning of November, SMDs ranged from 5 mm in our North West Region to 39 mm in our Anglian Region. During November, particularly in the early part of the month, SMDs decreased in all of our Regions in response to the wet weather. During the second half of November, SMDs either stabilised or began to increase in our Midlands, North West, South East and South West Regions following a period of relatively little rain. At the end of November, SMDs were between 1 and 15 mm less than the LTA in all our regions (Figure 2.2).

River flows

Compared with October, monthly mean river flows for November increased at four fifths of our reported indicator sites across England. The monthly mean flows expressed as a percentage of the LTA were however lower in November than they were in October at two thirds of our reported indicator sites and significantly lower than they were in November 2012 (Figure 3.1).

Monthly mean river flows for November were *normal* or higher for the time of year at four fifths of our indicator sites across England. These included all sites in our Midlands, North West and Yorkshire and North East Regions and a majority of indicator sites in our other regions. Indicator sites in Kent were *above normal* or higher for the time of year, with the River Darent being classed as *notably high* for the time of year. In comparison, monthly mean flows in the River Lud at Louth Weir and the River Frome at East Stoke were *below normal* for the time of year (Figure 3.1).

River flows at the regional index sites in almost all of our regions were *normal* for the time of year. One of the regional index sites in our South East Region and the regional index site in our South West Region were classed as *above normal* was for the time of year (Figure 3.2).

Groundwater levels

During November, groundwater levels continued to decline at approximately half of our sites reported on in England. At the other half, levels are now rising in the more responsive chalk and Jurassic Limestone aquifers in our Anglian, South East and South West Regions. At the end of November, groundwater levels were *normal* or higher for the time of year at all but two of the sites reported on. Groundwater levels were *below normal* for the time of year at Wetwang in the Hull and East Riding chalk aquifer in our Yorkshire and North East Region, and at Tilshead in the Upper Hampshire Avon chalk in our South West Region (Figures 4.1 and 4.2). Around three quarters of the groundwater sites reported on have *normal* levels for the time of year.

Groundwater levels continued to be classed as *exceptionally high* in relation to historic values for this time of year at Priors Heyes (West Cheshire Sandstone) in our North West Region because the aquifer is recovering from the effects of historic abstraction.

Reservoir storage

During November, reservoir stocks increased at more than 80% of the reported reservoirs. Increases were greater than 10% of full capacity at nearly half of the reservoirs or reservoir groups; notably in our South East Region Ardingly and Bough Beech stocks increased by more than 20% of full capacity, and in our South West Region, Clatworthy stocks increased by more than 30% of full capacity. Reservoir stocks are *normal* or higher for the time of year at all of the reported sites (Figure 5.1).

At a regional scale, reservoir stocks increased by between 3% and 13% of full capacity across all our Regions. At the end of November, regional reservoir stocks were lowest in our South West Region at 75% of total capacity and highest in our Yorkshire and North East Region at 91% of total capacity. Overall reservoir storage for England increased during November to 87% of total capacity (Figure 5.2).

Forward look

December is likely to be relatively settled with average to below average temperatures for most of England. Further ahead, for the period December to February inclusive, colder and drier than average conditions are favoured. This is due to the expected negative pattern of the North Atlantic Oscillation, which generally brings anticyclone conditions to the UK, typified by cold, dry weather in the winter[1].

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

March 2014: With average (100% of the LTA) rainfall between December 2013 and the end of March 2014, river flows are likely to be *normal* or higher at all except one of our modelled sites. With 120% of the LTA rainfall, river flows are likely to be *above normal* or higher at more than one third of the modelled sites. With 80% of the LTA rainfall river flows are likely to be *below normal* or lower at more than two thirds of the modelled sites (see Figure 6.1).

September 2014: With average rainfall between December 2013 and the end of September 2014, river flows are likely to be *normal* at all except four of our modelled sites. With above average rainfall (120% of the LTA), flows are likely to be *above normal* or higher at more than half of our modelled sites. With below average rainfall (80% of the LTA), river flows are likely to be *below normal* or lower at over three quarters of the modelled sites (see Figure 6.2).

[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.

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

March 2014: At more than half of the modelled sites, there is a greater than expected chance of *normal* flows at the end of March 2014. There is also a greater than expected chance of *below normal* flows at more than half of the modelled sites (see Figure 6.3).

September 2014: There is a greater than expected chance of *normal* flows at the end of September 2014 at more than half of the modelled sites (see Figure 6.4).

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

March 2014: With average rainfall (100% of the LTA) from December 2013 to March 2014, groundwater levels are likely to be *normal* for the time of year at more than half of the modelled sites. With above average rainfall (120% of the LTA) groundwater levels are likely to be *above normal* or higher at two thirds of the modelled sites. With 80% of the LTA rainfall, groundwater levels are likely to be *below normal* or lower for the time of year at a quarter of modelled sites (see Figure 6.5).

September 2014: With average rainfall (100% of the LTA) from August 2013 to March 2014, groundwater levels are likely to be *normal* at three quarters 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 more than a third of the modelled sites. With below average rainfall (80% of the LTA), groundwater levels are likely to be *normal* at half of our modelled sites (see Figure 6.6).

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

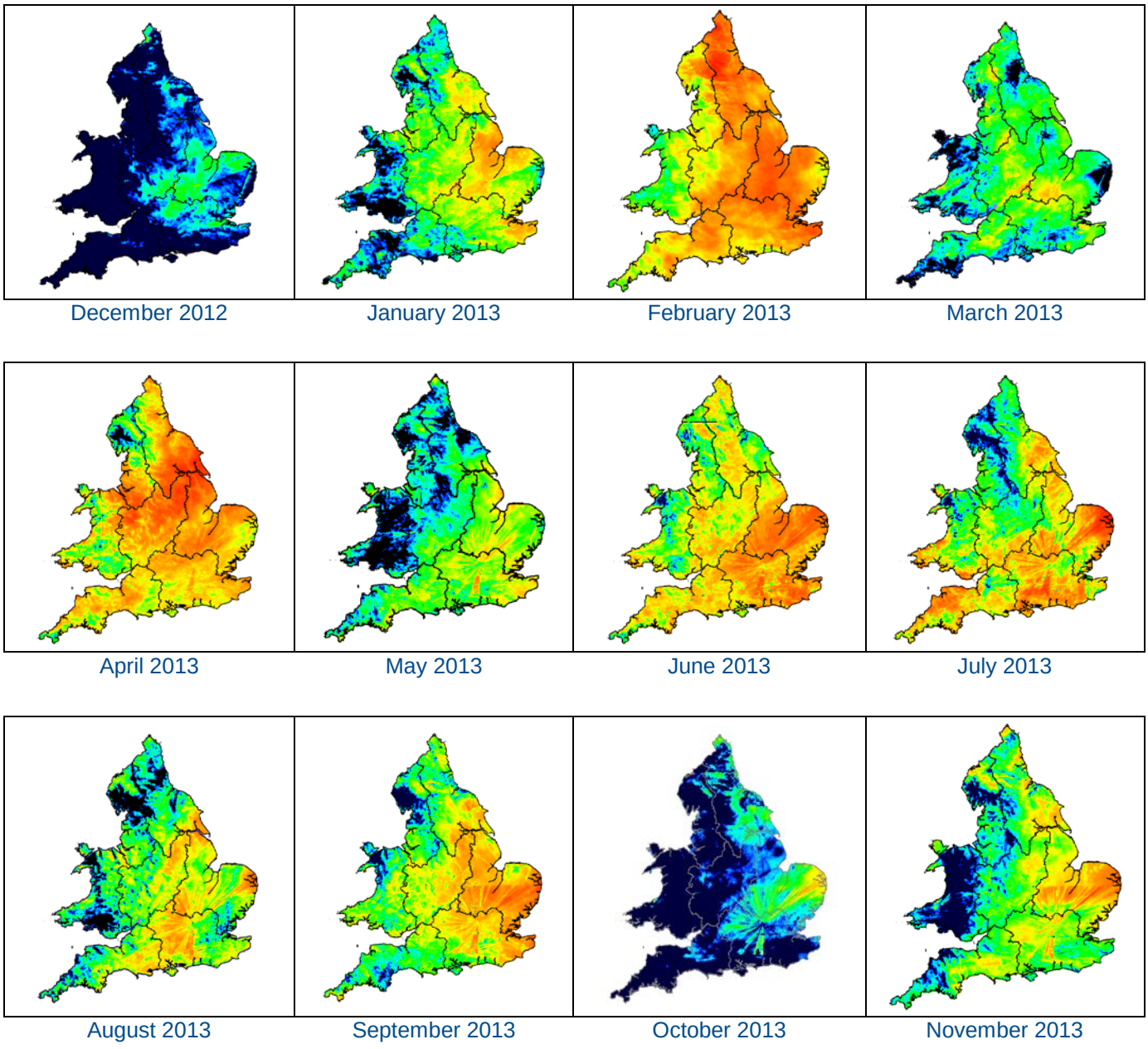
March 2014: The majority of the modelled sites have a greater than expected chance of *normal* groundwater levels at the end of March. The majority of sites have a lower than expected chance of *below normal* levels for the time of year (see Figure 6.7).

September 2014: Nearly two thirds of the modelled sites have a greater than expected chance of *normal* levels for the time of year. The majority of sites have a lower than expected chance of *below normal* levels for the time of year at the end of September (see Figure 6.8).

Authors: Hydrology Team – Water Resources Technical Services

[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



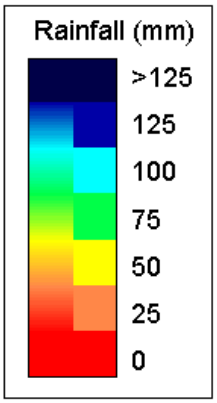


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2013). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2013.

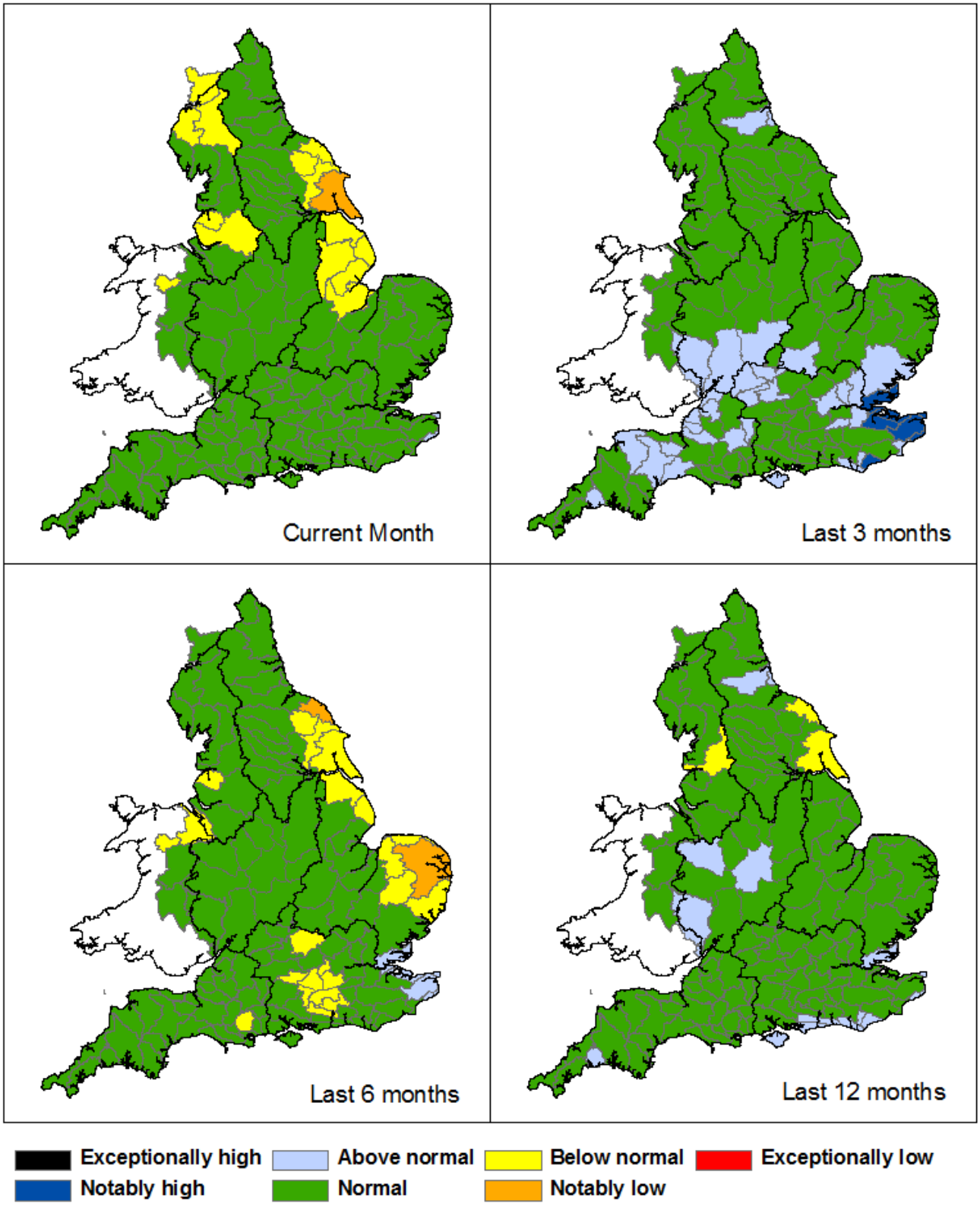


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30th November), the last three months, the last six months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2013).* Crown copyright. All rights reserved. Environment Agency, 100026380, 2013.

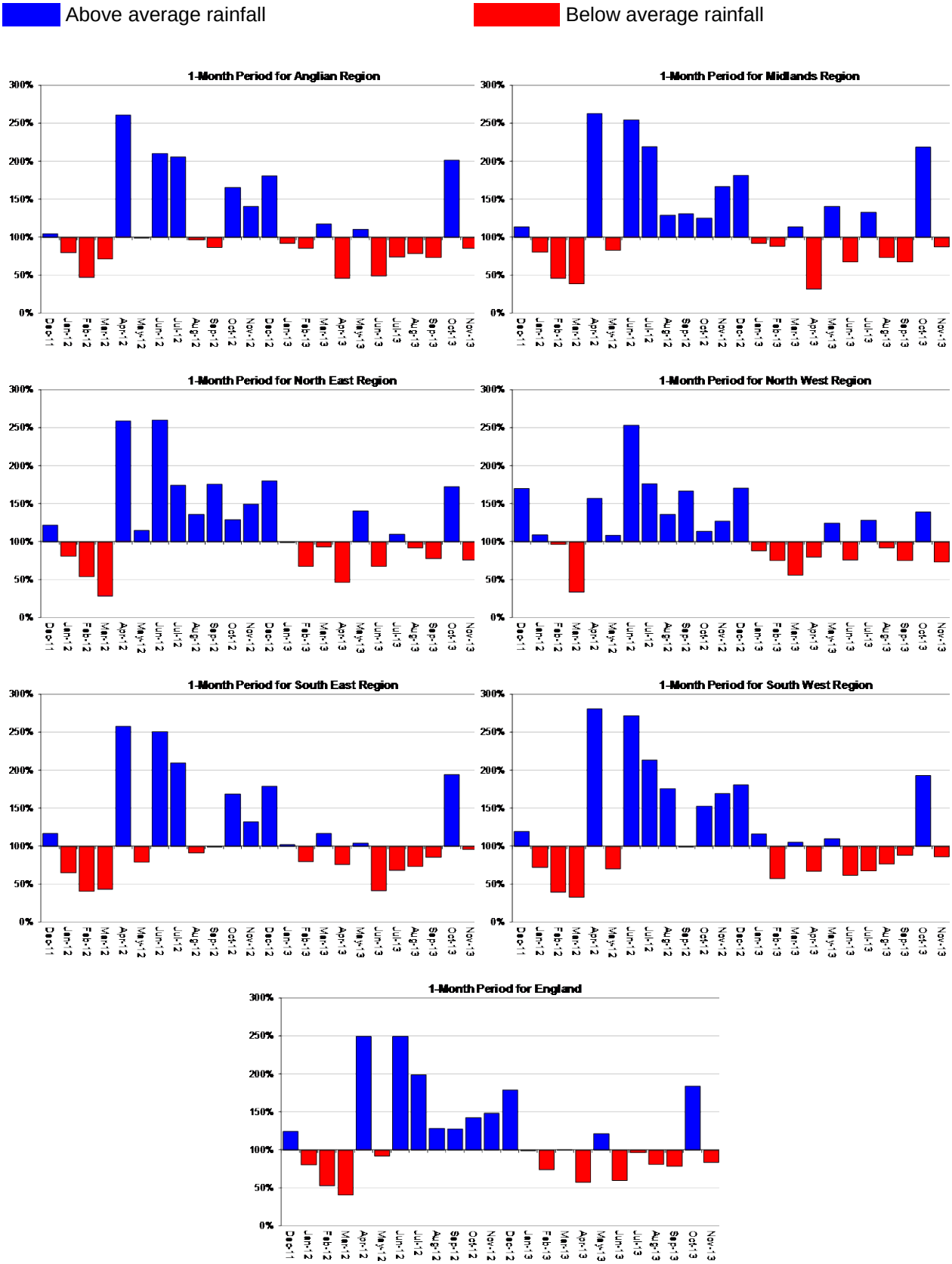


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each Environment Agency Region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2013).

Soil moisture deficit

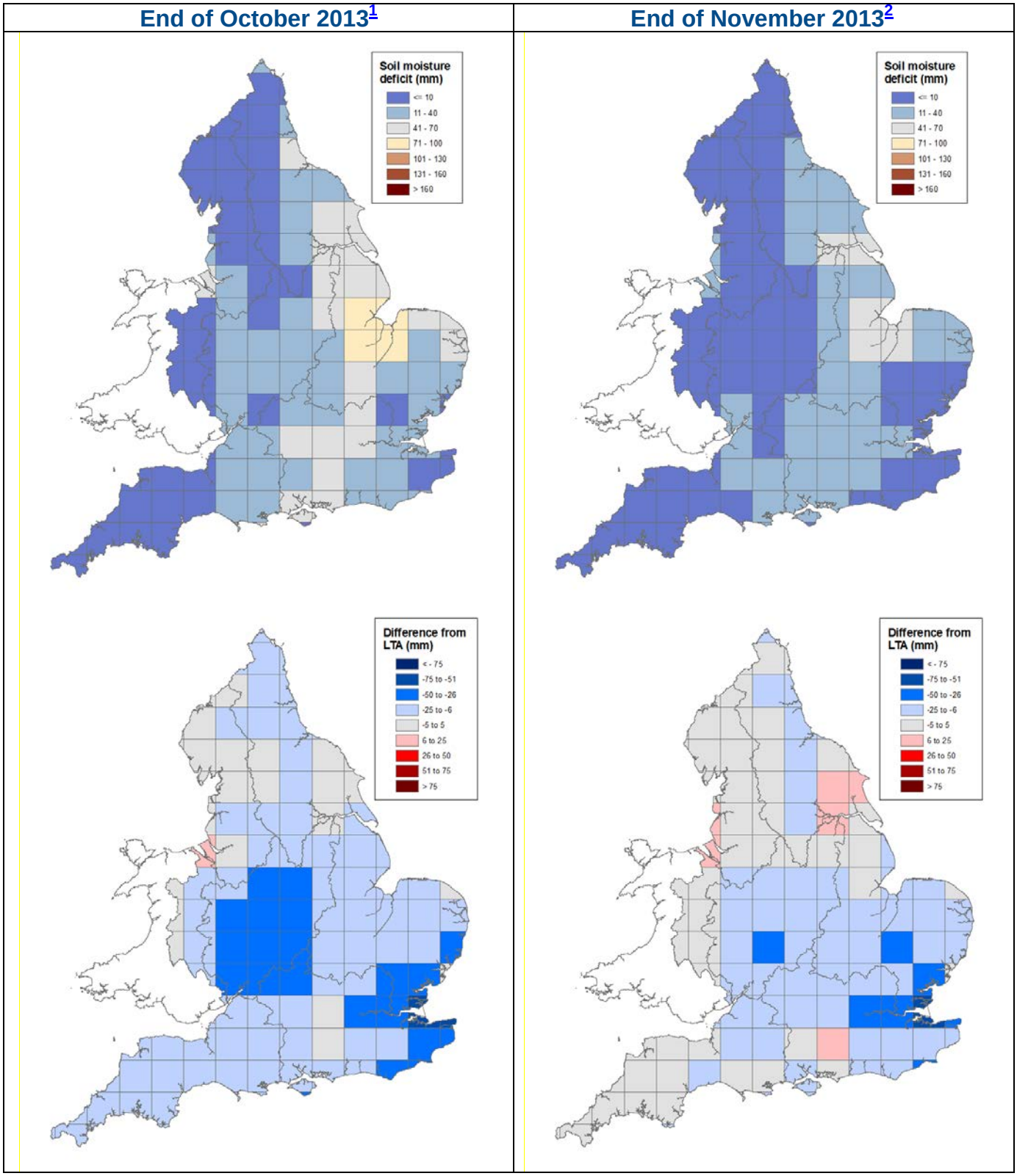


Figure 2.1: Soil moisture deficits for weeks ending 29 October 2013[1] (left panel) and 26 November 2013[2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2013). Crown copyright. All rights reserved. Environment Agency, 100026380, 2013

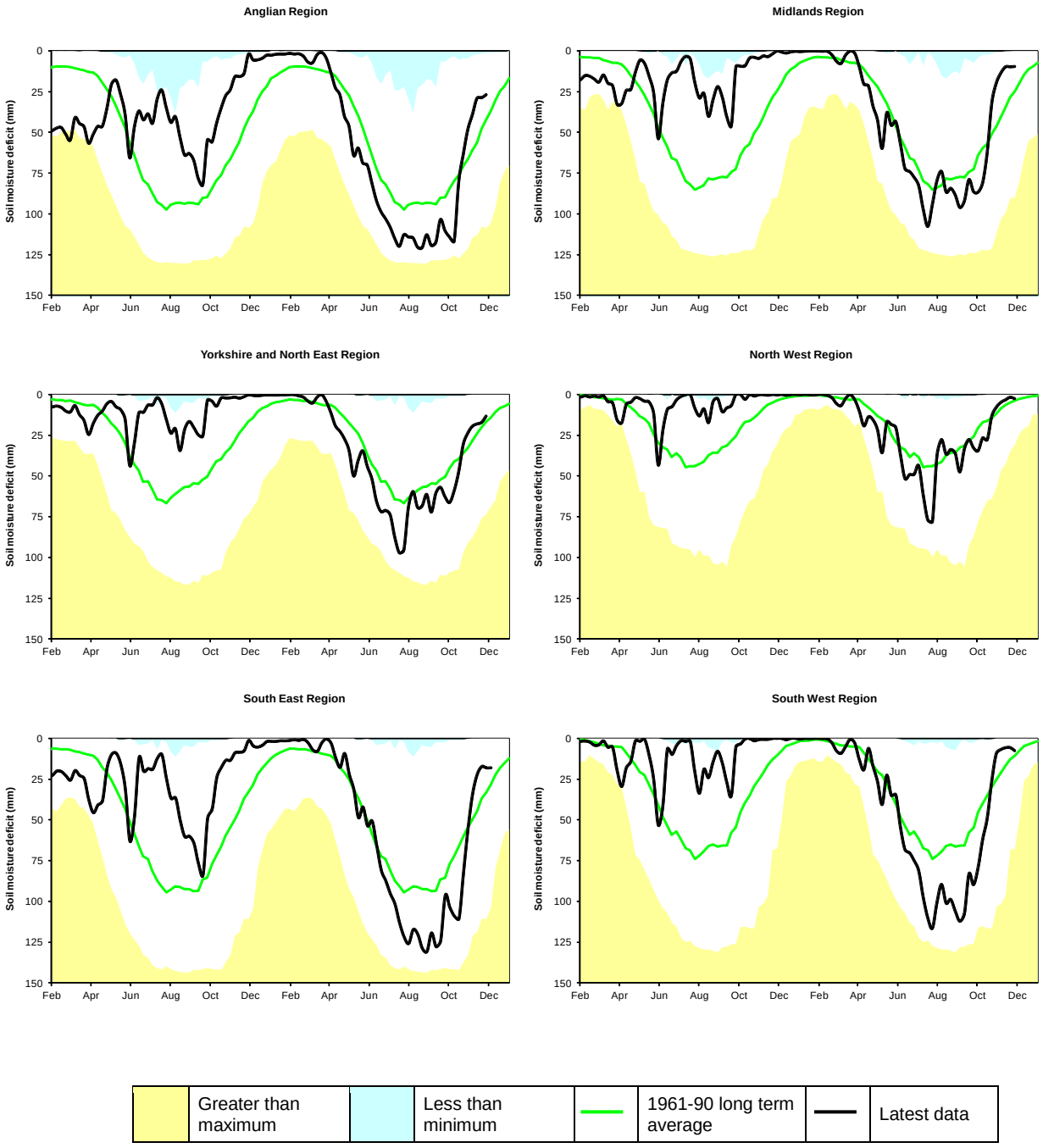
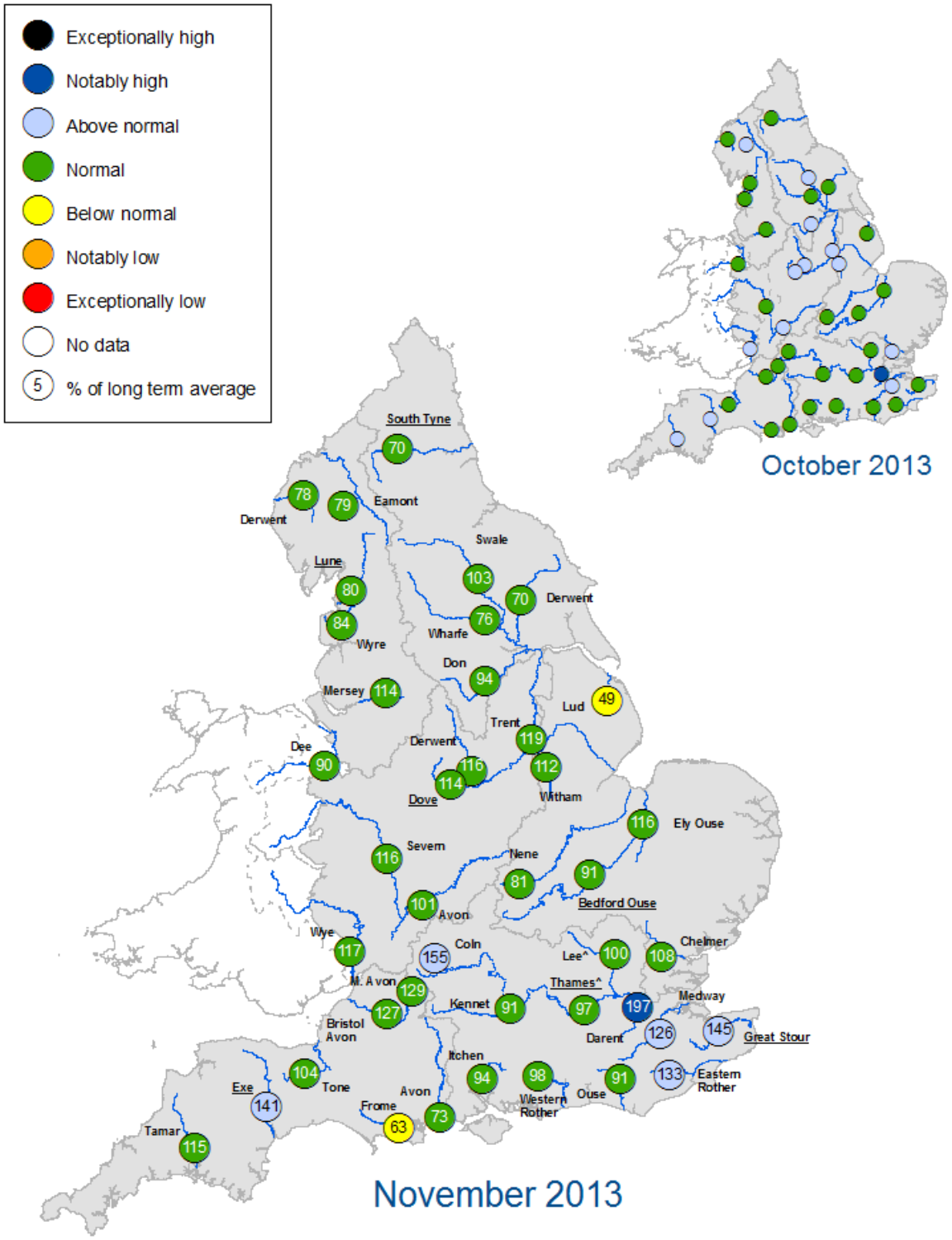


Figure 2.2: Latest soil moisture deficits for all Environment Agency Regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2013).

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 October 2013 and November 2013, expressed as a percentage of the respective long term average and classed relative to an analysis of historic October and November monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2013.

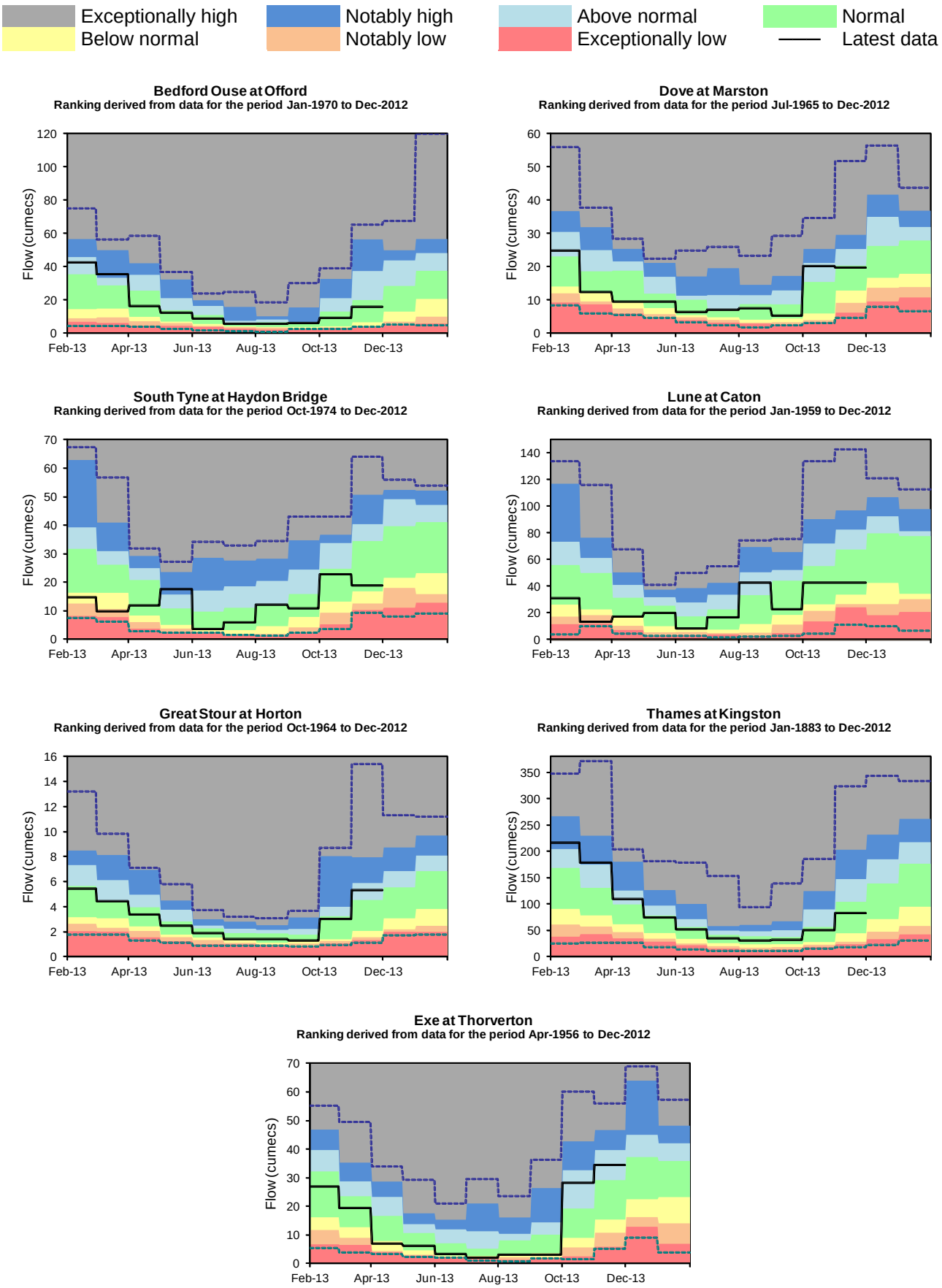
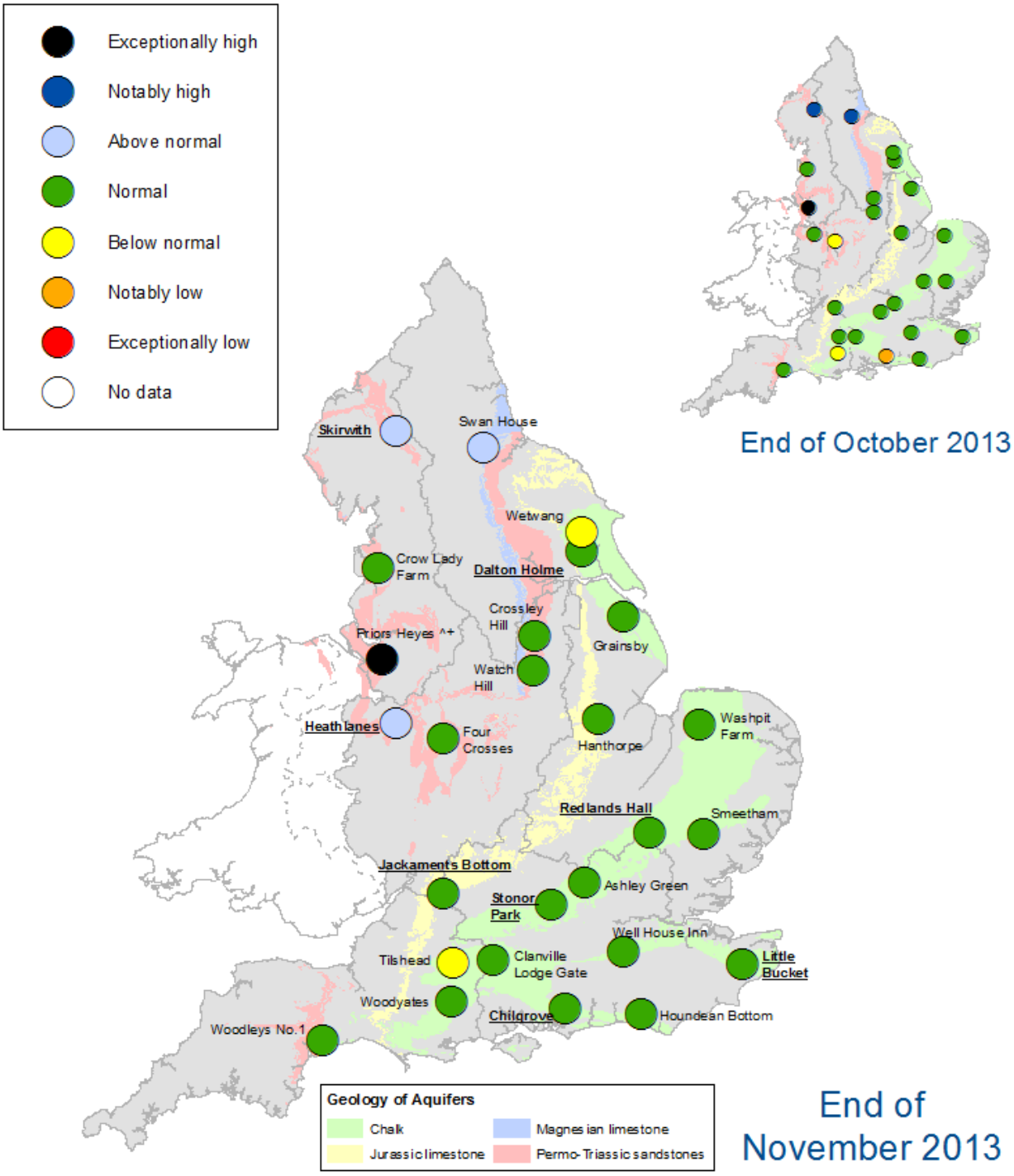


Figure 3.2: Index river flow sites for each Environment Agency Region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

Groundwater levels



^ The level at Priors Heyes remains high compared to historic levels because the aquifer is recovering from the effects of historic abstraction.
End of month groundwater level is the highest (+) and lowest (-) on record (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 October 2013 and November 2013, classed relative to an analysis of respective historic October and November levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Note: groundwater levels are reported at different times during the month and therefore may not be fully representative of levels at the month end.

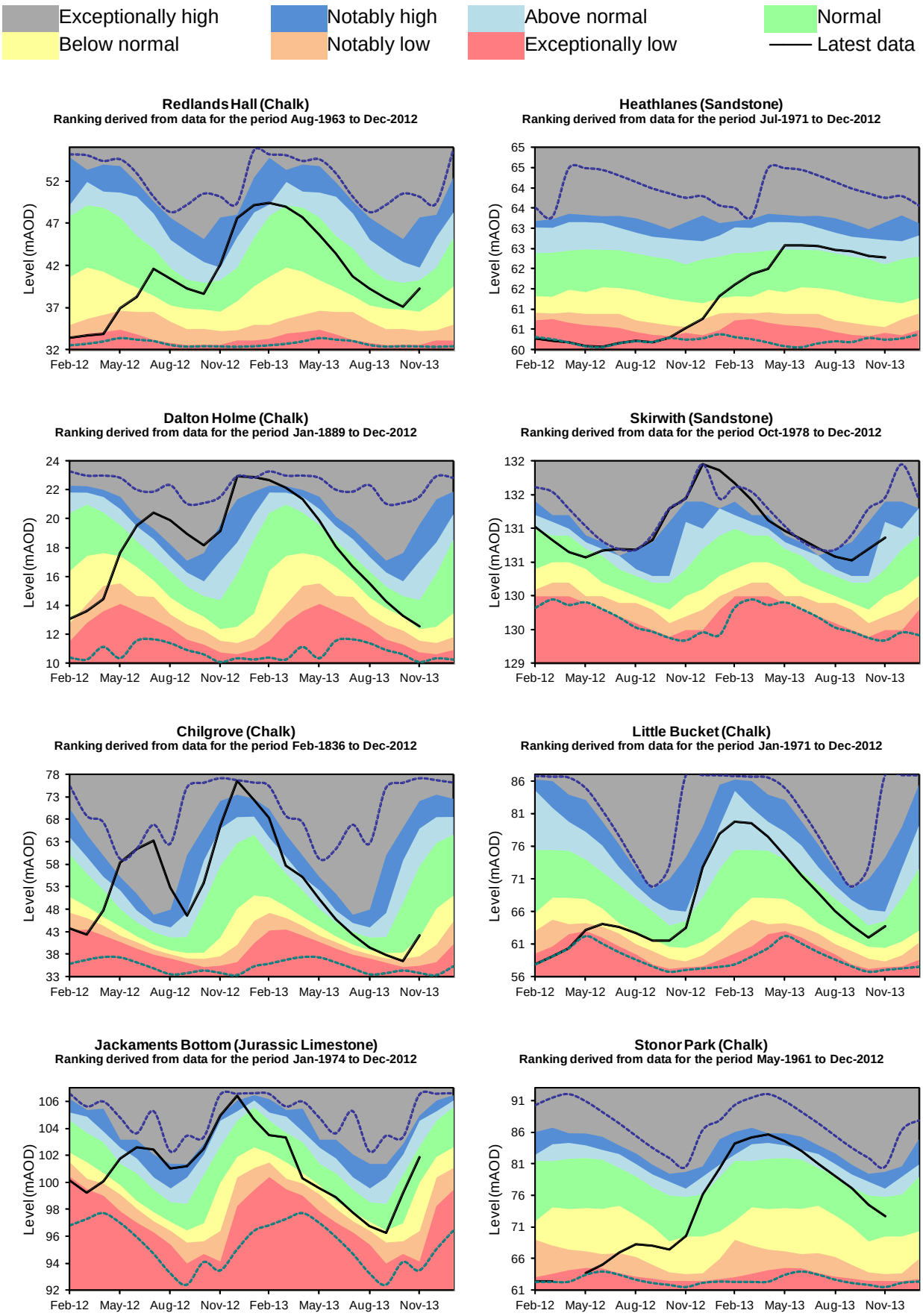
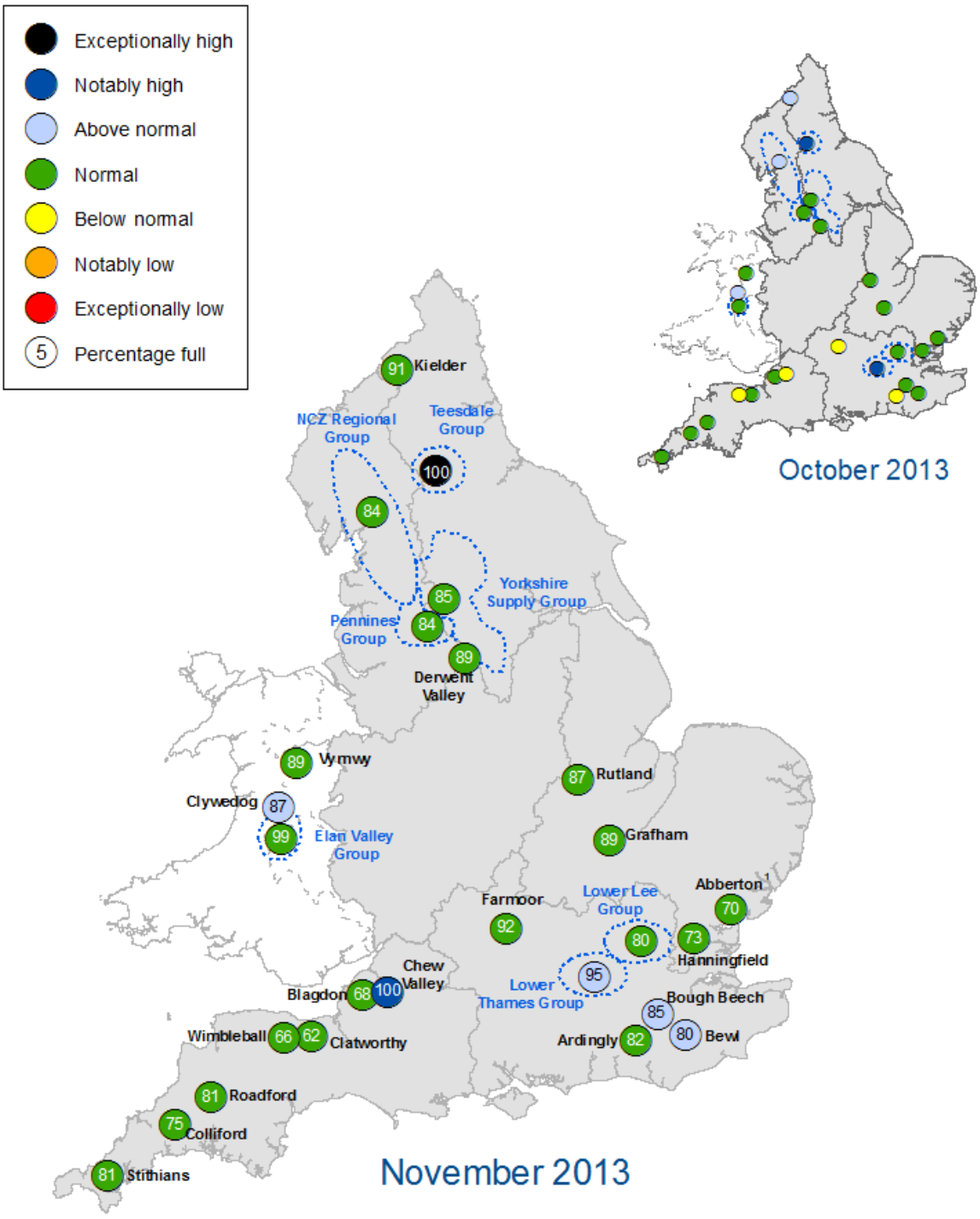


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2013).

Reservoir storage



1. The level at Abberton Reservoir in Anglian Region is affected by ongoing engineering works to increase capacity by 60%.
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 October 2013 and November 2013 as a percentage of total capacity and classed relative to an analysis of historic October and November 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, 2013.

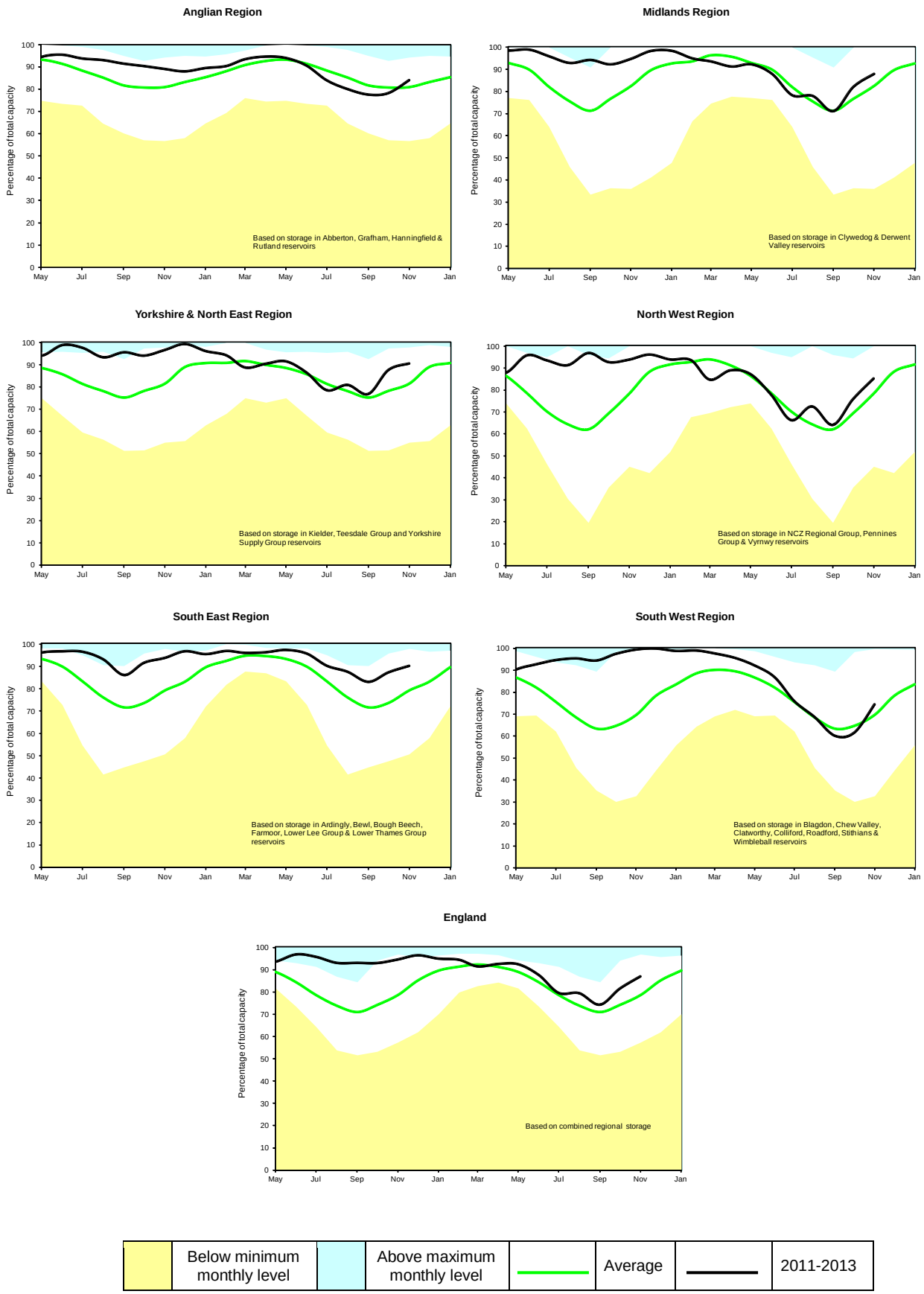


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

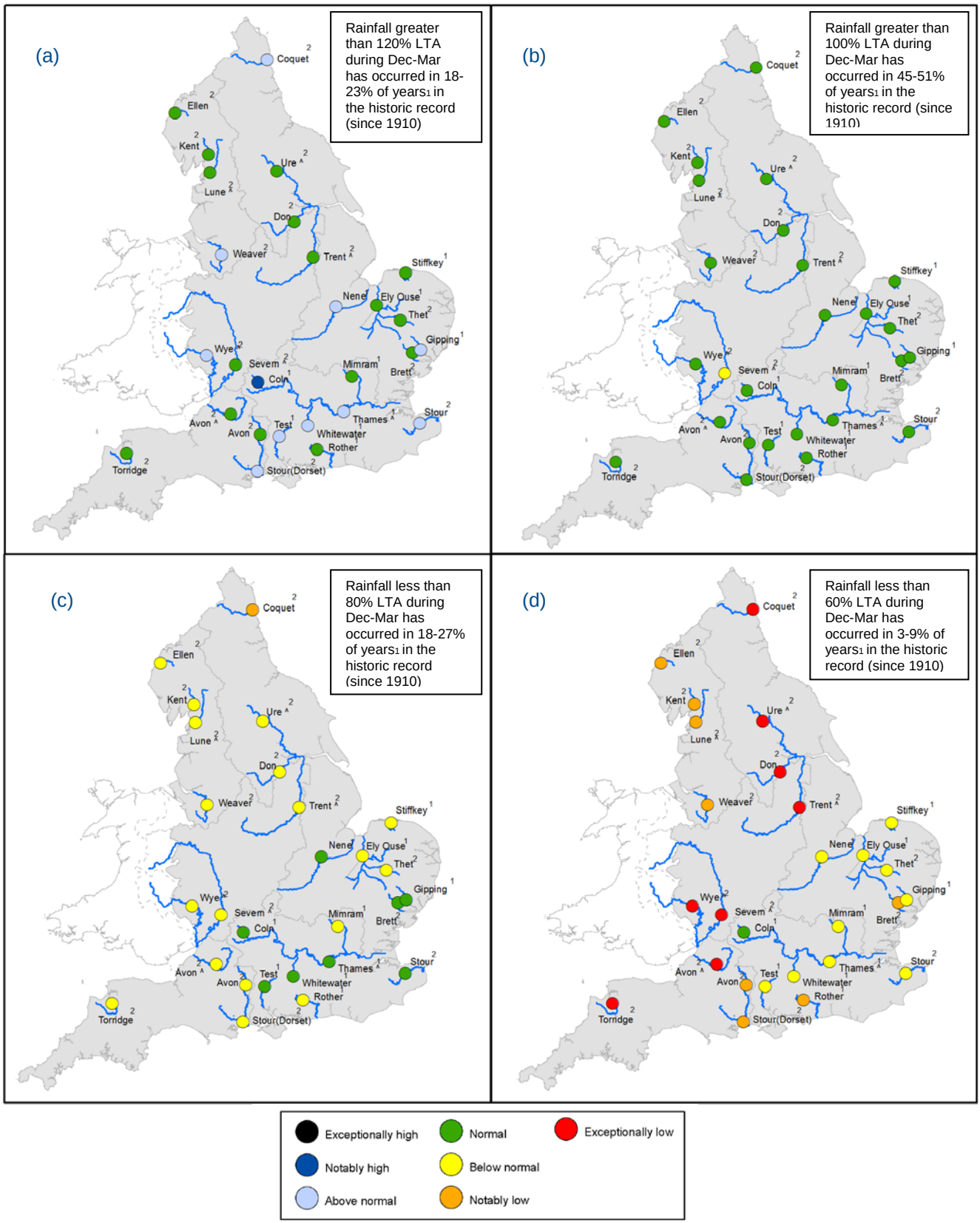
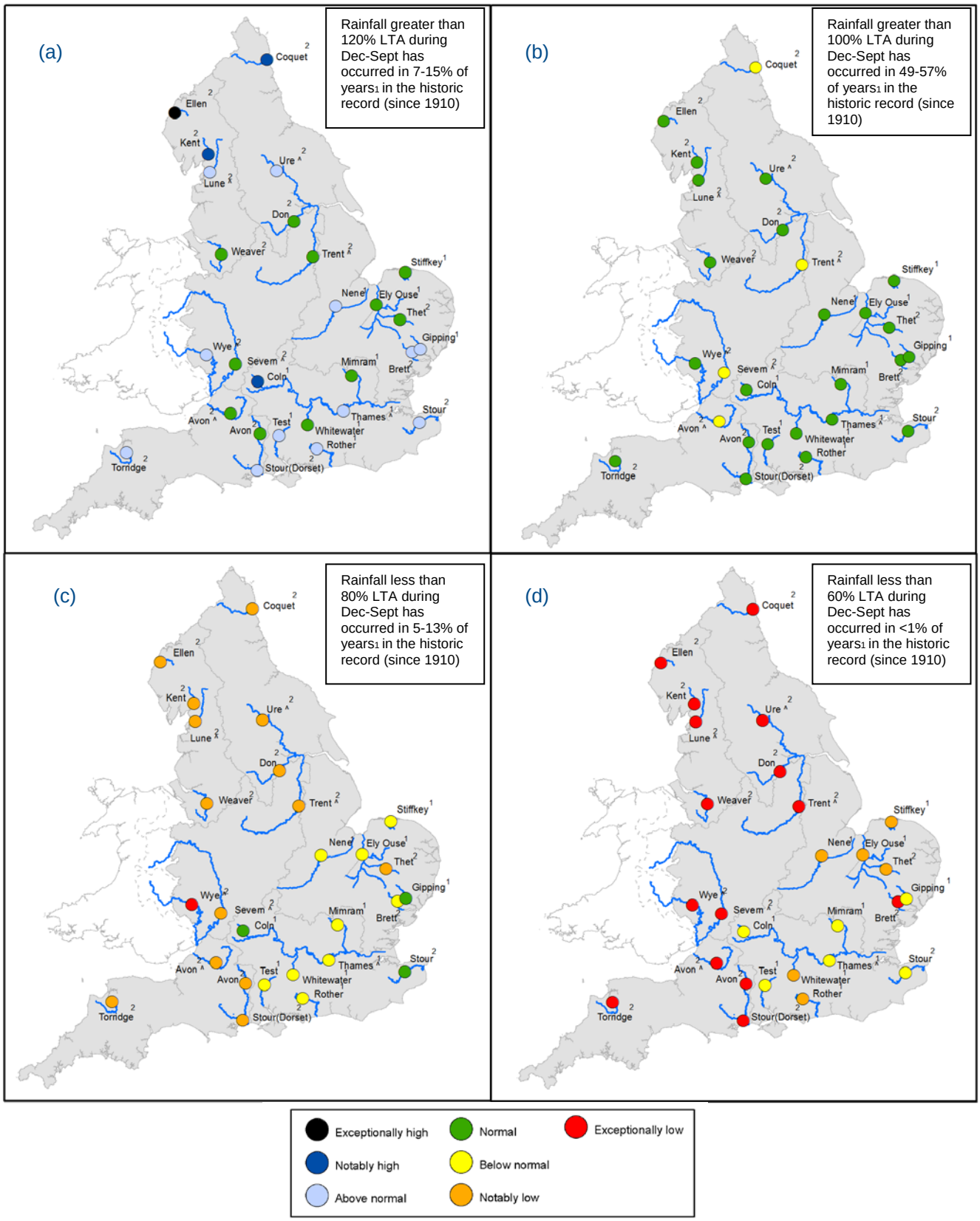


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2013 and March 2014 (Source: Centre for Ecology and Hydrology, Environment Agency)

[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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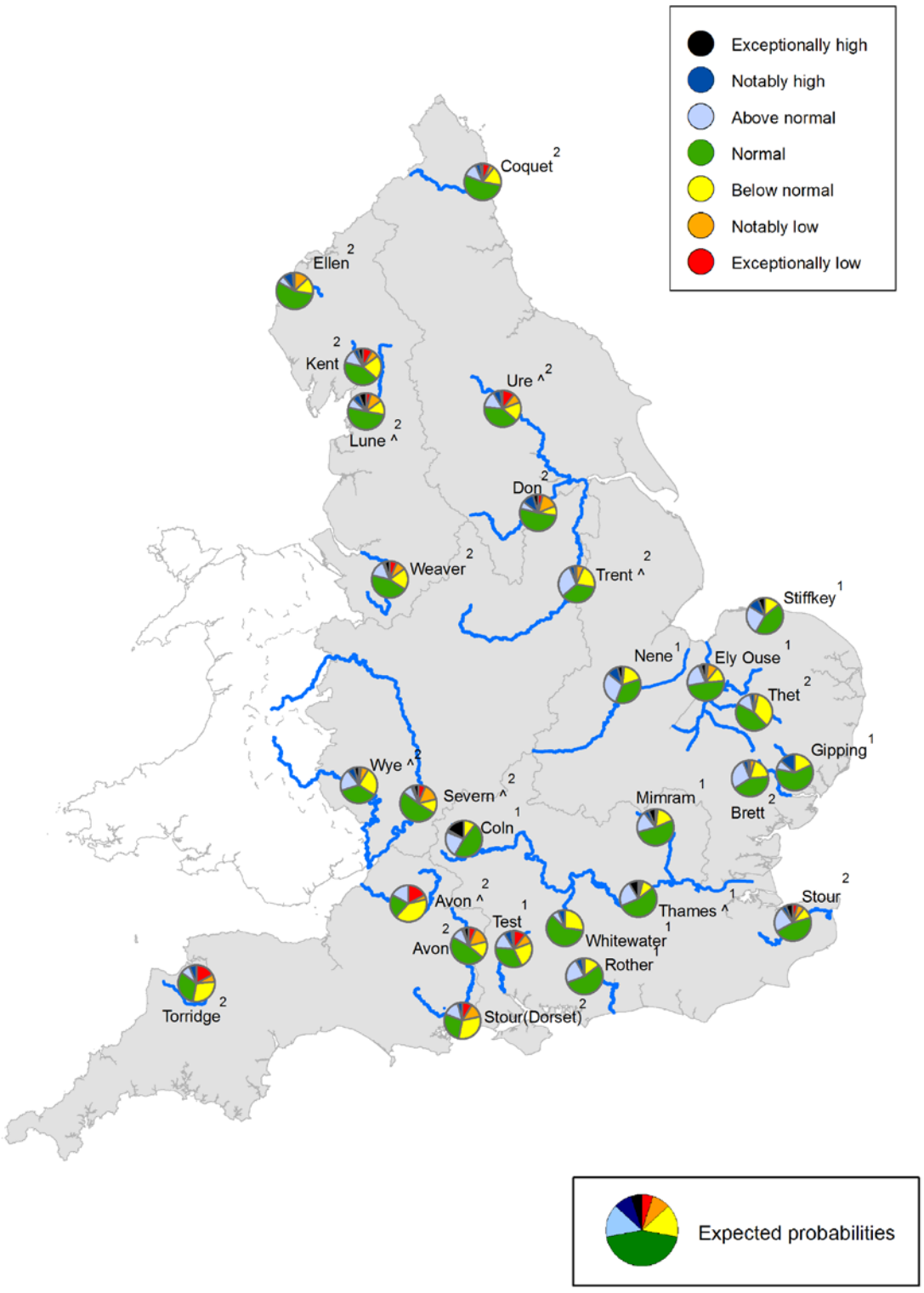

Figure 6.3: Probabilistic ensemble projections of river flows at key indicator sites up until the end of March 2014. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology,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

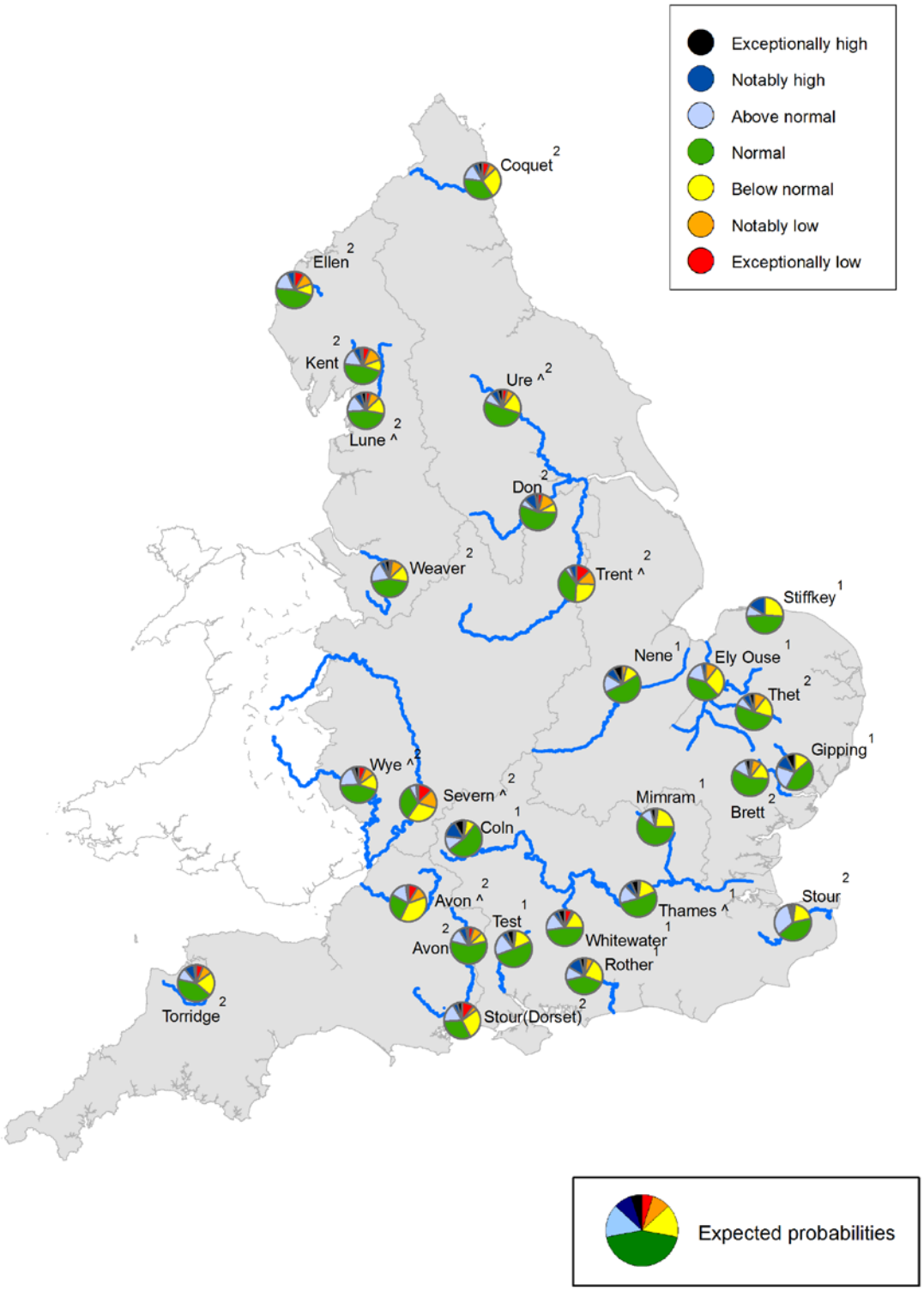

Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2014. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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

Forward look - groundwater

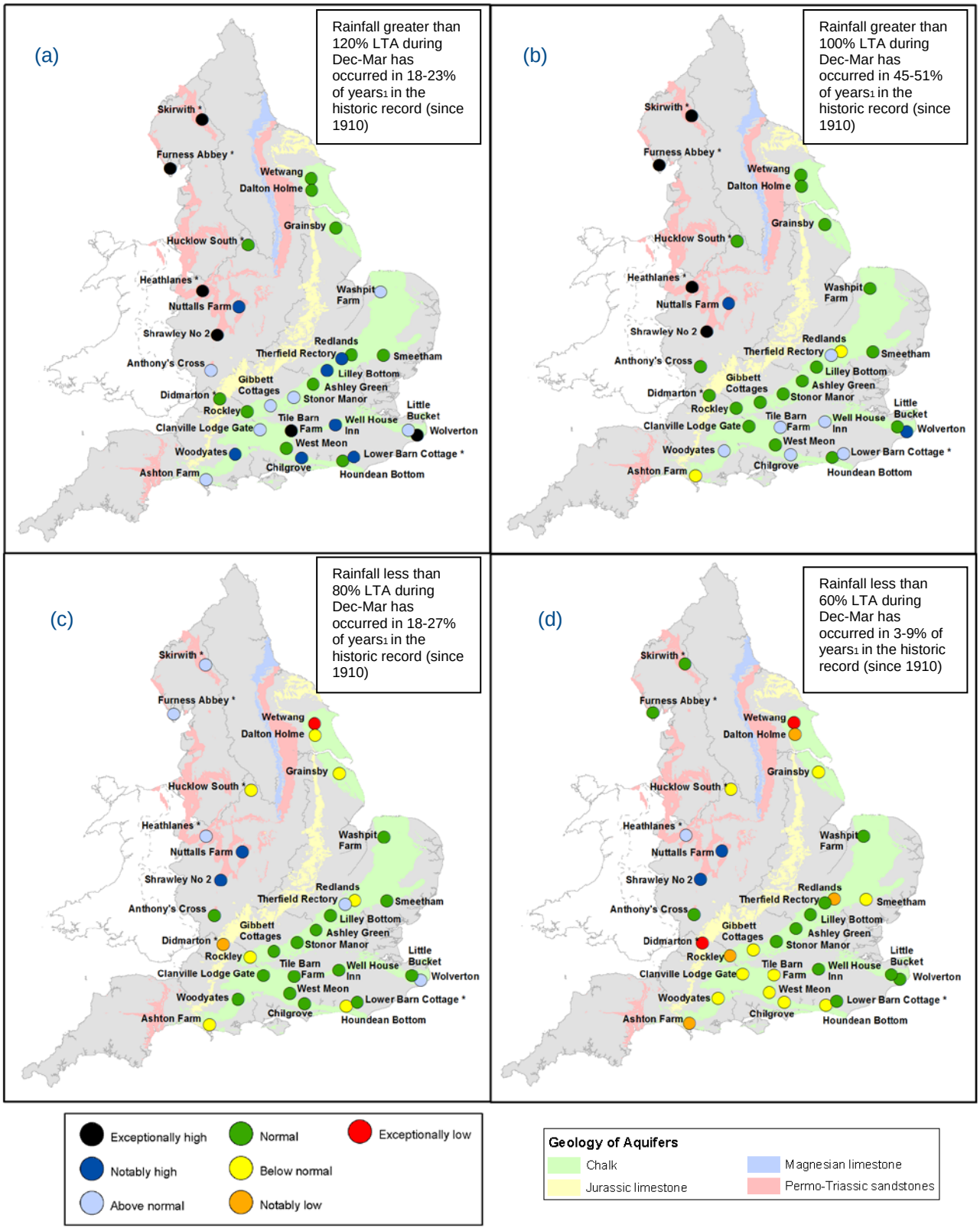

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2013 and March 2014 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2013.

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

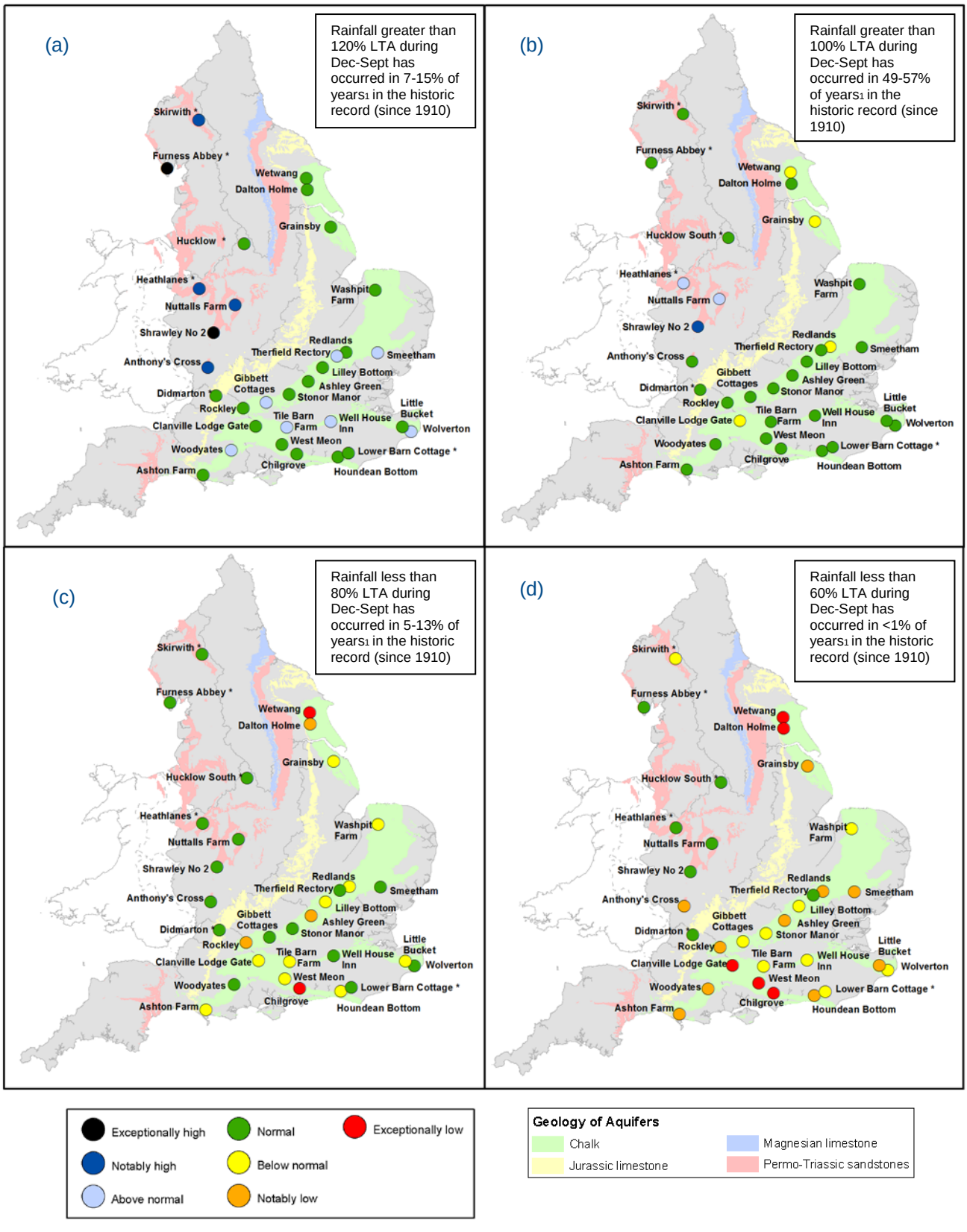

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2013 and September 2014 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2013.

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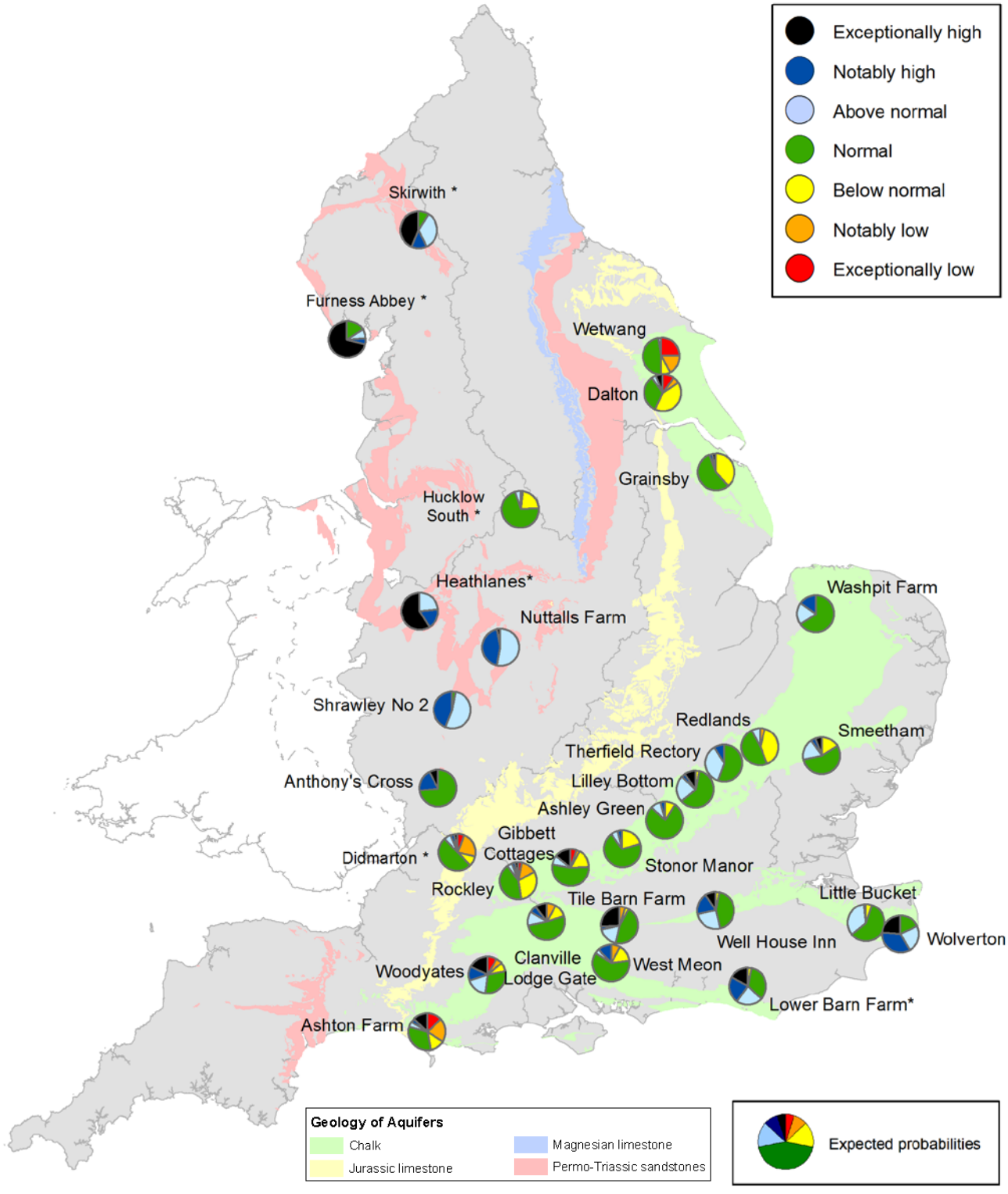
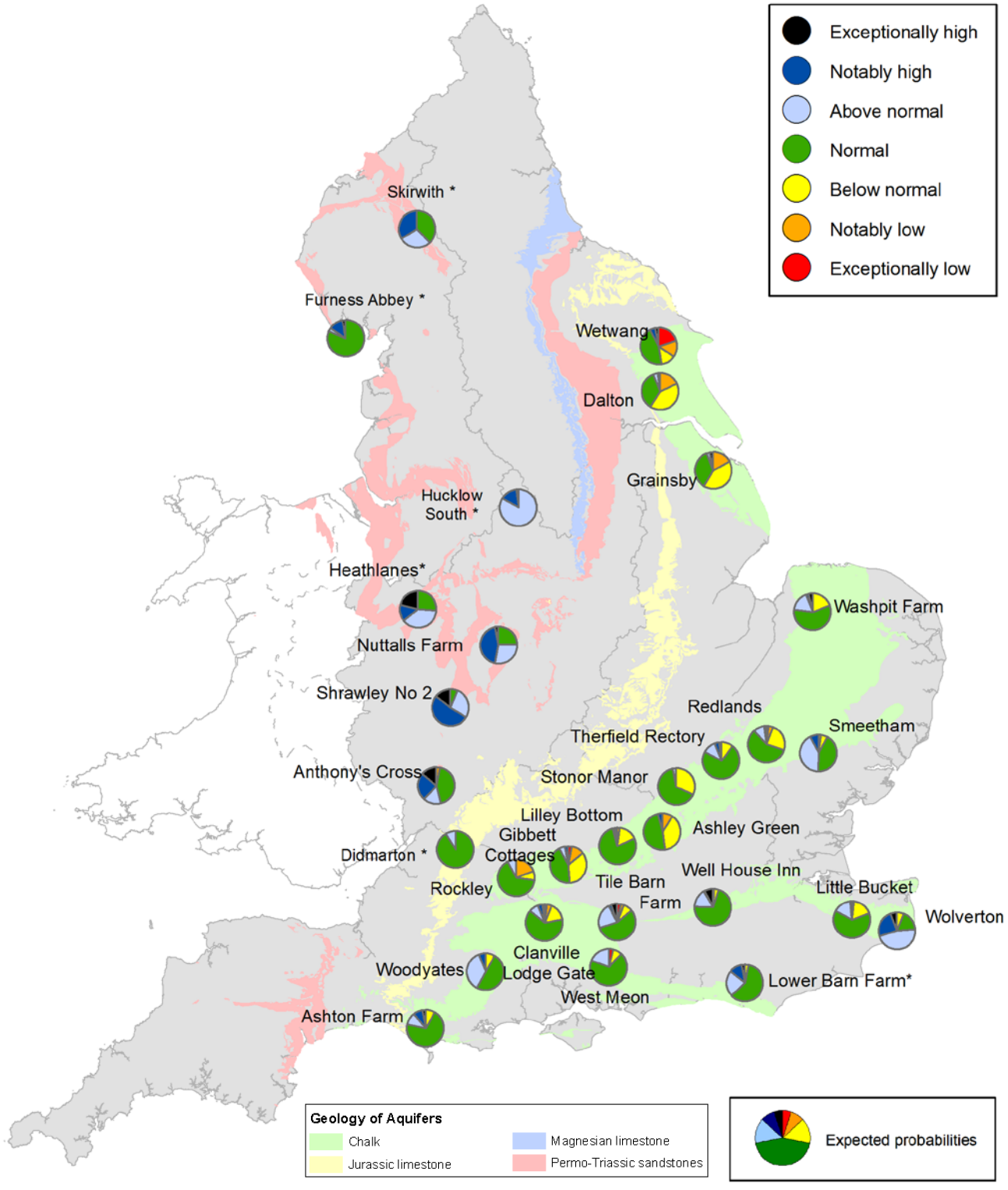


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 March 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, 2013.

** 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 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, 2013.

* Projections for these sites are produced by BGS

Figure 7.1: Environment Agency Region Location Map

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).