Monthly water situation report

England

Summary – October 2017

October rainfall was well below the monthly long term average (LTA) at 69%. Monthly rainfall totals were below normal or lower across the majority of hydrological areas. Soil moisture deficits increased during October across much of central, east and south-east England, although soils were wetter than average in north-east and north-west England. Monthly mean river flows increased compared to September at more than half of the indicator sites, but decreased at most sites in east and south-east England. River flows were normal or higher for the time of year at three quarters of the indicator sites. Groundwater levels continued to recede during October at just over three-quarters of the indicator sites, and end of month levels were below normal or lower for the time of year at nearly half of the sites. Reservoir stocks decreased or remained the same at just over half of the reported reservoirs or reservoir groups, but stocks remain normal or higher for the time of year at nearly three-quarters of sites. Overall reservoir storage for England was 80% of total capacity at the end of October.

Rainfall

October monthly rainfall totals were highest across north-west England and parts of north-east England at 123 to 251mm, and lowest across parts of east and south-east England at 12 to 16mm. Rainfall totals were below the October LTA at more than four-fifths of hydrological areas, and less than 50% of the LTA at nearly half of the hydrological areas. Parts of Kent, London, Berkshire, Hertfordshire, Northamptonshire, Surrey and Lincolnshire received less than 30% of the October LTA rainfall. It was the driest October since 1978 for nearly 20 hydrological areas across east and south-east England, and the 6th driest October on record (since 1910) for the North London and Cut hydrological areas in south-east England, and the Steeping Great Eau and Long Eau, Witham to Chapel Hill, South Forty Foot and Hobhole and Upper Welland and Nene hydrological areas in east England (Figure 1.1).

Rainfall totals for October were classed as below normal or notably low for the time of year for the majority of hydrological areas in central, east, south-east and south-west England, and normal or above normal for most hydrological areas in north-east and north-west England. Cumulative rainfall totals for the past 3 and 6 months are normal or higher across most of England. However, the rainfall deficit is still evident in the 12 month cumulative rainfall totals, with much of south-west, south-east and parts of central and east England being below normal or notably low for the time of year (Figure 1.2).

At a regional scale, October rainfall totals were below average across all regions, with the exception of north-west England, ranging from 35% of the LTA in east England to 119% in north-west England. October rainfall was classed as normal for the time of year across north-east and north-west England, below normal in central and south-west England and notably low in east and south-east England. The monthly rainfall total for England was 69% of the 1961-90 LTA for October (58% of the 1981-2010 LTA) (Figure 1.3).

Soil moisture deficit

In response to the below average October rainfall, soil moisture deficits (SMDs) increased across much of England, most notably in east and south-east, and parts of central England. SMDs ranged from 0mm in parts of north-west, north-east and south-west England to approximately 150mm in parts of Norfolk and Cambridgeshire. At the end of the month, soils were drier than the October LTA across much of England, particularly in central, east and south-east England. Soil moisture deficits were at or below the LTA across most of north-east and north-west England, parts of south-west England and parts of the south coast (Figure 2.1).

At a regional scale, soils were drier at the end of October compared to the end of September in central, east and south-east England, and wetter elsewhere. End of month SMDs ranged from 8mm in north-west England to 96mm in east England. SMDs were higher than average (drier soils) in central, east and south-east England at the end of October (Figure 2.2).

River flows

October monthly mean river flows increased compared with September at more than half of the indicator sites across England. The remaining sites, where flows decreased compared with September, lie mostly in east and

south-east England. Flows were classed as normal or higher for the time of year at three quarters of the indicator sites. In north-west England, flows at all indicator sites were above normal or notably high for the time of year. In east and south-east England, flows at half of the indicator sites were below normal or lower. Flows in the river Chelmer in east England were notably low for the time of year and exceptionally low for the time of year in the Great Stour in south-east England (Figure 3.1).

At the regional index sites, monthly mean river flows were below normal for the time of year on the Thames at Kingston, and exceptionally low on the Great Stour at Horton in south-east England but normal or higher elsewhere (Figure 3.2).

Groundwater levels

Groundwater levels continued to recede during October at just over three-quarters of the indictor sites, with just six sites showing a rise in levels, including three chalk aquifer sites: Wetwang in the Hull and East Riding chalk, Woodyates in the Upper Dorset Stour chalk and Chilgrove in the Chichester chalk. End of month groundwater levels were below normal or lower for the time of year at nearly half of the indicator sites, most of which are in the chalk aquifers in east and south-east England. End of October groundwater levels at Ashley Green (Chilterns East chalk aquifer) were exceptionally low for the time of year for the fifth month in a row and the lowest end of October level on record (since 1987). Levels were also exceptionally low at Little Bucket (east Kent Stour chalk).

End of month groundwater levels at the major aquifer index sites ranged from exceptionally low for the time of year at Little Bucket (East Kent Stour chalk) to above normal at Dalton Holme (Hull and East Riding chalk) and Skirwith (Carlisle Basin and Eden Valley sandstone) (Figures 4.1 and 4.2).

Reservoir storage

Reservoir stocks decreased or remained the same at just over half of the reported reservoirs or reservoir groups during October. The largest decrease (11%) occurred in the Lower Thames reservoir group. Increases in reservoir stocks of more than 10% occurred in the Derwent Valley (13%), NCZ Regional group (11%) and Pennines group (15%). End of month stocks were classed as normal or higher for the time of year at nearly three-quarters of all reported reservoirs and reservoir groups. Two sites were classed as notably low for the time of year (Carsington and Ogston and Draycote reservoirs), whilst Bewl reservoir was classed as exceptionally low and was the lowest end of October level on record at 36% of total capacity (Figure 5.1).

Compared with the end of September, regional reservoir stocks increased by between 1 and 9% in north-east, north-west, central and south-west England, and decreased by between 4 and 9% in east and south-east England. End of October stocks ranged from 59% of total capacity in south-east England to 91% in north-west England. Overall storage for England increased slightly to 80% of total capacity (Figure 5.2).

Forward look

The weather during November is expected to be changeable with spells of rain and showers interspersed with colder, drier conditions. For the 3-month period November-December-January, there is a slightly increased chance of above-average rainfall[1].

Projections for river flows at key sites[2]

More than four-fifths of the modelled sites have a greater than expected chance of cumulative river flows being below normal or lower for the time of year by both the end of March and the end of September 2018.

For scenario based projections of cumulative river flows at key sites by March 2018 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by September 2018 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by March 2018 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by September 2018 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

Nearly two thirds of the modelled sites have a greater than expected chance of groundwater levels being below normal or lower for the time of year at the end of both March and September 2018.

For scenario based projections of groundwater levels in key aquifers in March 2018 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2018 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2018 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2018 see Figure 6.8

Authors: National Water Resources 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

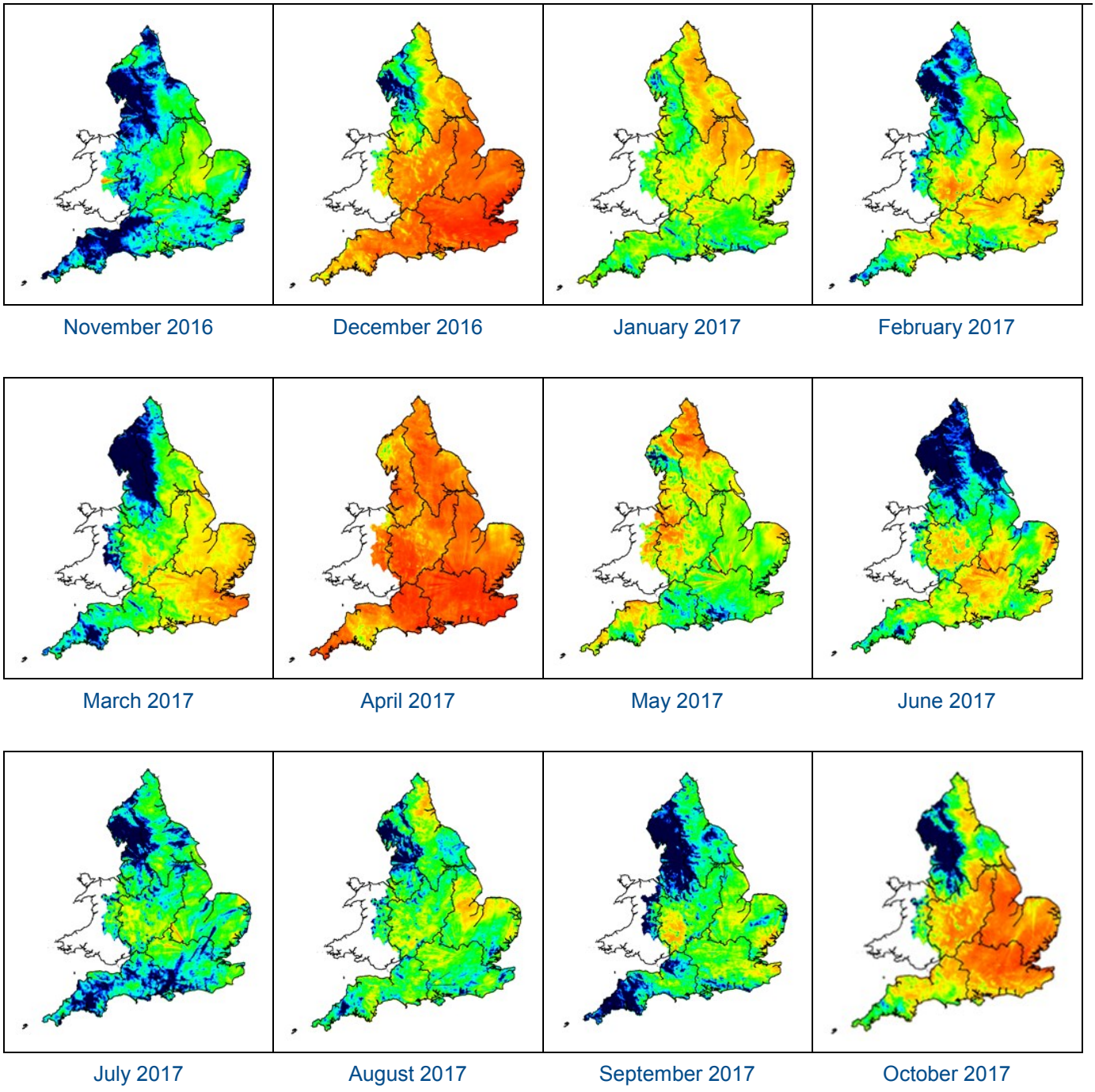


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2017). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2017.

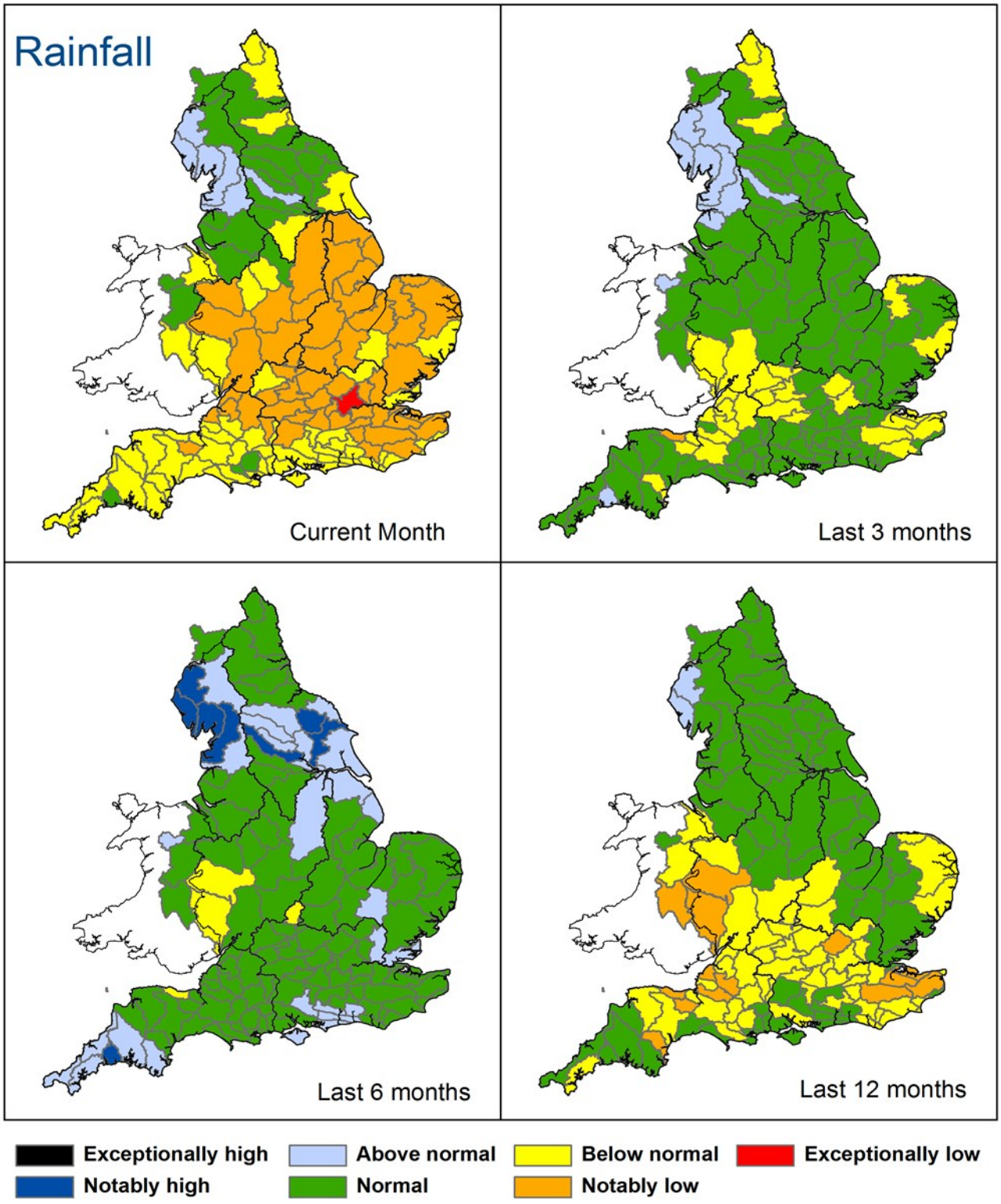


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 October), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2017).* 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, 2017.

Rainfall charts

Above average rainfall

Below average rainfall

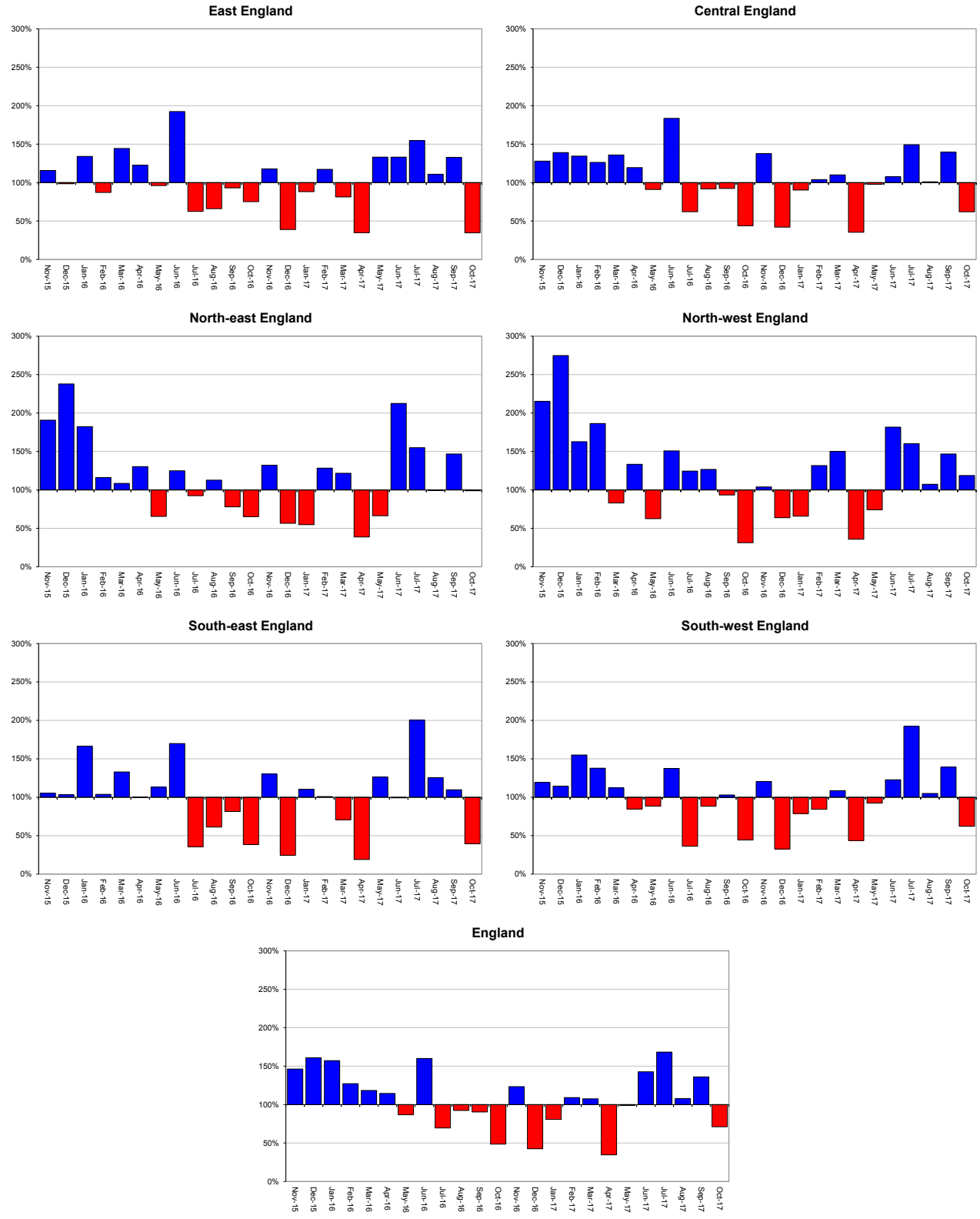


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2017).

Soil moisture deficit

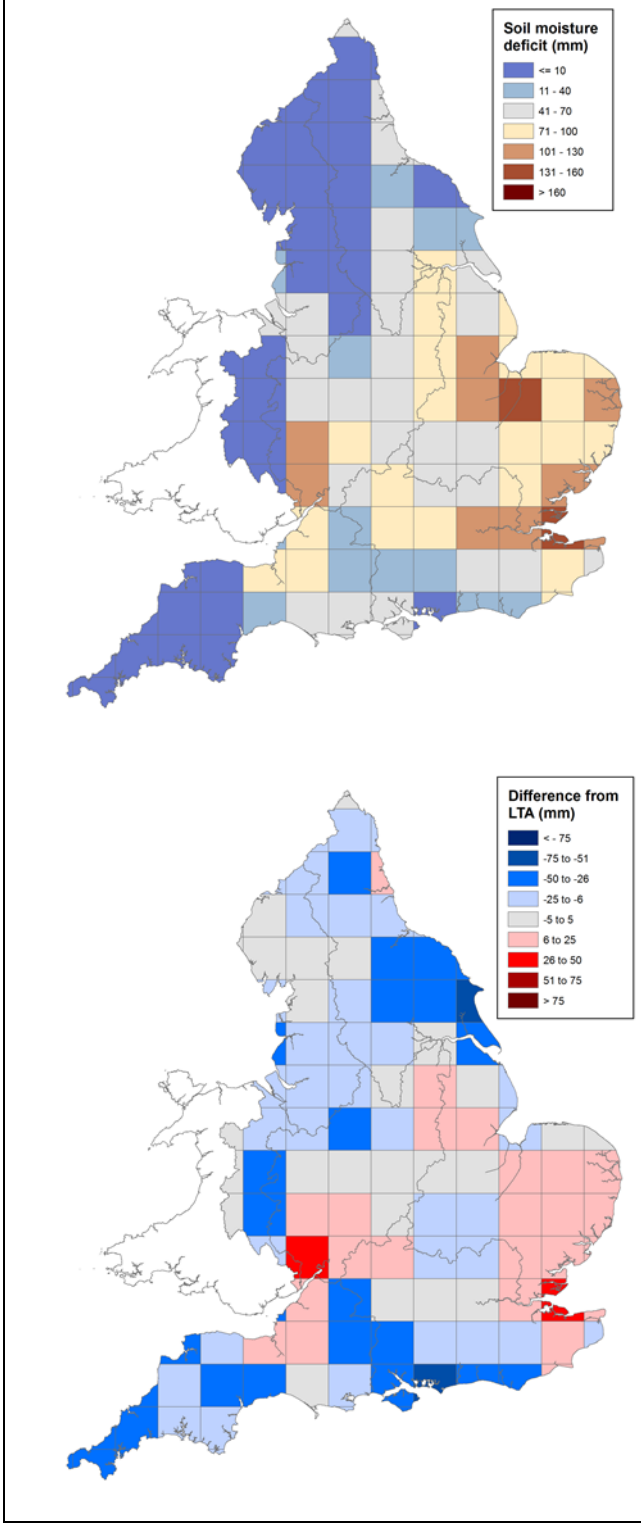
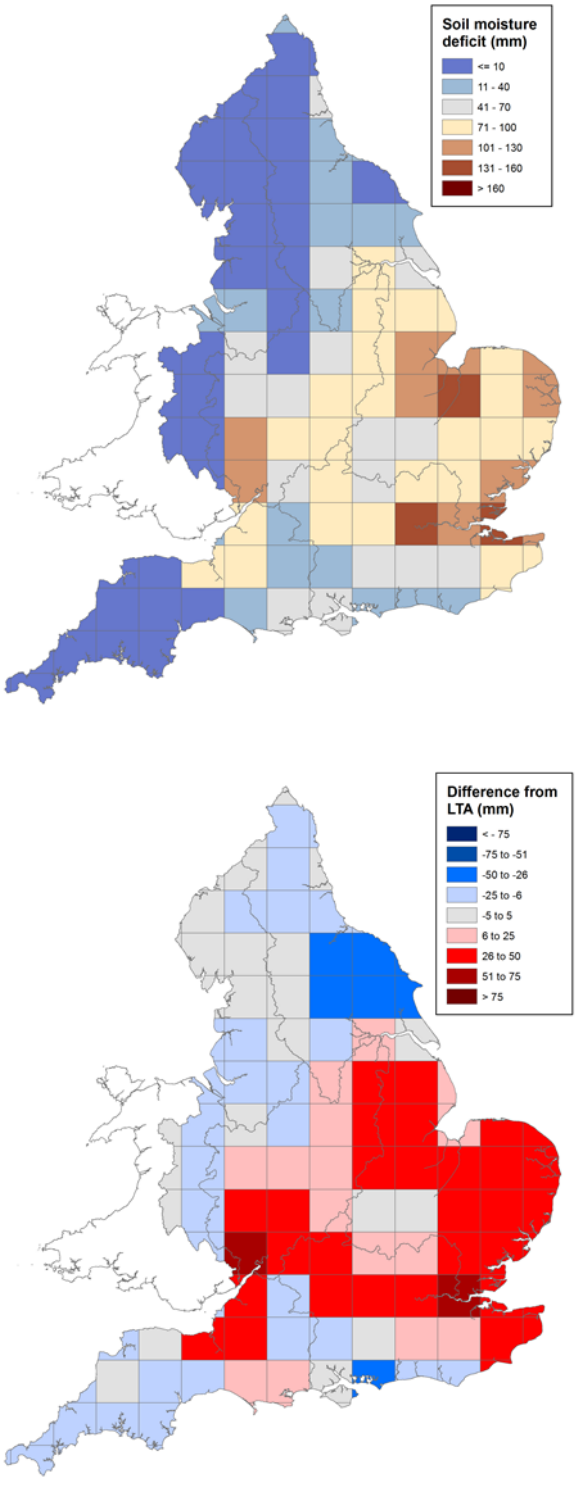
End of September 2017[1]	End of October 2017[2]
	

Figure 2.1: Soil moisture deficits for weeks ending 3 October 2017 [1] (left panel) and 31 October 2017 [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

Soil moisture deficit charts

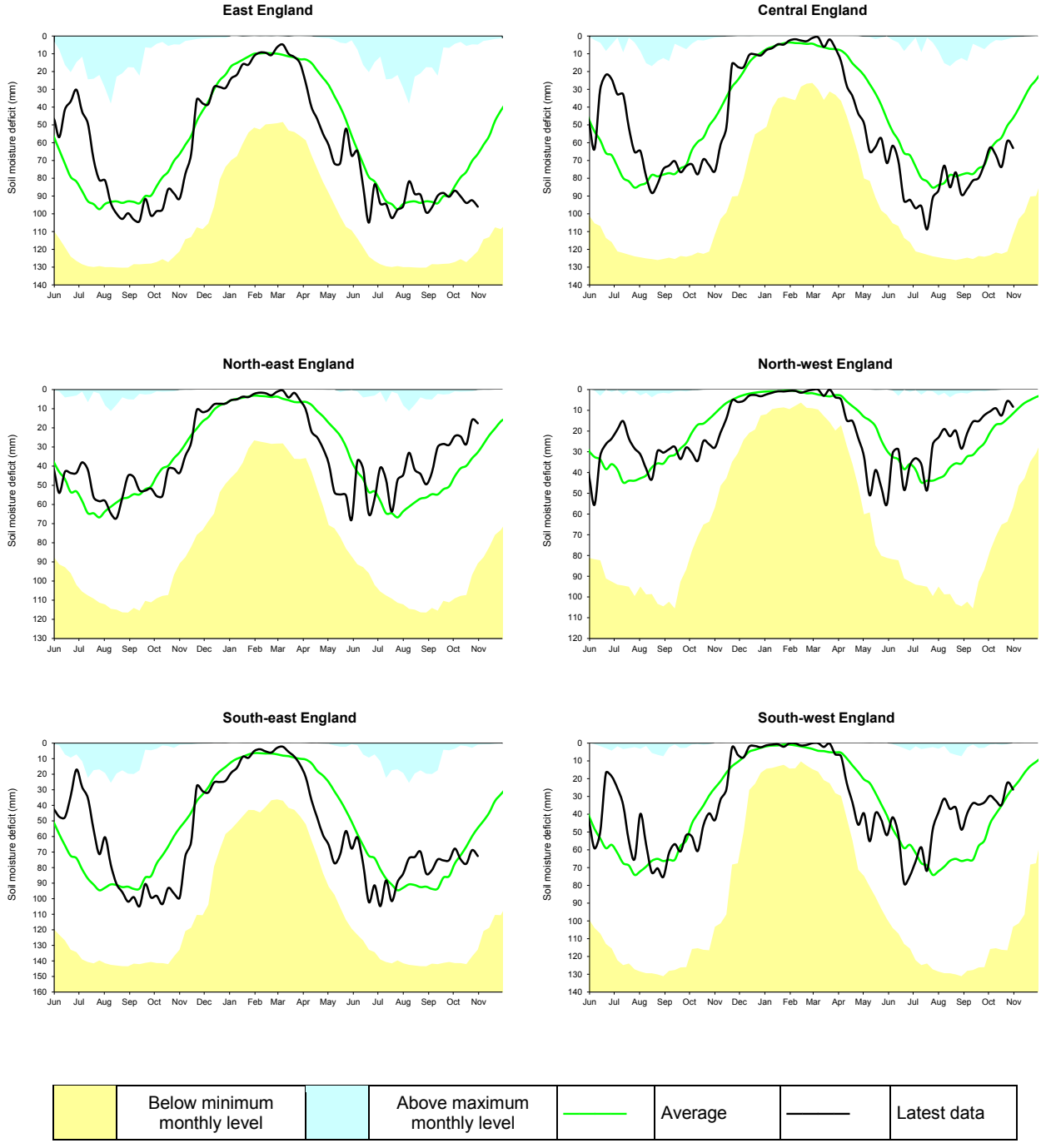
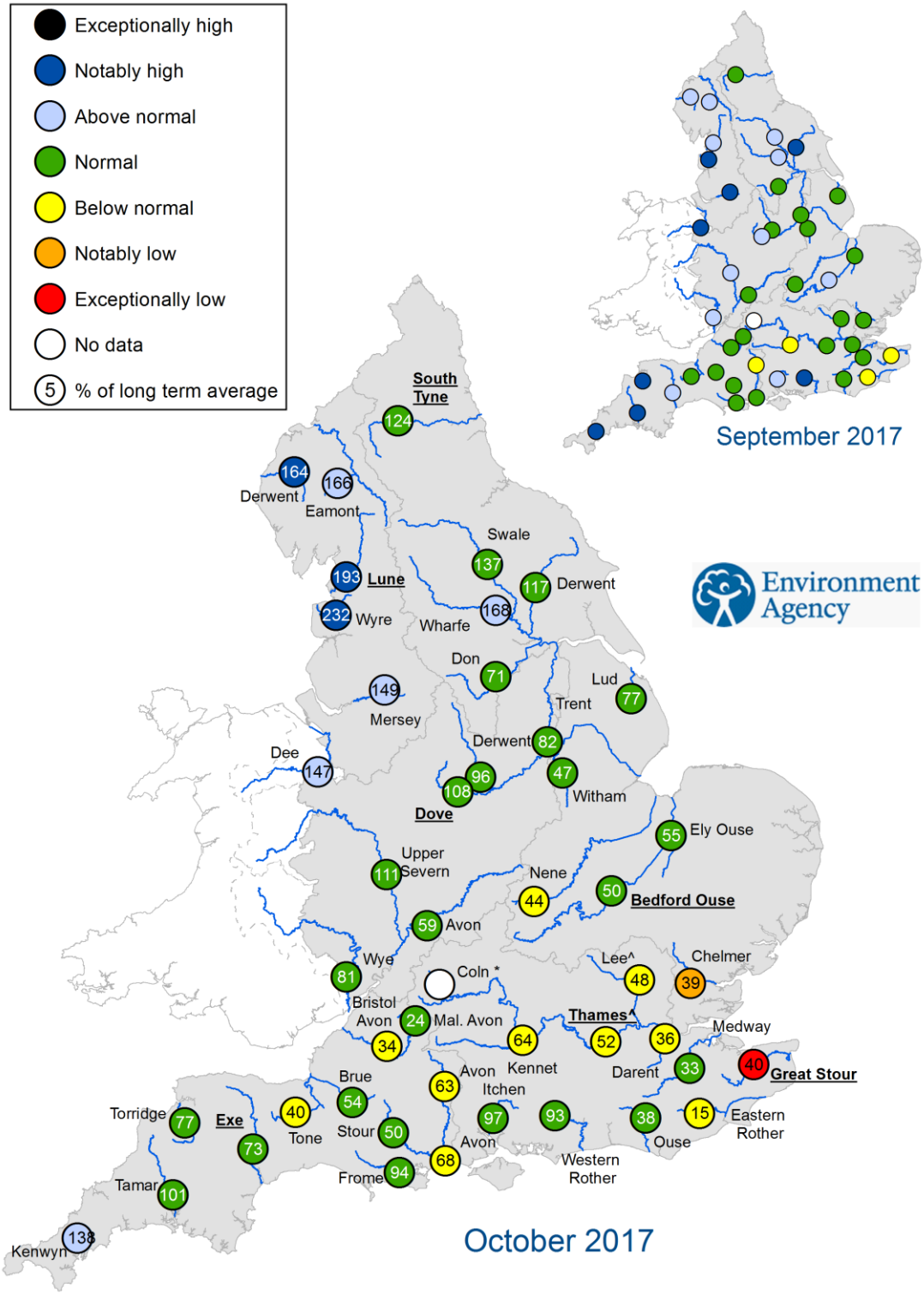


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2017).

River flows



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

* Data marked as unavailable for the River Coln at Bibury because the site is currently under investigation

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 September 2017 and October 2017, expressed as a percentage of the respective long term average and classed relative to an analysis of historic September and October monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2017.

River flow charts

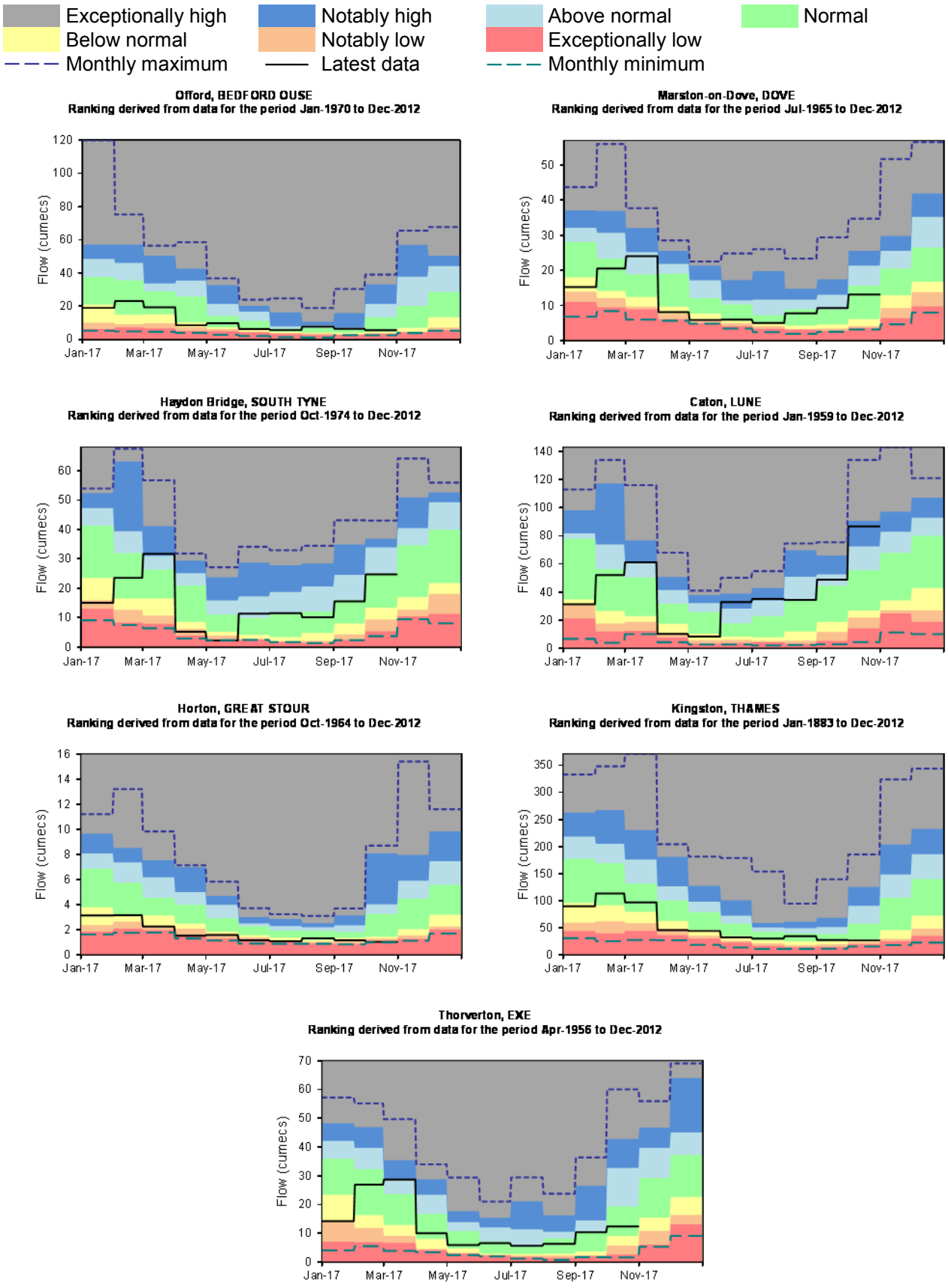
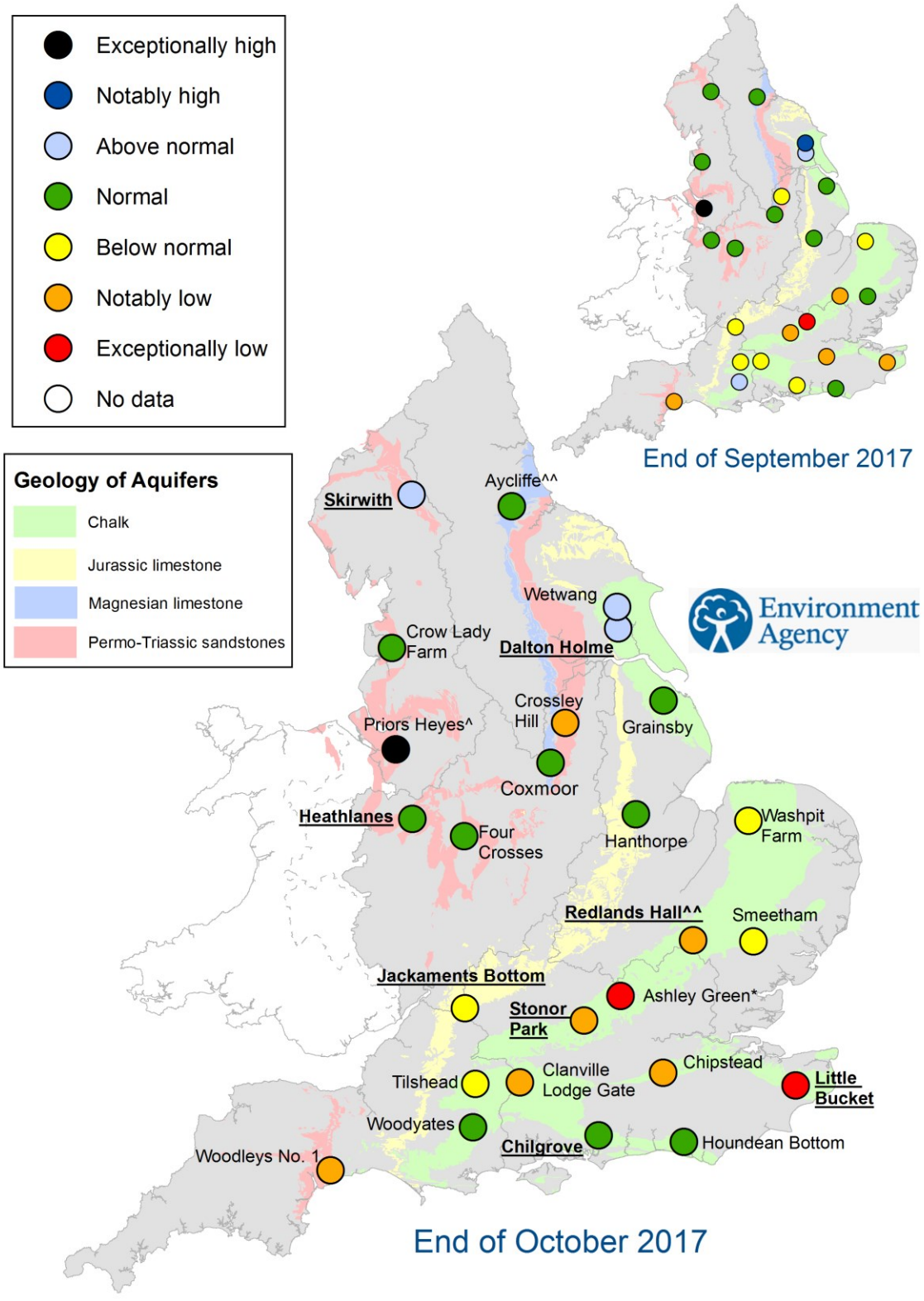


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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
* End of month groundwater level is the lowest on record for the current month (note that record length varies between sites).
Underlined 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 September 2017 and October 2017, classed relative to an analysis of respective historic September and October levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2017.

Groundwater level charts

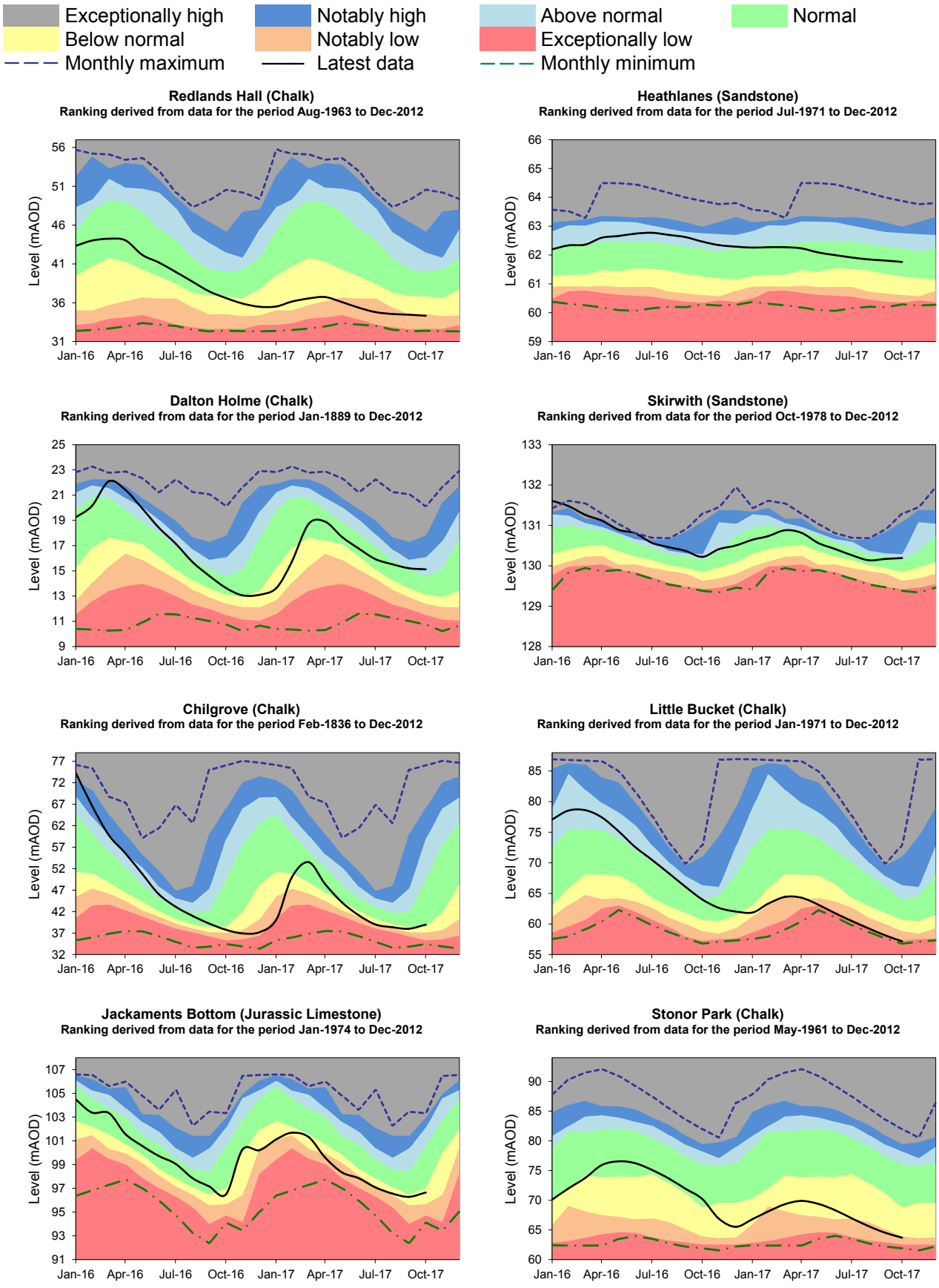
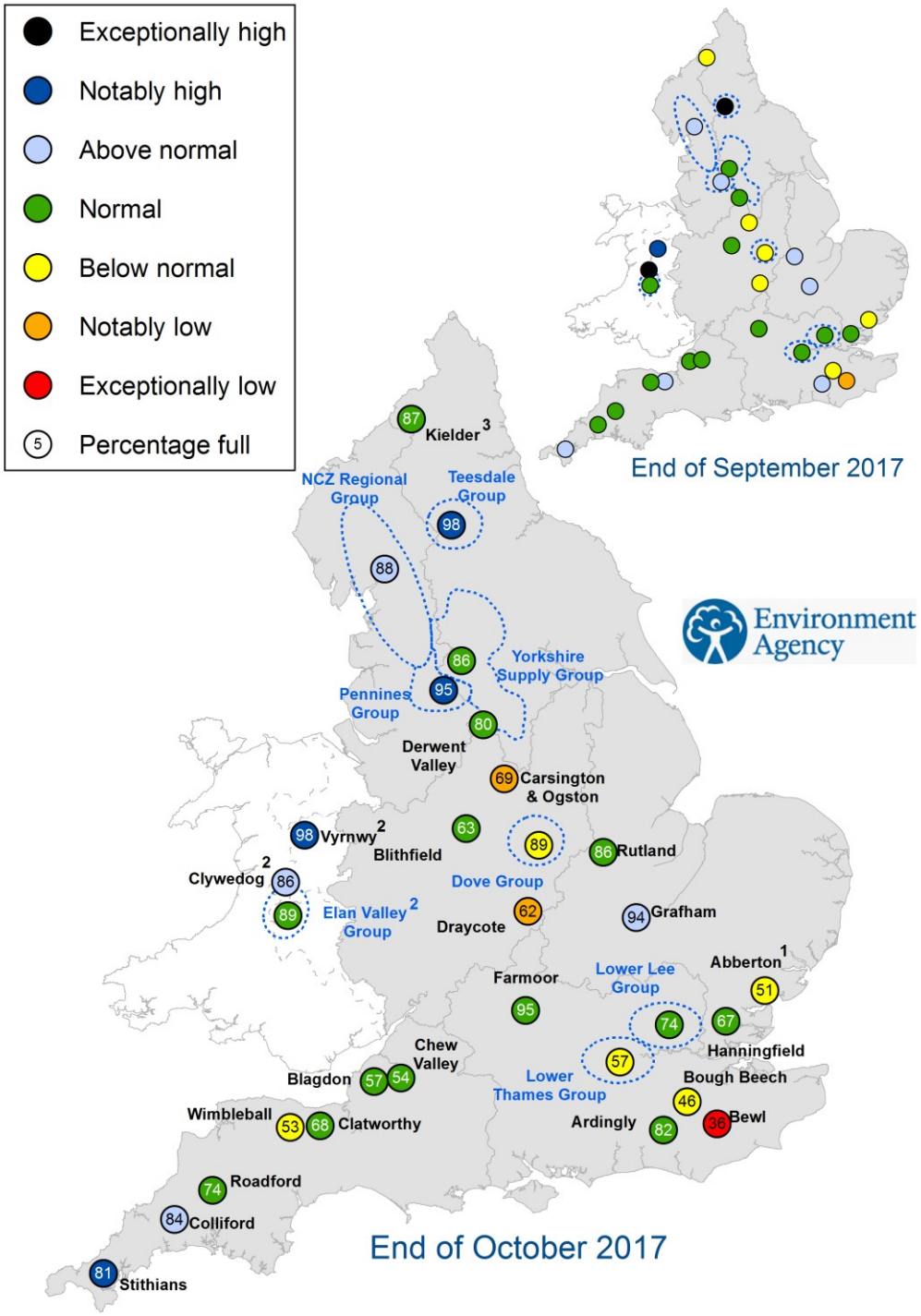


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2017).

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. Current levels at Kielder will be deliberately lower than historical levels during a trial of a new flood alleviation control curve

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of September 2017 and October 2017 as a percentage of total capacity and classed relative to an analysis of historic September and October 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, 2017.

Reservoir storage charts

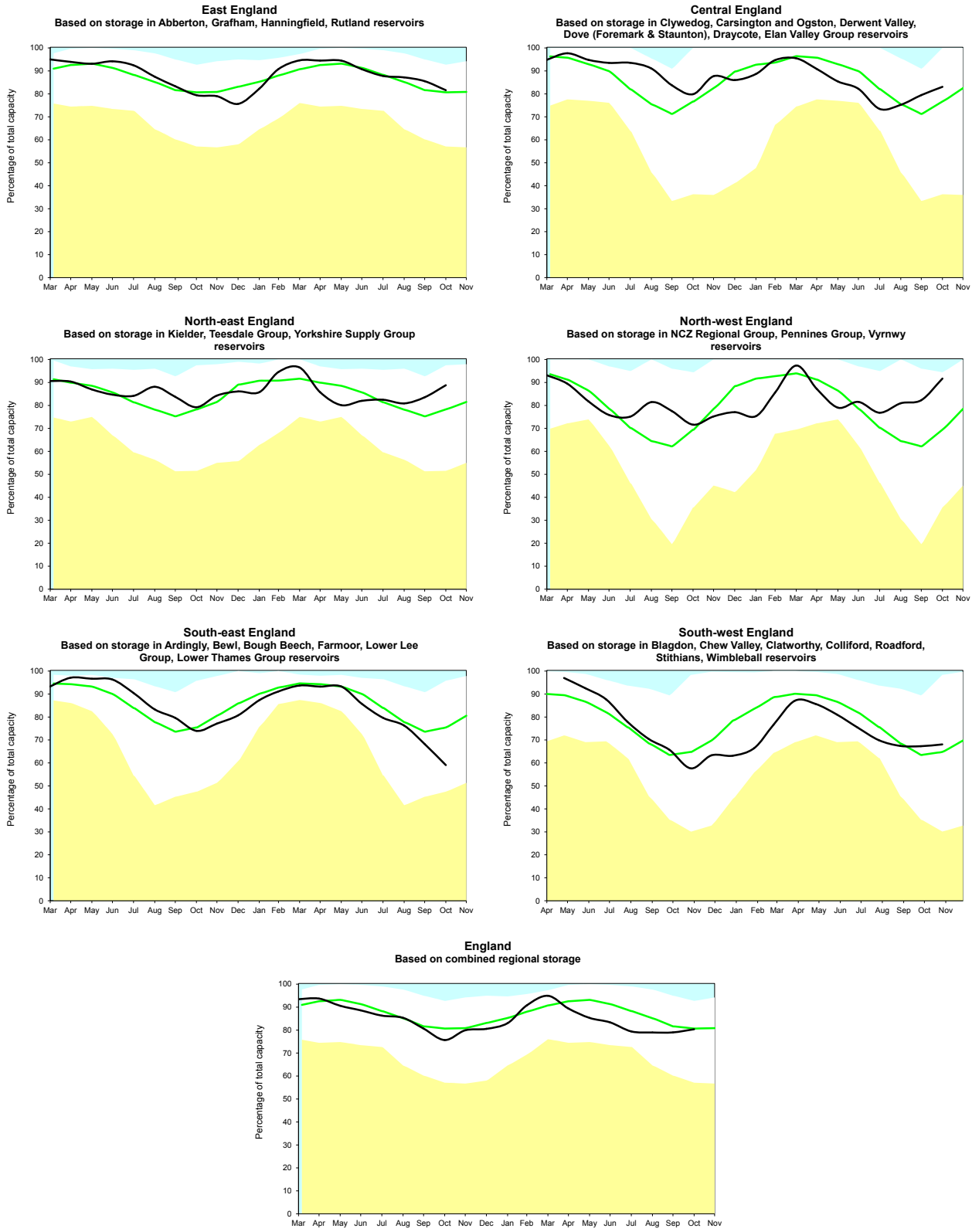


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

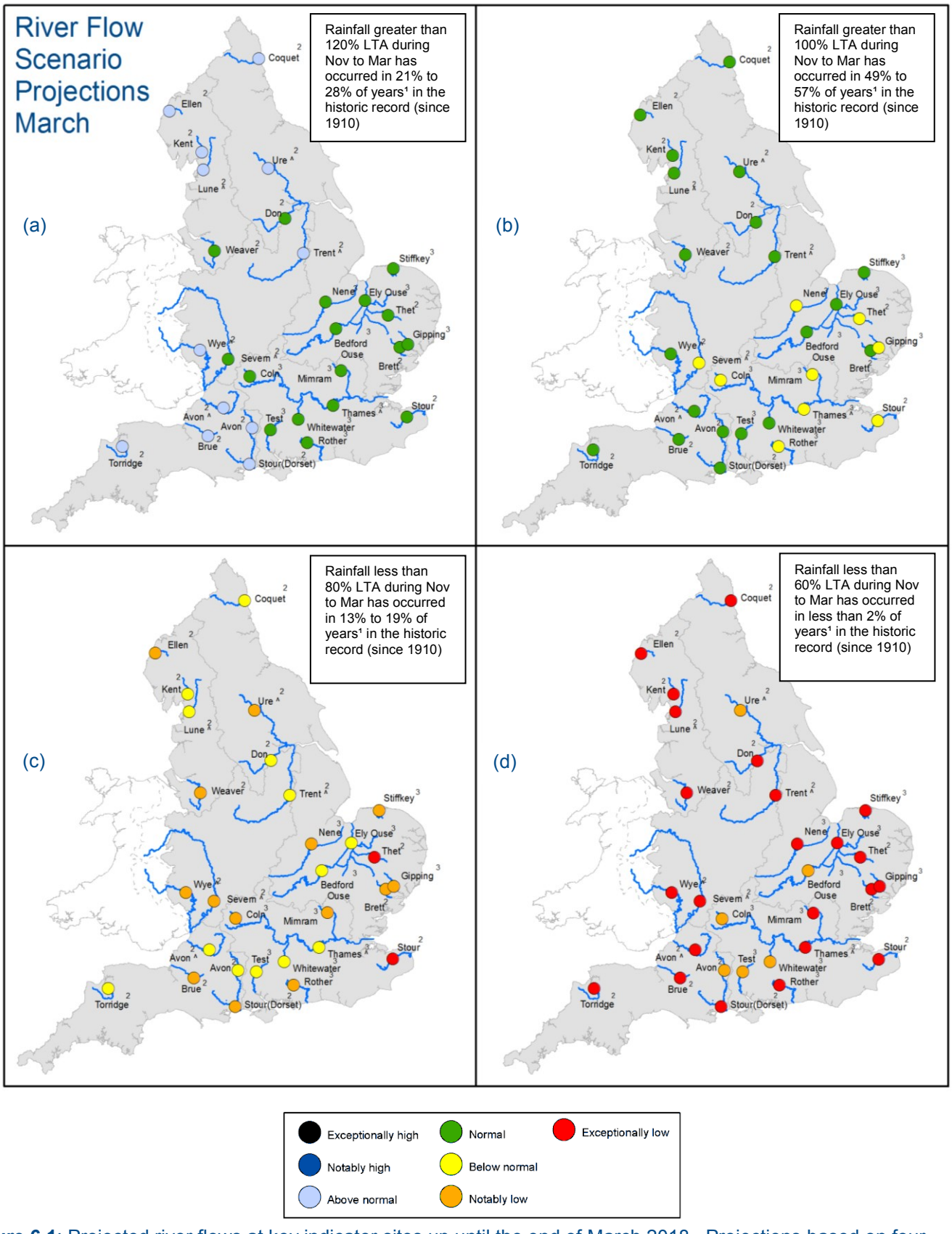
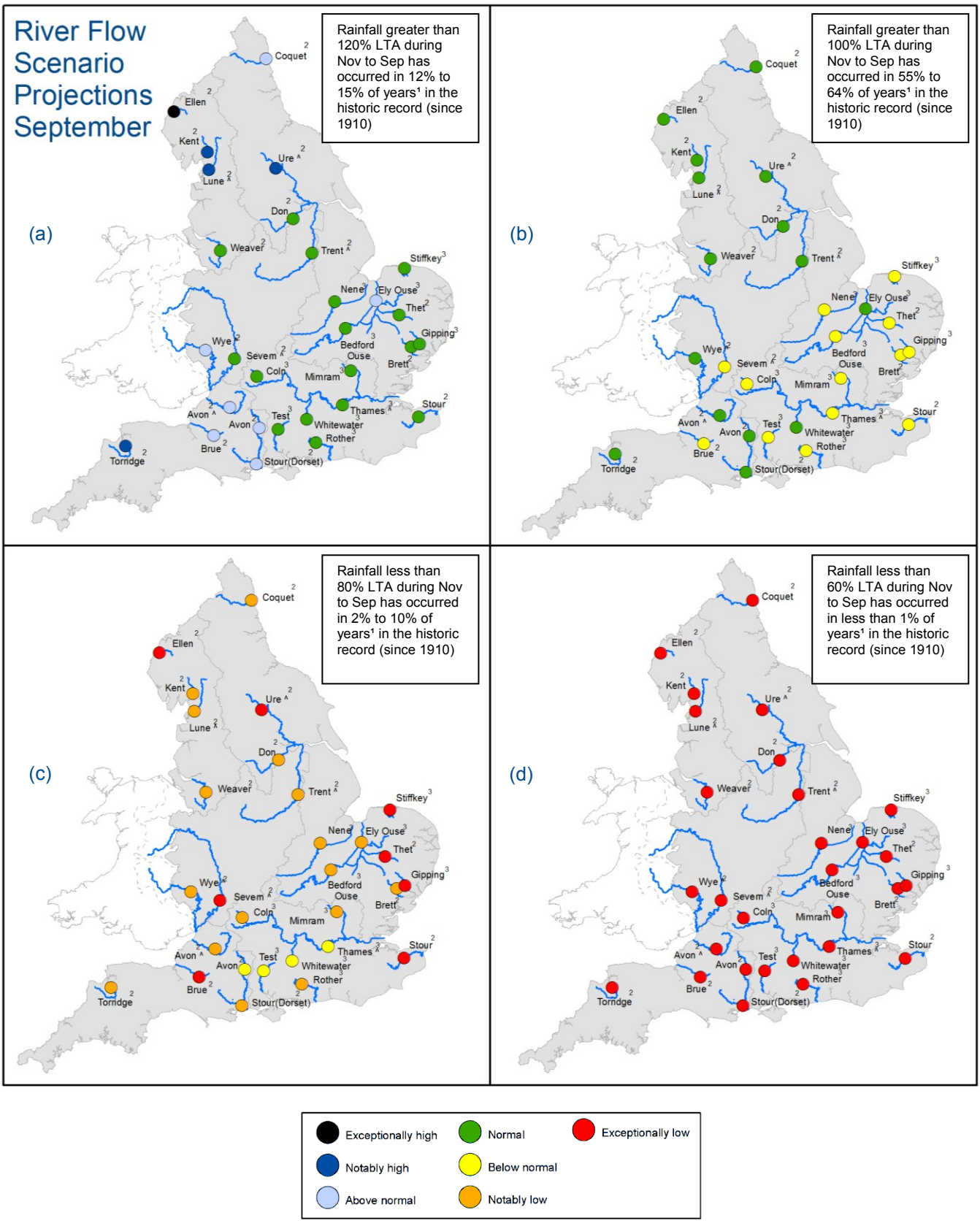


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between November 2017 and March 2018 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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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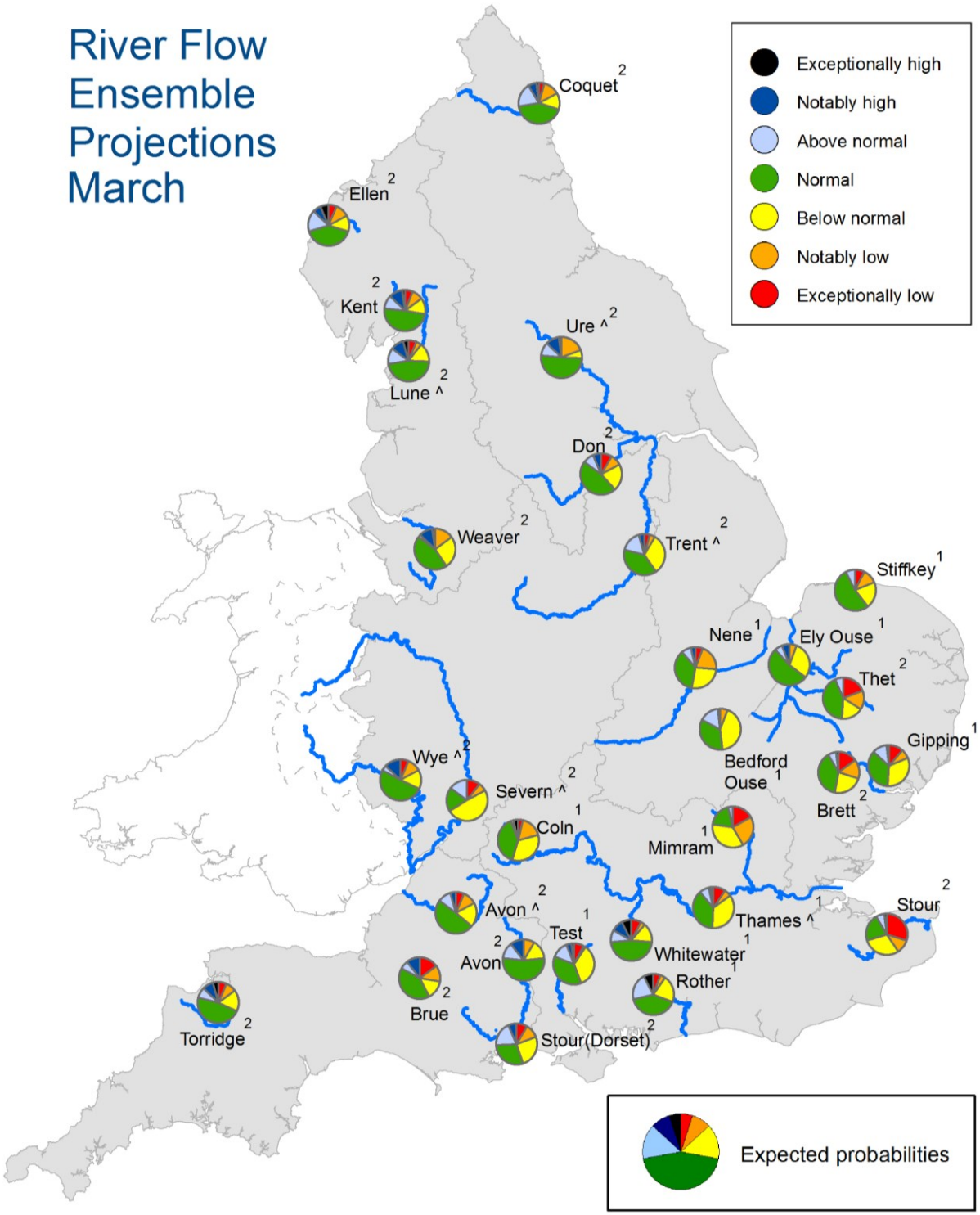

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are 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 2018. 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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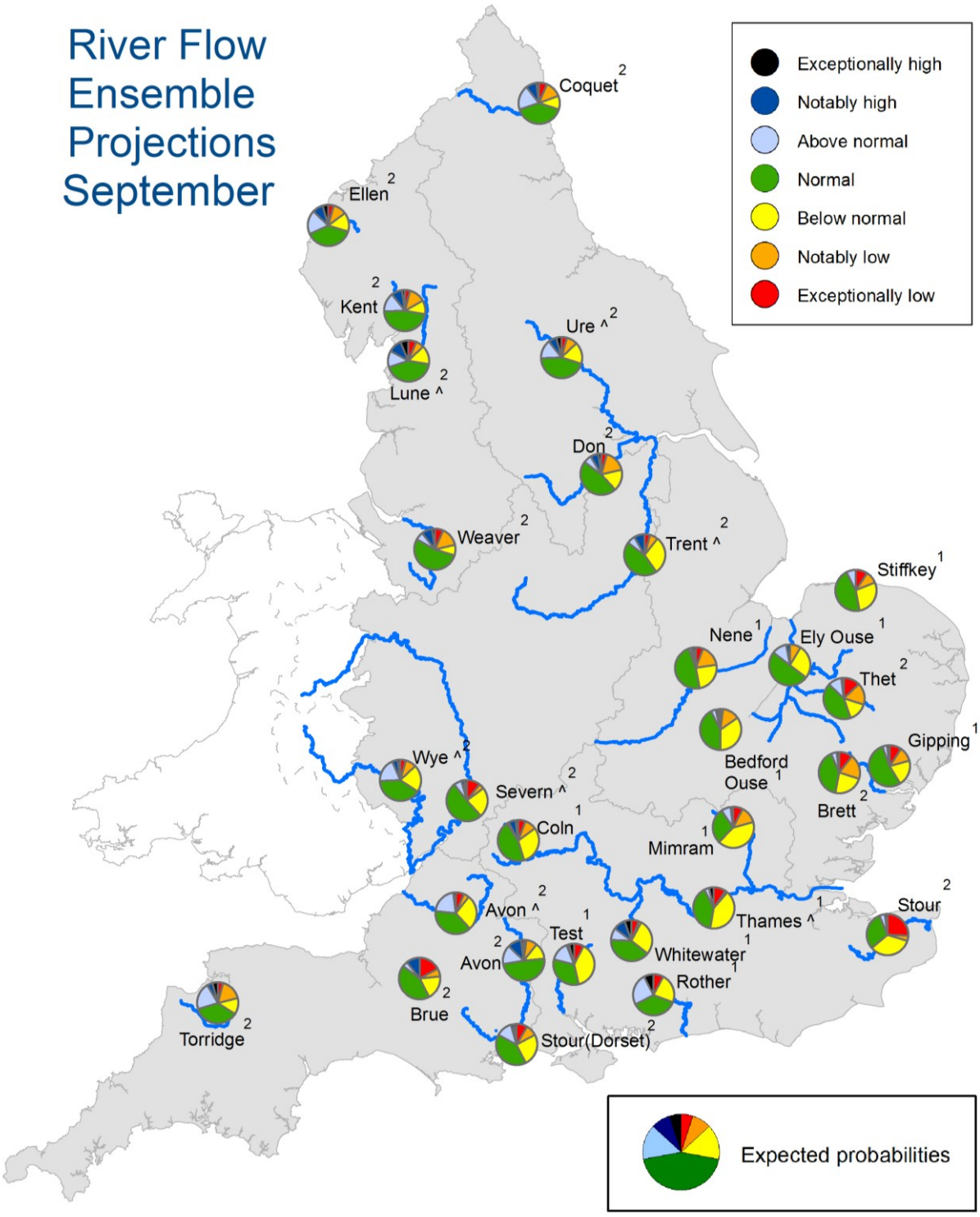

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Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2018. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for 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

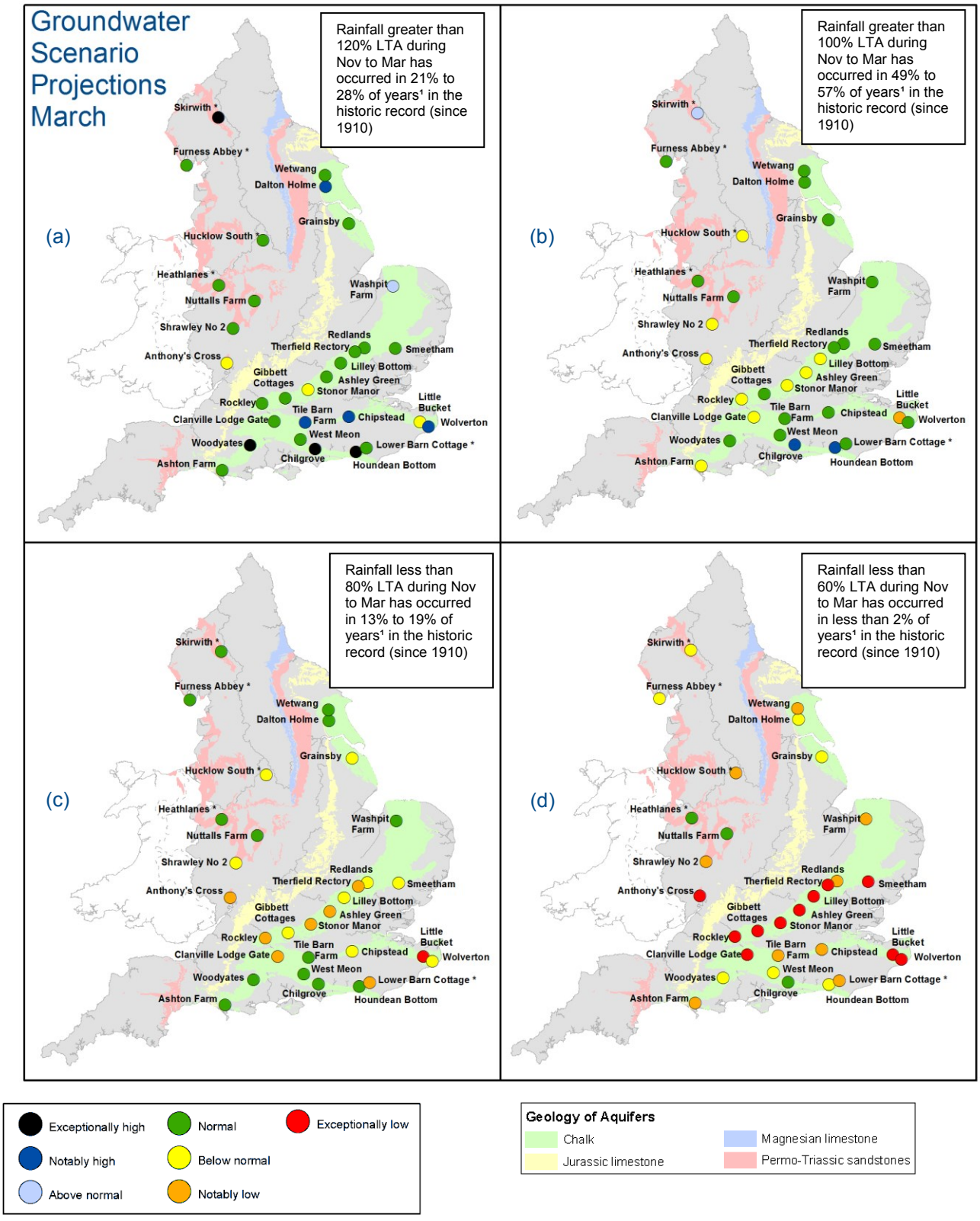

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between November 2017 and March 2018 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2017.

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

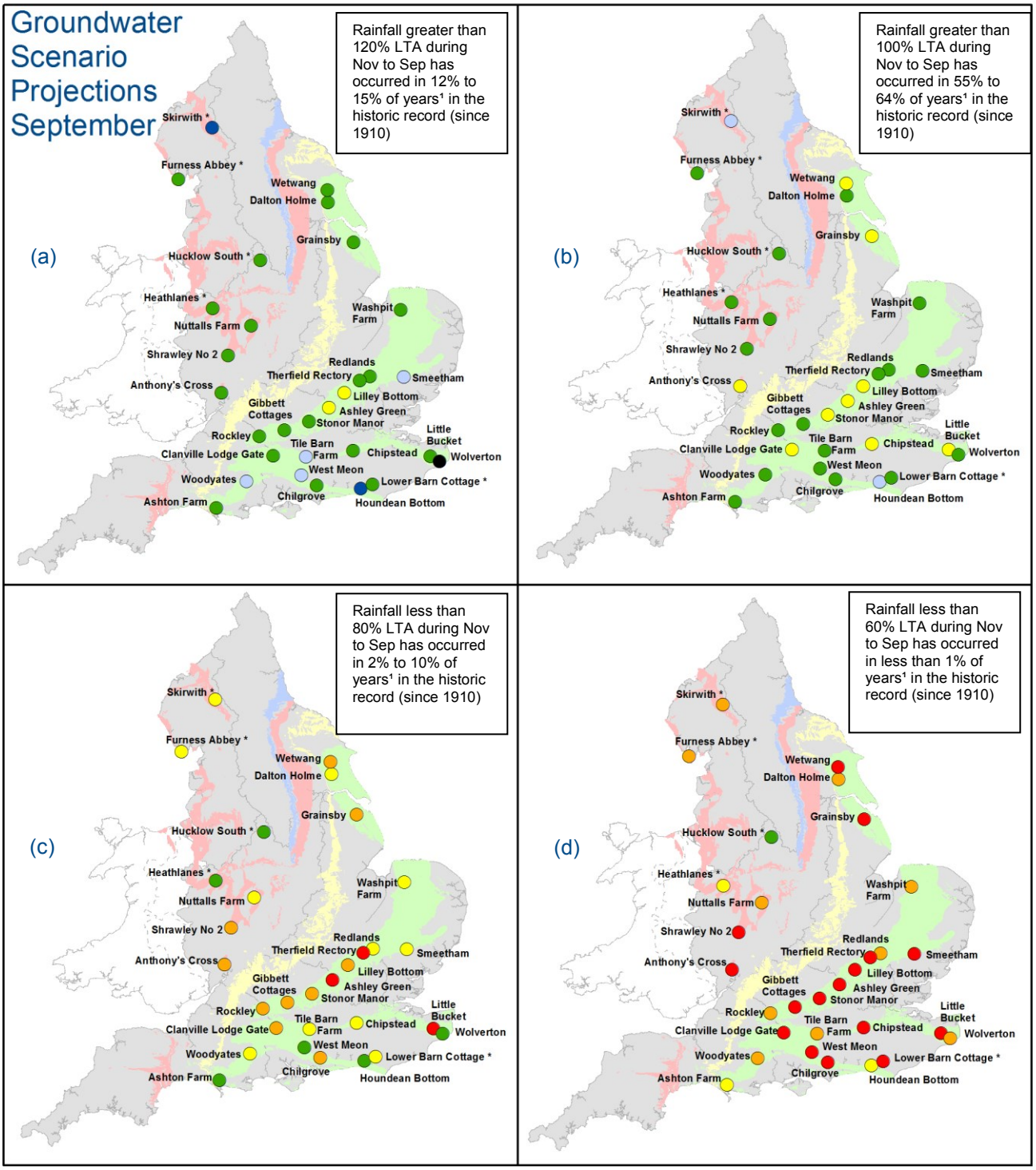

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2018. Projections based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between November 2017 and September 2018 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2017.

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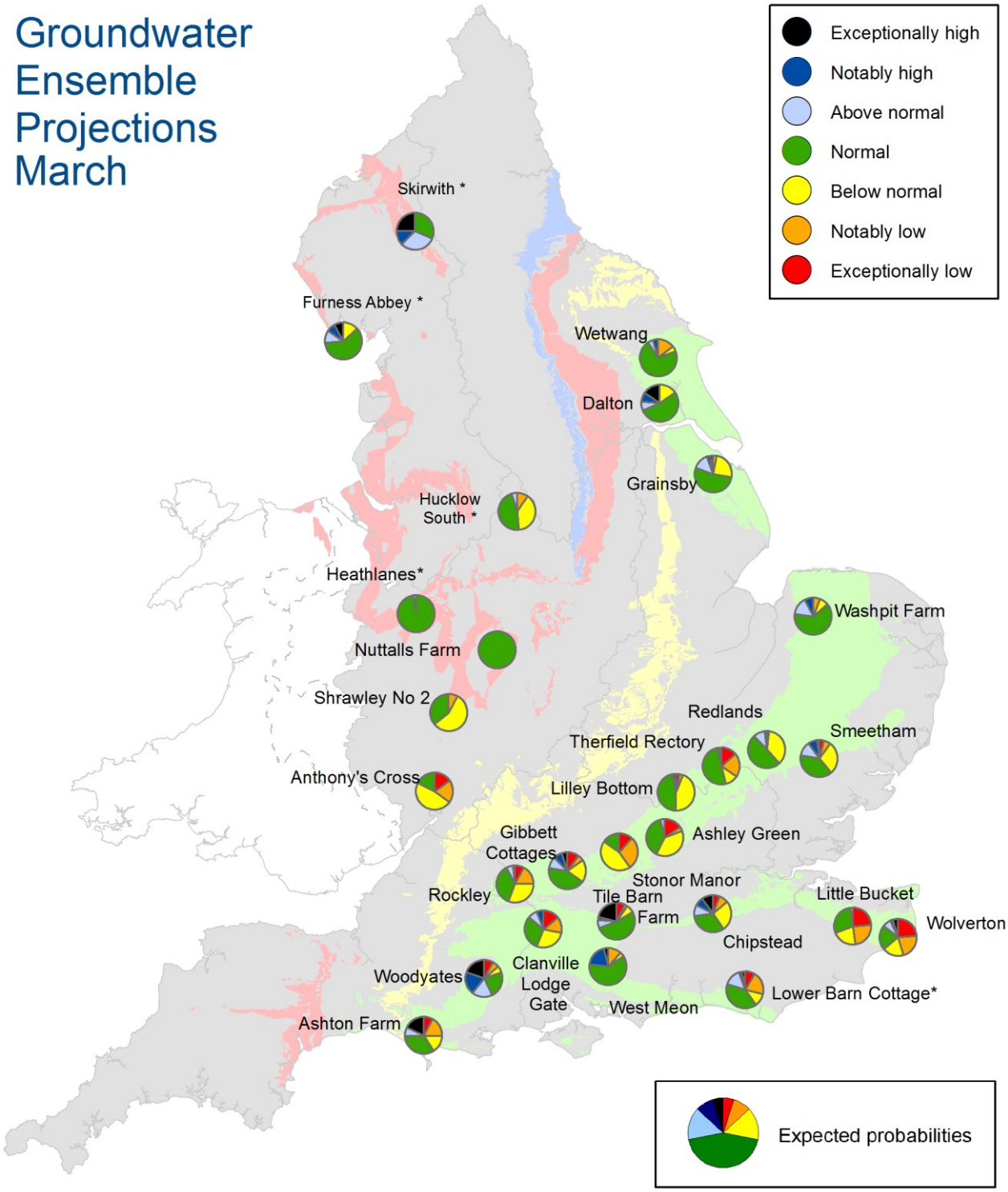
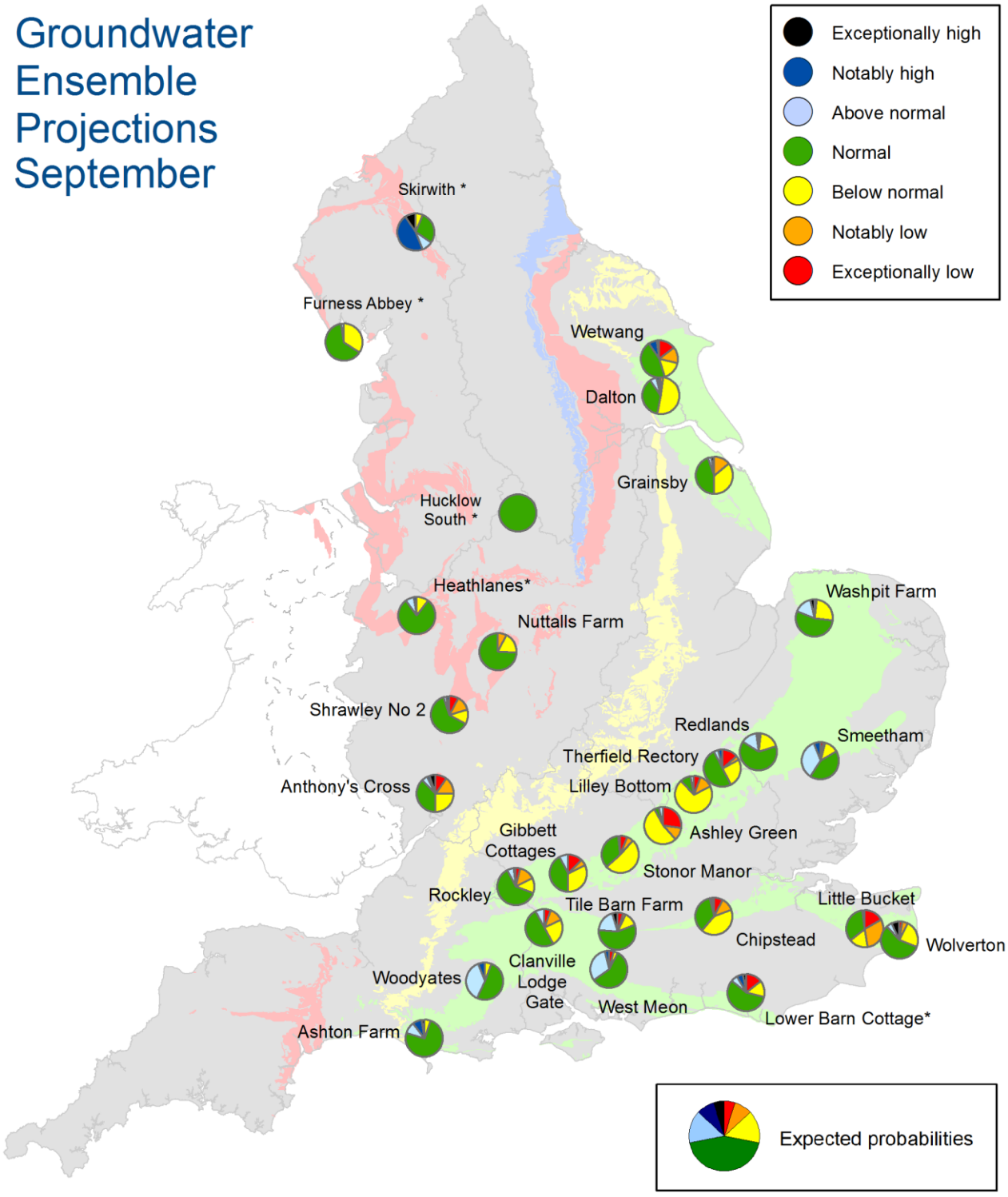
[1] This range of probabilities is a regional analysis



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 2018. 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, 2017.

** 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 2018. 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, 2017.

* 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. For rainfall and soil moisture deficit, the period refers to 1961-1990, unless otherwise stated. For other parameters, the period may vary according to data availability
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