Monthly water situation report

England

Summary – November 2016

November rainfall totals were above average for the first time in five months across many parts of England. The average rainfall for England was almost 130% of long term average (LTA), with much of the rain resulting from Storm Angus. Soils are generally wetter than the previous months across the country, although moderate SMDs still exist across parts of central and east England. River flows increased at all of our indicator sites, while groundwater levels decreased at the majority of sites. Both river flows and groundwater are normal for the time of year at the majority of sites. Reservoir stocks increased at two-thirds of reported reservoirs and reservoir groups during November and are normal for the time of year at the majority of sites. Overall stocks for England increased to 80% of total capacity.

Rainfall

November has been wet across much of England, with Storm Angus affecting many parts of the country between Saturday 19 and Monday 21 November. Rainfall totals were above 125mm in parts of north-west, north-east and south-west England, with the highest rainfall in parts of Devon and Cumbria where totals were more than 150mm. Elsewhere, rainfall totals were above 75mm across much of the rest of the country, with the exception of parts of Lincolnshire, Cambridgeshire and Norfolk where the lowest rainfall totals were slightly less than 60mm (Figure1.1).

Rainfall totals were above the long term average (LTA) for November in almost all hydrological areas, with almost two-thirds of catchments being above 120% of the November LTA. The highest rainfall total over 180% LTA occurred in Northumberland (Tweed) and hydrological areas in Devon received more than 150% of the November LTA. The lowest monthly rainfall was the Upper Dee (70% LTA) (Figure 1.2).

November rainfall totals were above average across all geographic regions of England. Month totals ranged from 113% of the LTA in north-west England to 144% in central England. Across England as a whole, monthly rainfall totals were almost 130% of the November long term average (Figure 1.3).

Soil moisture deficit

Soil moisture deficits (SMDs) decreased during November as soils became wetter. At the end of November, SMDs were less than 10mm across parts of west, north-west and south-west England and between 10 and 40mm across much of the rest of England. End of month SMDs were smaller than the long term average (LTA) across much of England, although soils were slightly drier than average in parts of south-east and east England (Figure 2.1).

At a regional scale, SMDs at the end of November were smaller than at the end of October. End of month values ranged from less than 10mm in north-west and south-west England to almost 40mm in east England (Figure 2.2).

River flows

Monthly mean river flows for November increased at all indicator sites across England compared with October. The majority of sites are classed as normal for the time of year. The River Exe at Thorverton (south-west England) and the River Derwent at Buttercrambe (north-east England) were above normal for November and the River Wyre at St Michaels (north-west England) was notably high for the time of year. Four sites are below normal for the time of year (Figure 3.1). Monthly mean river flows were normal for the time of year at all of the regional index sites (Figure 3.2).

Groundwater levels

At the end of November, groundwater levels had decreased at two thirds of the indicator sites compared to the end of October. Groundwater levels were normal for the time of year at the majority of sites, with the remaining sites ranging from notably low (Chilgrove in the Chichester Chalk) to exceptionally high (Coxmoor in the Nottinghamshire and Doncaster Sandstone and Priors Heyes in the West Cheshire Sandstone) (Figure 4.1). End of month groundwater levels at the major aquifer index sites ranged from notably low to above normal for the time of year (Figure 4.2).

Reservoir storage

During November, reservoir stocks increased by up to 25% at more than two thirds of reported reservoirs and reservoir groups. The largest increase of 25% occurred in Clatworthy reservoir in south-west England, with stocks in the Derwent Valley reservoir group in central England increasing by 20%. Stocks decreased during November at 9 reported reservoirs and reservoir groups, with Bough Beech reservoir in south-east England experiencing the largest decrease of 8%. End of month stocks were classed as normal or higher for the time of year at two thirds of reservoirs and reservoir groups, with the remaining third of sites being below normal or lower (Figure 5.1).

At a regional, scale reservoir stocks decreased slightly in east England but increased elsewhere by between 3 and 8%. At the end of November stocks ranged from 63% of total capacity in south-west England to 88% in central England. Overall storage for England decreased by 4% to 80% of total capacity (Figure 5.2).

Forward look

Unsettled weather is expected in the far north and west of England through December, with drier conditions in the east and particularly south-east of England. Over the 3 month period December to February, below average precipitation is slightly more likely than above average[1].

Projections for river flows at key sites[2]

By the end of March 2017, four-fifths of the modelled sites have a greater than expected chance of below normal or lower cumulative flows. By the end of September 2017, all modelled sites have a greater than expected chance of below normal or lower cumulative flows.

For scenario based projections of cumulative river flows at key sites by March 2017 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by September 2017 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by March 2017 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by September 2017 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

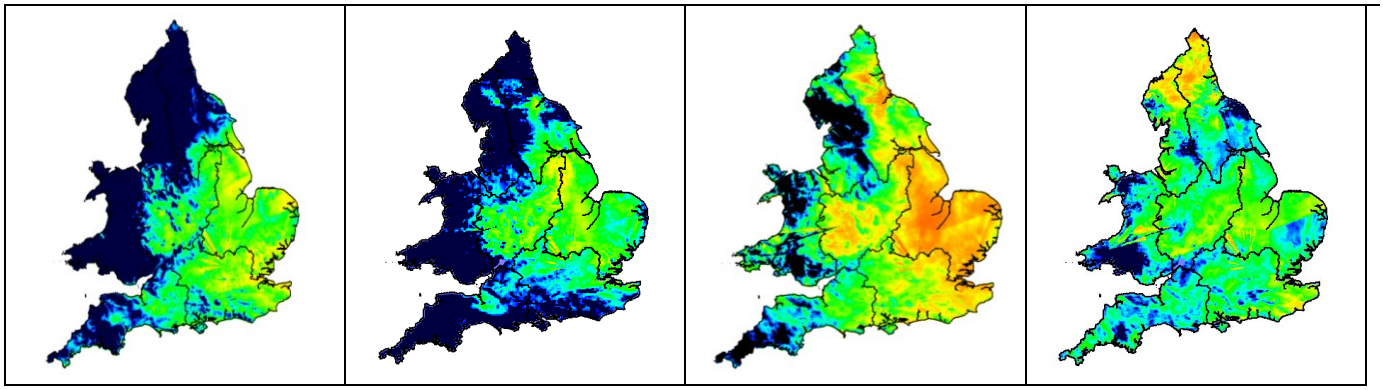
At the end of March 2017, nearly two-thirds of modelled sites have a greater than expected chance of normal or higher groundwater levels for the time of year. At the end of September 2017, half of the modelled sites have a greater than expected chance of normal or higher groundwater levels for the time of year.

For scenario based projections of groundwater levels in key aquifers in March 2017 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2017 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2017 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2017 see Figure 6.8

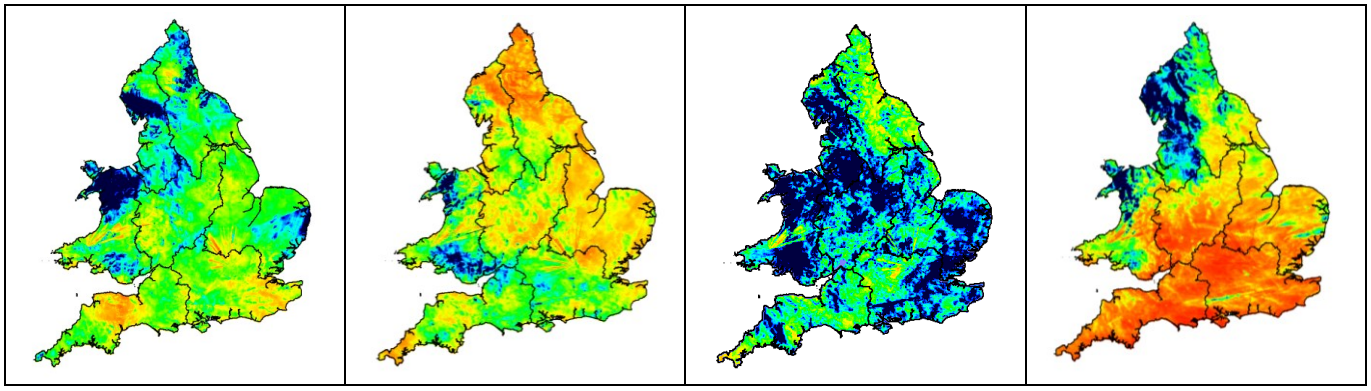
Authors: E&B Hydrology Team

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).

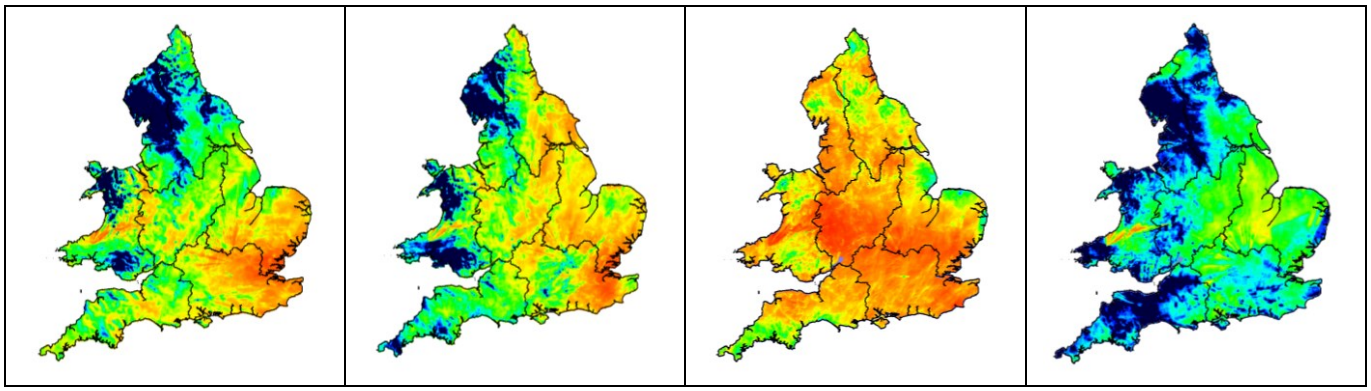
Rainfall



December 2015 | January 2016 | February 2016 | March 2016



April 2016 | May 2016 | June 2016 | July 2016



August 2016 | September 2016 | October 2016 | November 2016

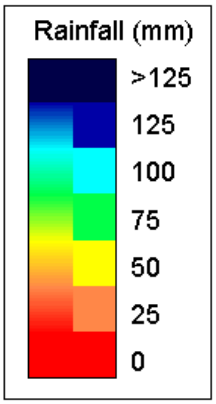


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2016). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

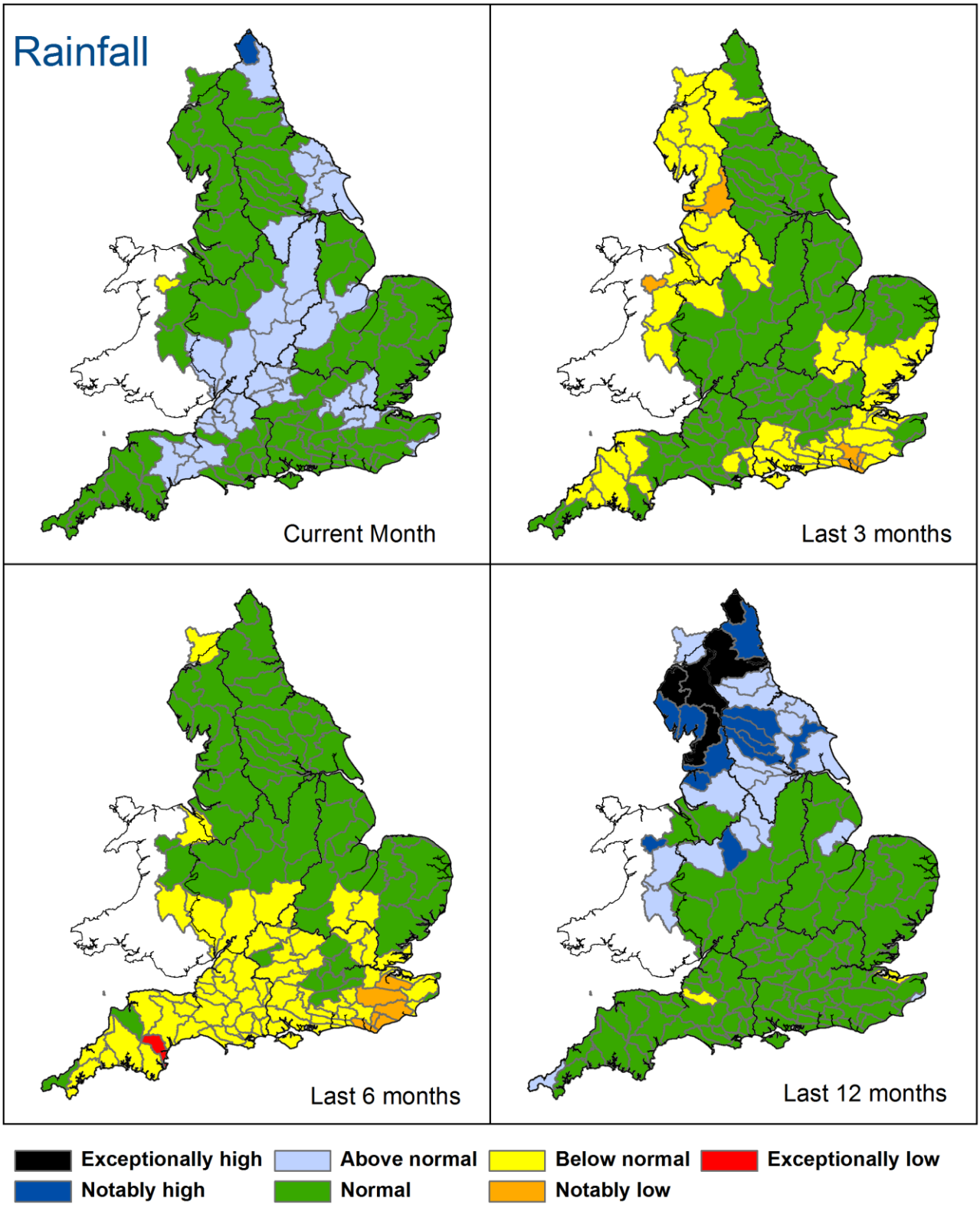


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 November), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2016).* Provisional data based on Environment Agency 1km gridded rainfall dataset derived from Environment Agency intensity rain gauges. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

Rainfall charts

Above average rainfall

Below average rainfall

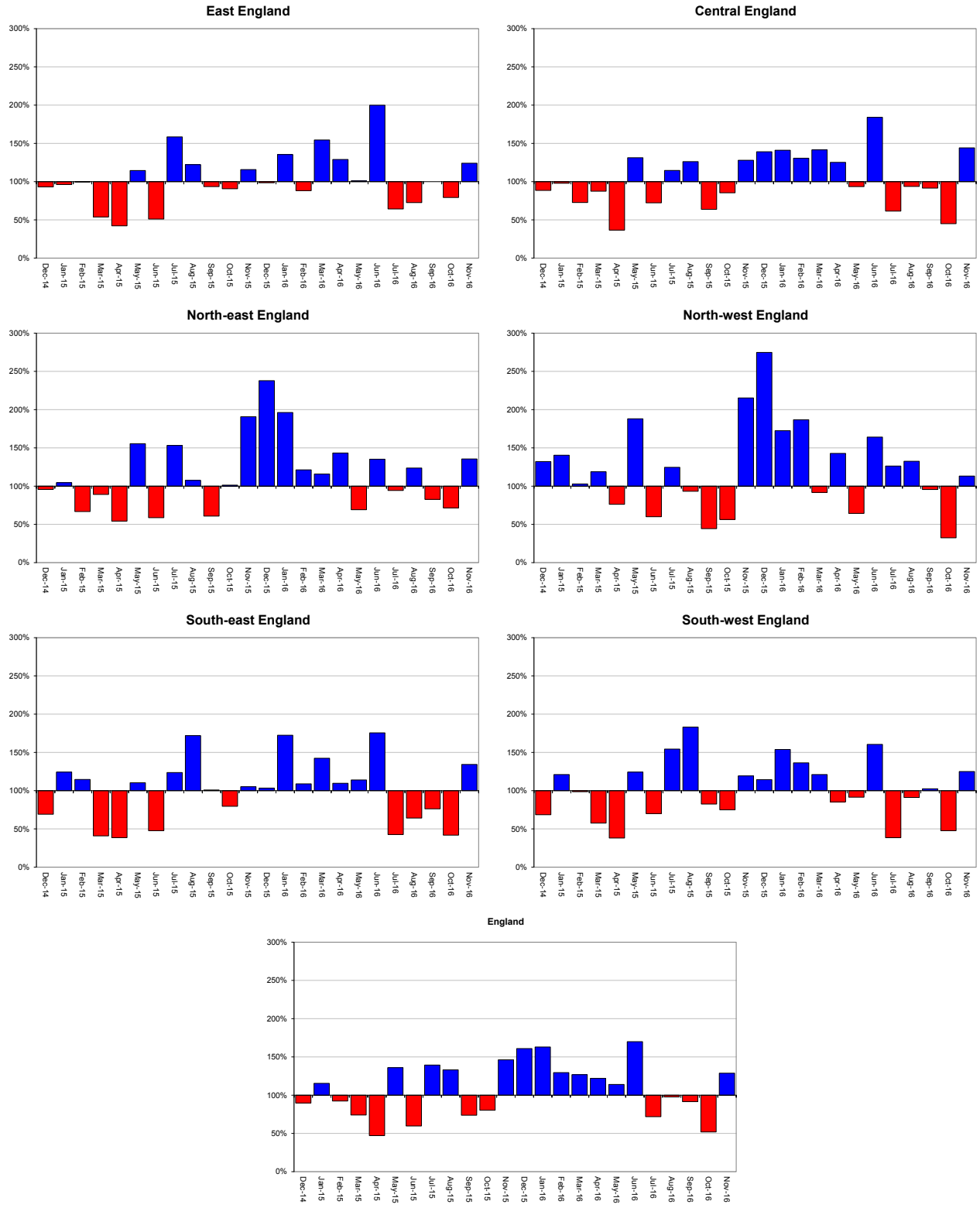


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2016).

Soil moisture deficit

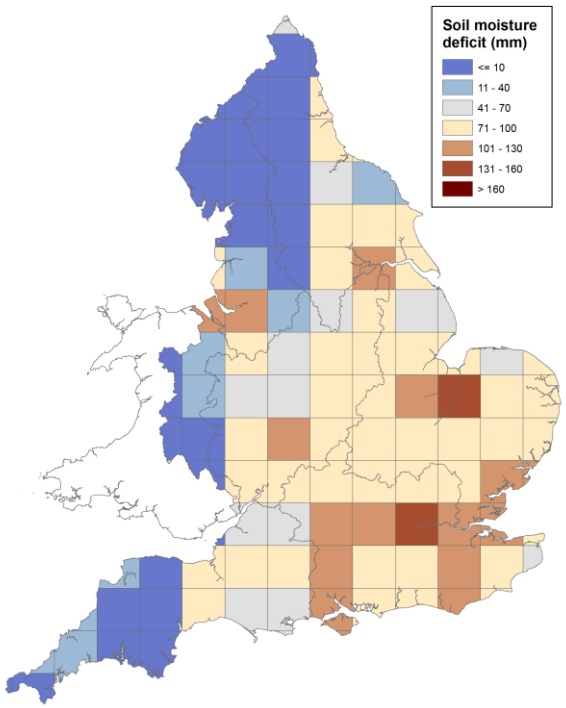
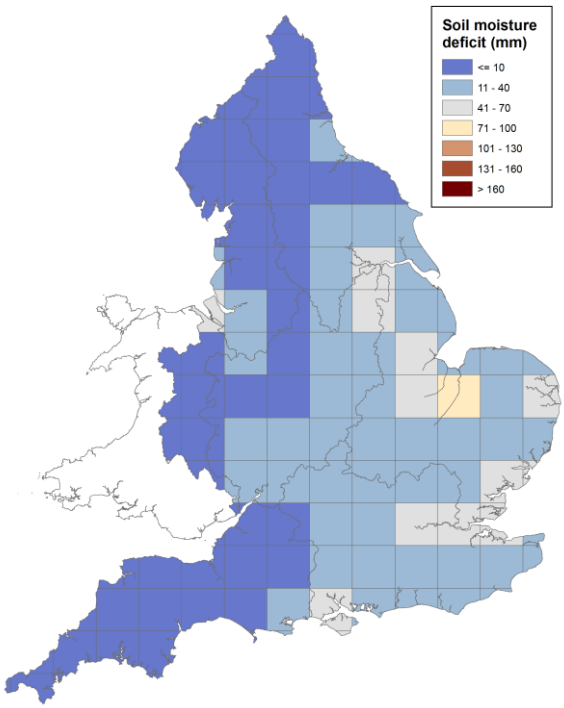
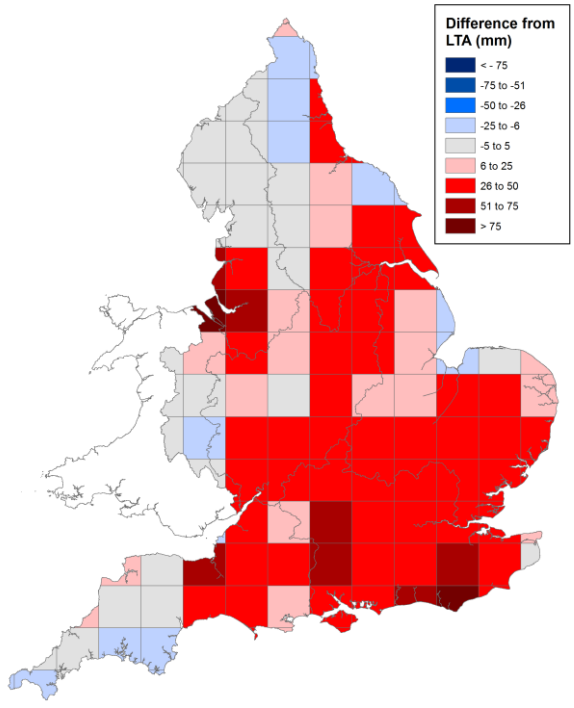
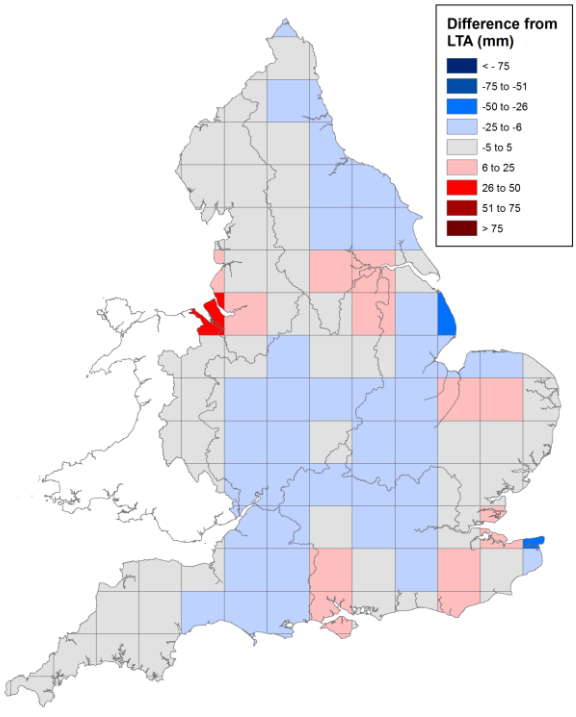
End of October 2016[1]	End of November 2016[2]
	
	

Figure 2.1: Soil moisture deficits for weeks ending 1 November 2016 [1] (left panel) and 29 November 2016 [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

Soil moisture deficit charts

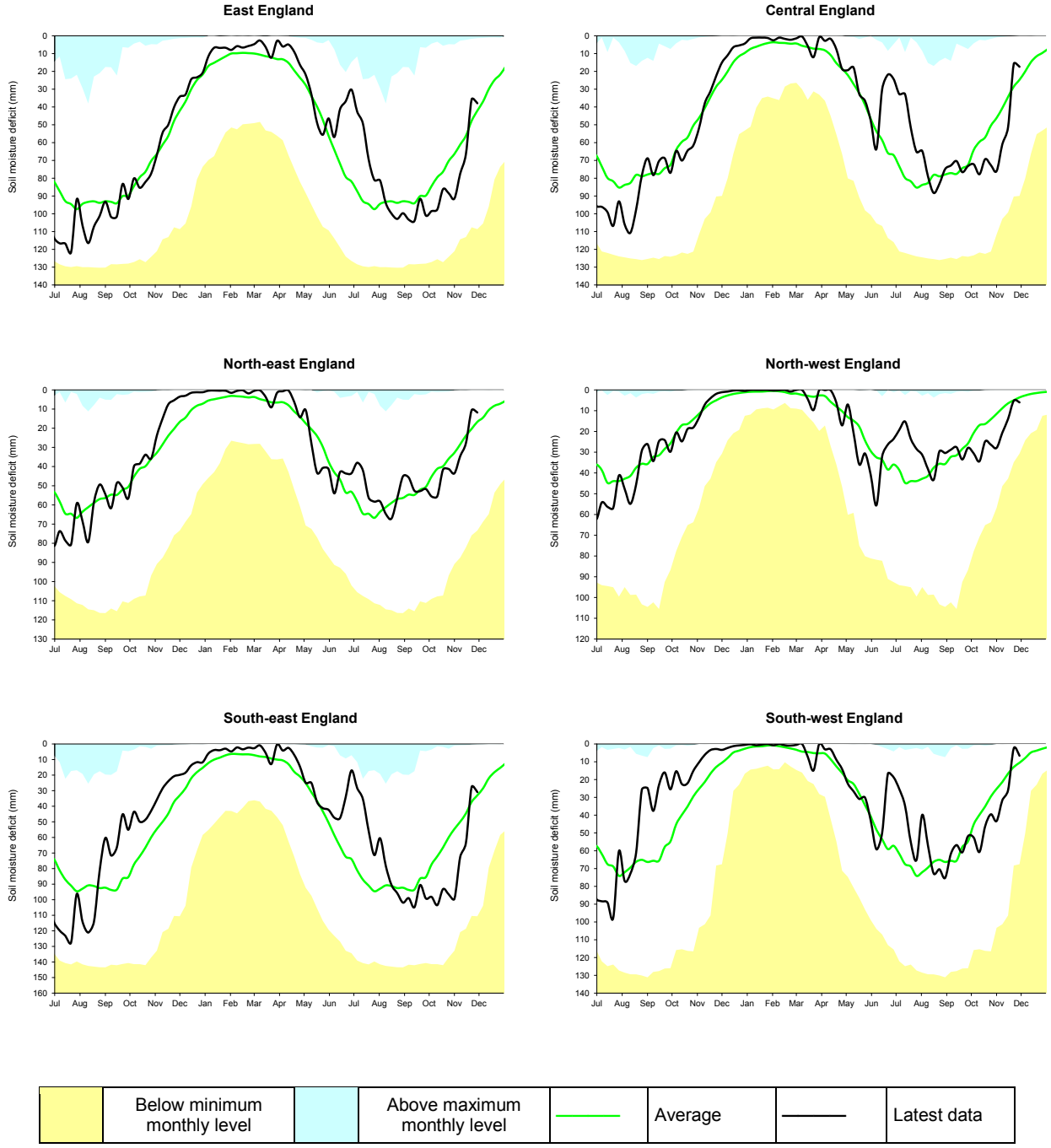
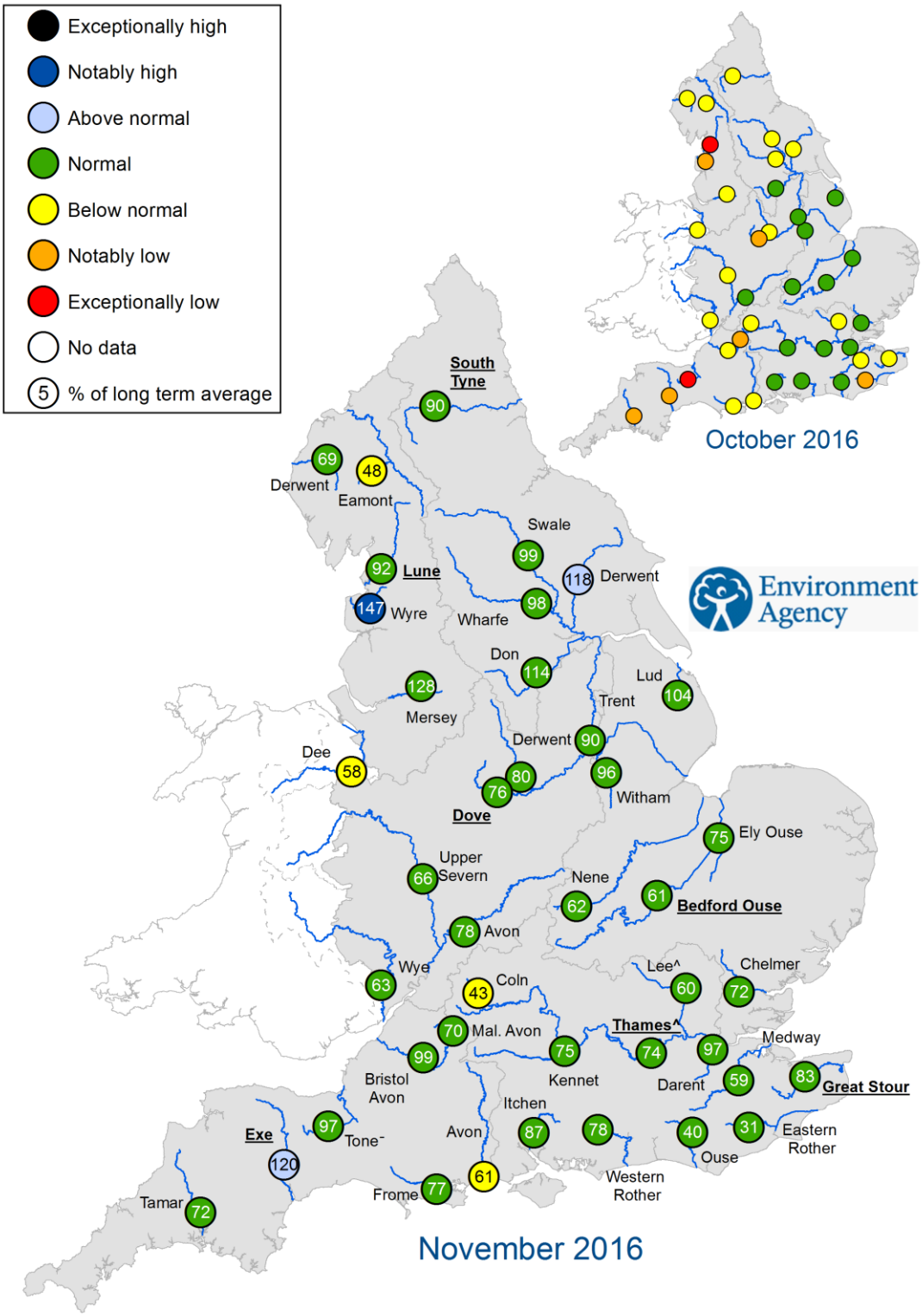


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2016).

River flows



^ "Naturalised" flows are provided for the 'Thames at Kingston' and the 'Lee at Feildes Weir'
Month mean flows are provisional and subject to further quality assurance this month
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 2016 and November 2016, 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, 2016.

River flow charts

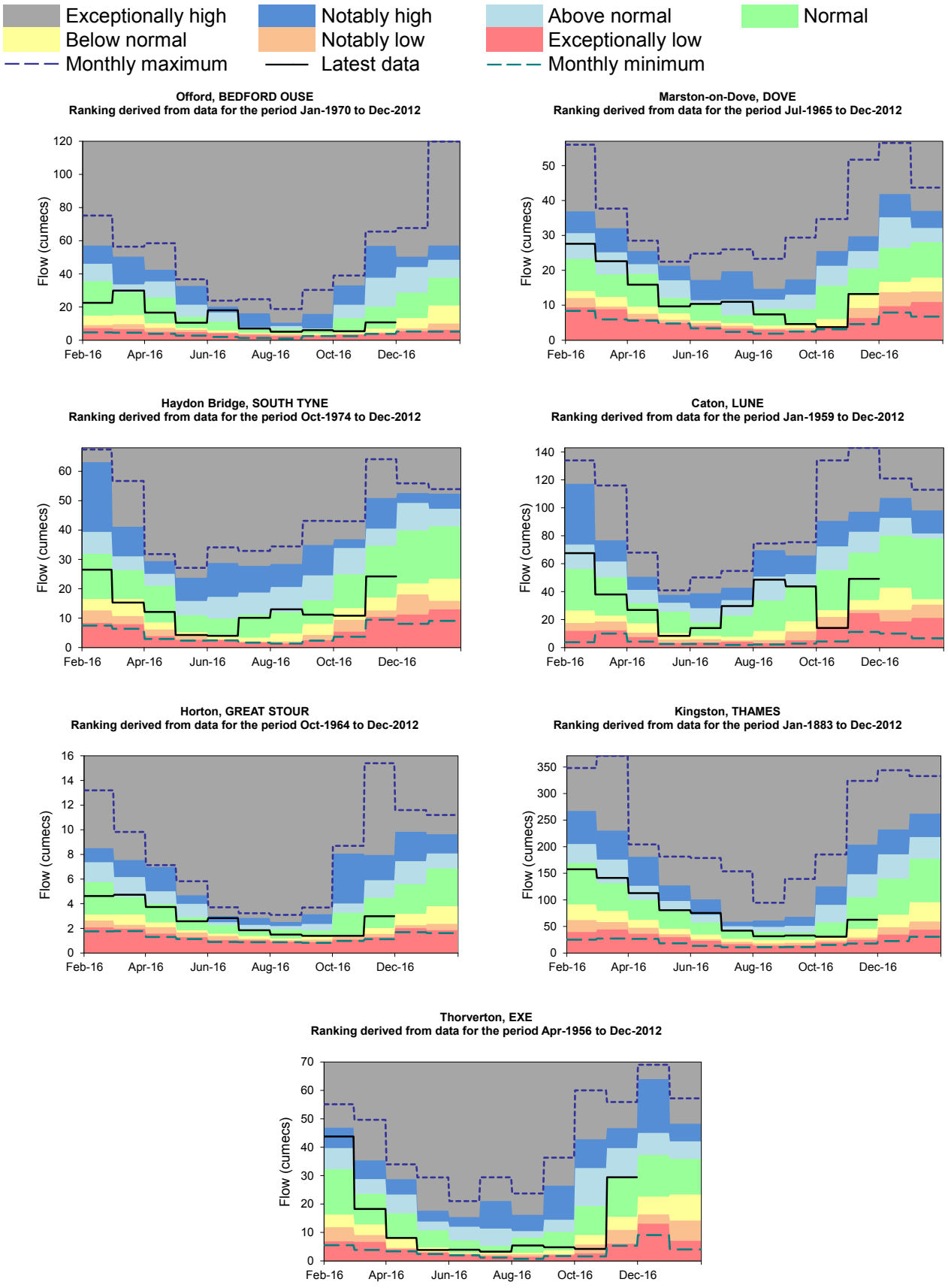
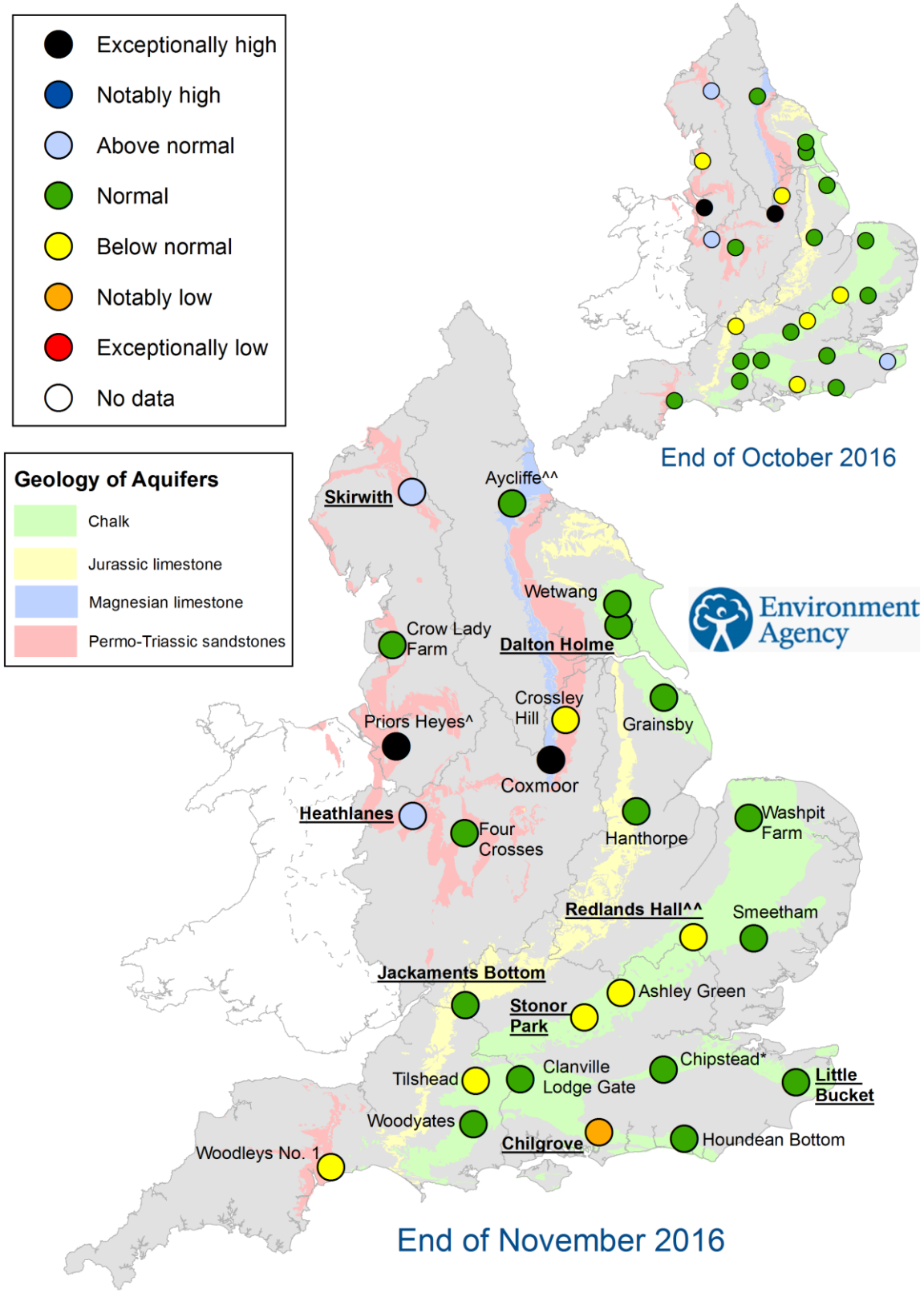


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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
Highlighted sites are major aquifer index sites and are shown in the groundwater level charts in Figure 4.2
* Chipstead replaces Well House Inn

Figure 4.1: Groundwater levels for indicator sites at the end of October 2016 and November 2016, 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, 2016.

Groundwater level charts

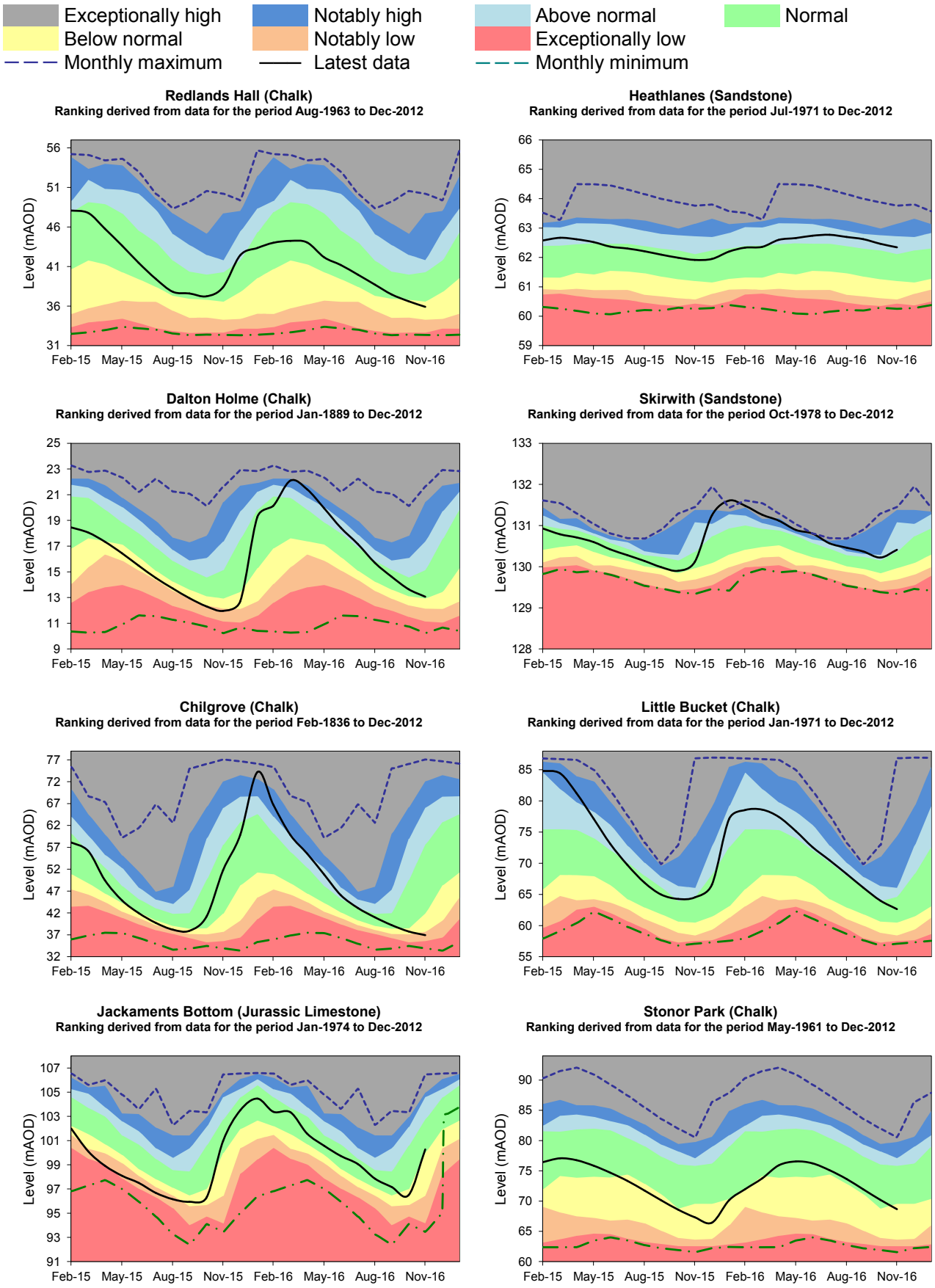
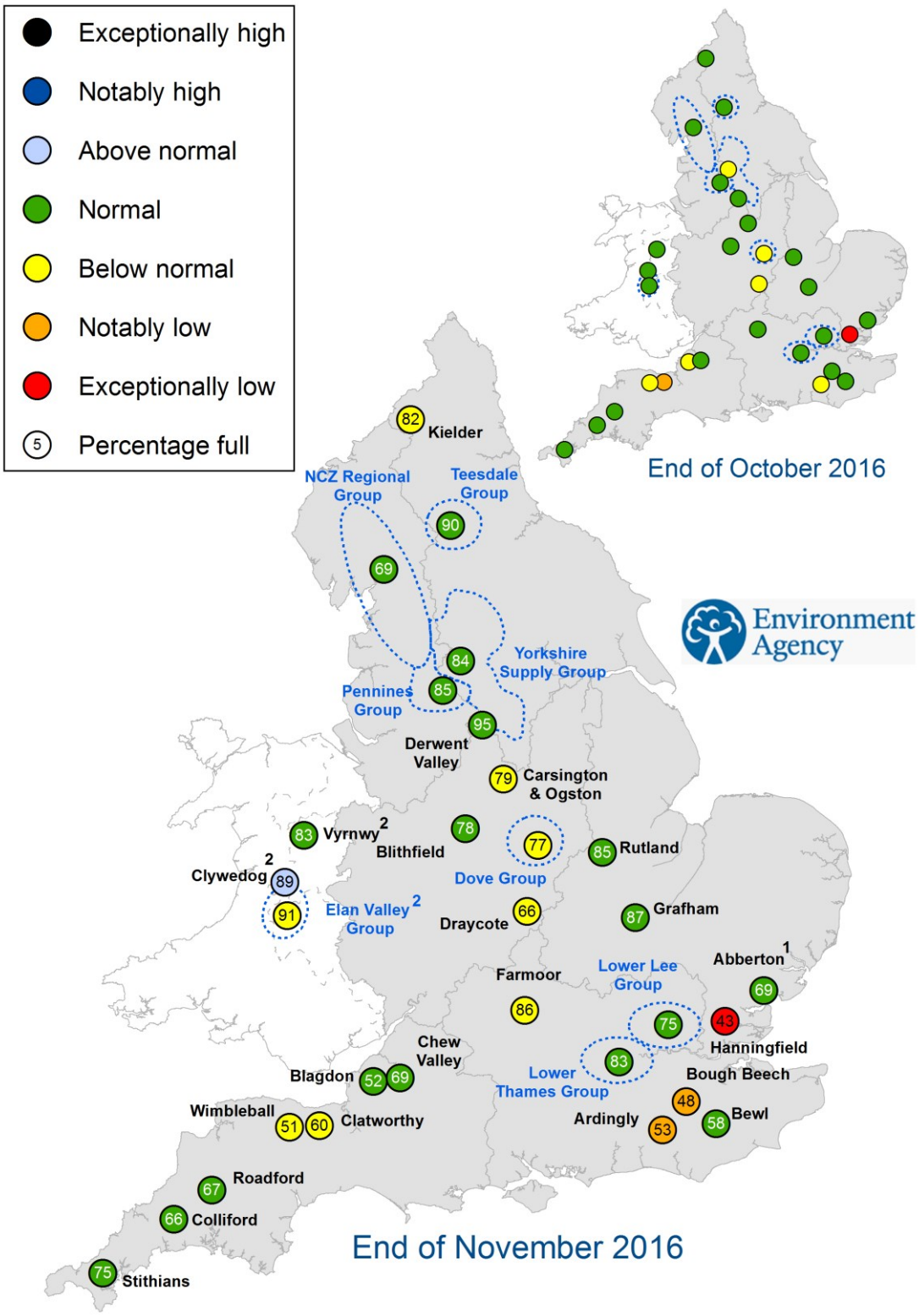


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2016).

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

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of October and November 2016 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, 2016.

Reservoir storage charts

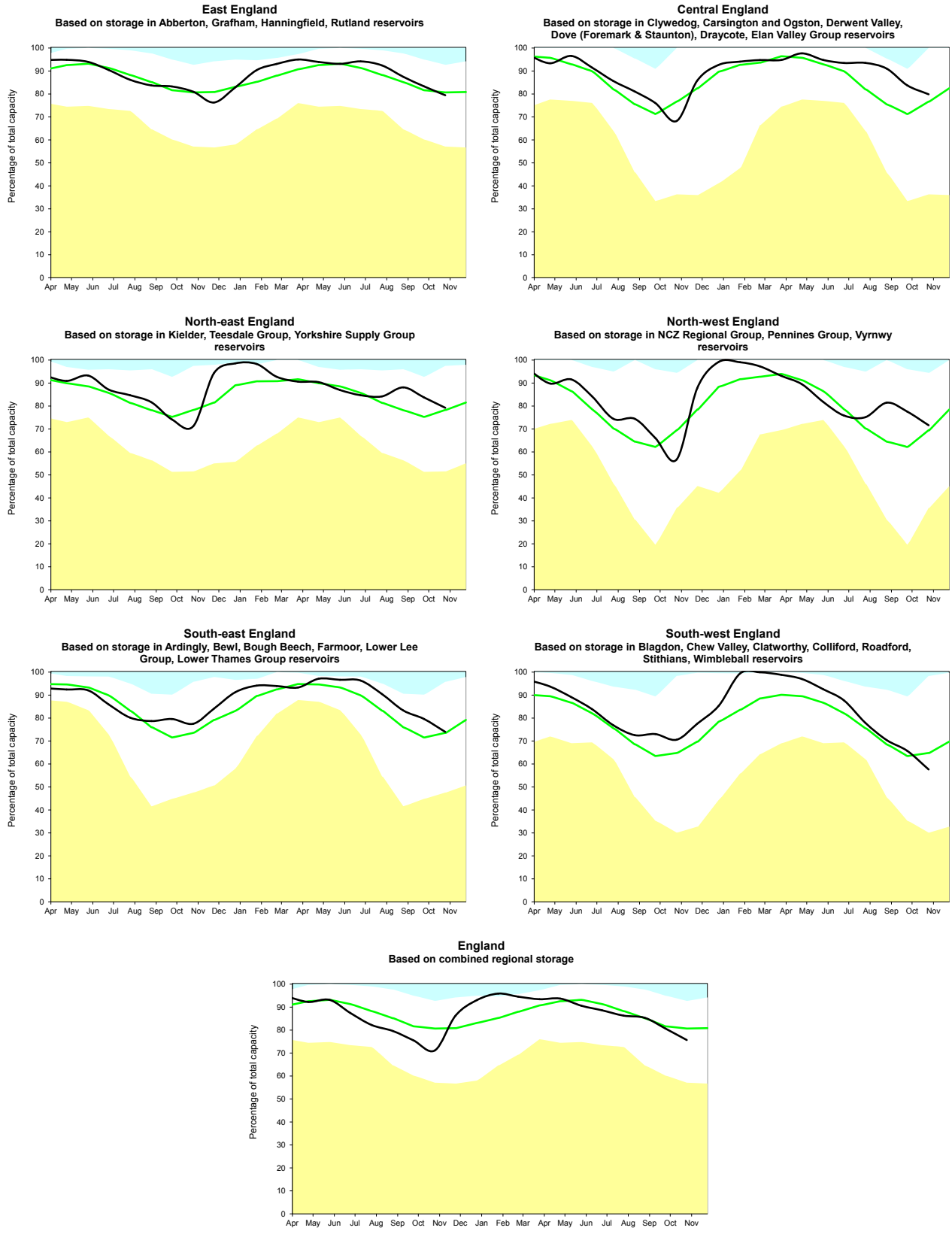


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

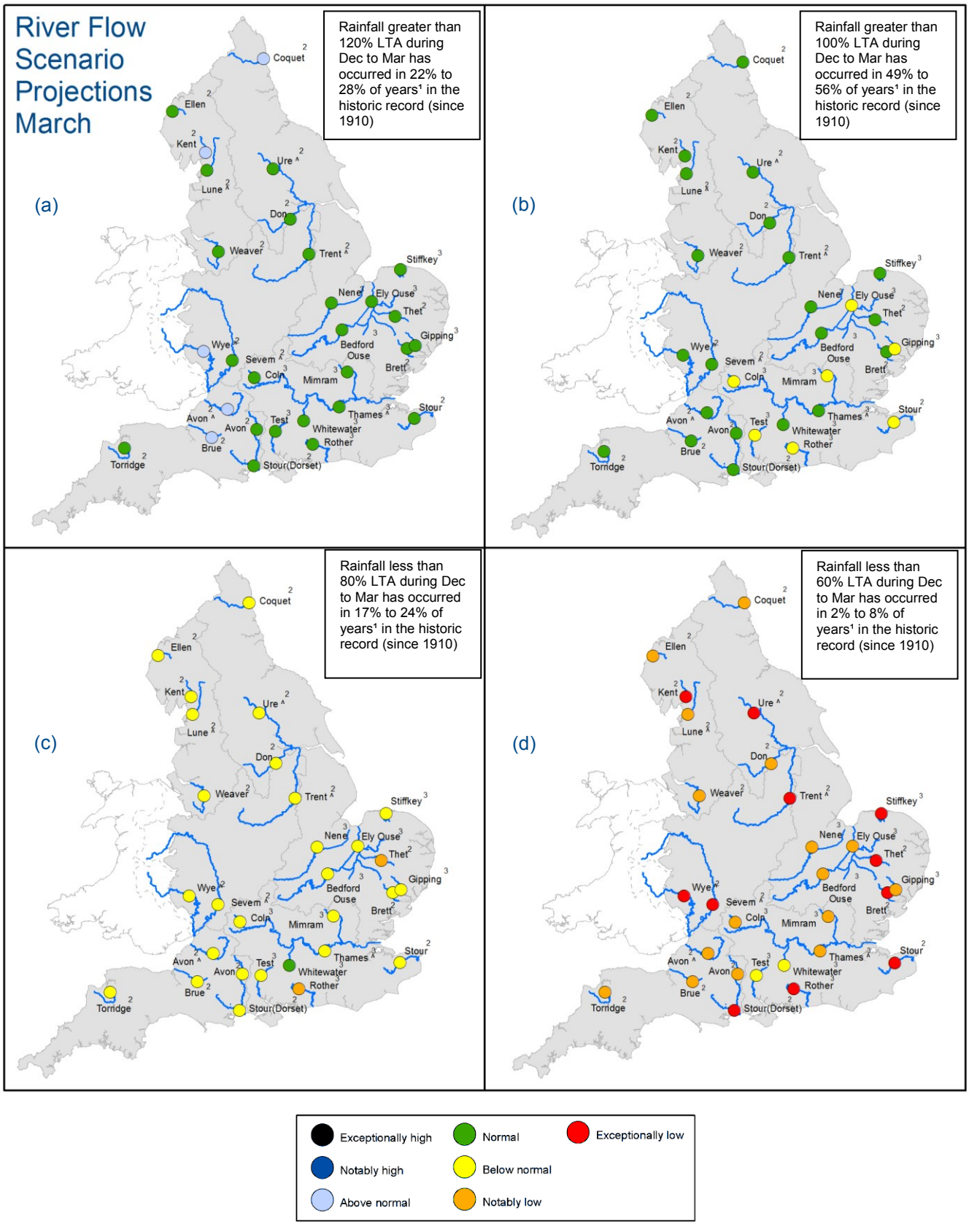
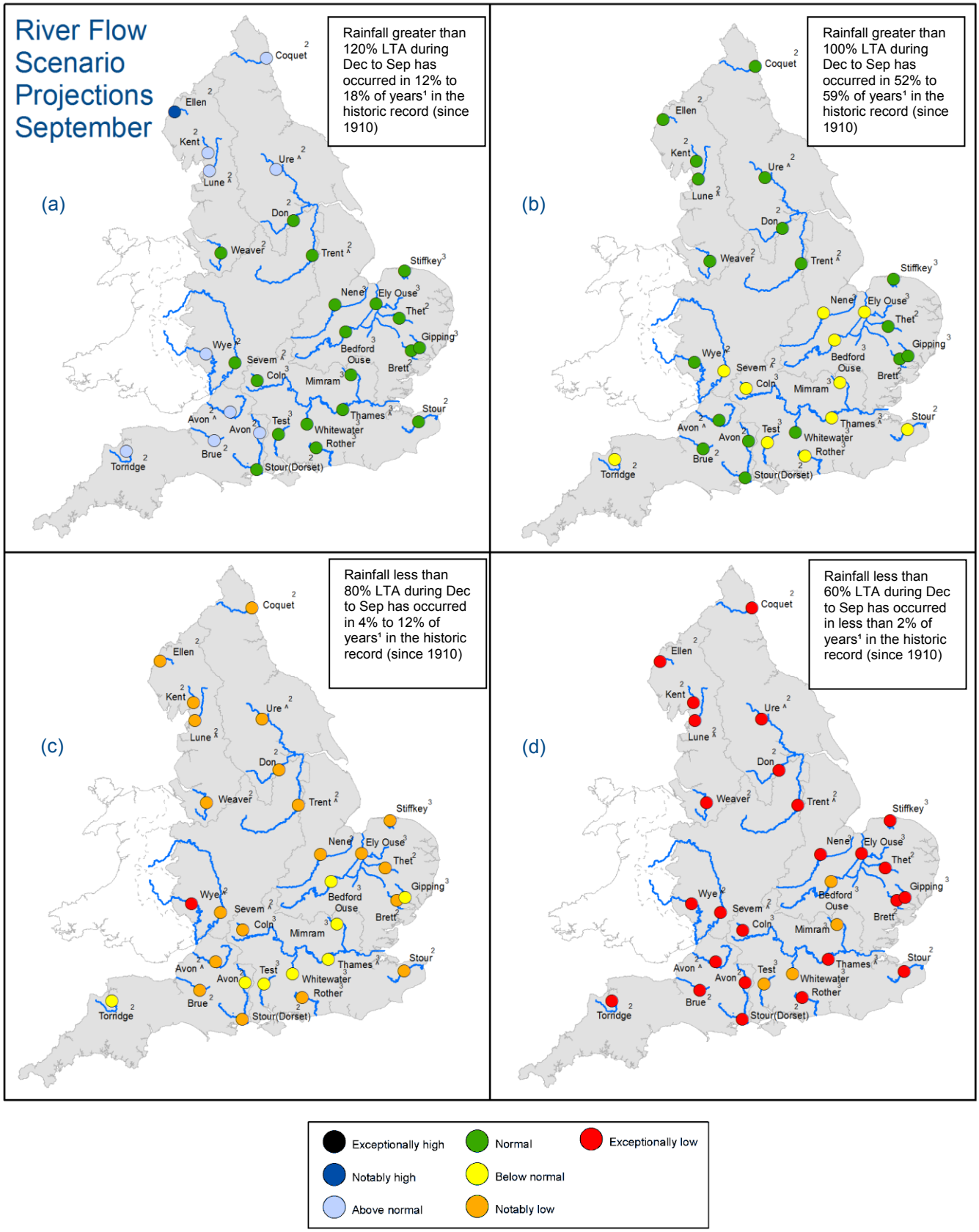


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2016 and March 2017 (Source: Centre for Ecology and Hydrology, Environment Agency)

[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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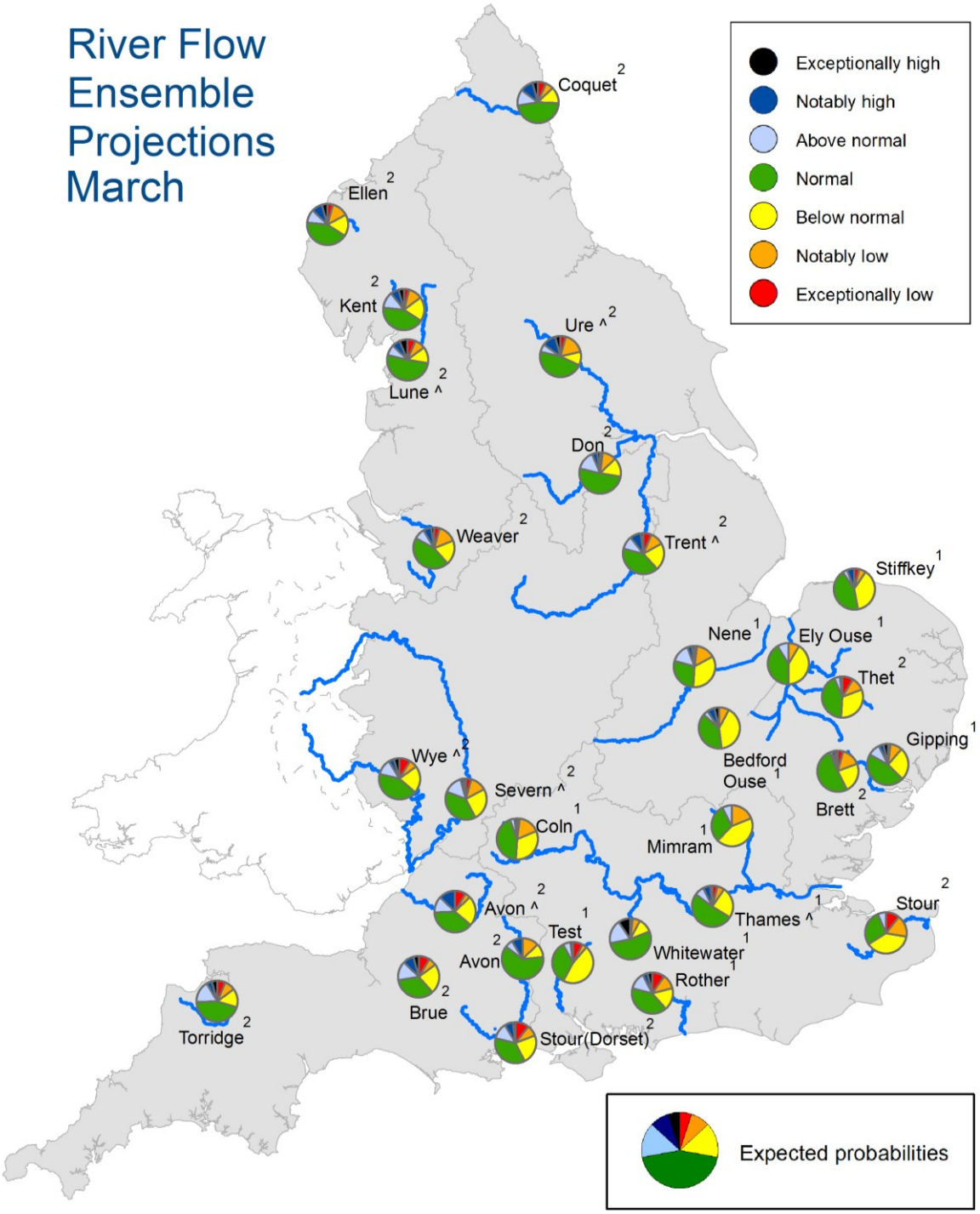

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 2017. 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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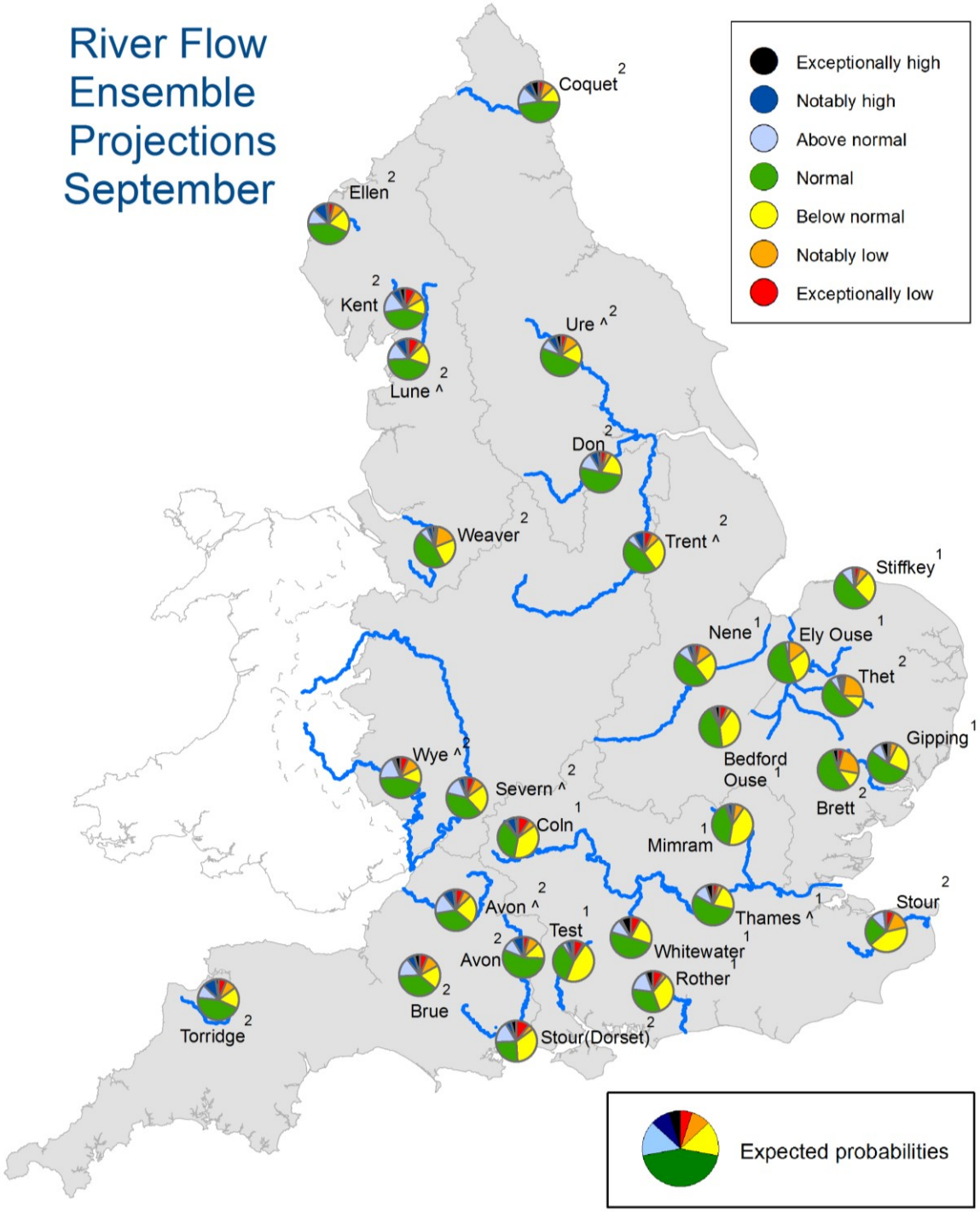
[2] Projections for these sites are produced by CEH
^"Naturalised" flows are projected for these sites



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 2017. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

[1] Projections for these sites are produced by the Environment Agency
[2] Projections for these sites are produced by CEH
^"Naturalised" flows are projected for these sites

Forward look – groundwater

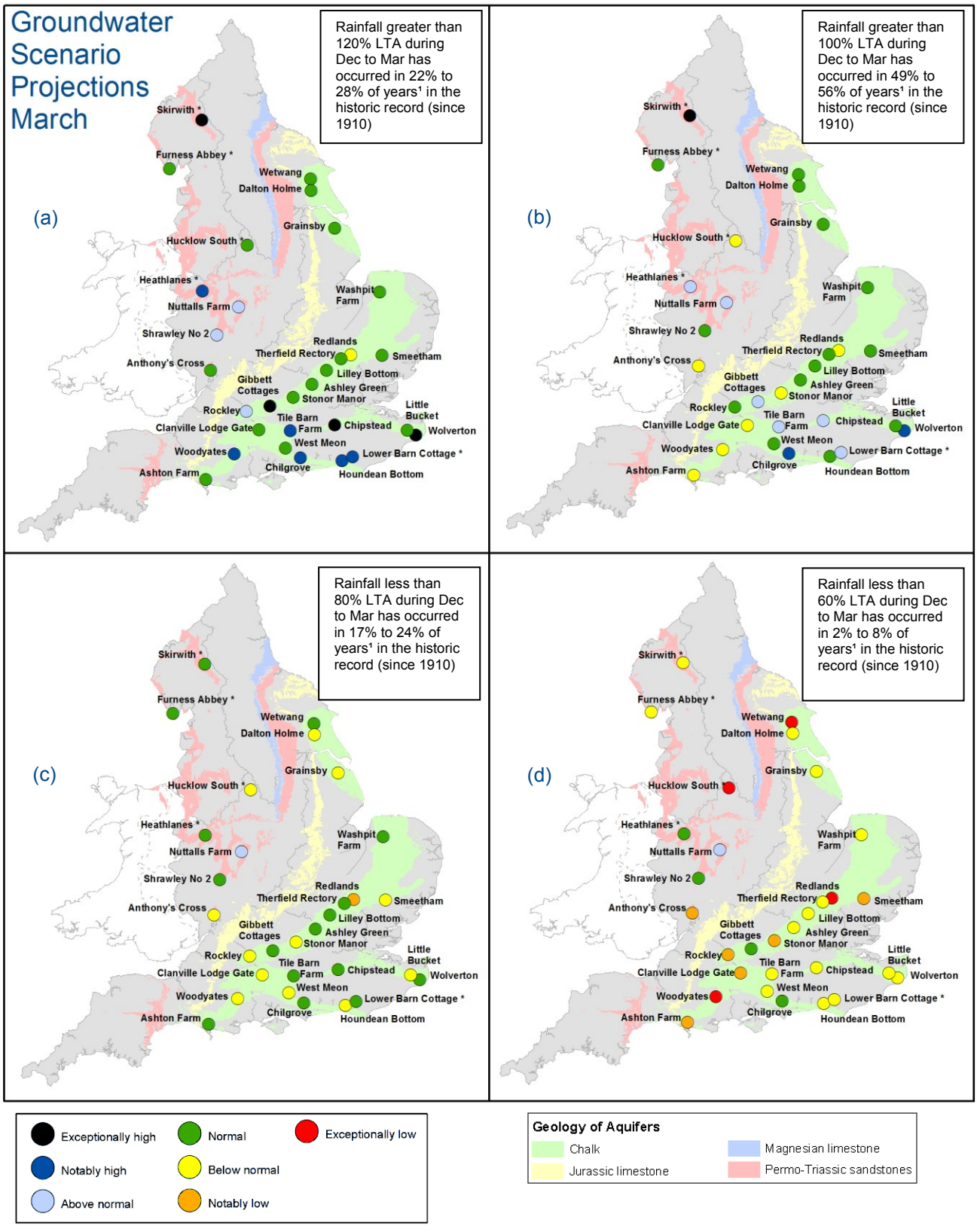


Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2016 and March 2017 (Source: Environment Agency) Geological map reproduced with kind permission 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

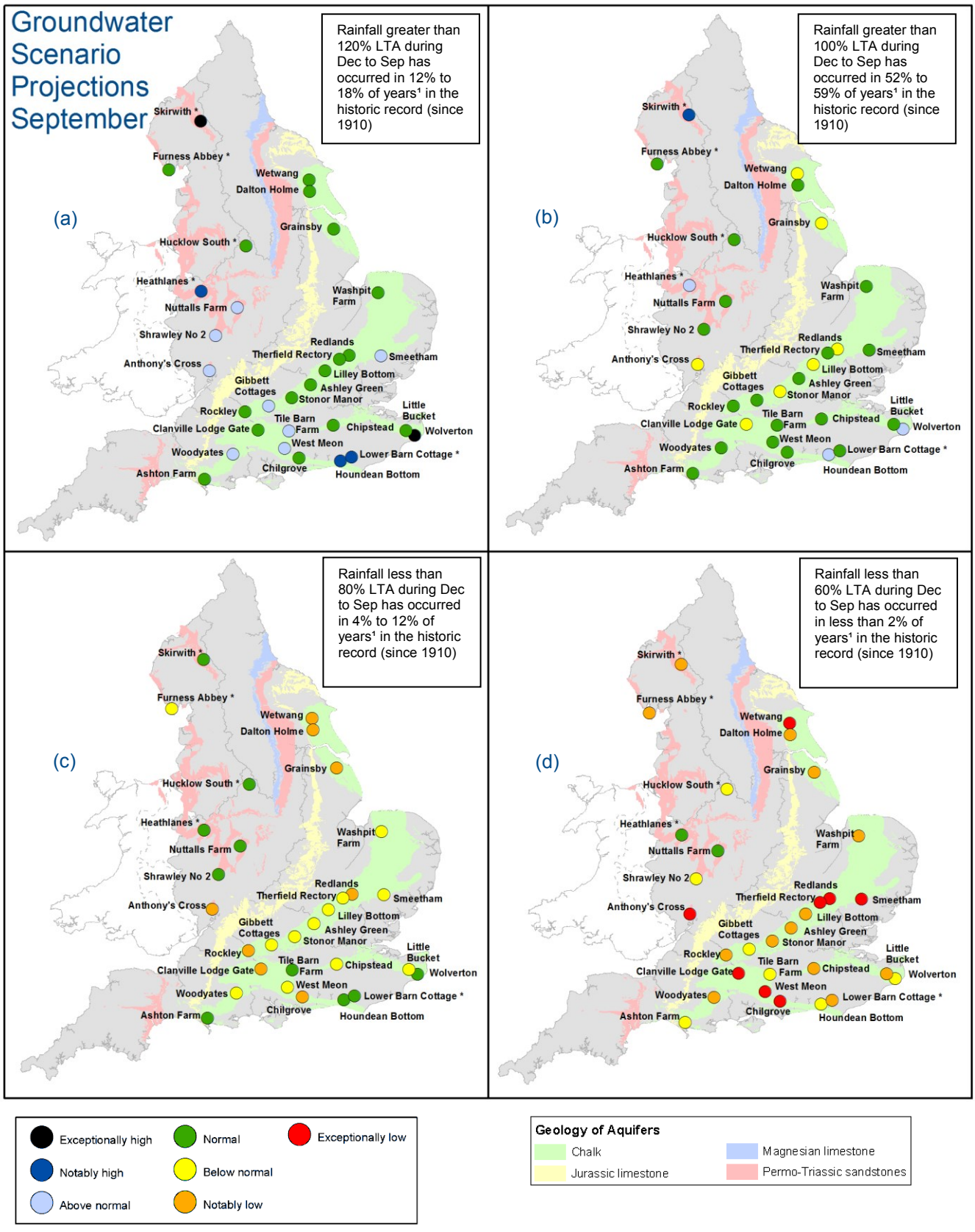
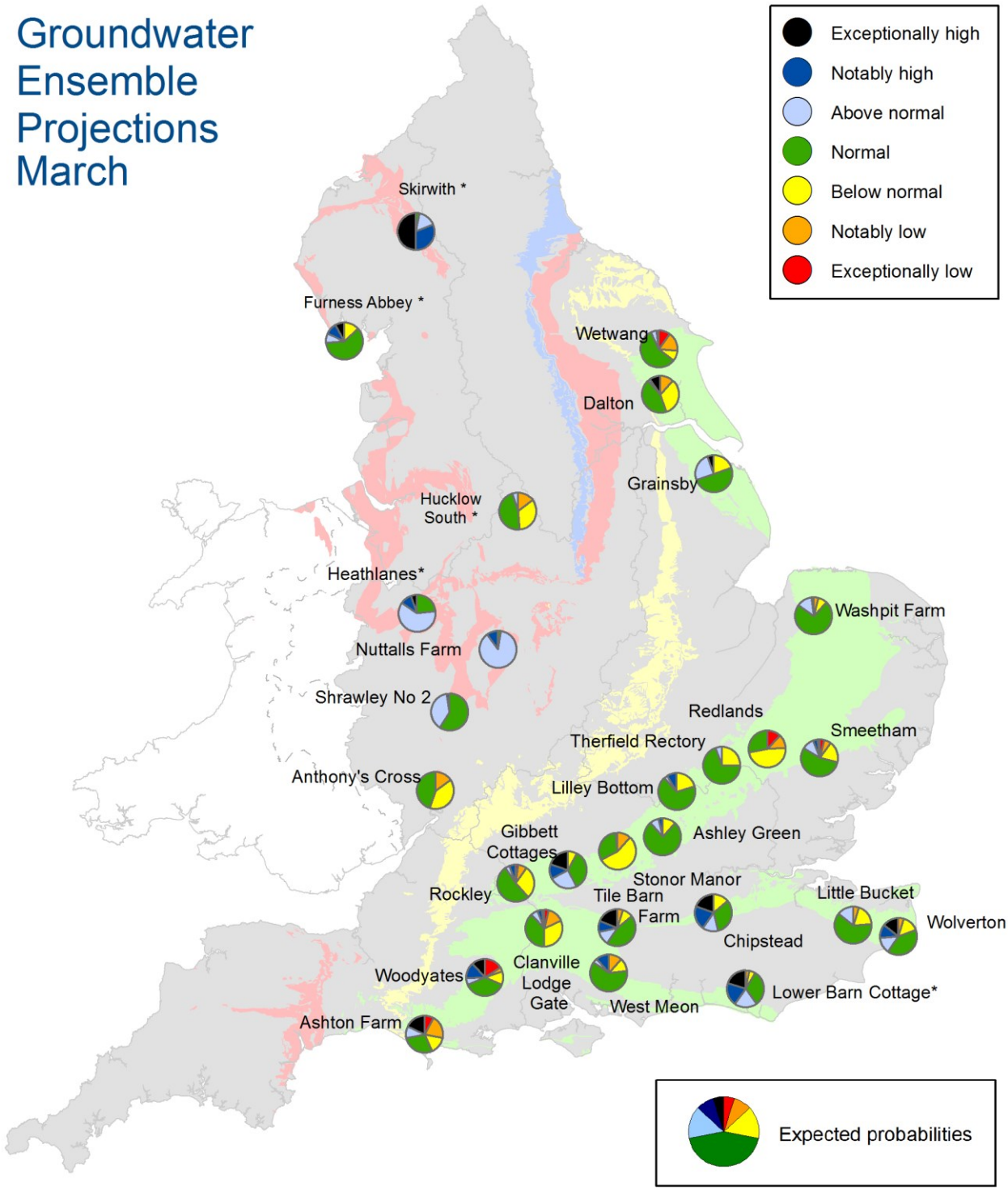


Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between December 2016 and September 2017 (Source: Environment Agency) Geological map reproduced with kind 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



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 2017. 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*

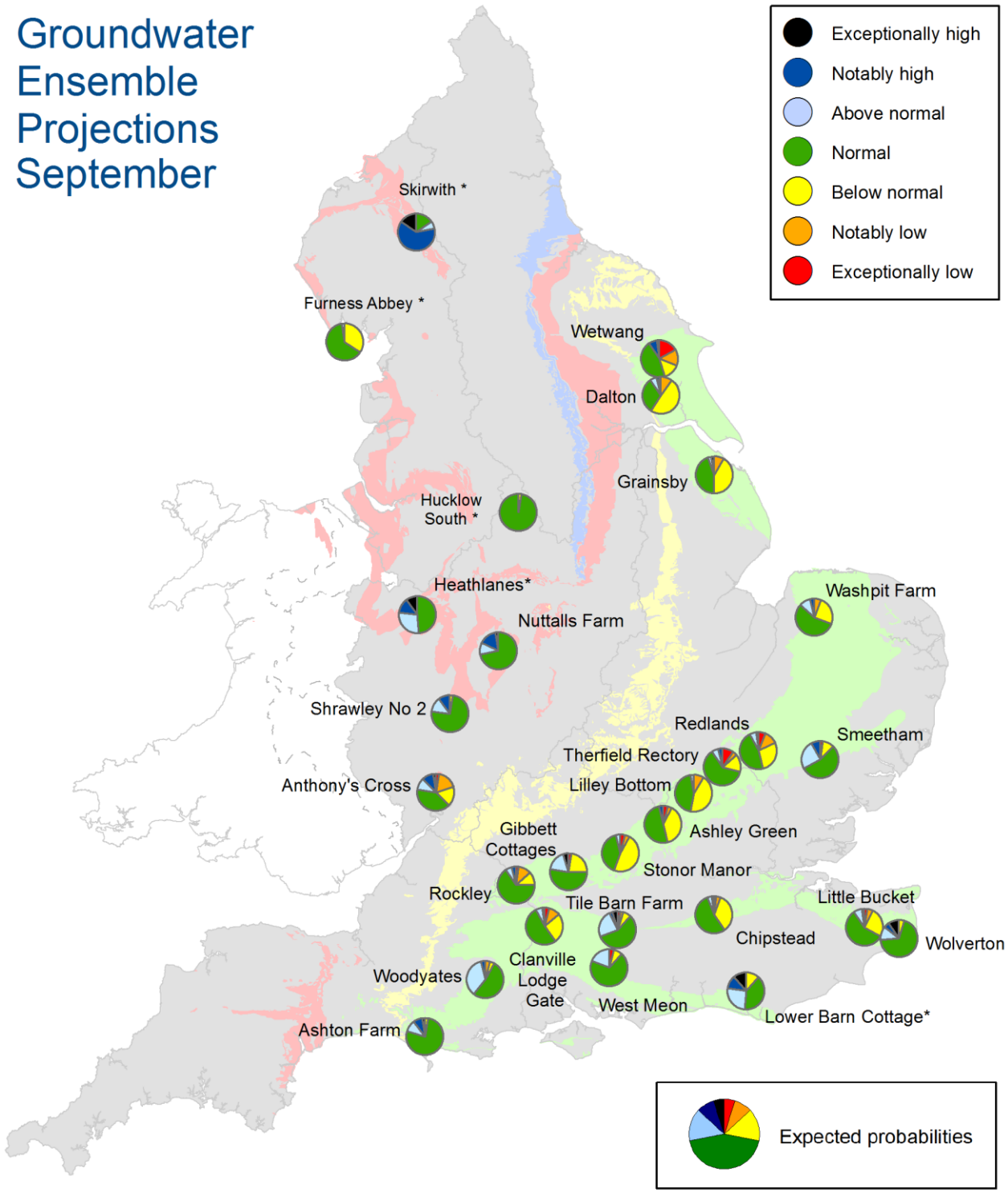


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Figure 6.8: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of September 2017. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for 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