Monthly water situation report

England

Summary – November 2015

Rainfall totals for November were above average across England at 147% of the long term average (LTA), with north-east and north-west England experiencing exceptionally high rainfall totals for the time of year. As a result, soil moisture deficits decreased during November by up to 82mm across England. Monthly mean river flows increased at all of the indicator sites. River flows were classed as normal at just over two-thirds of all sites, and the majority of sites in north-east and north-west England had notably high or exceptionally high river flows for November. Groundwater levels increased at just over half of all indicator sites during November, with two-thirds of sites classed as normal at the end of November. Reservoir stocks increased at more than three-quarters of the reported reservoirs and reservoir groups during November. Stocks were classed as normal or higher for the time of year at the majority of reported reservoirs and reservoir groups. Overall reservoir storage for England increased to 86% of total capacity.

Rainfall

Rainfall totals during November ranged from less than 65mm across a number of catchments in east and south-east England to above 300mm across parts of Cumbria, Lancashire and the Welsh borders. Monthly rainfall totals were above the November LTA in three-quarters of hydrological areas, with those covering much of northern England and the Upper Wye and Severn catchments receiving more than 200% of the LTA. Parts of south and south-west England received rainfall totals that were between 80 and 100% of the November LTA (Figure 1.1).

November rainfall totals were above normal or higher for the time of year across much of north, west and central England, with many catchments receiving exceptionally high rainfall for the time of year. Totals were normal for the time of year across the rest of England. In Cumbria, Lancashire and Yorkshire there were 11 catchments for which the rainfall for November was 2nd highest on record (since 1910) and second only to November 2009. The rainfall over the River Ribble catchment was highest on record, being almost 10mm higher than in 2009. Over the 3 month period to the end of November, cumulative rainfall totals were normal across most of England, although rainfall totals were above normal in much of the north-east and below normal in parts of south-west England. Over the 6 and 12 month periods ending in November, rainfall totals were mostly normal to below normal across England, except in most of north-west and parts of north-east England (Figure 1.2).

At the regional scale, November rainfall totals were above average in all parts of England, ranging from 107% of the LTA in south-east England to 215% in north-west England. Rainfall totals across England as a whole were above average for the time of year at 147% of the November LTA (Figure 1.3).

Soil moisture deficit

Soil moisture deficits (SMDs) decreased by up to 77mm during November across England. At the end of November, SMDs were at, or close, to zero across much of north, west and south-west England. Soils were drier across parts of Lincolnshire, Cambridgeshire and Norfolk, with SMDs of between 40 and 100mm. End of month SMDs were at, or smaller than, the LTA across most of England with soils being wetter than average in many areas, but particularly in parts of Yorkshire and Greater London. In parts of Lincolnshire, however, soils were drier than average for the time of year (Figure 2.1).

At a regional scale, SMDs decreased during November across all regions, with month end values ranging from 3mm in south-west and north-east England to 34mm in east England. At the end of November, soils were wetter than average across the whole of England (Figure 2.2).

River flows

Monthly mean river flows for November increased compared with October at all of the indicator sites across England. Monthly mean river flows were classed as normal for the time of year at just over two-thirds of the indicator sites; all sites across central, east, south-east and south-west England were classed as normal, with the

exception of the River Itchen in south-east England, which remained at above normal, and the River Lud in east England which was below normal for November. There is a clear response in river flows across north-east and north-west England to the large rainfall totals experienced during November, with 9 out of 10 sites having notably high or exceptionally high monthly mean river flows for November (Figure 3.1).

Monthly mean river flows were classed as normal for the time of year at 5 out of the 7 regional index sites. The River Lune at Caton in north-west England was classed as exceptionally high for November, increasing from a notably low status in October. Similarly, the South Tyne at Haydon Bridge in north-east England was classed as exceptionally high for November, increasing from exceptionally low monthly mean flows for October (Figure 3.2).

Groundwater levels

Groundwater levels increased at just over half of all indicator sites during November. At the end of November, groundwater levels were classed as normal or higher for the time of year at two-thirds of the sites. Levels at 9 sites, notably in the chalk aquifers, remained at below normal or lower. Notably low levels for the end of November were recorded at Dalton Holme (in the Hull and East Riding chalk aquifer), Ashley Green (Chilterns East Chalk aquifer), Tilshead (Upper Hampshire Avon chalk aquifer) and Woodleys (Otter Valley Sandstone aquifer).

End of month groundwater levels at the major aquifer index sites were normal for the time of year at 6 out of the 8 sites, with Dalton Holme (in the Hull and East Riding chalk aquifer) being notably low for the time of year. Stonor Park (in the South West Chilterns chalk) was below normal for the time of year (Figures 4.1 and 4.2).

Reservoir storage

Reservoir stocks increased at over three-quarters of the reported reservoirs and reservoir groups during November, with increases of at least one-third occurring in the Pennines group (39%) and the NCZ Regional group (34%) in north-west England and the Derwent Valley group (32%), which supplies central England. Reservoirs in east England and parts of south-east England decreased during the month. End of month stocks were classed as normal or higher for the time of year at almost all of reported reservoirs and reservoir groups. The remaining sites, all located in, or supplying parts of central and southern England, were below normal or lower for the time of year (Figure 5.1). Levels in the Dove group remain classified as exceptionally low for the time of year owing to ongoing operational issues.

Regional-scale reservoir stocks increased during November by up to 31%, except in east England, where stocks fell by 5%. At the end of November, regional stocks ranged from 76% of total capacity in east England to 94% in north-west England. Overall reservoir storage for England increased by 15% to 86% of total capacity (Figure 5.2).

Forward look

December is likely to remain unsettled, with strong winds and heavy rain at times for most parts of England. In the south there may be some drier interludes between rain events. Further ahead, the winter period (December-January-February) has an increased probability of being mild at the beginning, with colder than average weather toward the end. There is an increased probability of above average rainfall for the period December-January-February[1].

Projections for river flows at key sites[2]

Nearly two thirds of modelled flow sites have a greater than expected chance of above normal or higher cumulative flows by March 2016. By September 2016, more than half of the modelled sites have a greater than expected chance of normal cumulative flows.

For scenario based projections of cumulative river flows at key sites by March 2016 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by September 2016 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by March 2016 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by September 2016 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

Over two thirds of modelled groundwater sites have a greater than expected chance of normal or higher groundwater levels at the end of March 2016. At the end of September 2016, three quarters of modelled sites have a greater than expected chance of normal groundwater levels.

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 (www.hydoutuk.net).

For scenario based projections of groundwater levels in key aquifers in March 2016 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2016 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2016 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2016 see Figure 6.8

Authors: E&B Hydrology Team

Rainfall

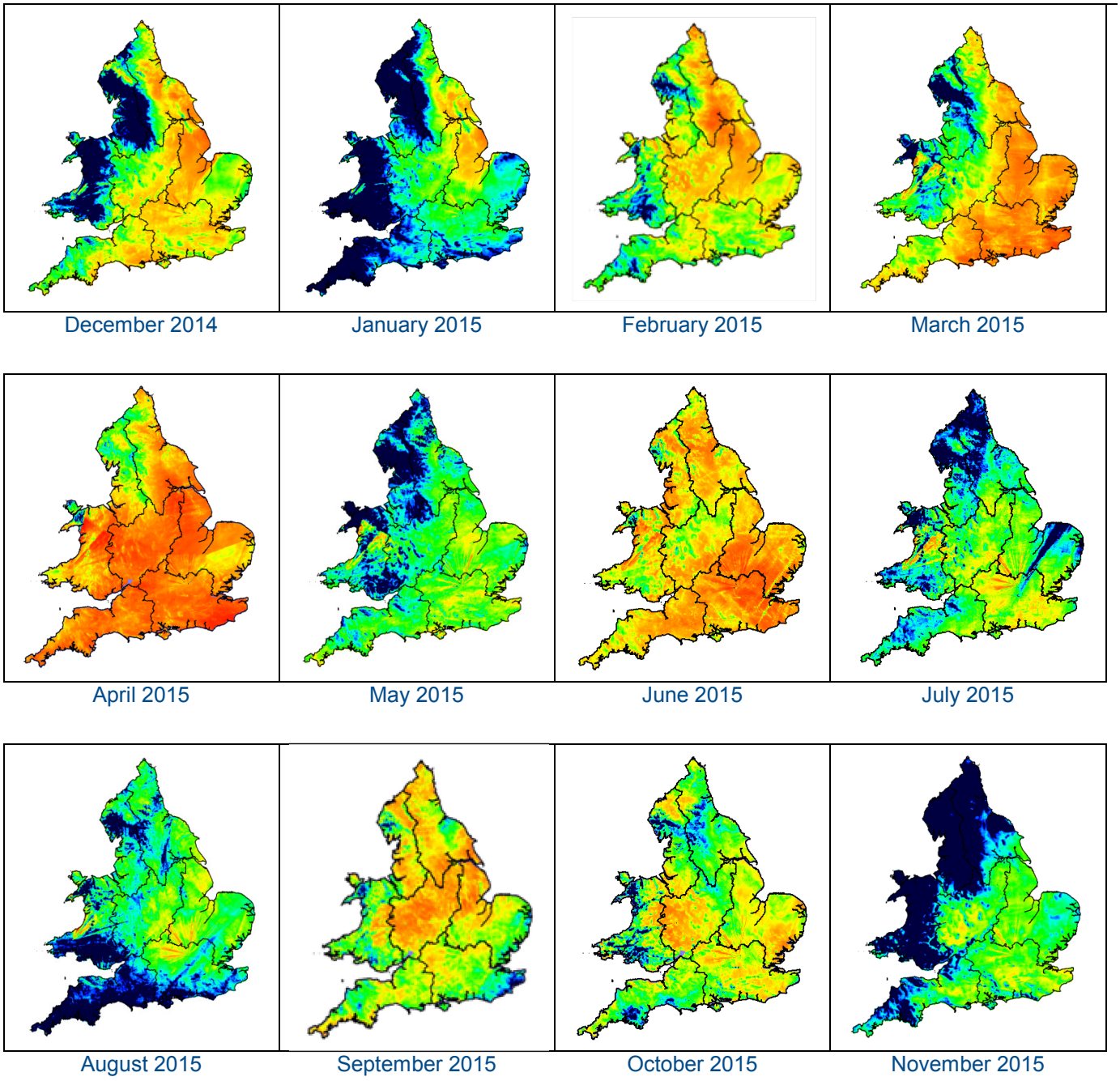
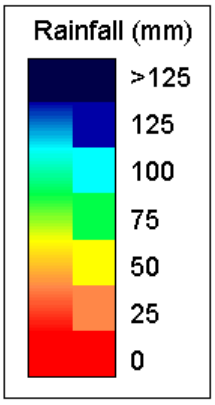


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2015). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2015.



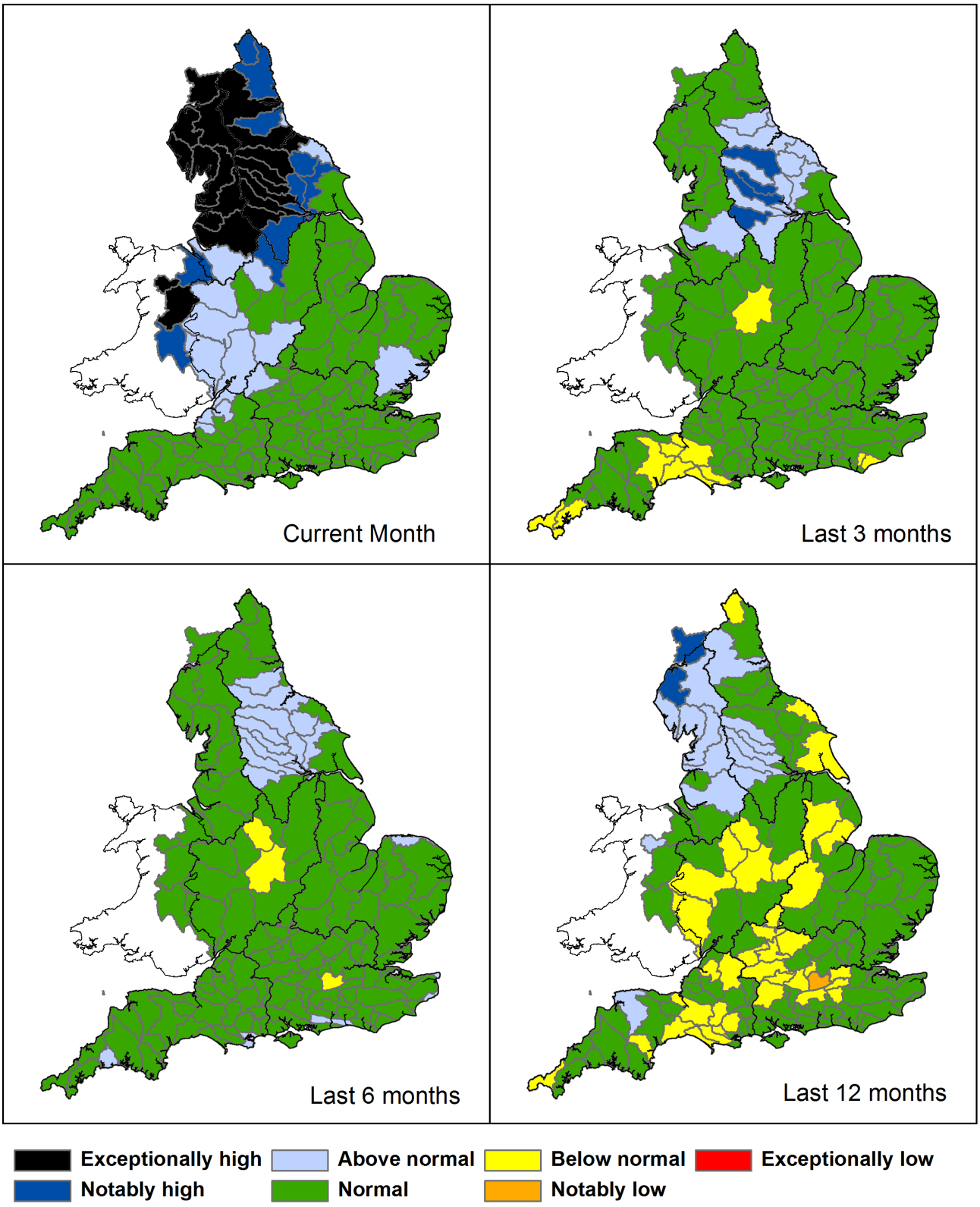


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 November), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2015).* Crown copyright. All rights reserved. Environment Agency, 100026380, 2015.

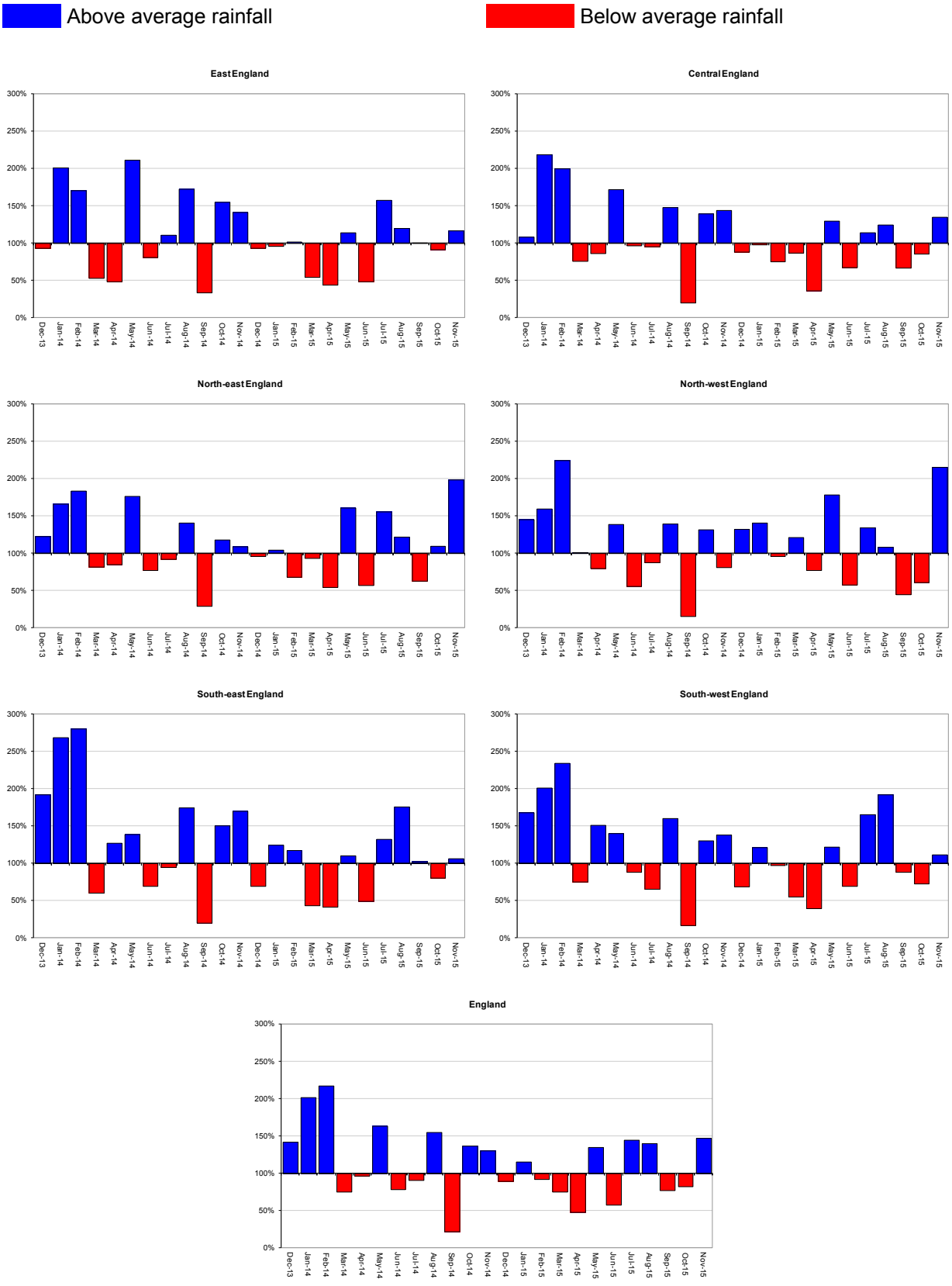


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2015).

Soil moisture deficit

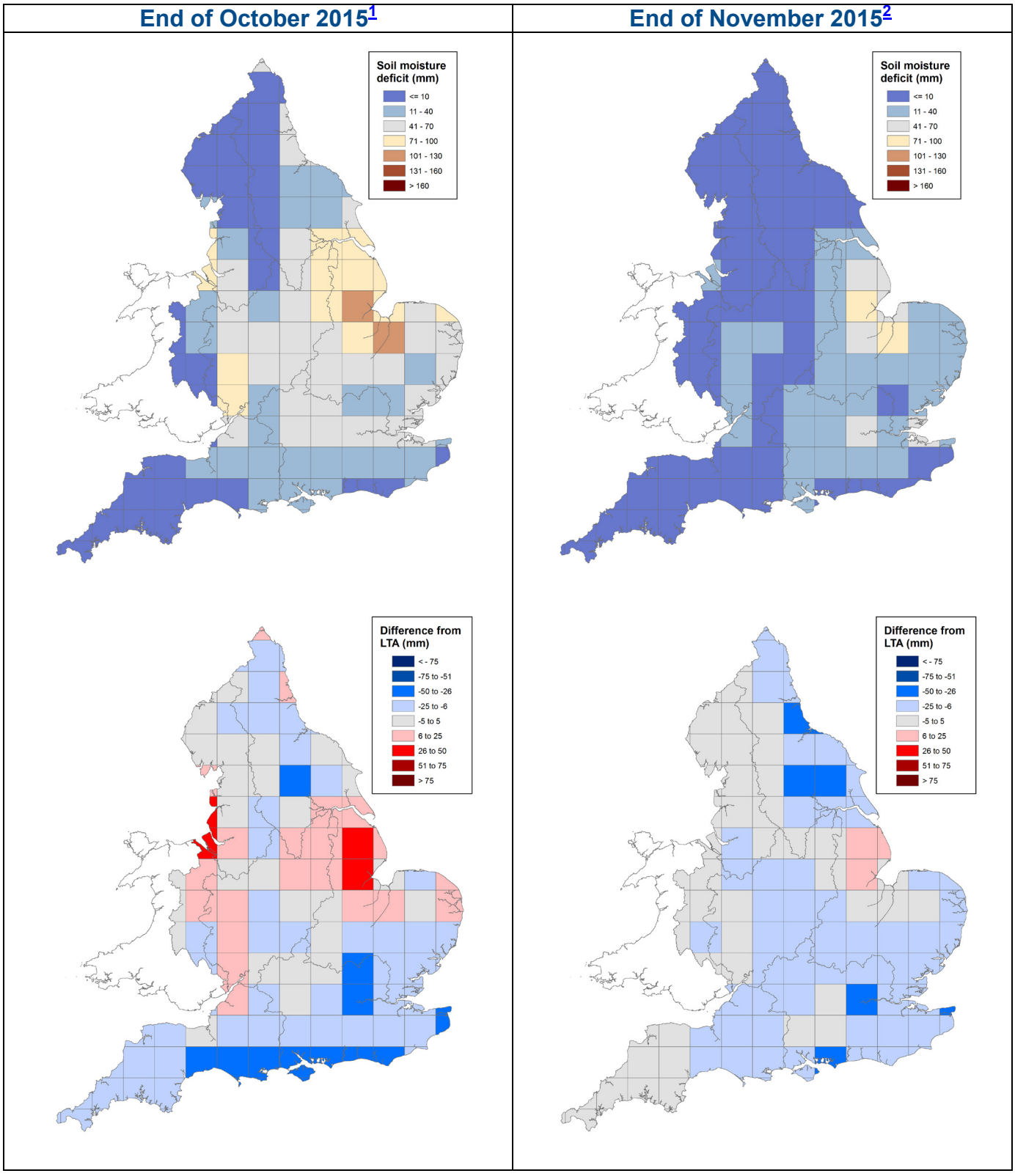


Figure 2.1: Soil moisture deficits for weeks ending 3 November 2015 [1] (left panel) and 1 December 2015 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2014). Crown copyright. All rights reserved. Environment Agency, 100026380, 2015

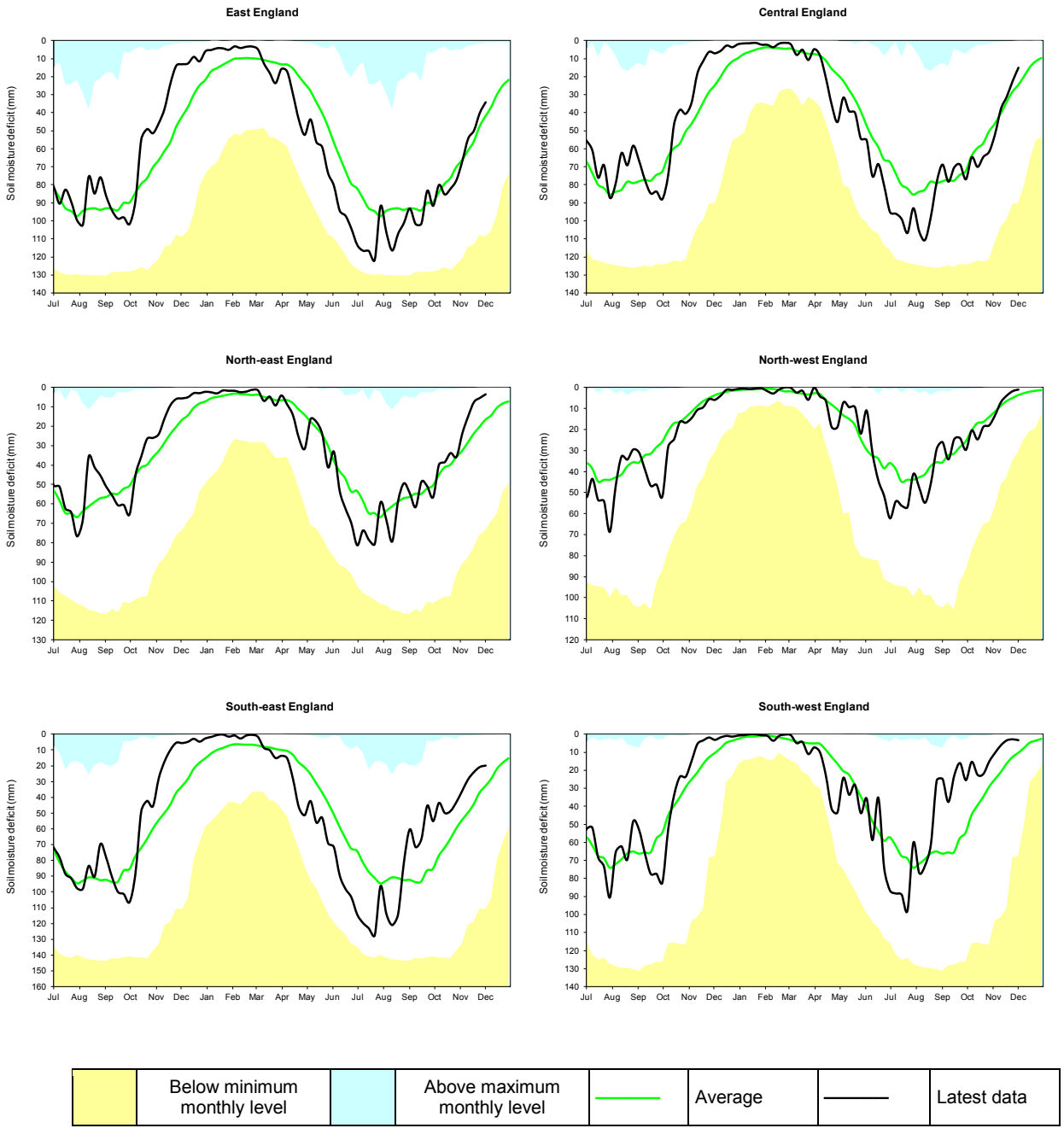
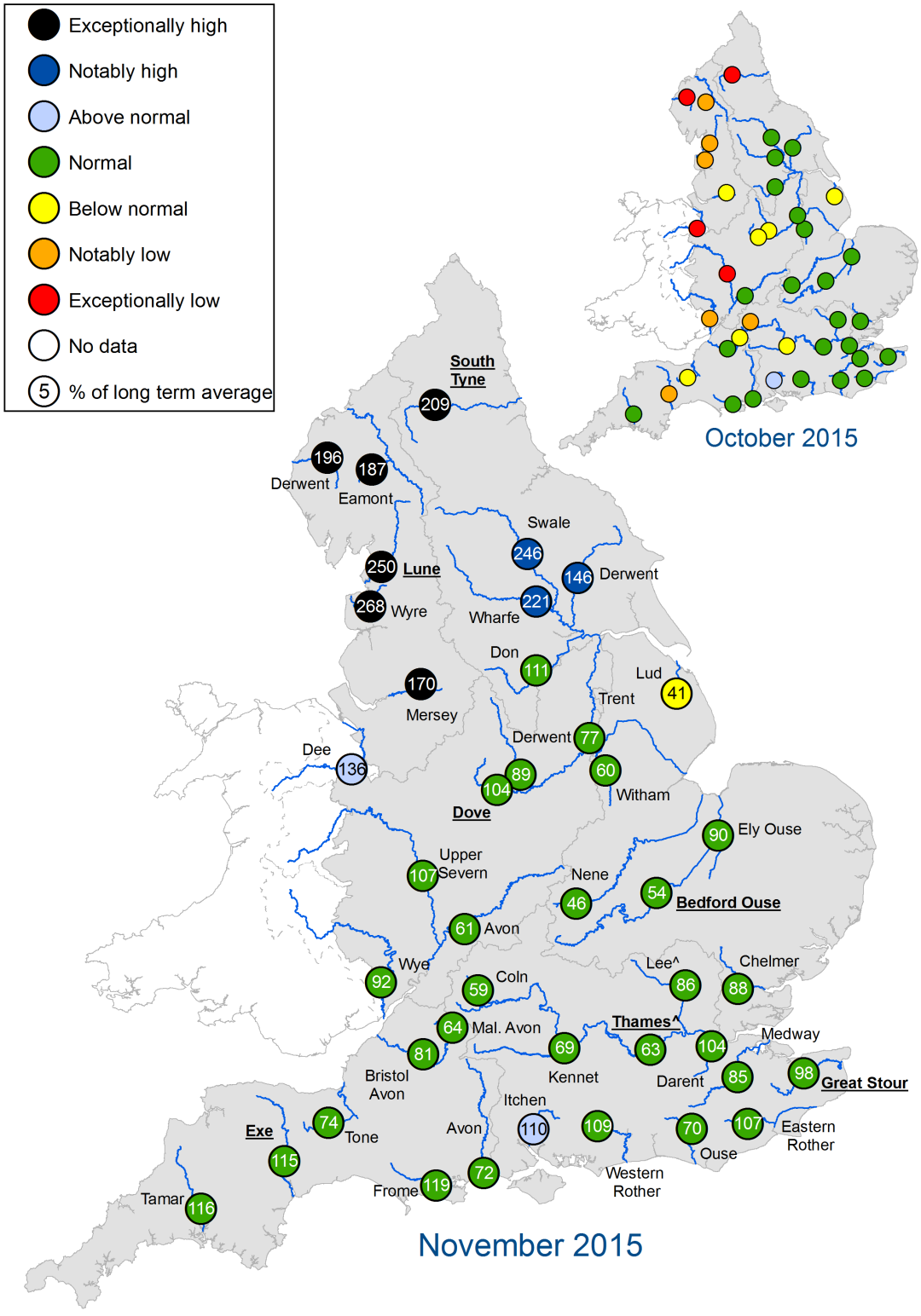


Figure 2.2: Latest soil moisture deficits for all regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2015).

River flows



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

\+ Monthly mean flow is the highest on record for the current month (note that record length varies between sites)

Underlined sites are regional index sites and are shown on the hydrographs in Figure 3.2

Figure 3.1: Monthly mean river flow for indicator sites for October 2015 and November 2015, 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, 2015.

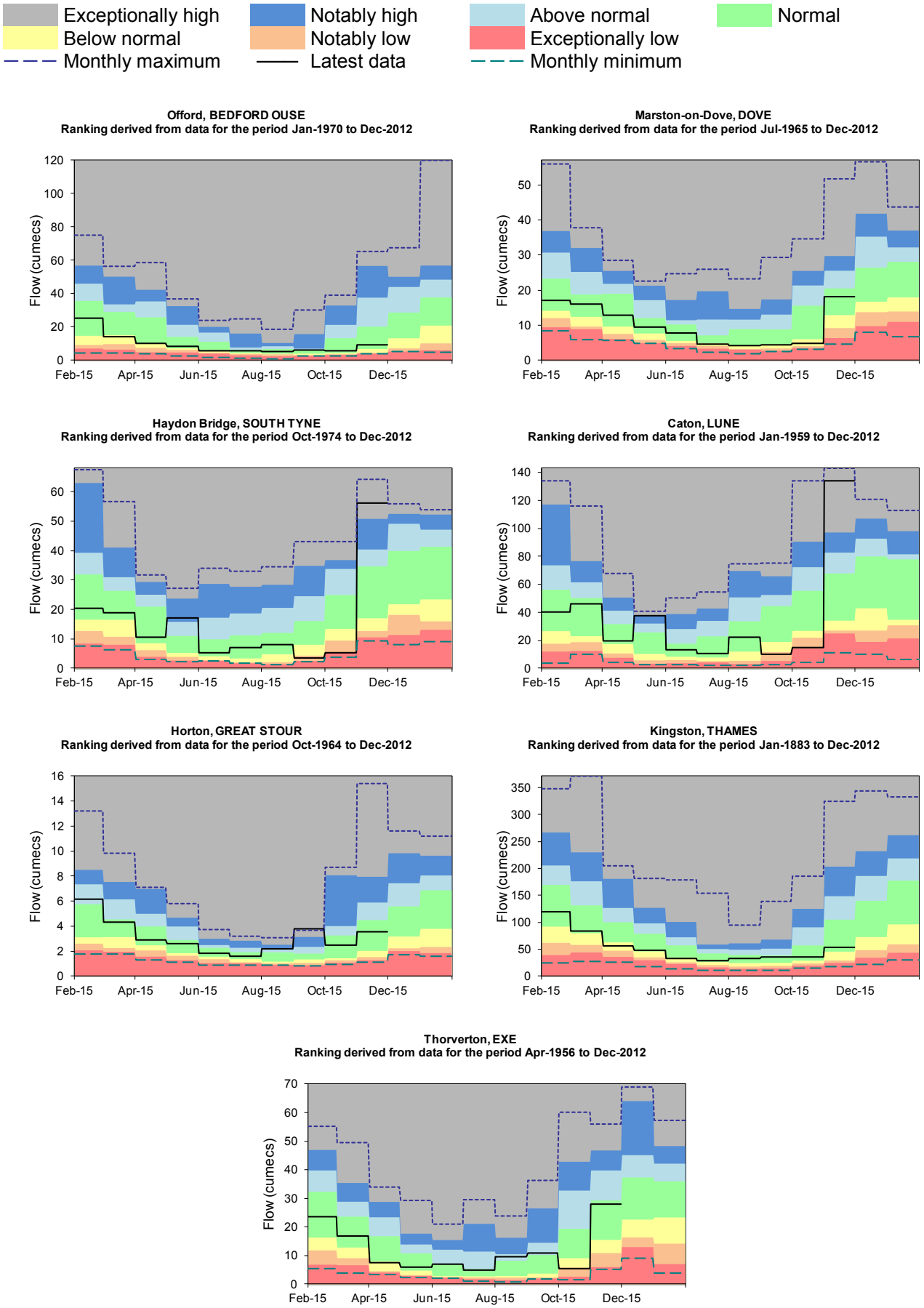
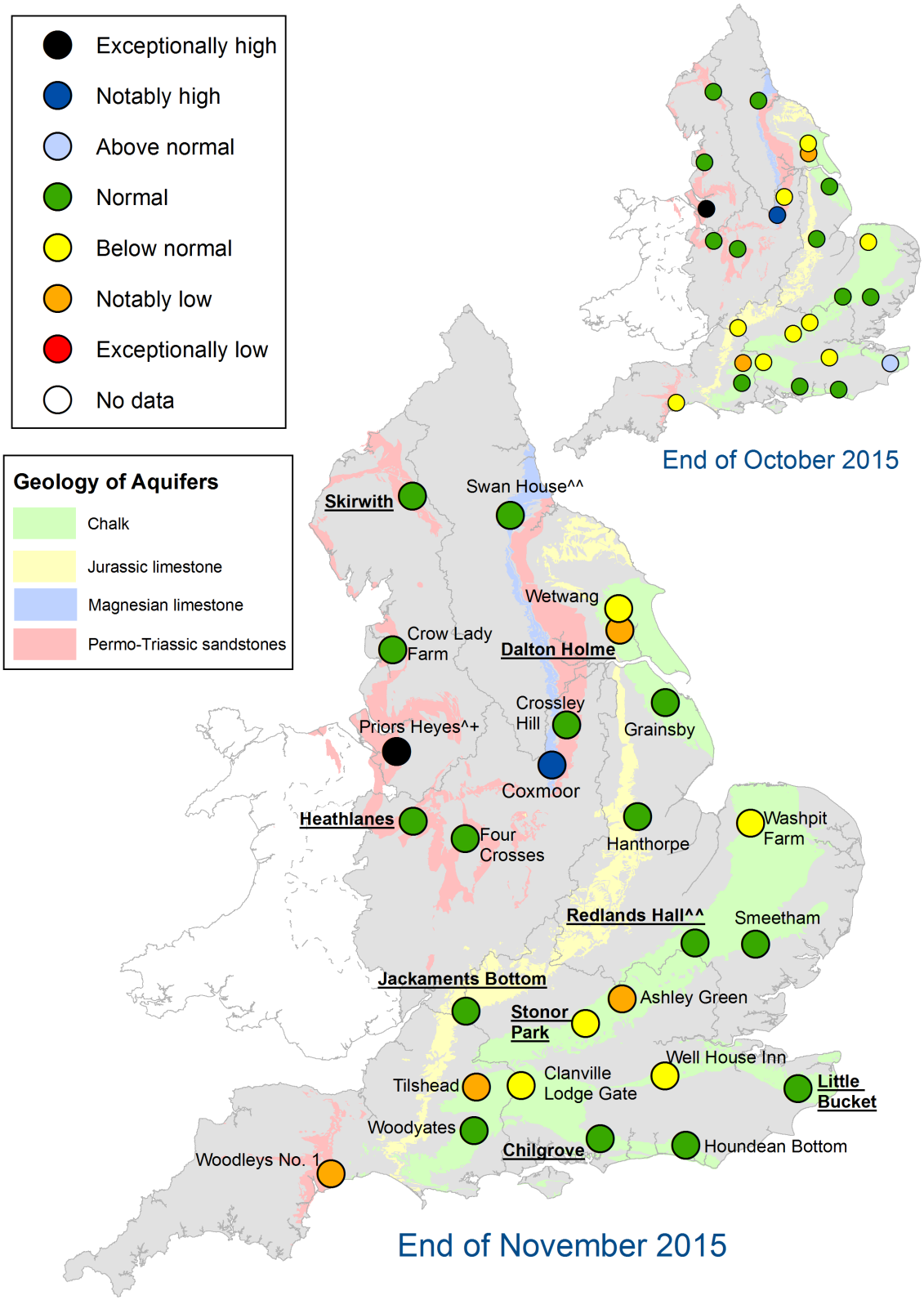


Figure 3.2: Index river flow sites for each Environment Agency Region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 October 2015 and November 2015, 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. Crown copyright. All rights reserved. Environment Agency, 100026380, 2015.

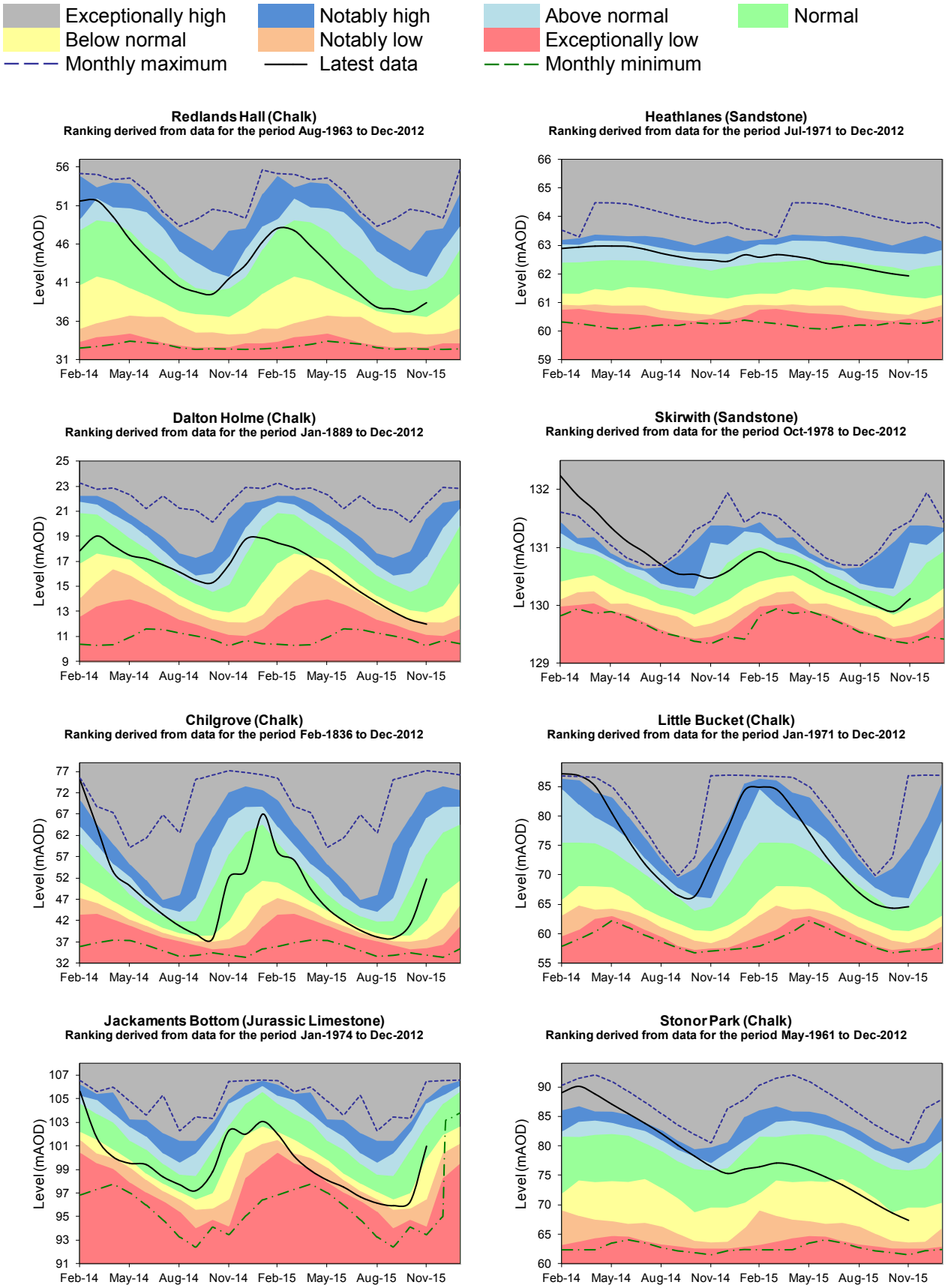
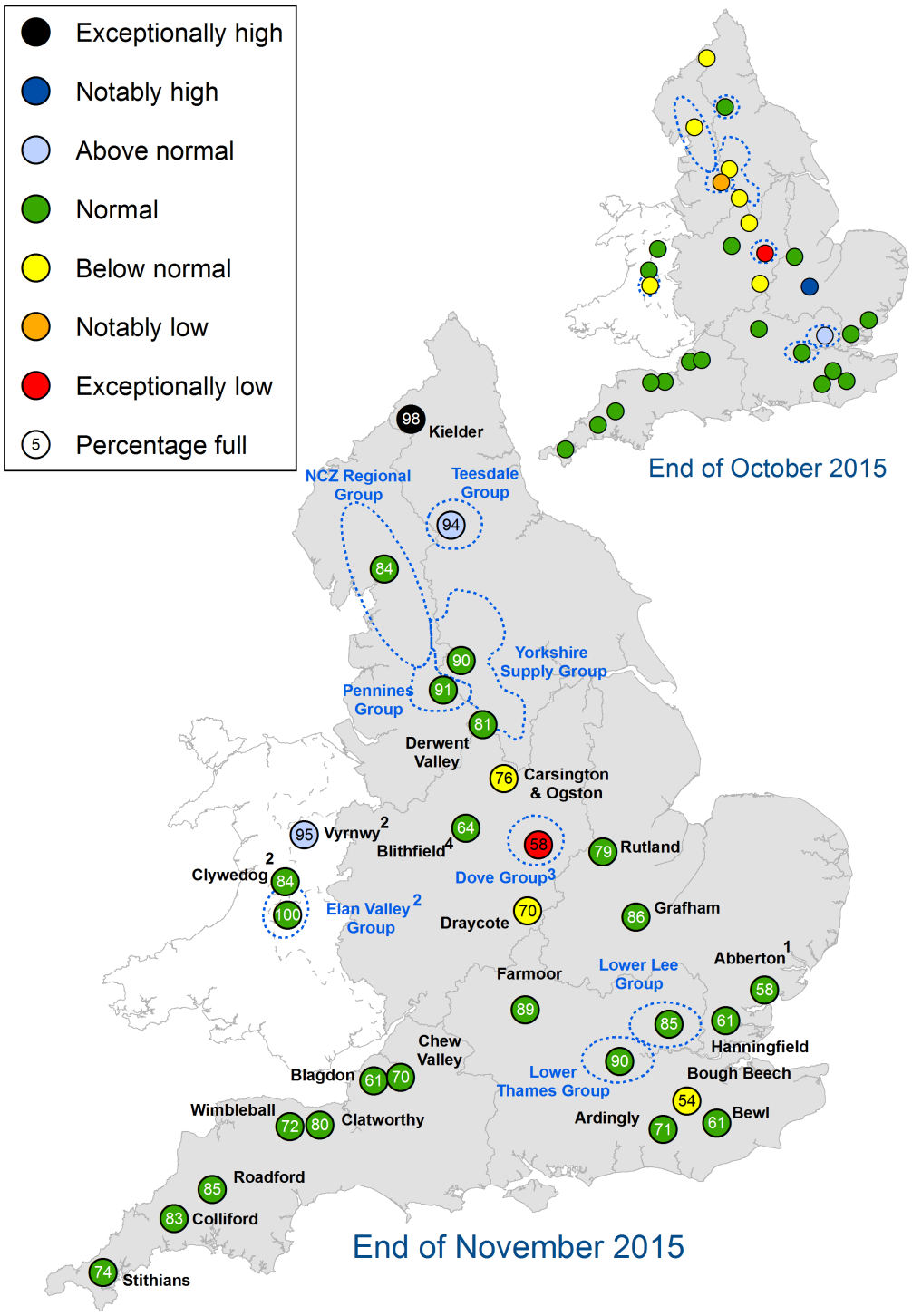


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2015).

Reservoir storage



1. Engineering work at Abberton Reservoir in east England to increase capacity has been completed
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England
3. Levels in the Dove Group are affected by ongoing operational issues
4. Latest Blithfield levels relate to 21 November

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of October 2015 and November 2015 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.

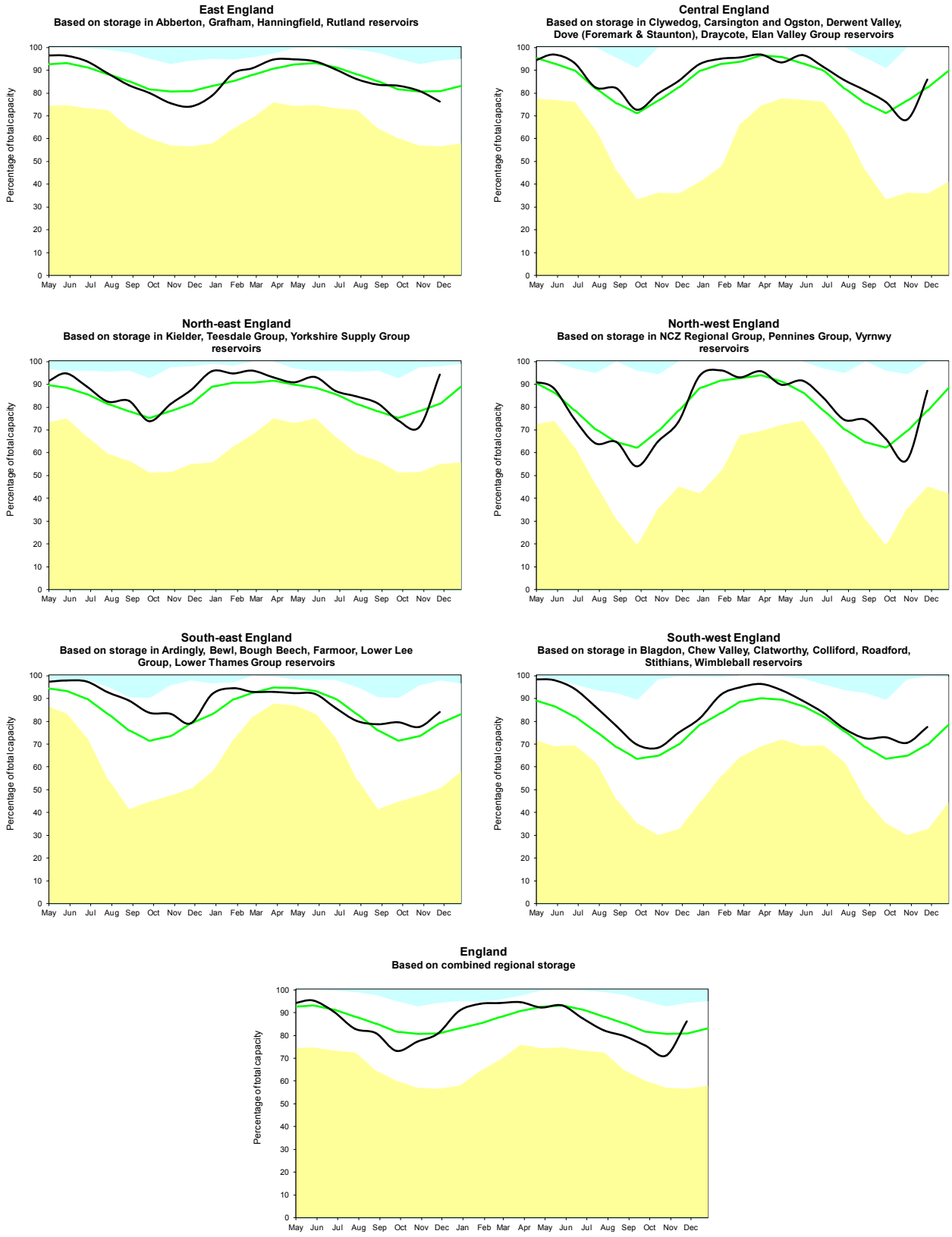


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

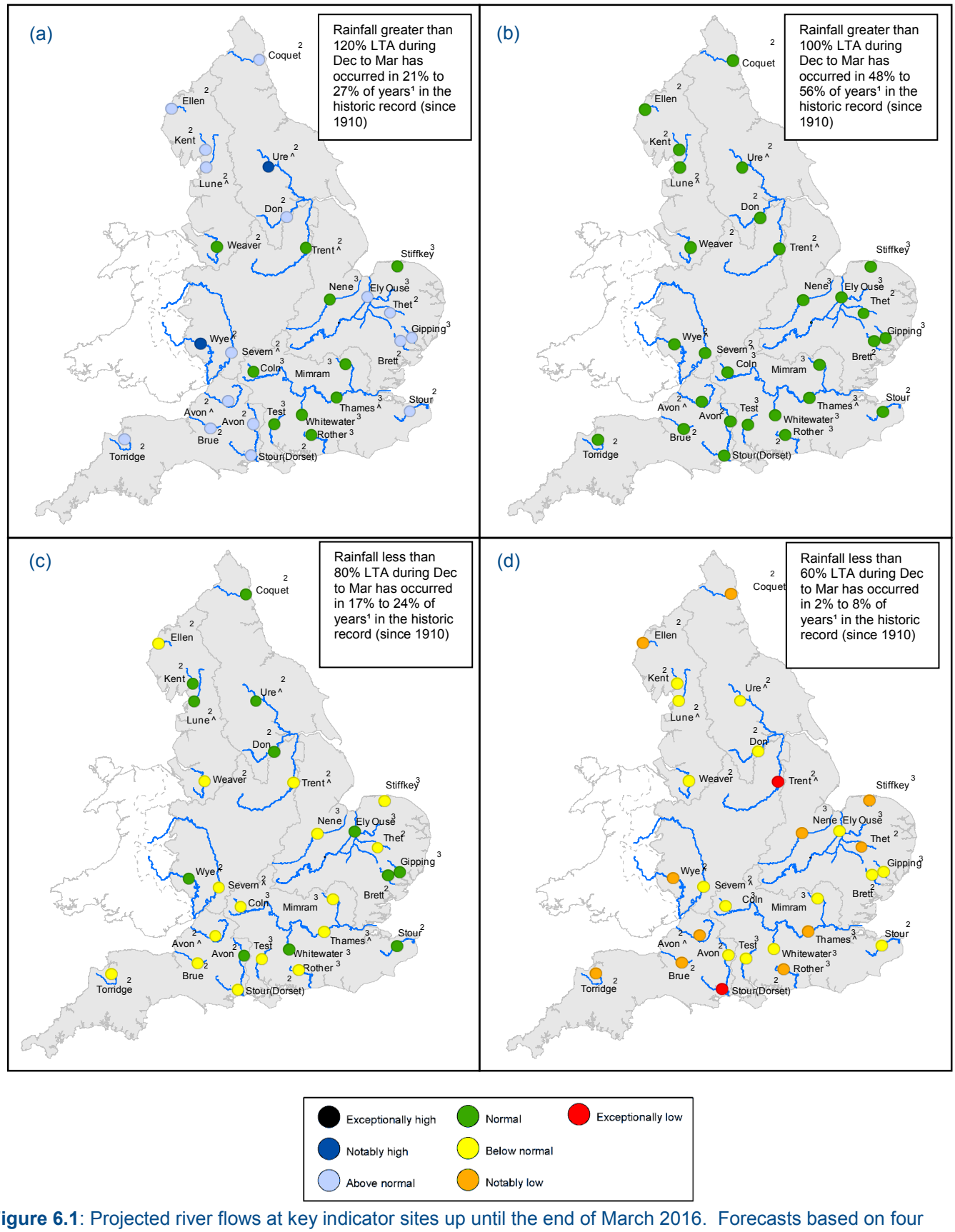
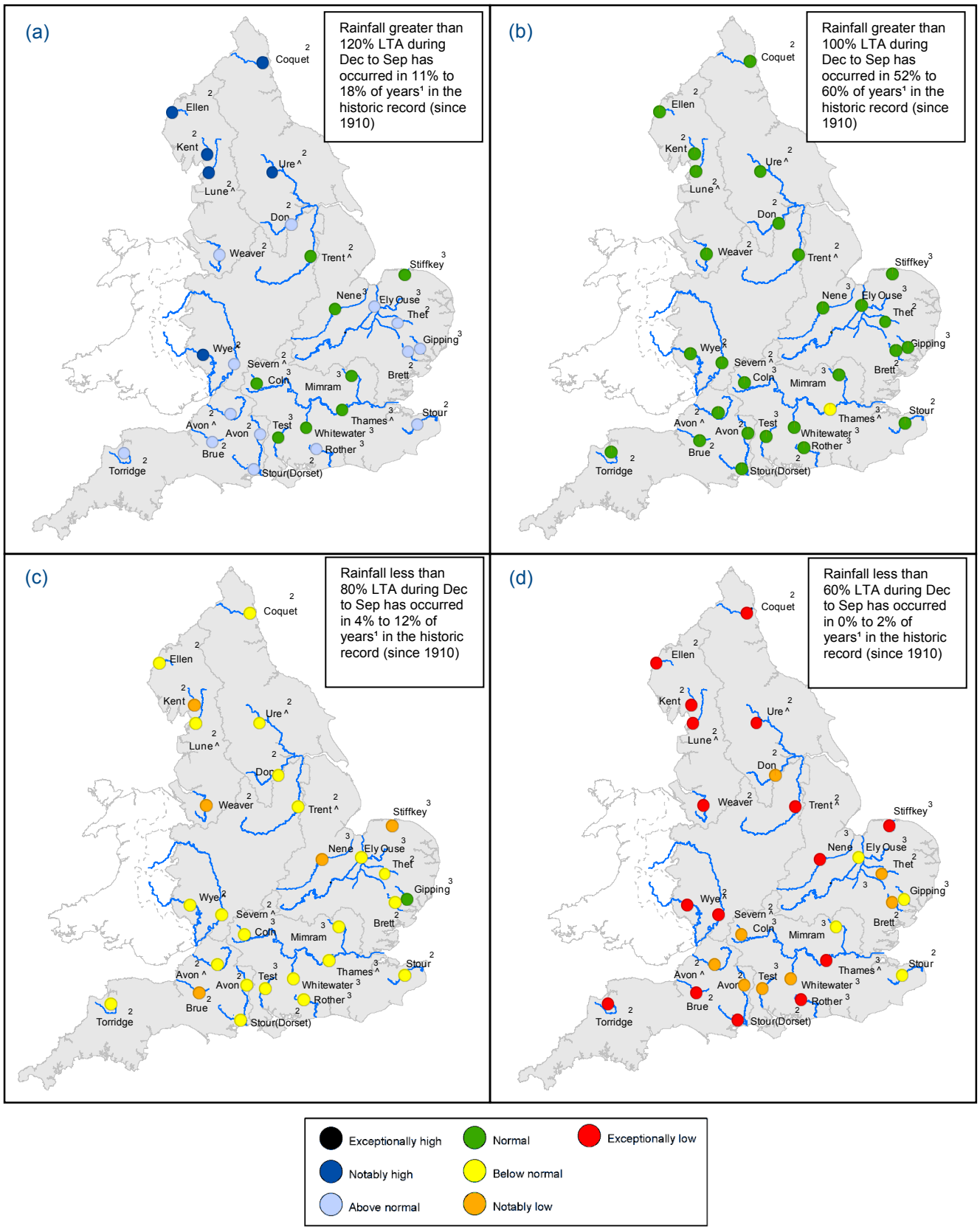


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2015 and March 2016 (Source: Centre for Ecology and Hydrology, Environment Agency)

[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*



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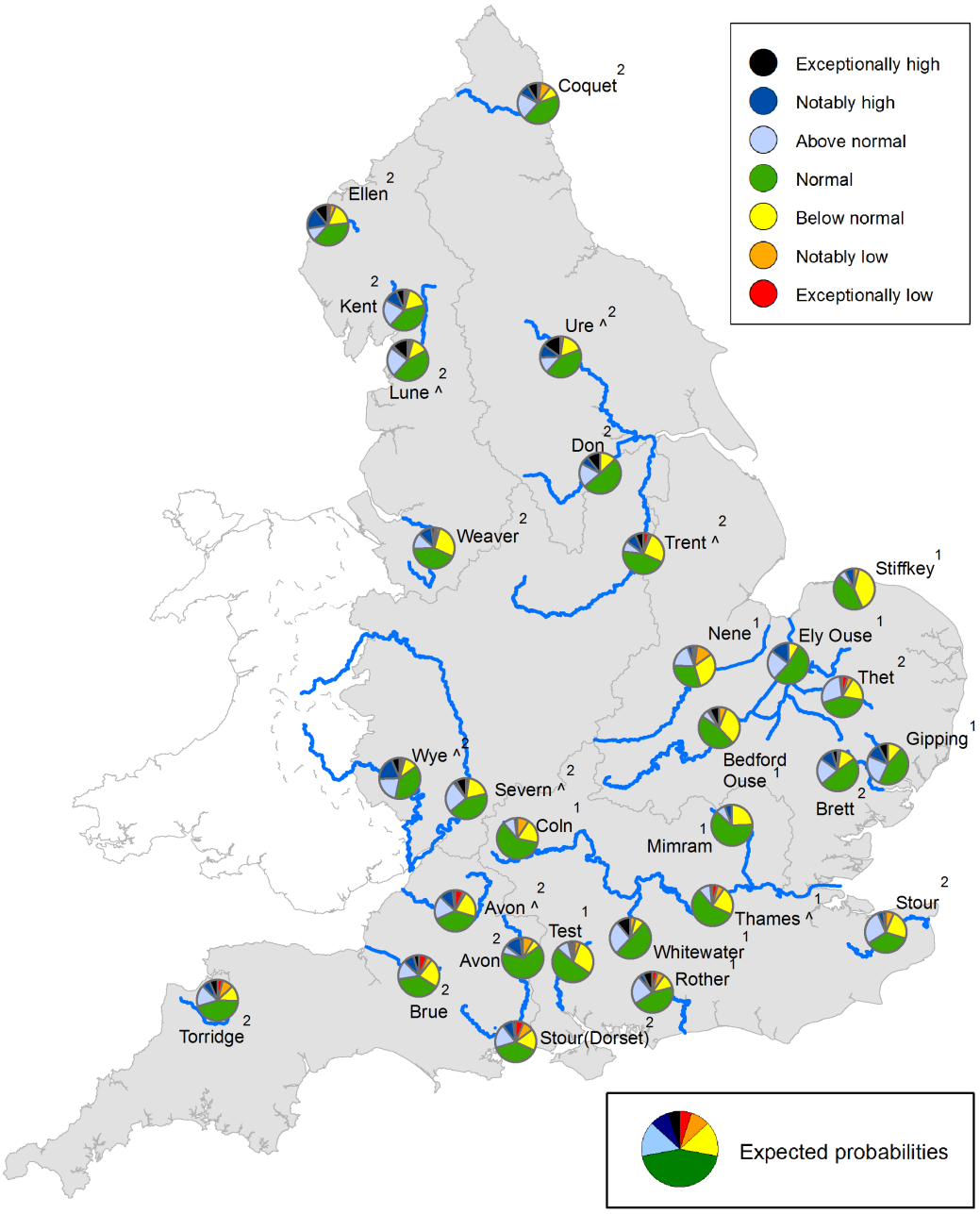

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 2016. 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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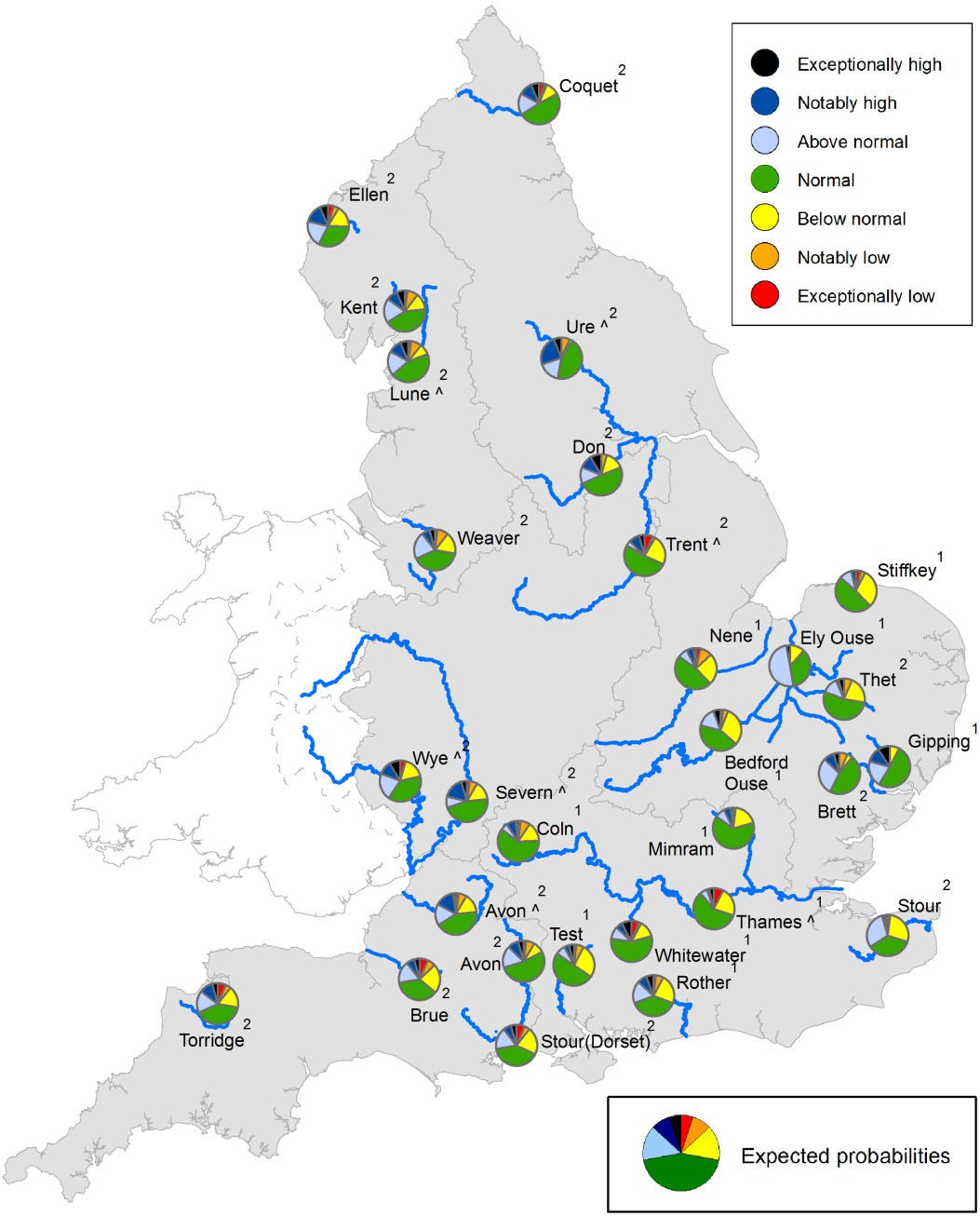

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 2016. 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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[2] Projections for these sites are produced by CEH
^"Naturalised" flows are projected for these sites

Forward look - groundwater

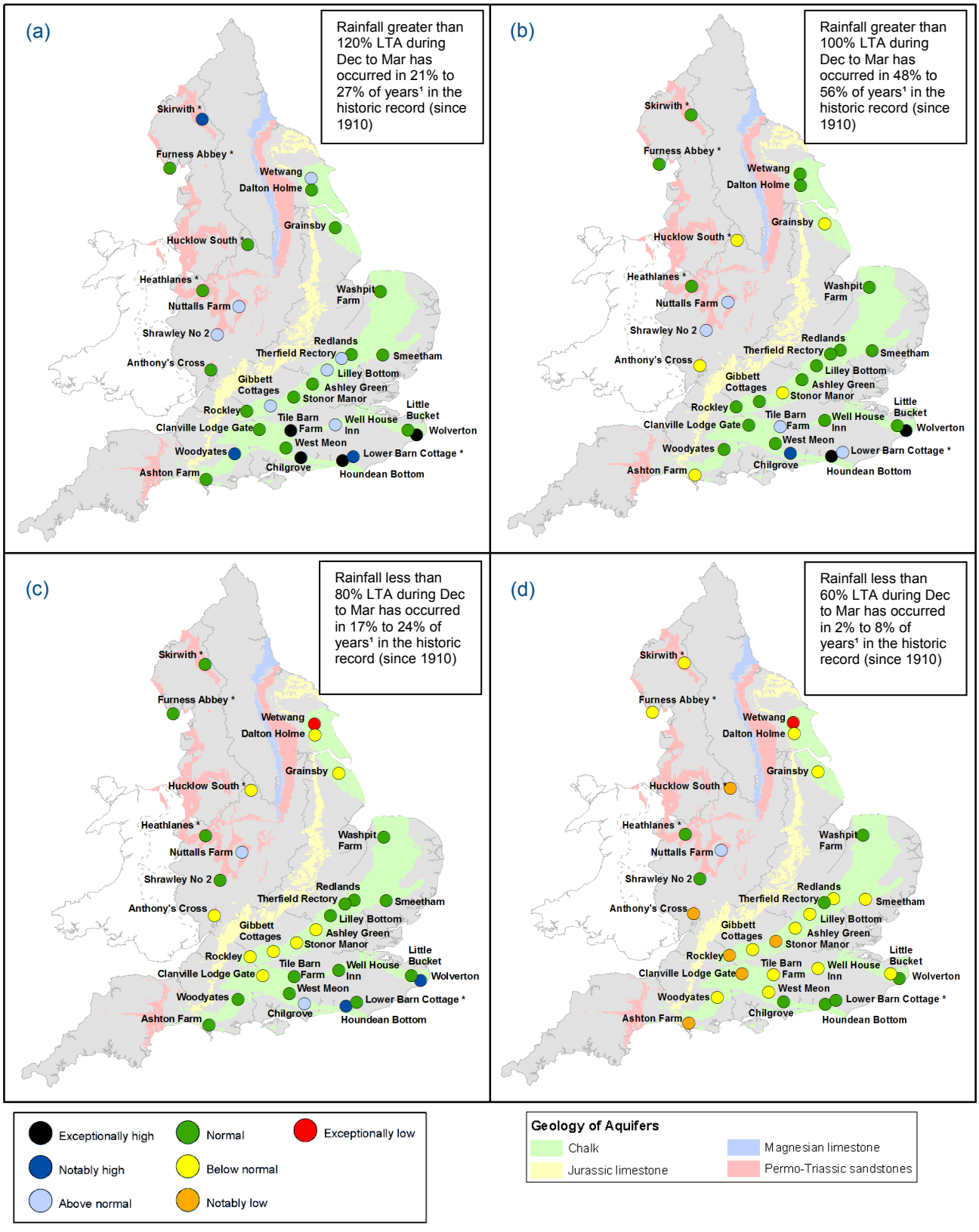

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2015 and March 2016 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2015.

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

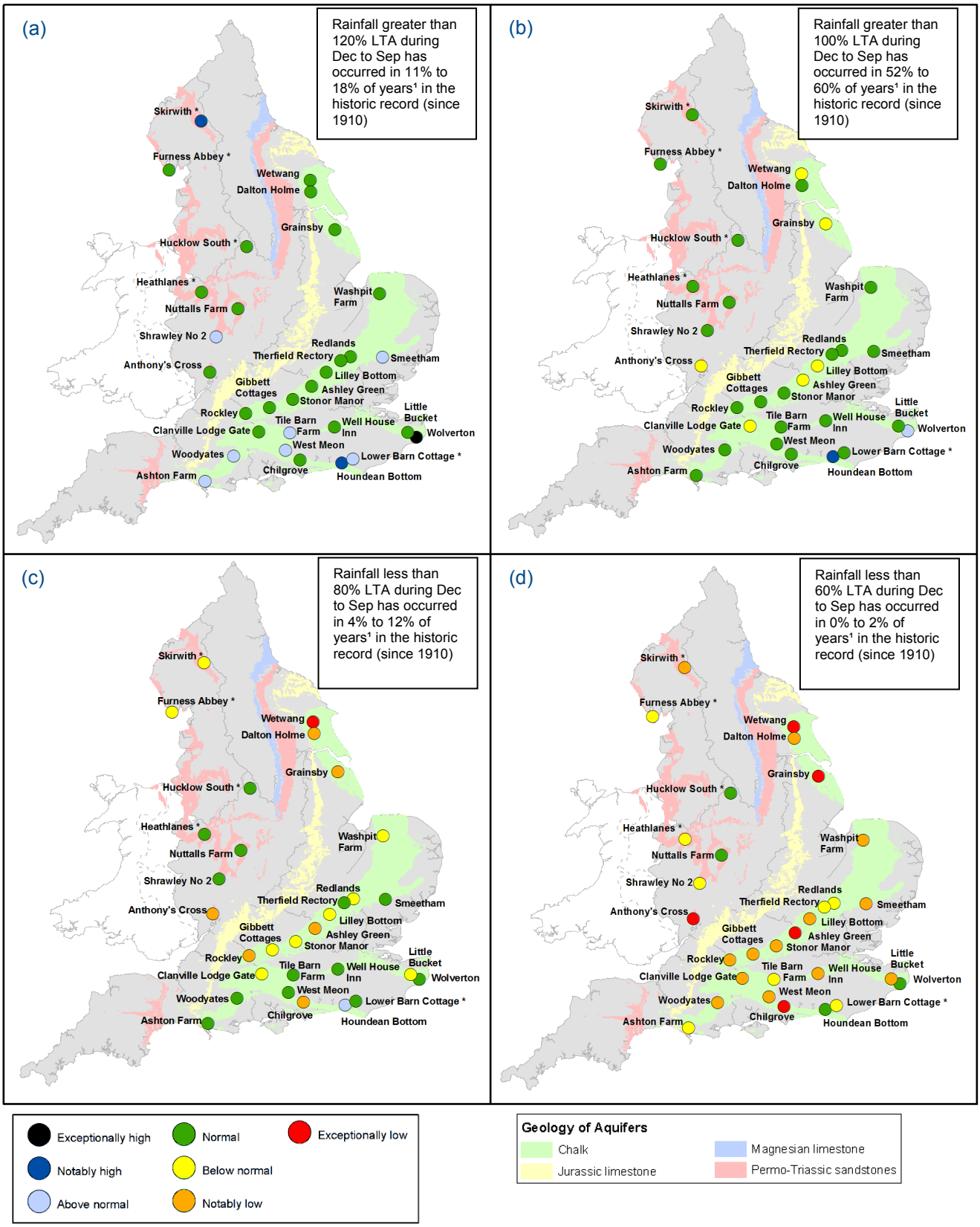

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2015 and September 2016 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2015.

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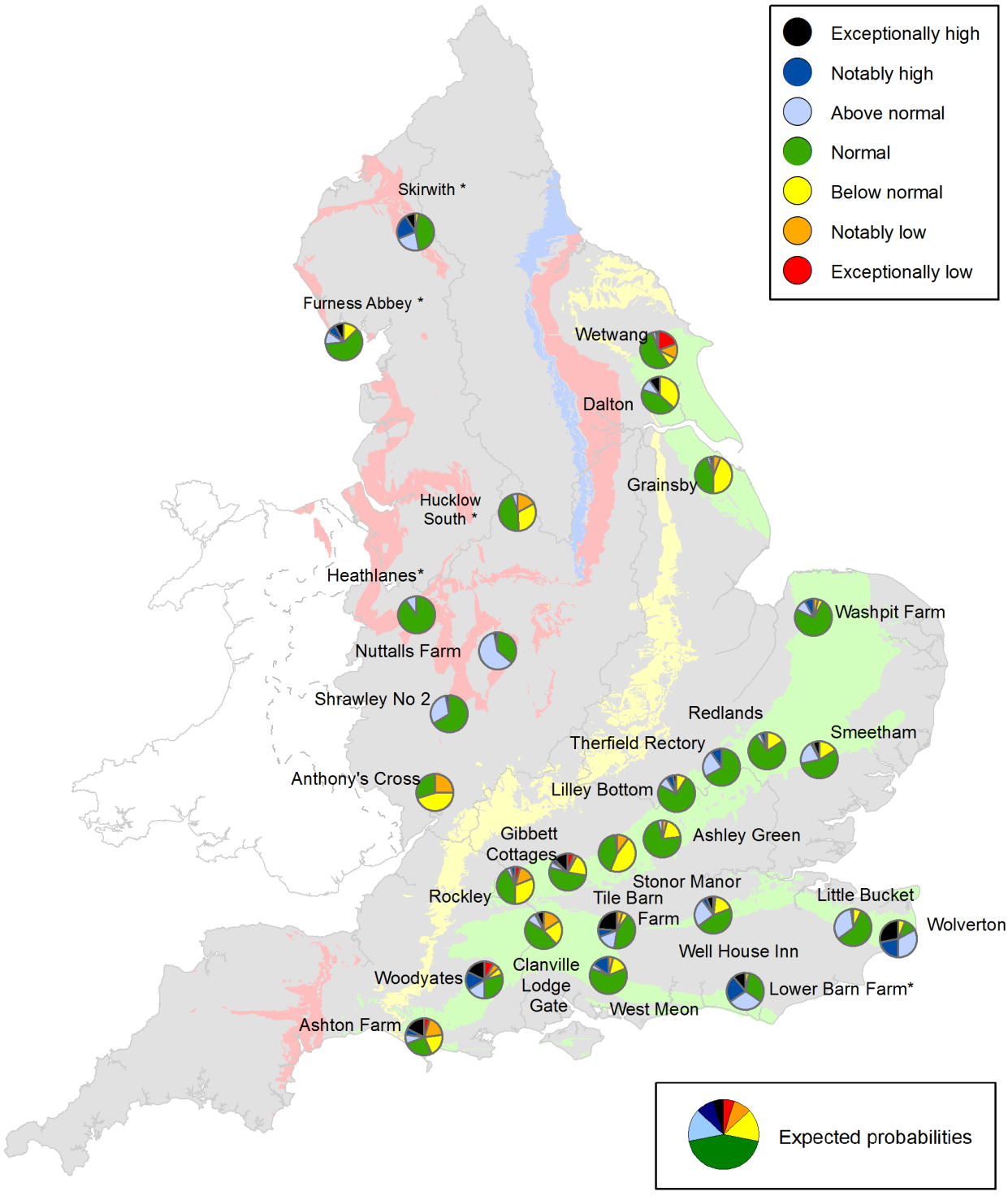
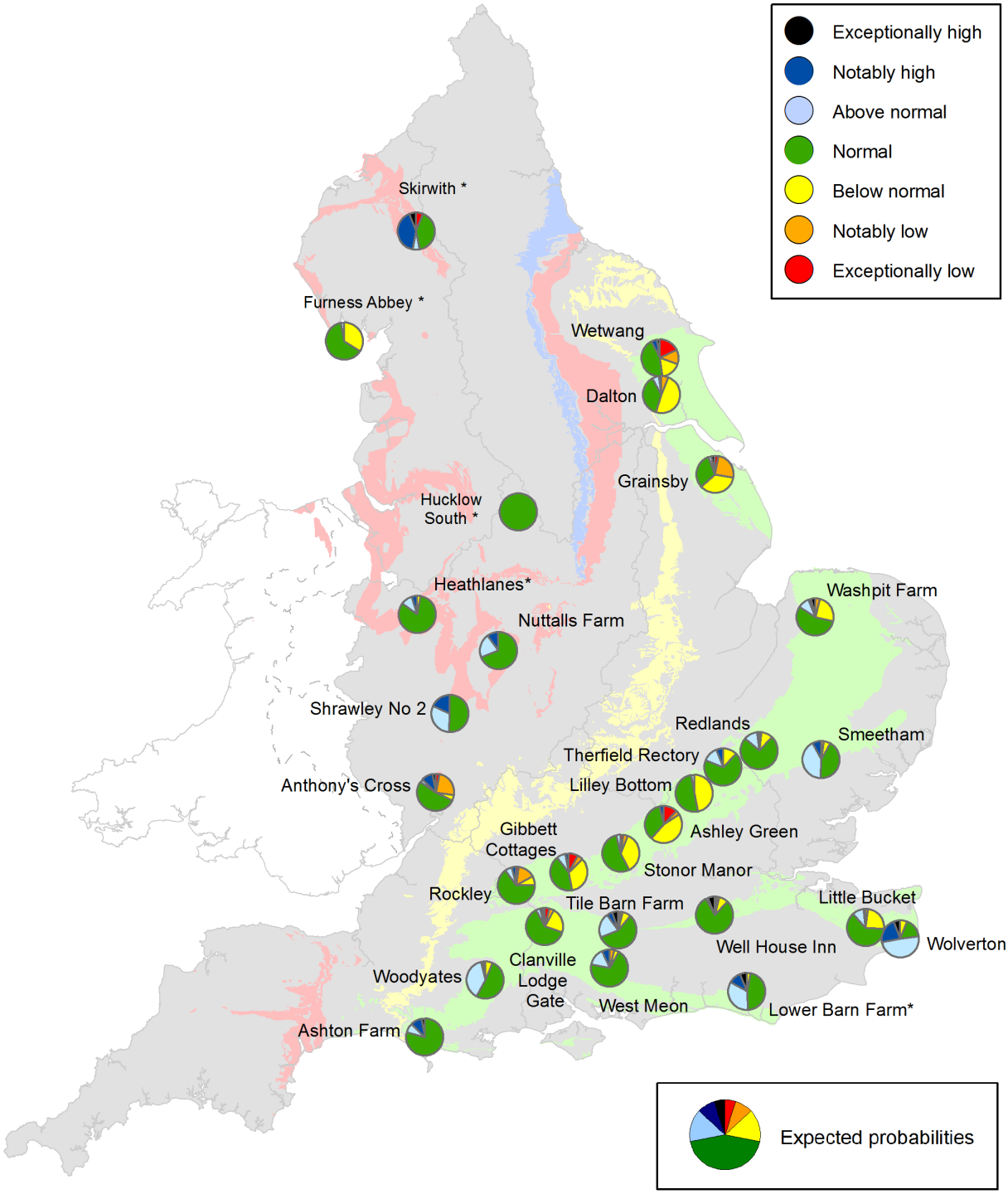


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 2016. 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, 2015.

** 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 2016. 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, 2015.

* 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