Monthly water situation report

England

Summary – December 2015

Rainfall totals for December were above average across England at 165% of the long term average (LTA). For a second consecutive month, north-east and north-west England had exceptionally high rainfall totals for the time of year. Soil moisture deficits again decreased across much of England in December by up to 31mm. Monthly mean river flows increased at all indicator sites again in December. River flows were classed as normal for the time of year at nearly two-thirds of sites, and sites in north-east and north-west England were classed as exceptionally high for the time of year in response to significant rainfall events during December. Groundwater levels increased at approximately two-thirds of indicator sites during December and two thirds of sites were classed as normal or higher for the time of year. Reservoir stocks increased at nine-tenths of the reported reservoirs and reservoir groups during December. Stocks were classed as normal or higher for the time of year at more than three-quarters of reservoirs and reservoir groups. Overall reservoir storage for England increased to 93% of total capacity.

Rainfall

Rainfall totals for December ranged from less than 50 mm across a number of catchments in east and south-east England to more than 400 mm across parts of Cumbria, Lancashire and the Welsh borders. Monthly rainfall totals were above the December LTA in three-quarters of hydrological areas. Most hydrological areas in north-east England, north-west England and the Welsh borders received more than twice the December LTA rainfall. Most of east, south-east and south-west England received rainfall roughly equal to the December LTA (Figure 1.1).

December rainfall totals were above normal or higher for the time of year across most of central, north and west England; the majority of catchments in north-east and north-west England received exceptionally high rainfall for the time of year (Figure 1.2). Totals were normal for the time of year across the rest of England. In Cumbria, Lancashire, Northumberland, Yorkshire and parts of Wales there were 15 catchments where the rainfall for December was the highest monthly total on record for any month (since 1910). 17 catchments received the highest December rainfall total on record, whilst in Northumberland and County Durham there were 3 catchments for which the rainfall for December was the 2nd highest on record, second only to 1978. Over the 3, 6 and 12 month periods to the end of December, cumulative rainfall totals were normal across most of central, east, south-east and south-west England. In north-east and north-west England cumulative rainfall totals to the end of December for the last 3, 6 and 12 months were mostly above normal or higher.

At the regional scale December rainfall totals were above average in all parts of England, ranging from 103% of the LTA in east England to 289% in north-west England. Rainfall totals across England as a whole were above average for the time of year at 165% of the December LTA (Figure 1.3).

Soil moisture deficit

Soil moisture deficits (SMDs) decreased during December across much of England. At the end of December, SMDs were at or close to zero across much of England. Soils were slightly drier across parts of Lincolnshire, Cambridgeshire and Norfolk with SMDs generally between 10 and 40mm; SMDs in two squares in Lincolnshire and Cambridgeshire remain between 40 and 70mm. End of month SMDs were at or smaller than the LTA across most of England with soils being wetter than average in parts of Yorkshire, the Midlands, London and the Thames Estuary and for parts of the south coast. In parts of Lincolnshire, Hampshire and Berkshire, however, soils were drier than average for the time of year (Figure 2.1).

At a regional scale, SMDs decreased during December across all regions, with month end values ranging from less than 1mm in south-west and north-west England to 21mm in east England. At the end of December, soils were wetter than average across much of England but average in east England (Figure 2.2).

River flows

Monthly mean river flows for December increased at all indicator sites across England compared with November. Monthly mean river flows were classed as normal for the time of year at almost two-thirds of the indicator sites; mainly at sites across central, east, south-east and south-west England. Sites in north-east, north-west and west England were exceptionally high for the time of year in response to significant rainfall events during December. For 8 indicator sites, the month mean flows were the highest on record for December; by contrast the River Lud in east England remains below normal for December (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 and the South Tyne at Haydon Bridge in north-east England remained exceptionally high for December (Figure 3.2)

Groundwater levels

Groundwater levels rose at approximately two-thirds of all indicator sites during December. At the end of December groundwater levels were classed as normal for the time of year at nearly half of all indicator sites and were classed as normal or higher for the time of year at two-thirds of the sites. Levels at 9 sites were classed as below normal or lower. Notably low levels for the end of December were recorded at Ashley Green (Chilterns East Chalk aquifer) and Woodleys (Otter Valley Sandstone aquifer) (Figure 4.1).

End of month groundwater levels at the major aquifer index sites were normal for the time of year at 5 out of the 8 sites; Dalton Holme (in the Hull and East Riding chalk aquifer) was below normal, Skirwith (in the Carlisle Basin and Eden Valley sandstone aquifer) was notably high and Stonor Park (in the South West Chilterns chalk) was below normal for the time of year (Figure 4.2).

Reservoir storage

Reservoir stocks increased at the majority of reported reservoirs and reservoir groups during December. At Grafham water in east England, and Carsington and Ogston in central England, stocks remained the same, whilst at Farmoor in south-east England stocks decreased by 11% through the month. The greatest increases in storage were at Bough Beech reservoir in south-east England (30%), and Blithfield reservoir in central England (26%). End of month stocks were classed as normal or higher for the time of year at most reservoir 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 December by up to 11%. At the end of December, regional stocks ranged from 83% of total capacity in east England to 99% in north-west England. Overall reservoir storage for England increased by 7% to 93% of total capacity (Figure 5.2).

Forward look

January is likely to remain unsettled, with a mixture of sunshine and showers giving way to colder conditions and a chance of snow in places before a return of further rainfall towards the end of the month. Rainfall totals are likely to be above average in the north and west and slightly below average in the south and east. For the next three months (January-February-March) while it is likely there will be above average rainfall at first, at the moment there is still an equal chance of either above average or below average rainfall totals for the whole period[1].

Projections for river flows at key sites[2]

Nearly two thirds of sites, mostly in north and west England, have a greater than expected chance of above normal or higher cumulative flows between January and March 2016. Between January and the end of September 2016 nearly half of the sites have a greater than expected chance of above normal or higher 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]

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).

At the end of March 2016 the projections show a mixed picture of probable groundwater levels. A third of sites, in sandstone aquifers of north-west England, central England and in chalk aquifers in the far south and east of England have a greater than expected chance of above normal or higher groundwater levels at the end of March 2016. Also at the end of March 2016, a quarter of sites have a greater than expected chance of below normal or lower groundwater levels. At the end of September 2016 nearly a third of sites have a greater than expected chance of above normal or higher groundwater levels, and a third of sites have a greater than expected chance of below normal or lower groundwater levels.

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

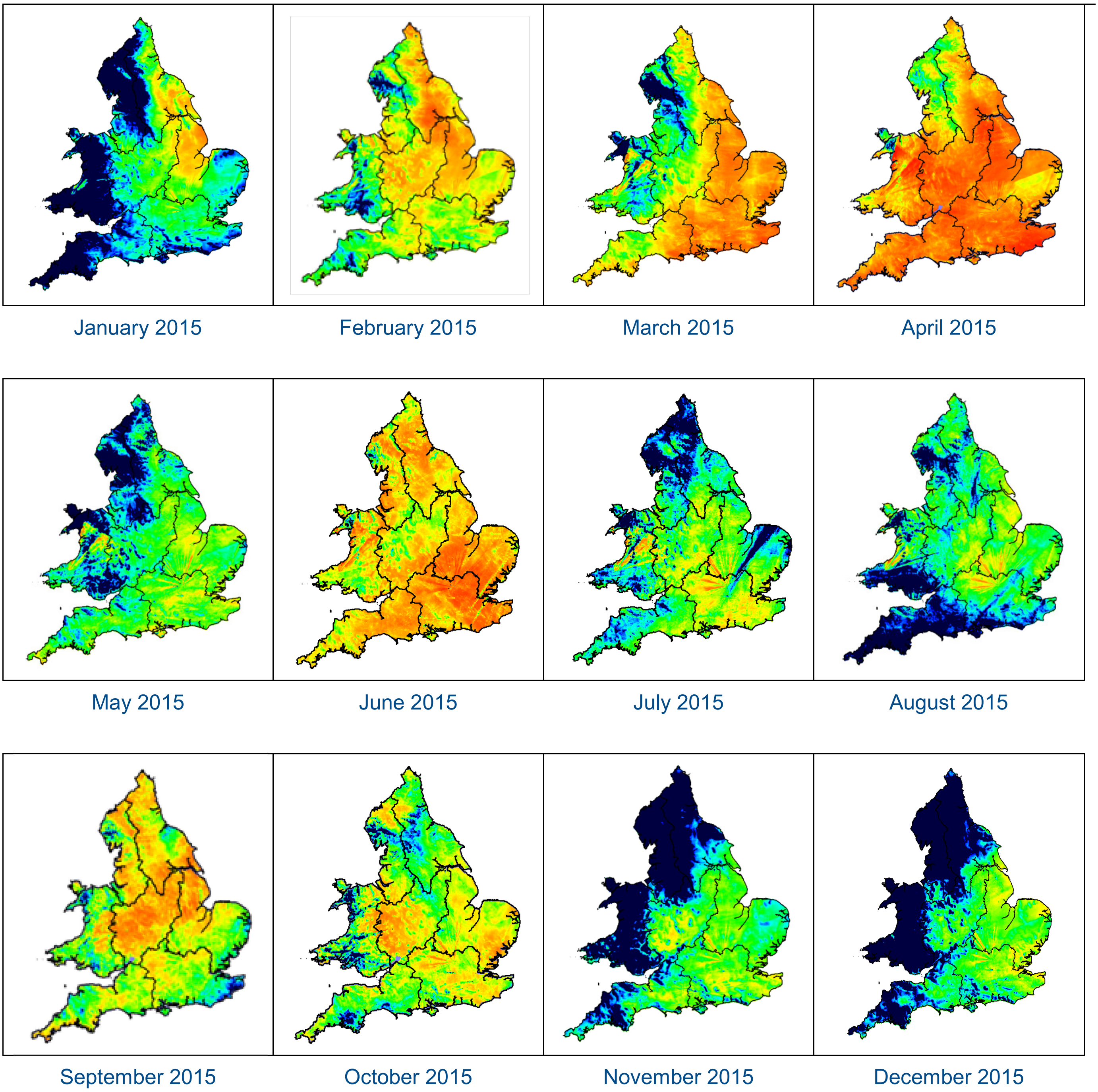
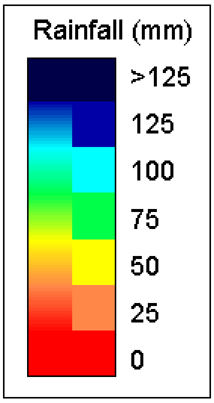


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2016). Note: Radar beam blockages in some regions may give anomalous totals in some areas.



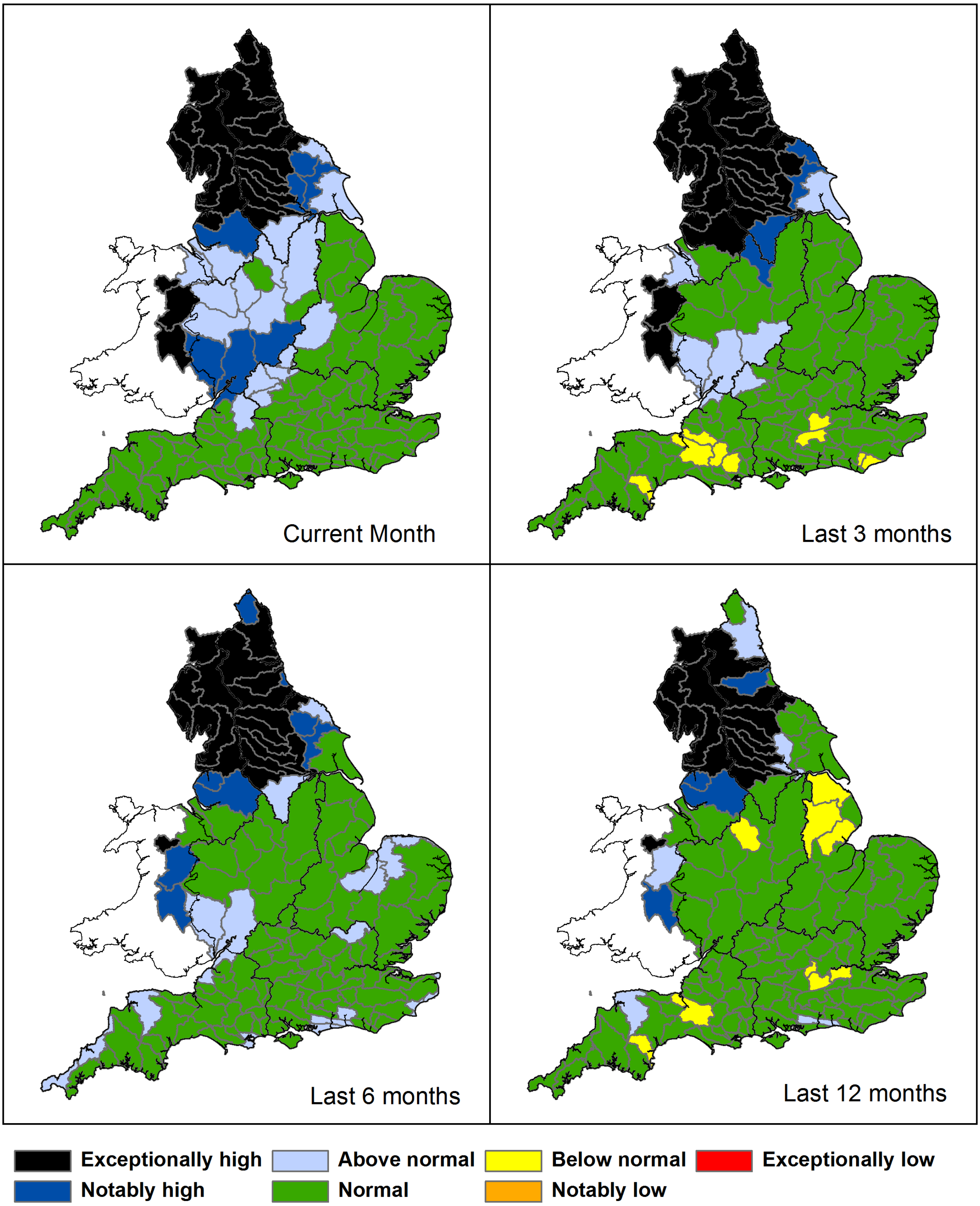


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 December), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2016)*. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

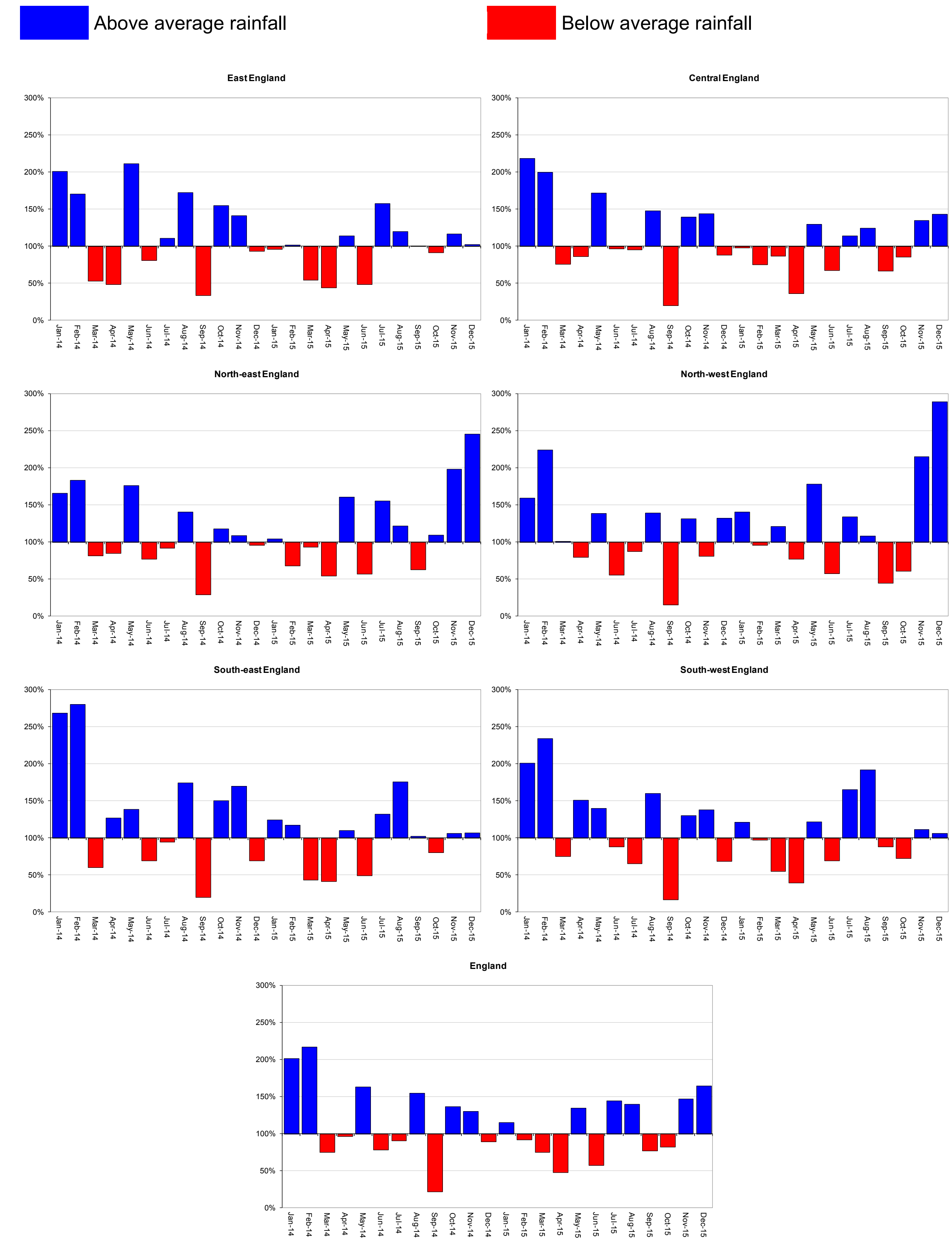
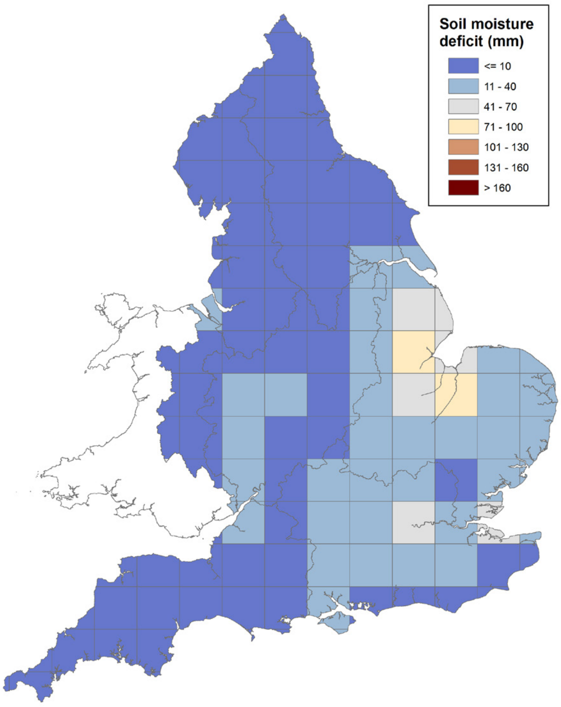
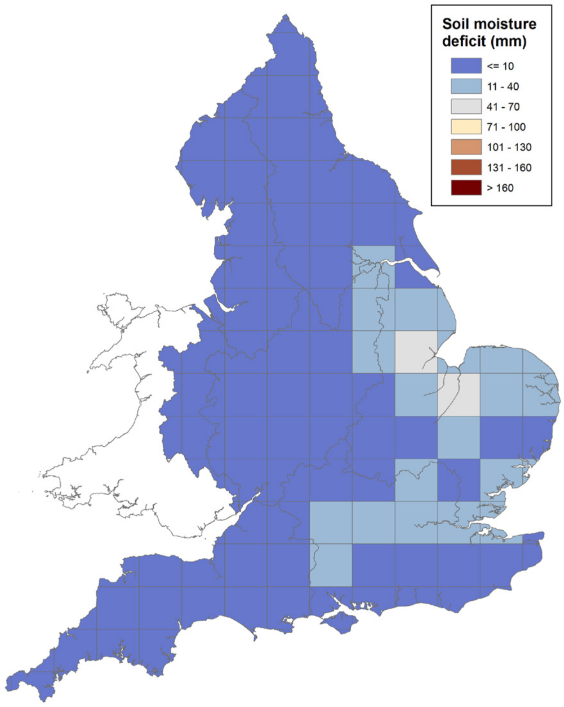


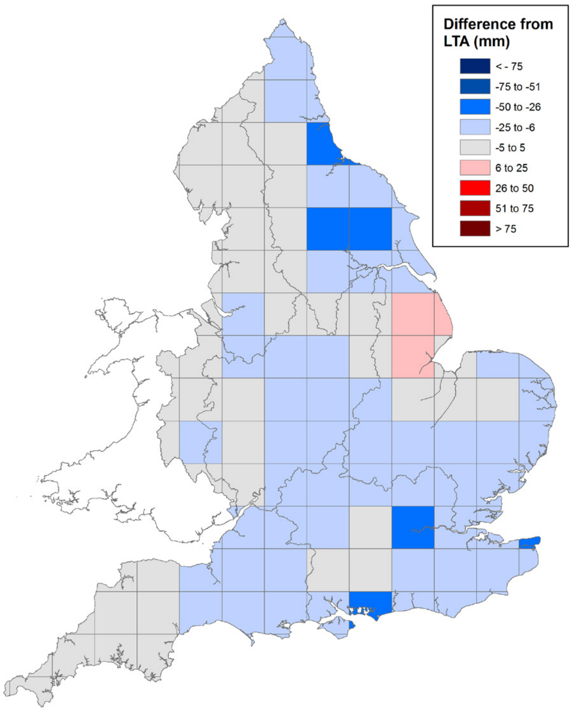
Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2016).

Soil moisture deficit

End of November 2015[1]	End of December 2015[2]







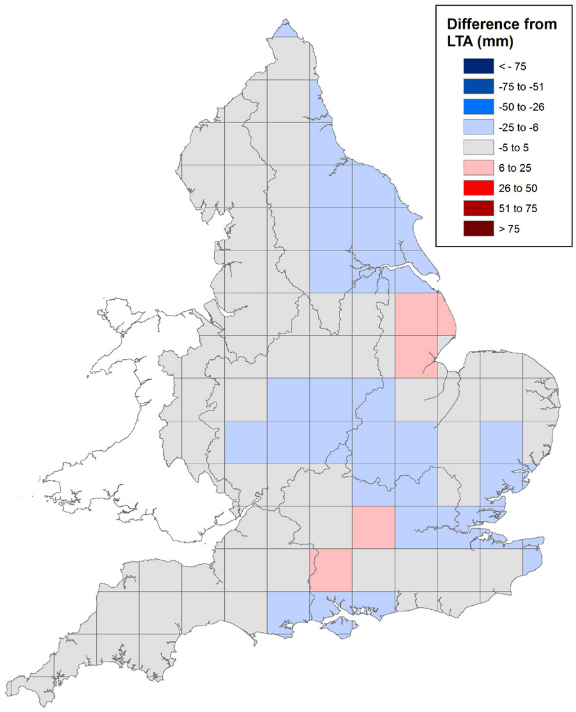


Figure 2.1: Soil moisture deficits for weeks ending 1 December 2015 [1] (left panel) and 29 December 2015 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2016). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016

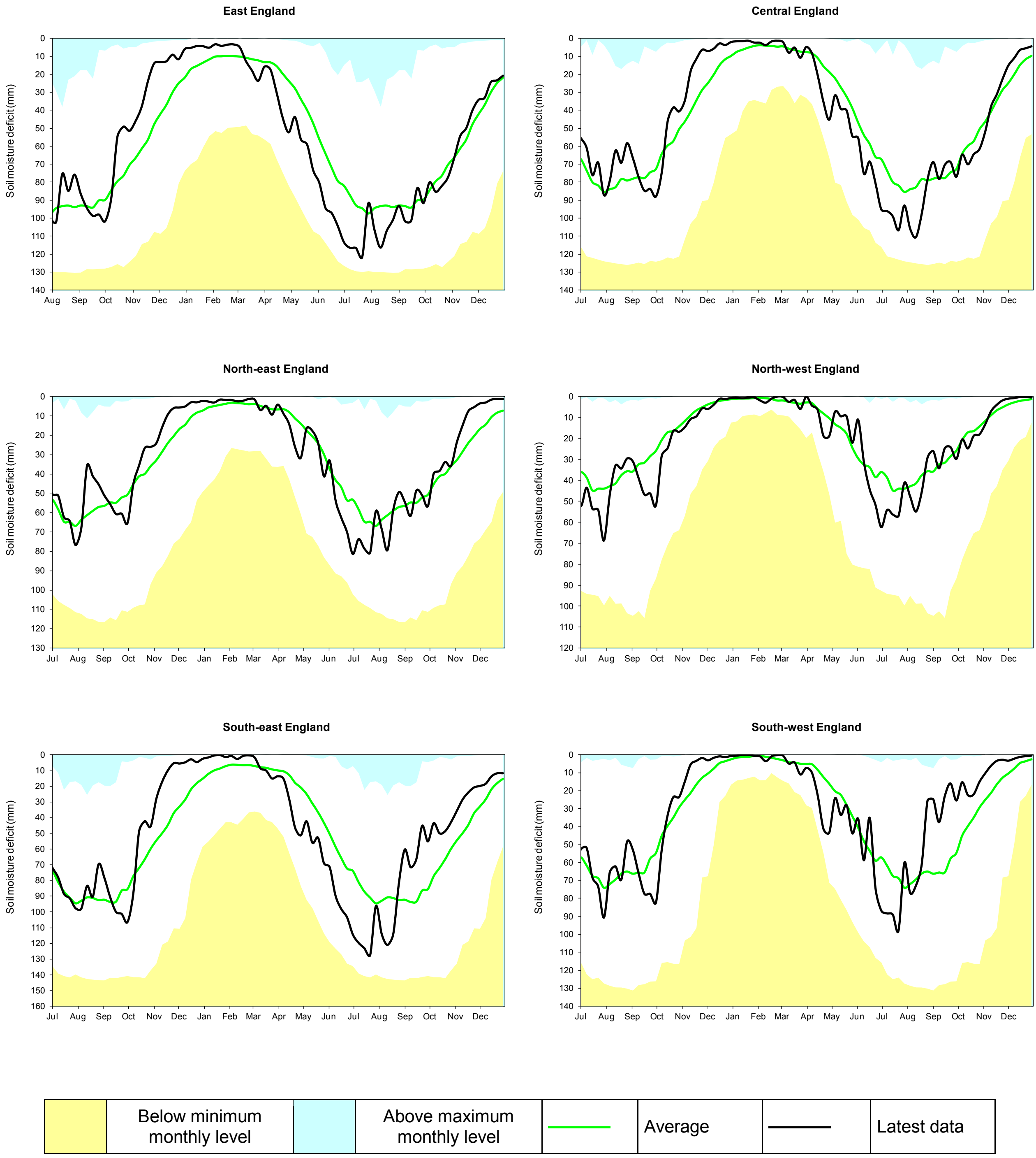
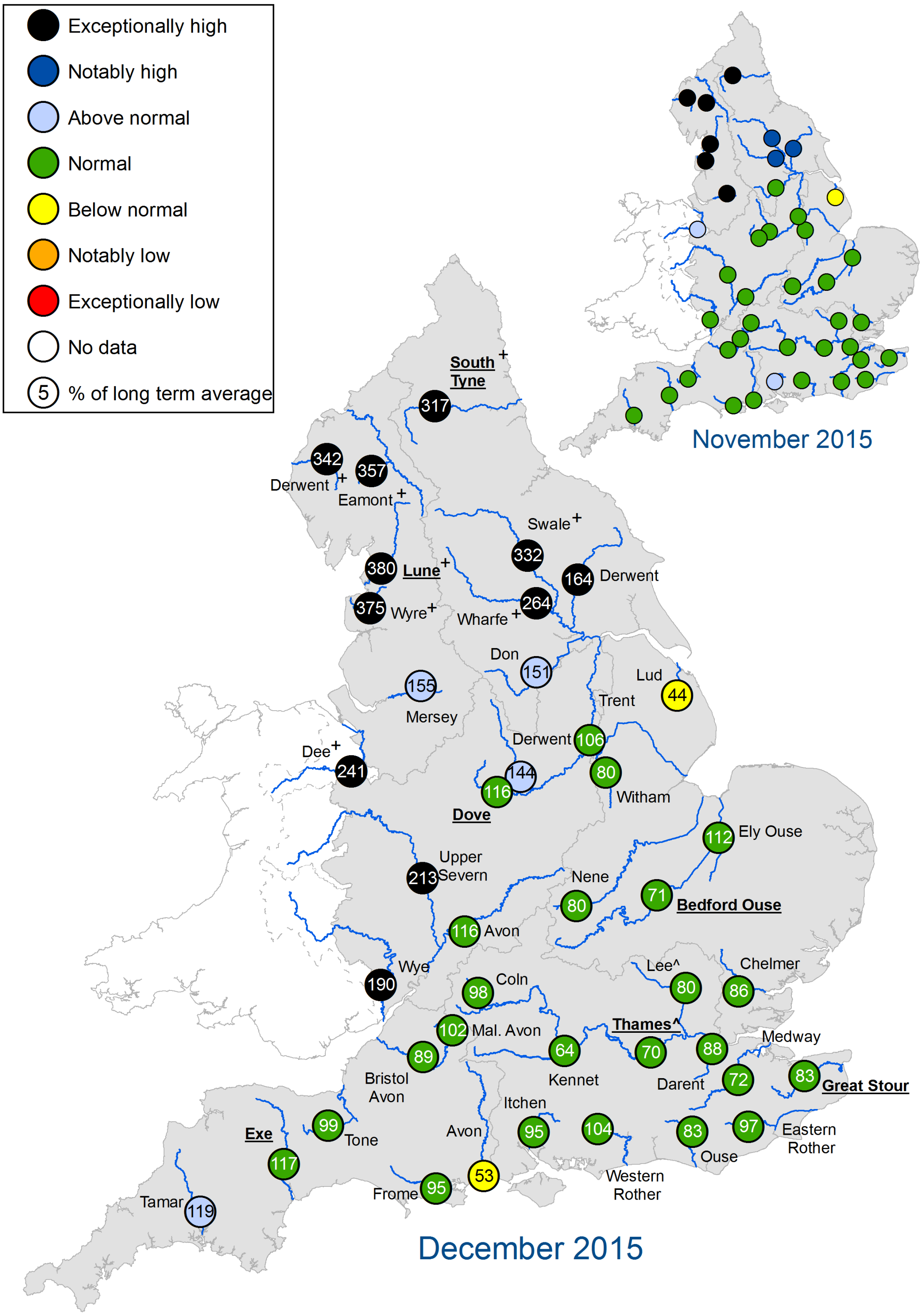


Figure 2.2: Latest soil moisture deficits for all regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2016).

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, also that these figures are provisional subject to validation)

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 November 2015 and December 2015, expressed as a percentage of the respective long term average and classed relative to an analysis of historic November and December monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

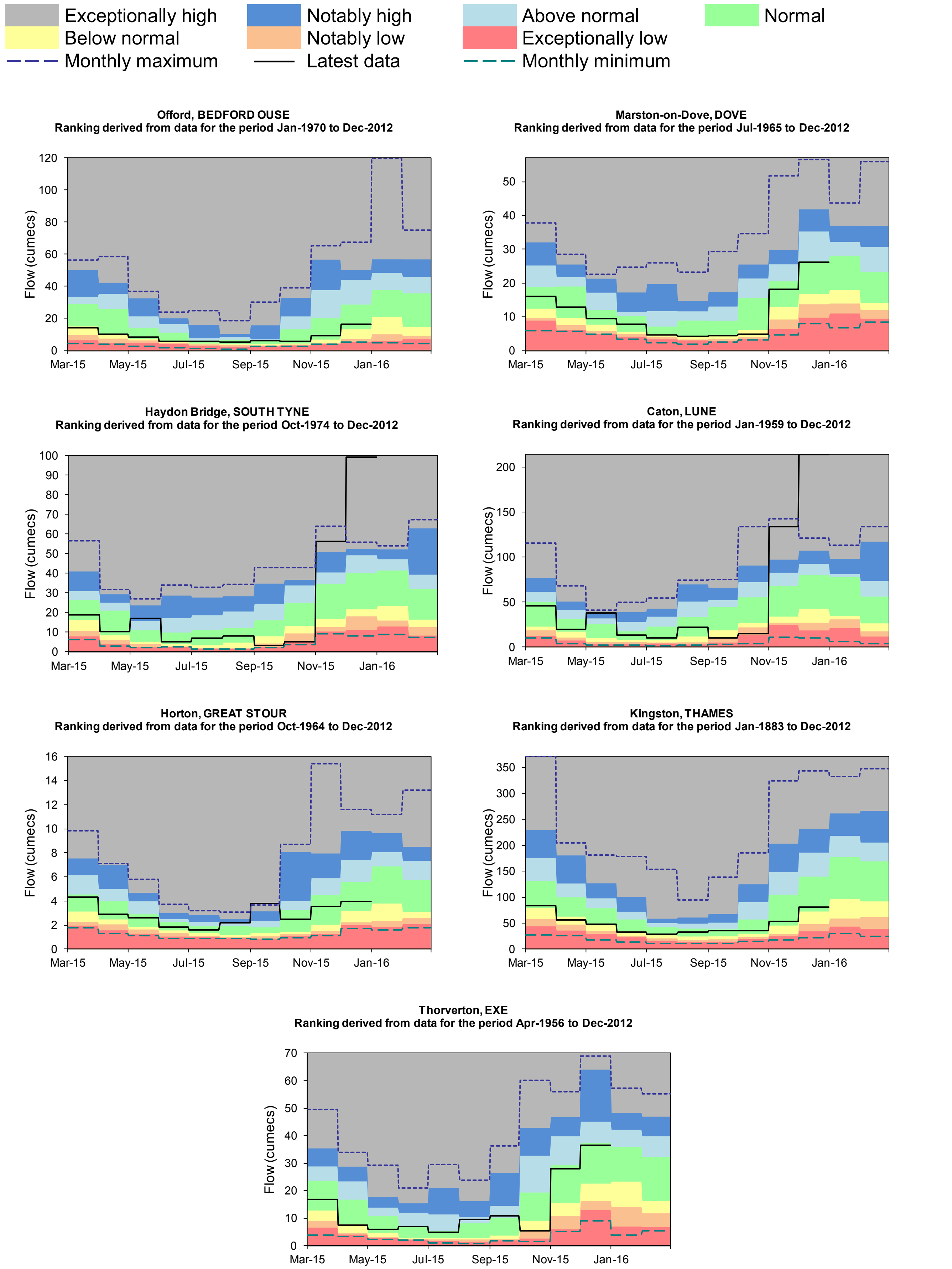
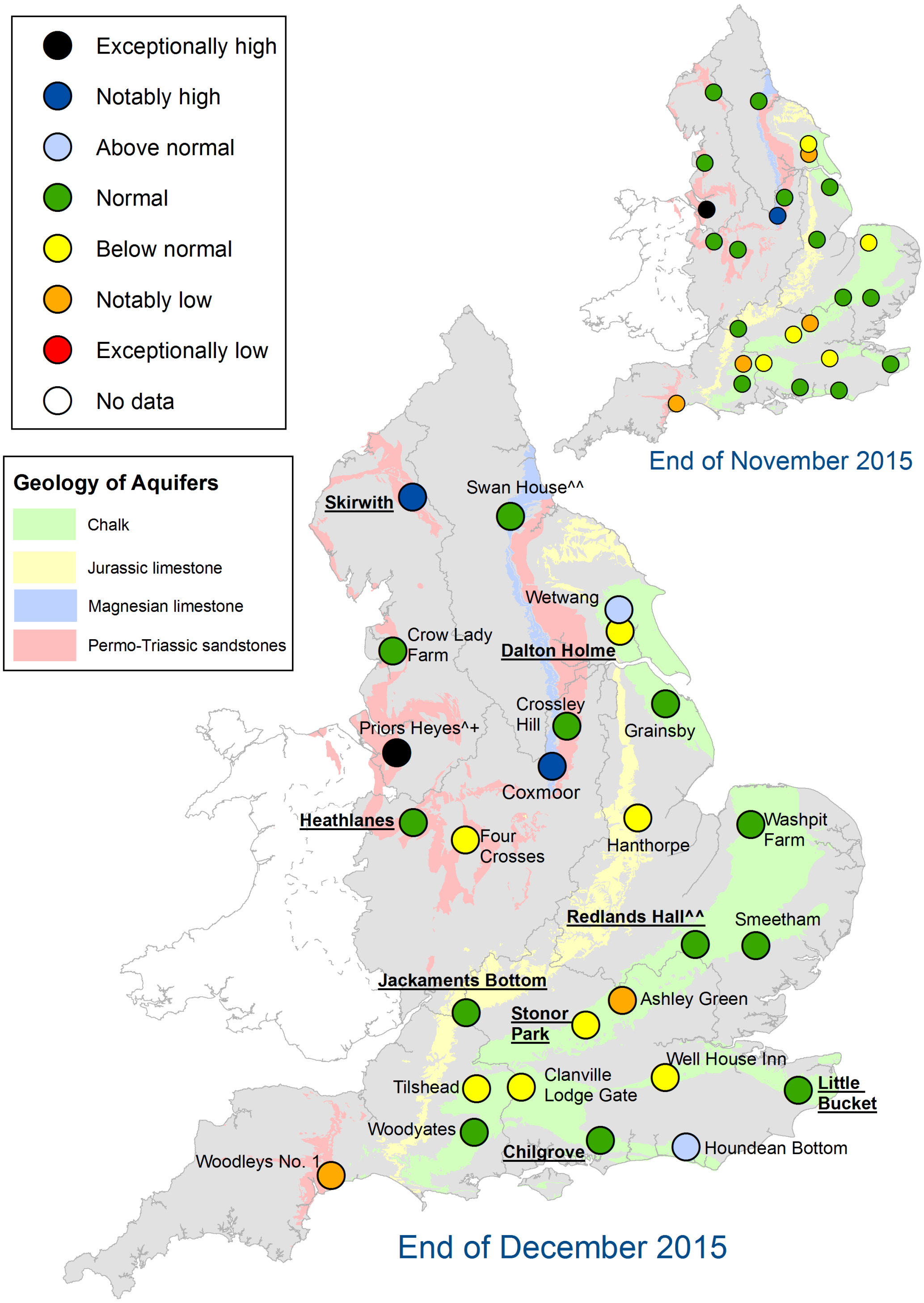


Figure 3.2: Index river flow sites for each Environment Agency Region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 November 2015 and December 2015, classed relative to an analysis of respective historic November and December levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

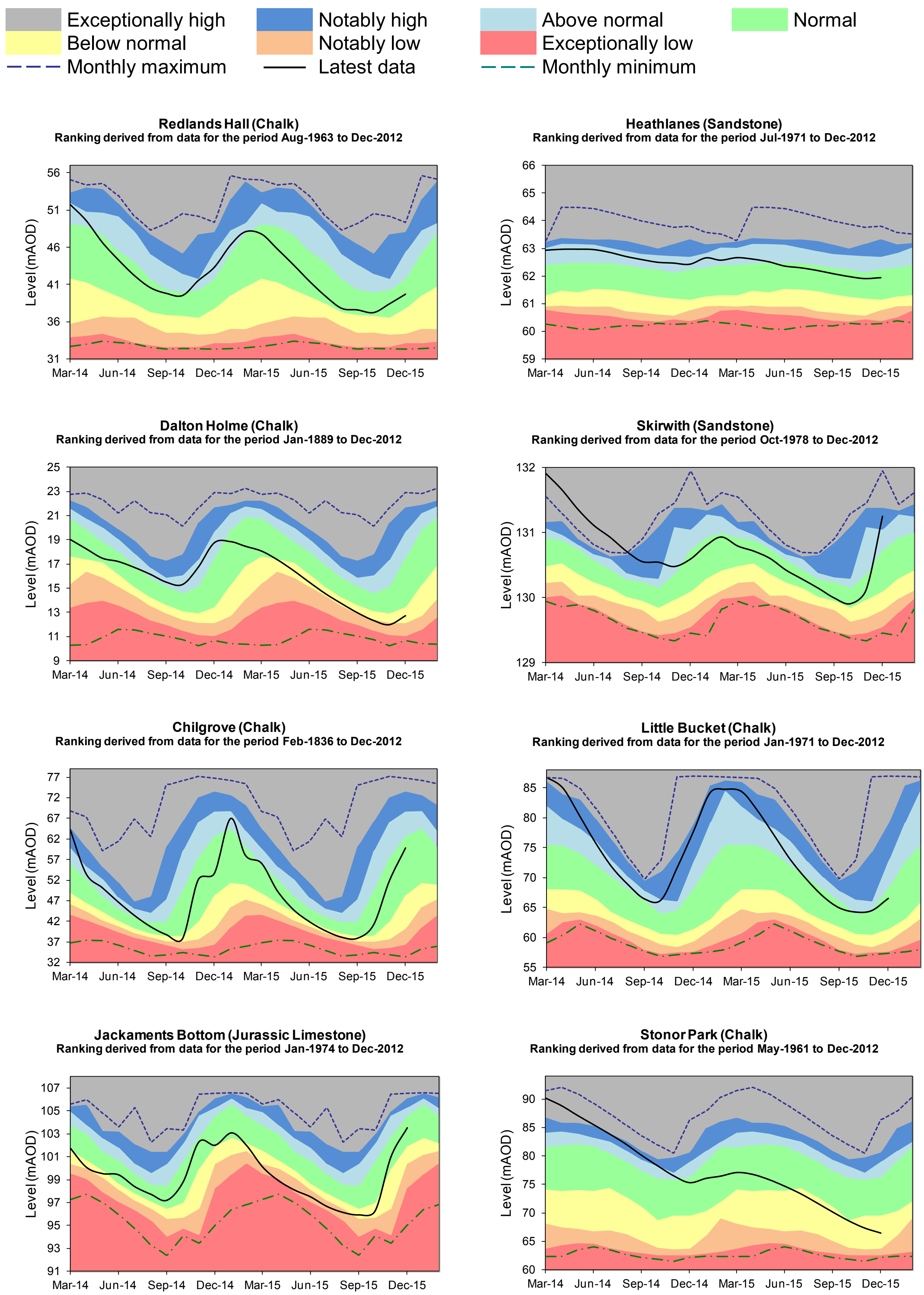
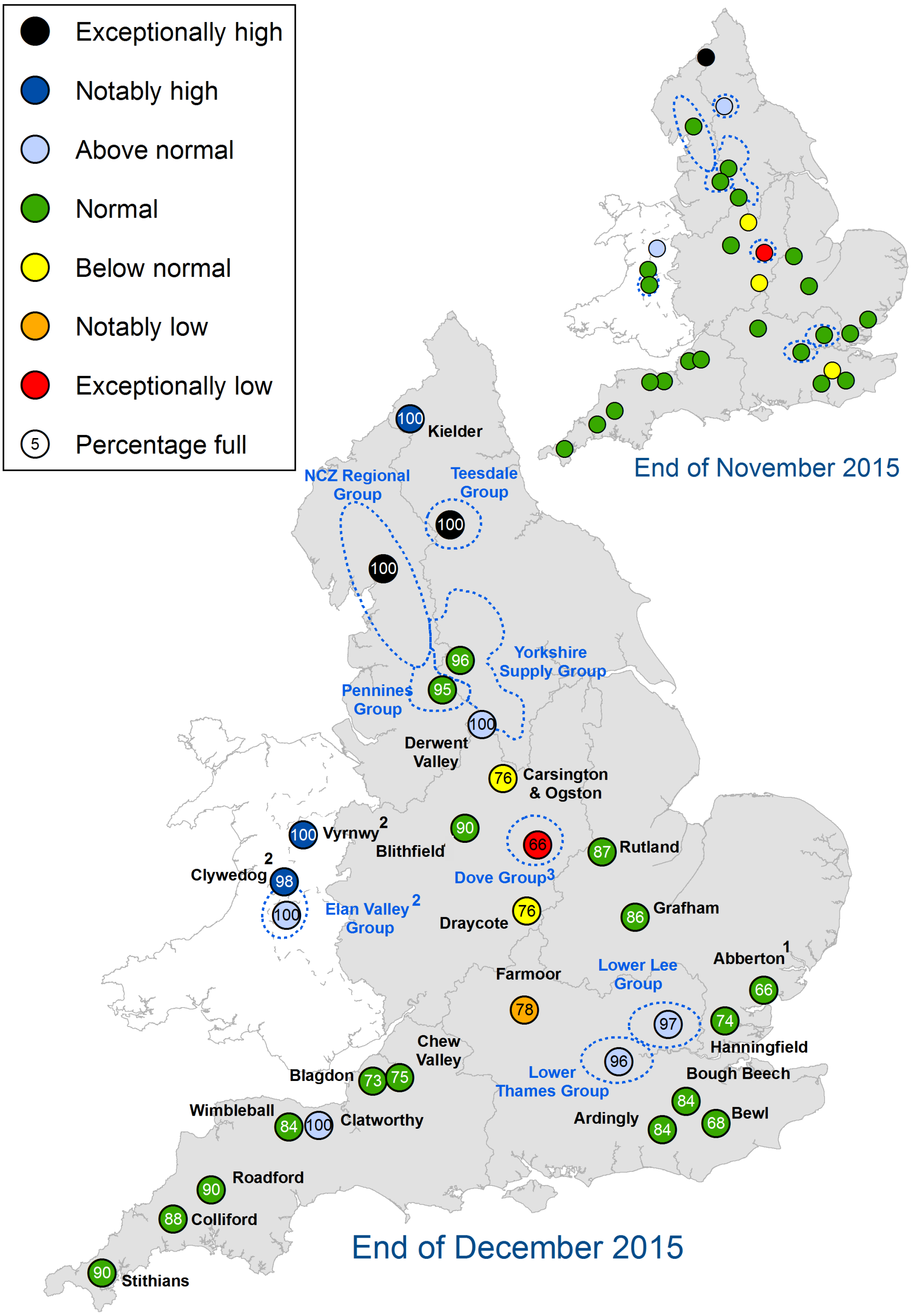


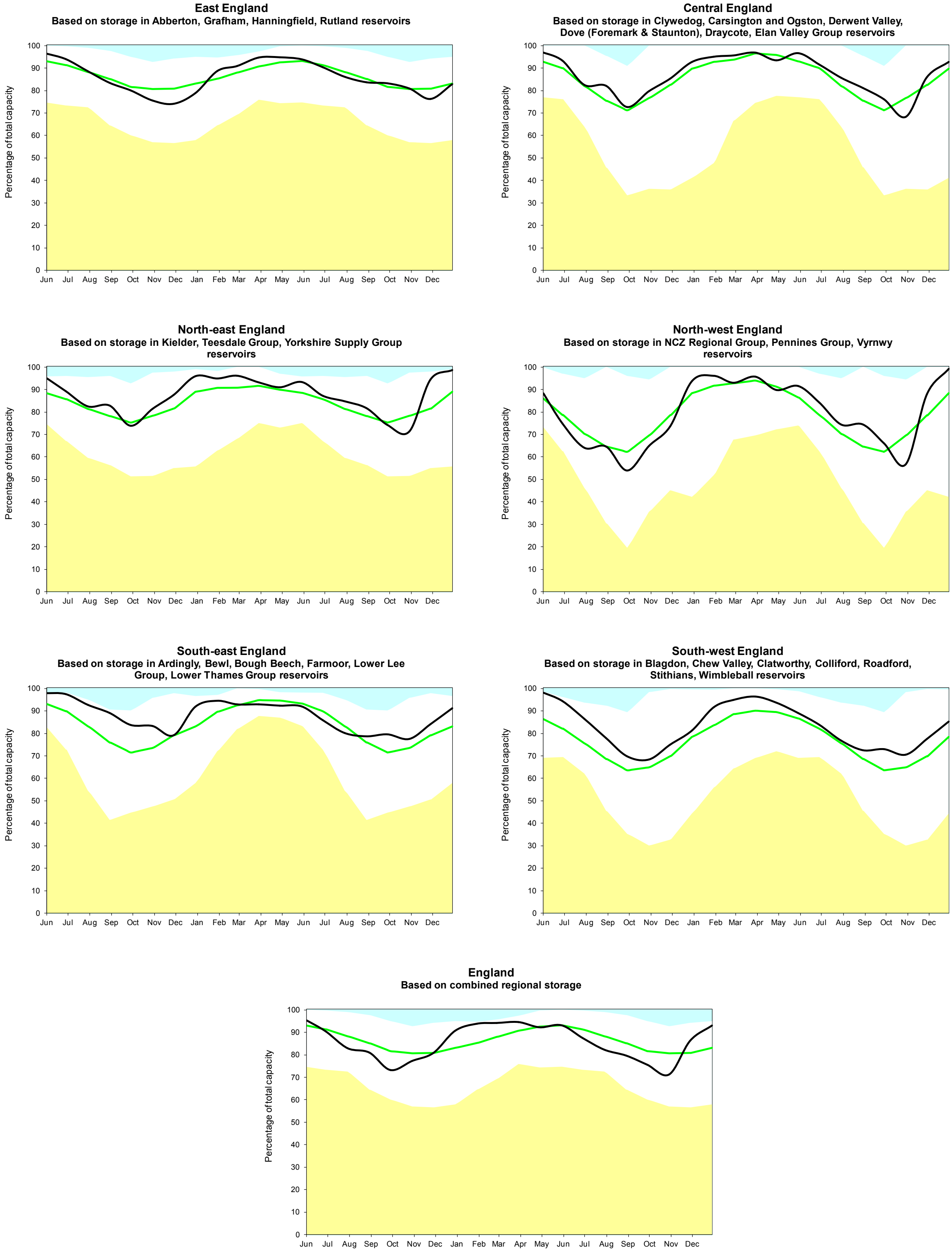
Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2016).

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 remain classified as exceptionally low for the time of year owing to ongoing operational issues

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of November 2015 and December 2015 as a percentage of total capacity and classed relative to an analysis of historic November and December 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, 2016.



	Below minimum monthly level		Above maximum monthly level		Average		Latest data

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

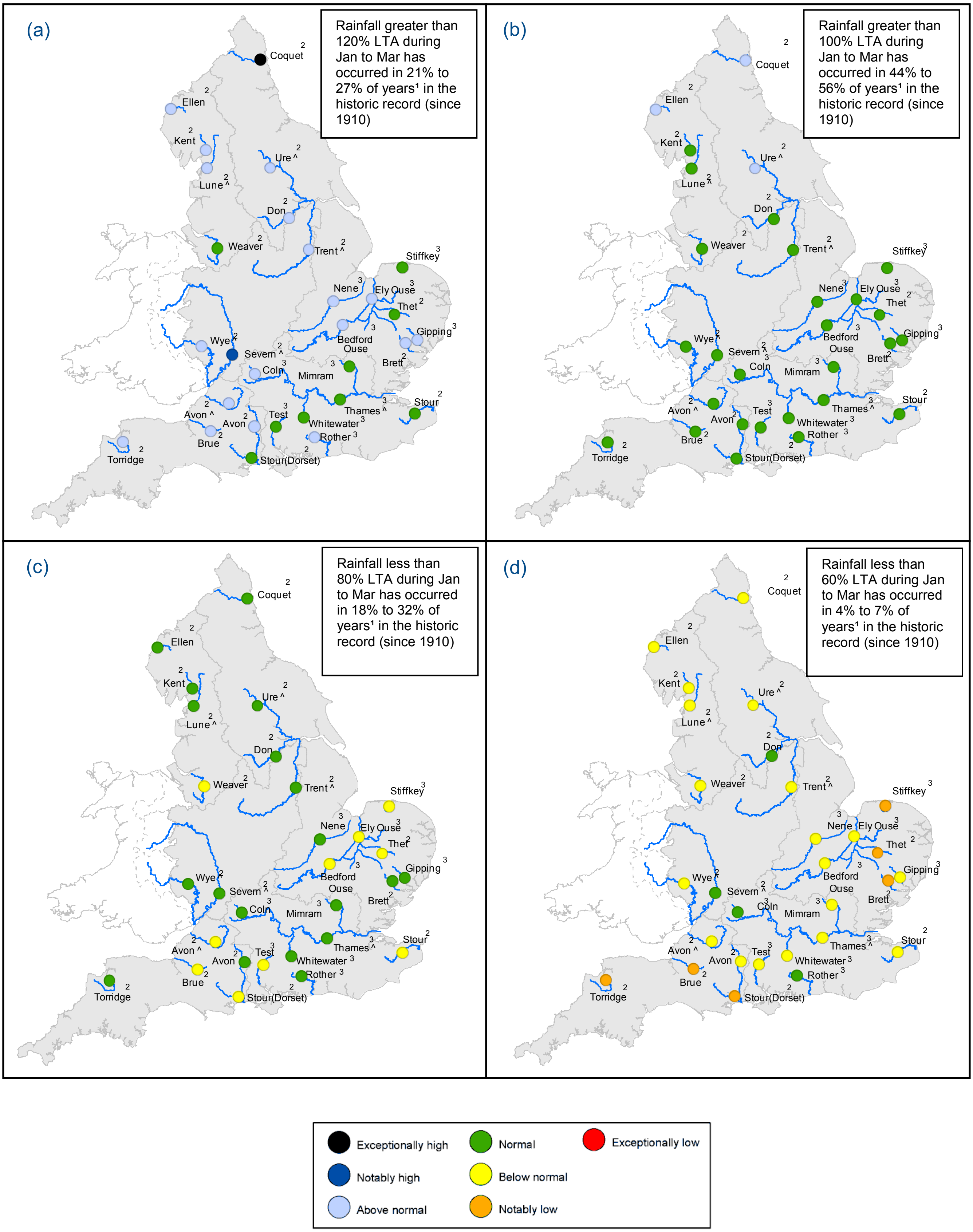


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2016 (Source: Centre for Ecology and Hydrology, Environment Agency)

[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*

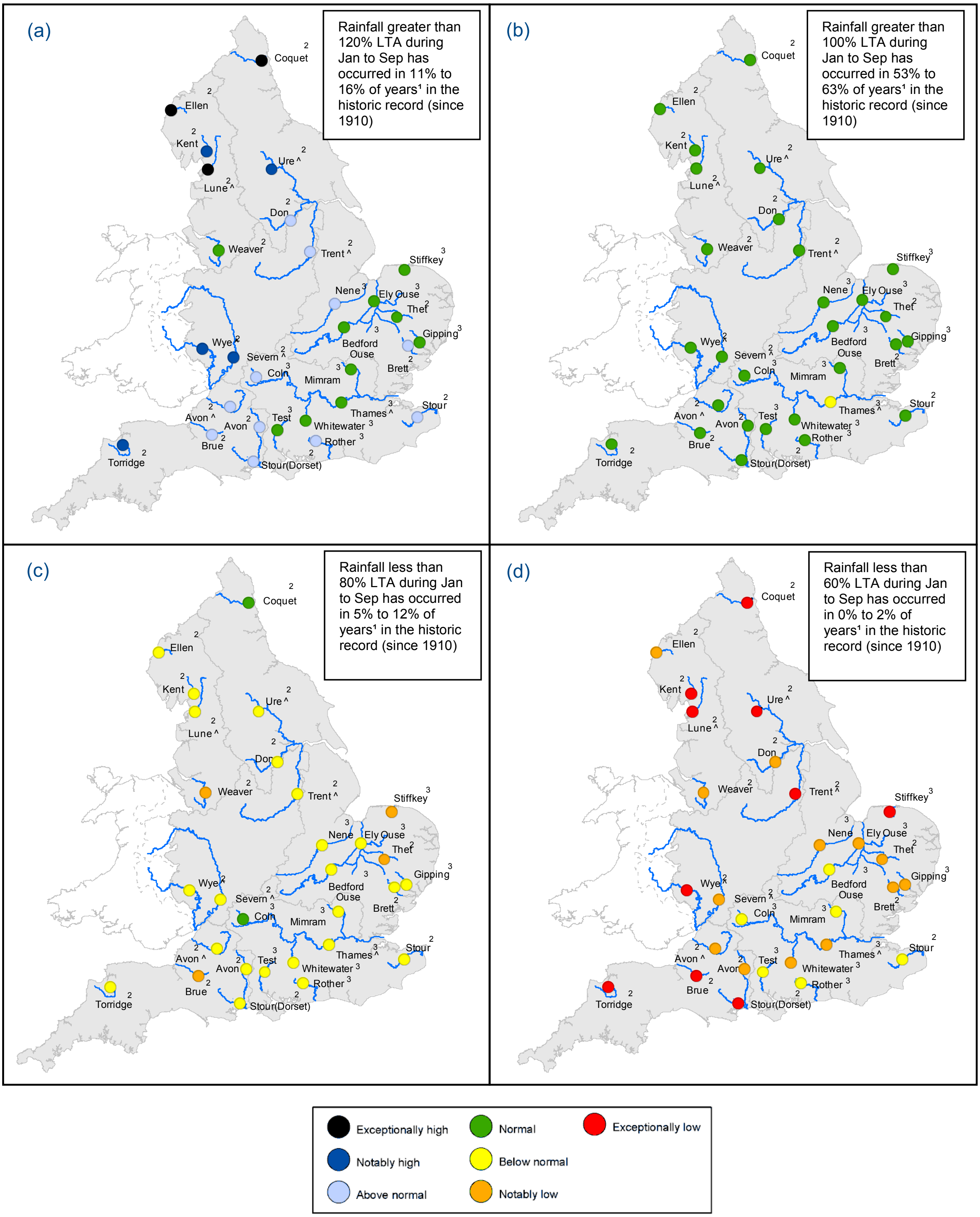


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and September 2016 (Source: Centre for Ecology and Hydrology, Environment Agency)

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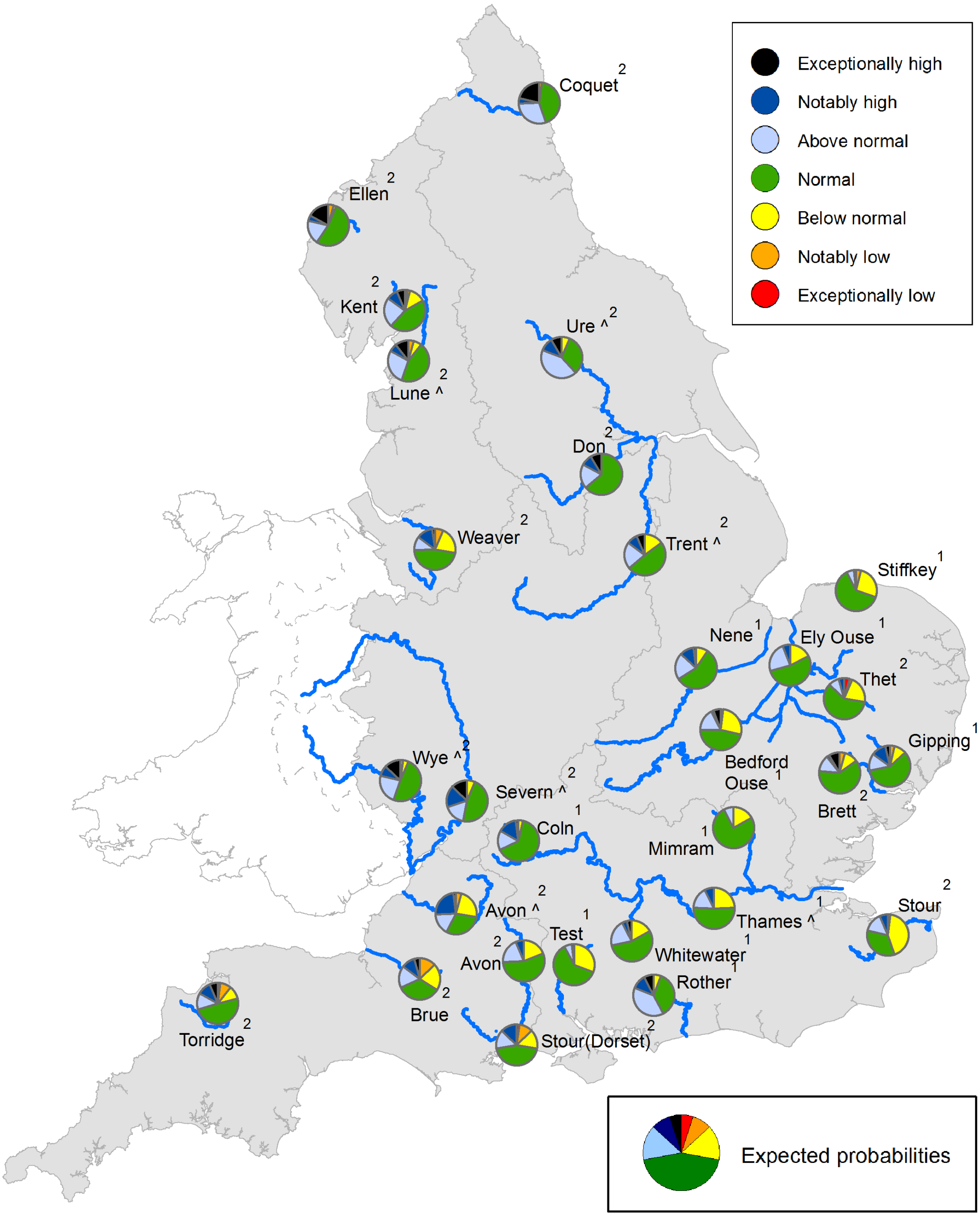

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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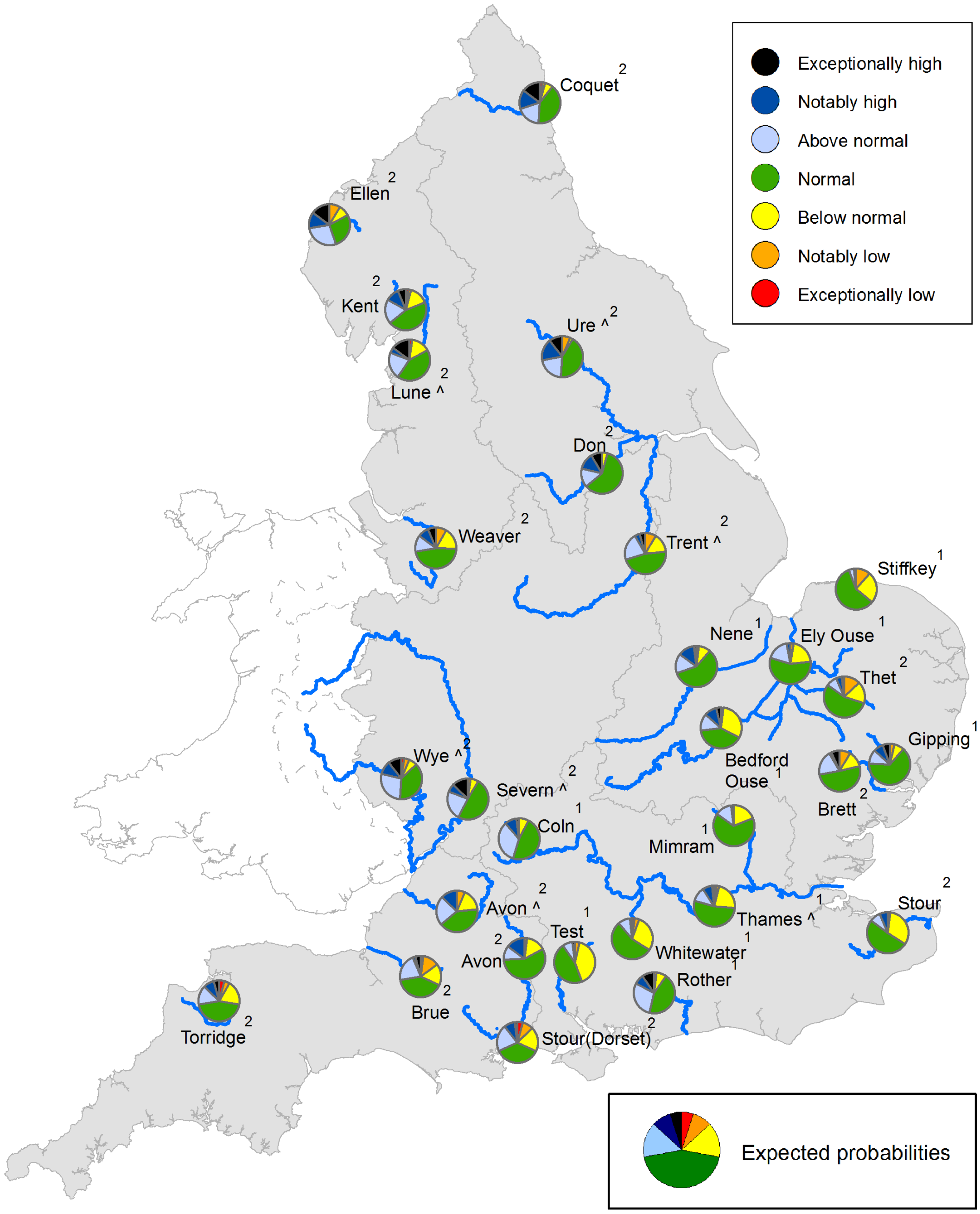

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

Forward look - groundwater

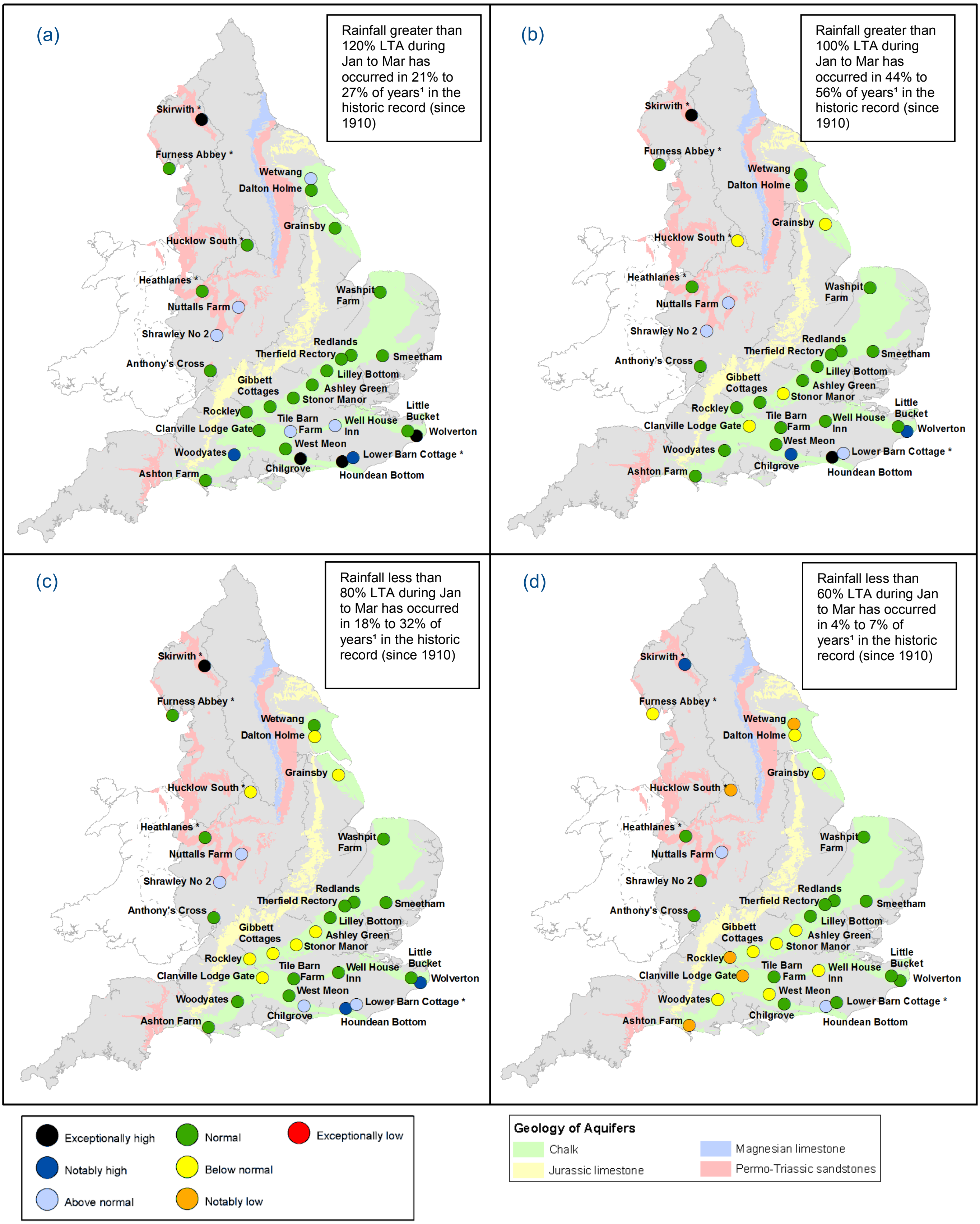

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and March 2016 (Source: Environment Agency) Geological map reproduced with kind permission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

* Projections for these sites are produced by BGS

[1] This range of probabilities is a regional analysis

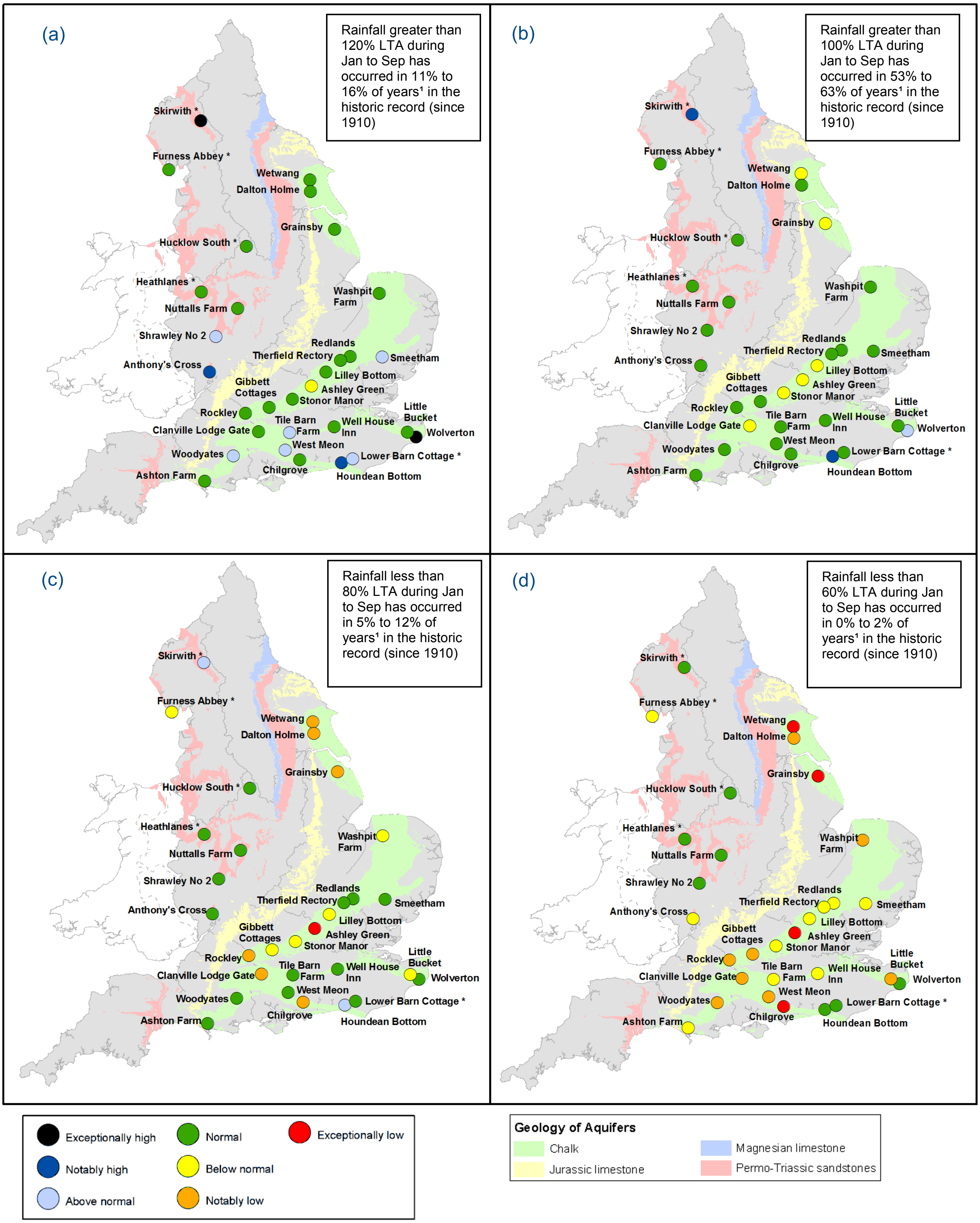

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between January and September 2016 (Source: Environment Agency) Geological map reproduced with kind permission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

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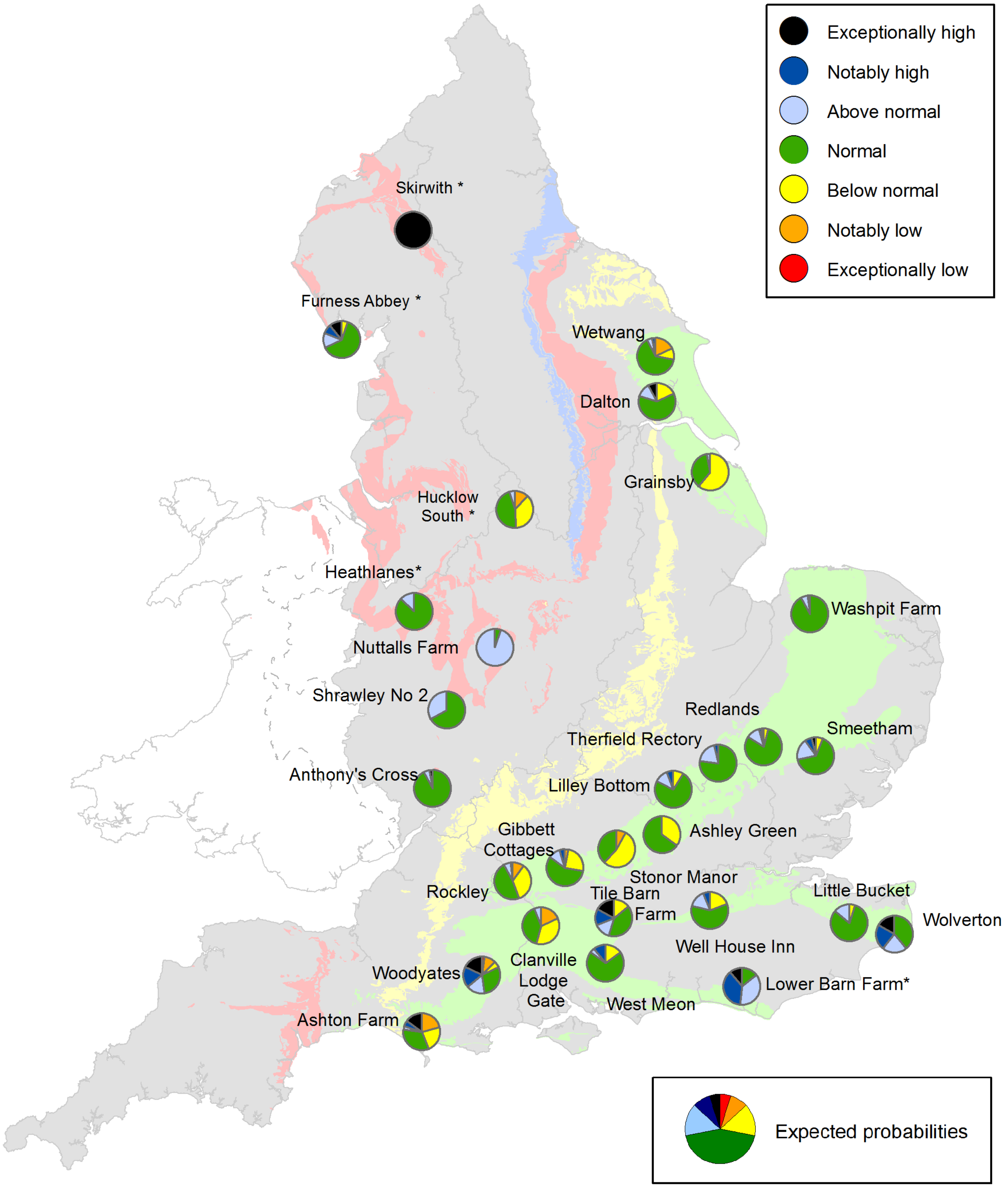
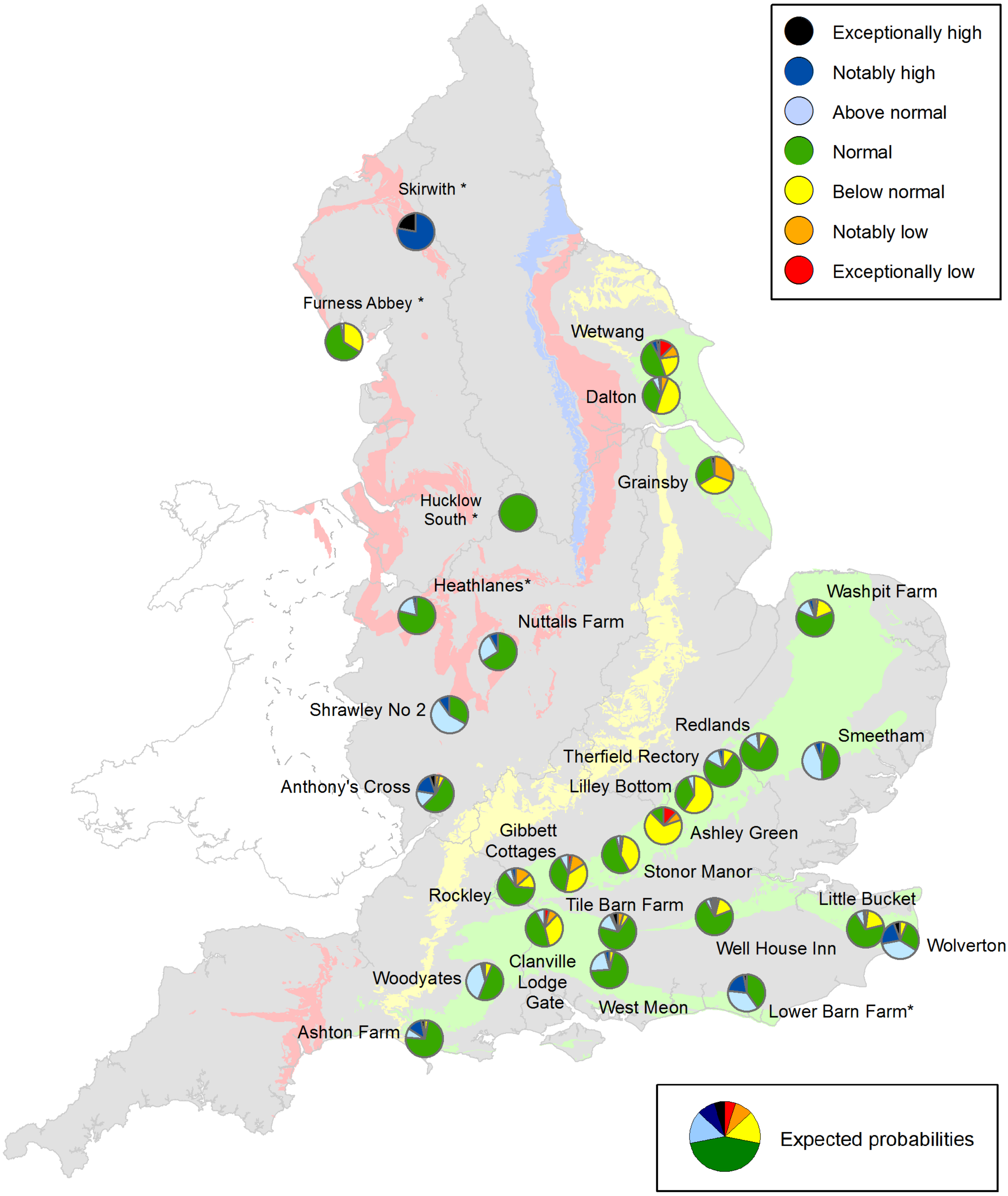


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

** 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, 2016.

* 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